pISSN 1976-1902
eISSN 1976-7846

Asian Spine Journal

Official Journal of the Asia Pacific Spine Society (APSS),
Middle East Spine Society (MESS), Association of Spine Surgeons of India (ASSI),
Taiwan Spine Society (TWSS), and Korean Society of Spine Surgery (KSSS),
Chinese Spine Society of Medicine Education (CSSME)

Volume 16 · Number Supplement 1 · June 2022

APSS 2022

(APSS Annual Meeting 2022 with Live Operative Surgical Course)

10-12 June 2022,
Ganga Hospital, Coimbatore, India

www.asianspinejournal.org

Asian Spine Journal

www.asianspinejournal.org
pISSN 1976-1902 · eISSN 1976-7846

Official Journal of the Asia Pacific Spine Society (APSS),
Middle East Spine Society (MESS), Association of Spine Surgeons of India (ASSI),
Taiwan Spine Society (TWSS), and Korean Society of Spine Surgery (KSSS),
Chinese Spine Society of Medicine Education (CSSME)

Aims & Scope

Asian Spine Journal (Asian Spine J), the official journal of the Asia Pacific Spine Society (APSS), Middle East Spine Society (MESS), Association of Spine Surgeons of India (ASSI), Taiwan Spine Society (TWSS), Chinese Spine Society of Medicine Education (CSSME), and Korean Society of Spine Surgery (KSSS), is an international peer-reviewed journal which publishes articles related to basic and clinical researches of all spine fields bimonthly in end of February, April, June, August, October, and December. *Asian Spine Journal* was founded in 2007.

The journal aims to promote communications among spine surgeons especially in Asian countries regarding spine problems and to provide Asian spine surgeons more opportunities to publish their works in international journal. All manuscripts should be creative, informative and useful for the diagnosis and treatment of spine problems. Manuscripts regarding disease and treatment which shows more characteristic features in Asian people would be preferable. Every researcher who has interested in the aims and scope of *Asian Spine Journal* is encouraged to submit the papers from all over the world.

Subscription Information

- Korean Society of Spine Surgery will send *Asian Spine Journal* for free to some important individuals and institutions. The subscription fee will be charged only for those issues that were requested by written order. The subscription fee includes postal and handling charges.
- For individual subscribers, the annual subscription fee is 20,000 won (Korean) or 30 US dollars (International). The subscription fee for a single issue is 10,000 won (Korean) or 15 US dollars (International). For institutional subscribers, there will be no subscription fee until 2015.
- No. of circulation of paper journal:
  - Domestic (The Korean Medical Library Association, National Assembly Library, etc.) 730 copies,
  - Overseas (The Library; various regions in 18 countries) 90 copies.
- To subscribe to *Asian Spine Journal*, please contact the editorial office for detailed information (spinepjb@catholic.ac.kr).

Electronic Edition

A free full-text service both in the XML and PDF formats is available at our home page (http://www.asianspinejournal.com or http://www.asianspinejournal.org). No registration or subscription is required for access to the electronic edition of *Asian Spine Journal*.

■ Editorial Office

Correspondence for subscriptions, reprints, address changes, and advertisements should be sent to the address below:
Asian Spine Journal
Department of Orthopaedic Surgery, Asan Medical Center, University of Ulsan College of Medicine, Seoul, Korea,
88, Olympic-ro 43-gil, Songpa-gu, Seoul 05505, Korea
Tel: +82-2-3010-3549, Fax: +82-2-3010-8555, E-mail: spinecjh@gmail.com

■ Publisher Office

Korean Society of Spine Surgery
Department of Orthopaedic Surgery, Yonsei University College of Medicine, 50 Yonsei-ro, Seodaemun-gu, Seoul 03722, Korea
Tel: +82-2-831-3413, Fax: +82-2-831-3414, E-mail: korspine@hanmail.net

■ Printing Office

Newest Medicine Company
Choisin B/D 27-11, Dongho-ro 24-gil, Jung-gu, Seoul 04617, Korea
Tel: +82-2-2263-4723, Fax: +82-2-2263-4726, E-mail: newmedj115@gmail.com

Asian Spine Journal is indexed/tracked/covered by PubMed, PubMed Central, KoreaMed, Synapse, KoMCI, CrossRef, Scopus, Google Scholar, and DOAJ .

This paper meets the requirements of KS X ISO 9706, ISO 9706-1994 and ANSI/NISO Z.39.48-1992 (Permanence of paper).

www.asianspinejournal.org
pISSN 1976-1902 · eISSN 1976-7846

Asian Spine Journal

www.asianspinejournal.org
pISSN 1976-1902 · eISSN 1976-7846

Asian Spine Journal

Asian Spine Journal

www.asianspinejournal.org
pISSN 1976-1902 · eISSN 1976-7846

Volume 16 · Number Supplement 1 · June 2022

Abstracts for Medal Papers Basic Science Papers

Abstracts for Medal Papers Clinical Award Papers

"This journal was supported by the Korean Federation of Science and Technology Societies (KOFST) Grant funded by the Korean Government."

Asian Spine Journal

www.asianspinejournal.org
pISSN 1976-1902 · eISSN 1976-7846

Volume 16 · Number Supplement 1 · June 2022

Course Abstracts for Free

"This journal was supported by the Korean Federation of Science and Technology Societies (KOFST) Grant funded by the Korean Government."

Asian Spine Journal

www.asianspinejournal.org
pISSN 1976-1902 · eISSN 1976-7846

Volume 16 · Number Supplement 1 · June 2022

"This journal was supported by the Korean Federation of Science and Technology Societies (KOFST) Grant funded by the Korean Government."

Asian Spine Journal

www.asianspinejournal.org
pISSN 1976-1902 · eISSN 1976-7846

Volume 16 · Number Supplement 1 · June 2022

"This journal was supported by the Korean Federation of Science and Technology Societies (KOFST) Grant funded by the Korean Government."

Asian Spine Journal

www.asianspinejournal.org
pISSN 1976-1902 · eISSN 1976-7846

Volume 16 · Number Supplement 1 · June 2022

"This journal was supported by the Korean Federation of Science and Technology Societies (KOFST) Grant funded by the Korean Government."

www.asianspinejournal.org
pISSN 1976-1902 · eISSN 1976-7846

Asian Spine Journal

Volume 16 · Number Supplement 1 · June 2022

"This journal was supported by the Korean Federation of Science and Technology Societies (KOFST) Grant funded by the Korean Government."

Asian Spine Journal

www.asianspinejournal.org
pISSN 1976-1902 · eISSN 1976-7846

Volume 16 · Number Supplement 1 · June 2022

Abstracts for E-Posters

"This journal was supported by the Korean Federation of Science and Technology Societies (KOFST) Grant funded by the Korean Government."

Asian Spine Journal

www.asianspinejournal.org
pISSN 1976-1902 · eISSN 1976-7846

Volume 16 · Number Supplement 1 · June 2022

"This journal was supported by the Korean Federation of Science and Technology Societies (KOFST) Grant funded by the Korean Government."

www.asianspinejournal.org
pISSN 1976-1902 · eISSN 1976-7846

Asian Spine Journal

Volume 16 · Number Supplement 1 · June 2022

"This journal was supported by the Korean Federation of Science and Technology Societies (KOFST) Grant funded by the Korean Government."

Asian Spine Journal

www.asianspinejournal.org
pISSN 1976-1902 · eISSN 1976-7846

Volume 16 · Number Supplement 1 · June 2022

"This journal was supported by the Korean Federation of Science and Technology Societies (KOFST) Grant funded by the Korean Government."

Asian Spine Journal

www.asianspinejournal.org
pISSN 1976-1902 · eISSN 1976-7846

Volume 16 · Number Supplement 1 · June 2022

"This journal was supported by the Korean Federation of Science and Technology Societies (KOFST) Grant funded by the Korean Government."

Asian Spine Journal

www.asianspinejournal.org
pISSN 1976-1902 · eISSN 1976-7846

Volume 16 · Number Supplement 1 · June 2022

"This journal was supported by the Korean Federation of Science and Technology Societies (KOFST) Grant funded by the Korean Government."

www.asianspinejournal.org
pISSN 1976-1902 · eISSN 1976-7846

Asian Spine Journal

Volume 16 · Number Supplement 1 · June 2022

"This journal was supported by the Korean Federation of Science and Technology Societies (KOFST) Grant funded by the Korean Government."

Asian Spine Journal

www.asianspinejournal.org
pISSN 1976-1902 · eISSN 1976-7846

Volume 16 · Number Supplement 1 · June 2022

"This journal was supported by the Korean Federation of Science and Technology Societies (KOFST) Grant funded by the Korean Government."

ASIAN SPINE JOURNAL
ABSTRACTS
Asian Spine J 2022; 16(Supplement 1):S1–S112 • http://dx.doi.org/10.31616/asj.2022.16.S1.S1

APSS Annual Meeting 2022 with Live Operative Course in Coimbatore

Abstracts for Medal Papers
Basic Science Papers

22

Elucidation of Gait Characteristics of Patients with Dropped Head Syndrome Using a Three-Dimensional Motion Analysis

Norihiro Isogai, Tatsuya Igawa, Haruki Funao, Ken Ishii

Department of Orthopaedic Surgery, School of Medicine, International University of Health and Welfare (IUHW), Otawara, Japan

Objectives: In patients with dropped head syndrome (DHS), cervical malalignment is one of the risk factors for impaired horizontal gaze and walk disturbance. The characteristics of gait in patients with DHS have not been clarified biomechanically from the viewpoint of dynamic alignment and lower limb kinematics. The aim of this study was to clarify kinematic and kinetic differences during level walking in patients with DHS compared to the healthy elderly.

Methods: Twelve patients with idiopathic DHS (DHS group: mean age, 73.5±4.1 years, two males and 10 females) and age and gender matched healthy volunteers (control group: mean age, 72.6±3.8 years) were enrolled in this study. Level walking at a self-selected speed was compared between the two groups using a three-dimensional (3D) motion analysis system. The system consisted of 10 infrared cameras and six force plates. Spatiotemporal, kinematic, and kinetic data were recorded using a 3D motion analysis system. Statistical analysis was performed to compare these data between the two groups, respectively using Mann-Whitney *U*-test. Cervical sagittal parameters on the whole spine standing lateral radiograph were also evaluated in the DHS group.

Results: In patients with DHS, the mean C2–C7 sagittal vertical axis (SVA) was +54.2±16.0 mm, C2–C7 angle was -13.4°±26.4°, and C7–S1 SVA was -11.4±44.8 mm. The walking speed of patients in the DHS group was significantly slower (DHS: 0.82±0.15 m/sec, control: 1.13±0.20 m/sec, $p<0.01$), and stride length was also significantly shorter (DHS: 0.91±0.13 m, control: 1.16±0.19 m, $p<0.01$) than that in the control group. The thorax was also significantly tilted backwards in the DHS group compared to that in the control group during a gait cycle (DHS: 9.9°±4.0°, control: 5.5°±3.4°, $p<0.05$). Pelvis tended to be retroversion in patients with DHS, but no statistically significant difference in the pelvis angle was found between the two groups (DHS: -1.6°±6.5°, control: -6.3°±5.2°, $p=0.07$). The peak hip-joint extension moment during single stance in the DHS group was smaller than that in the control group (DHS: -0.07±0.14 Nm/kg, control: -0.24±0.18 Nm/kg, $p<0.05$).

Conclusions: The walking of DHS patients demonstrated kinematic and kinetic characteristics of the lower limb joints and alignment of the thorax and pelvis corresponding to their short stride and walking speed.

32

Efficacy and Outcome of Bone Marrow Derived Stem Cells Transplanted via Intramedullary Route in Acute Complete Spinal Cord Injury: A Randomized Placebo Controlled Trial

Bhavya Pahwa, Renu Saini, Deepak Agrawal

Guru Teg Bahadur Hospital, University College of Medical Sciences, New Delhi, India

Objectives: Due to lack of well-designed trials, there is no

good evidence on the efficacy of stem cells in spinal cord injury. We aim to study the efficacy and outcome of bone marrow derived stem cells (BMSCs) in acute complete spinal cord injury (SCI).

Methods: In this prospective study over a 3-year period, 27 patients with acute, complete SCI were randomized to receive BMSCs or placebo (intramedullary route) intraoperatively. Institutional ethics approval was taken and informed consent was taken from all patients. Functional outcome was assessed using the American Spinal Injury Association (ASIA) scale, Spinal Cord Independence Measure (SCIM) score and somatosensory evoked potential (SSEP) responses preoperatively, 3 and 6 months after surgery.

Results: Thirteen patients were available for the final analysis of which six were in the stem cell group and seven received placebo. Six patients had improvement by at least one grade in ASIA score in the stem cell group as compared to only one patient in the placebo group. However, no functional motor improvement in any of the patients. ASIA sensory score improved from a preoperative mean of 124 to 224 at 6 months compared to the static mean of 115 in the control group. Absent SSEP waveform converted to abnormal waveform at 6 months in three patients in the stem cell group and one patient in the control group. There was no significant difference in the SCIM scores between the groups at last follow-up. All patients in the stem cell group reported improved bladder sensation, decreased spasticity, and improved posture control as compared to nine in the placebo group.

Conclusions: BMSCs through intramedullary route are a potential therapy for acute complete SCI and more research is required in this area.

52

The Prevalence and Distribution of Dysplastic and Fully Corticalized Pedicles in Adolescent Idiopathic Scoliosis Patients with Major Lumbar Curves

Wee Jieh Wang, Chee Kidd Chiu, Weng Hong Chung, Chris Yin Wei Chan, Mun Keong Kwan

Universiti Malaya, Kuala Lumpur, Malaysia

Objective: To determine the prevalence of dysplastic and fully corticalized pedicles in adolescent idiopathic scoliosis patients with major lumbar curves.

Methods: This was a retrospective analysis of preoperative computed tomography (CT) images of T1 to L5 vertebrae. All scoliotic patients with major (curve with largest Cobb angle) thoracolumbar and lumbar curves who had CT scans prior to corrective spine surgery from 2015 to 2020 were retrospectively reviewed. The exclusion criteria of the study were: (1) non-idiopathic scoliosis, (2) thoracic major curves, (3) patients with previous spinal surgery or trauma, and (4) reverse curves (left-sided thoracic curves). Pedicles were classified as type A: cancellous channel of >4 mm; type B: cancellous channel of 2 to 4 mm; type C: cancellous channel of <2 mm or corticalized pedicle of >4 mm; and type D: corticalized pedicle of ≤4 mm. Type B, C, and D were considered dysplastic pedicles and type C and D were considered narrow-dysplastic pedicles. Fully corticalized pedicles were type C with corticalized pedicle of >4 mm and type D.

Results: A total of 1,972 pedicles from 58 patients were obtained and measured. We found out that left-sided T5–T9 had the highest prevalence of fully corticalized pedicles (10.3%–24.1%), followed by right-sided T3–T5 (8.6%–19.0%). The prevalence of narrow-dysplastic pedicles was highest at left T5–T9 (50.0%–75.9%) and right T3–T5 (58.6%–69.0%). The smallest pedicle widths were found at right T4 and T5 (2.6±1.0 mm and 2.9±0.9 mm, respectively) and left T6–T8 (2.9±1.0 mm, 2.8±1.4 mm, and 2.8±1.0 mm, respectively). These regions generally represented the concave side of the main thoracic and proximal thoracic curves. There was a transition from larger pedicle width (5.8–6.9 mm) and less narrow-dysplastic pedicles (1.7%–5.2%) at T11 and T12 pedicles to smaller pedicle width (4.1–4.9 mm) and more narrow-dysplastic pedicles (15.5%–34.5%) at L1 and L2 pedicles on both sides of the vertebra.

Conclusions: The concave pedicles of the main thoracic and proximal thoracic curves had smaller pedicles width and more dysplastic pedicles. There was a transition of larger pedicle width and less dysplastic pedicles to smaller pedicle width and more dysplastic pedicles at the thoracolumbar junction.

85

Multilayer Electrospun-Aligned Fibroin-Gelatin Scaffold for Annulus Fibrosus Repair

Chih-Wei Chen, Ming-Hsiao Hu, Po-Han Chu, Yuan-Hui Sun, Feng-Hui Lin, Shu-Hua Yang

Department of Biomedical Engineering, National Taiwan University, Taipei, Taiwan

Objectives: Annulus fibrosus (AF) damage is proven to prompt intervertebral disc (IVD) degeneration and unrepaired AF lesions after surgical discectomy may boost herniation of the nucleus pulposus (NP) which may lead to further compression of neural structures. Besides, vascular and neural in growth may occur within the defect which is known as a possible reason of discogenic pain. Due to a limited healing capacity, an effective strategy to repair and close the AF defect is necessary.

Methods: In this study, we chose two nature polymers as scaffold material: silk fibroin and gelatin. To produce the scaffold which mimics the structure of native AF, we use electrospinning technic with high-speed rotating collector to produce membranes with preferred orientation fiber. Then gelatin is used as adhesive to stack the membrane layer by layer with specific angle alternatively. After cross-linking, a multilayer scaffold would be produced. Fourier transform infrared spectroscopy is used to confirm the fingerprint region of fibroin extracted from nature silk cocoon. The single layer electrospun membrane and multilayer scaffold were analyzed by scanning electron microscope (SEM) to confirm that the fiber diameter is around 200–300 nm with preferred orientation. *In vivo* study had been done using porcine model.

Results: Mechanical properties of the single layer electrospun membrane developed in this study: elastic modulus is around 3.18–6.70 MPa, UTS is around 0.96–1.81 MPa, elongation is around 60%–90% and toughness is around 0.3–1.1 MJ/m^3. And all the mentioned mechanical properties are similar or superior to native AF tissue. The results of swelling test showed that the multilayer scaffold would swell 20%–30% in aqueous solution, and the swelling would provide better scaffold fixation after surgery. WST-1, lactate dehydrogenase, and live/dead staining were done to verify the biocompatibility of the electrospun membrane. The SEM images showed that both AF cell and NP cell can adhere on electrospun membrane and migrate into the pores of electrospun fibers. From magnetic resonance imaging images of *in vivo* study, we suspected that the multilayer scaffold developed in this study may prevent the formation of high-intensity zone; hence, it's better for annulus repair. The results of discography showed that the effectiveness of annulus repair of implant group was much superior to untreated (injury) group.

Conclusions: We supposed that the fibroin/gelatin multilayer scaffold developed in this study have great potential for annulus fibrosis repair.

131

Inhibitory Effect of Insulin Treatment on Apoptosis of Intervertebral Disc Cells in a Streptozotocin-Induced Diabetic Rat Model

Jong-Beom Park

Department of Orthopaedic Surgery, College of Medicine, The Catholic University of Korea, Seoul, Korea

Objectives: Diabetes is an important factor for causing disc degeneration due to excessive apoptosis of disc cells and matrix degradation. Fas, a well-known apoptotic receptor, triggers apoptosis after binding to its natural ligand (Fas ligand) or to agonistic anti-Fas antibody. Previous studies demonstrated that excessive Fas-mediated apoptosis of disc cells accelerates matrix degradation of disc tissues, which leads to disc degeneration. However, there have been no studies to demonstrate the inhibitory effect of insulin treatment on apoptosis of disc cells and matrix degradation in diabetic patients. The streptozotocin (STZ)-induced diabetic rat model is an animal model of human type 1 diabetes and has been used widely for many aspects of basic research in diabetes. The purpose of current study was to investigate whether insulin treatment could attenuate apoptosis of disc cells and matrix degradation in a STZ-induced diabetic rat model.

Methods: The 30 rats were allocated randomly into one of three groups: control (n=6), STZ (n=12), and STZ-insulin (n=12). Diabetes was induced by a single intraperitoneal injection of STZ (65 mg/kg) in the STZ and STZ-insulin groups. At 2 weeks after STZ injection, the blood glucose level was confirmed to be consistently above 400 mg/dL in the STZ and STZ-insulin groups. Beginning 2 weeks

after STZ injection, insulin treatment (1.5 unit/100 g) was administered daily for up to 4 weeks in the STZ-insulin group. At 4 weeks after insulin treatment, blood glucose level of the STZ-insulin rats had significantly decreased to normal level. At 6 weeks after STZ injection (at 4 weeks after insulin treatment), the rats were sacrificed, and disc cells and tissues were harvested for reverse transcription polymerase chain reaction and western blot analyses.

Results: Expressions of apoptosis markers (Fas, caspase-8, -9, and -3) and matrix degradation markers (MMP-2 and -3) were significantly increased in the STZ group compared to those of control group. On the contrary, insulin treatment significantly decreased expressions of apoptosis markers (Fas, caspase-8, -9, and -3) and matrix degradation markers (MMP-2 and -3) in the STZ-insulin group compared to those of STZ group. Our results demonstrated that insulin treatment attenuates excessive apoptosis of disc cells and matrix degradation in the diabetic rat model. Accordingly, strict blood glucose control should be recommended to prevent disc degeneration in diabetic patients.

Conclusions: This study is the first to demonstrate therapeutic effect of insulin treatment on apoptosis of disc cells and matrix degradation.

146

Redefining the Diagnosis of Tether Failure in Vertebral Body Tethering: A Biomechanical Analysis

Ogulcan Guldeniz, Christopher C. H. Yip, Wanis Nafo, Kenneth M. C. Cheung

Department of Orthopaedics & Traumatology, The University of Hong Kong, Hong Kong

Objectives: Tether failure is a common complication of Vertebral Body Tethering, which is diagnosed based on the inter-screw angle. However, this method has only been proven to be 56% accurate. It is known that the material of tether, polyethylene-terephthalate, has a high degree of stretch before it fails. In line with that, our clinical studies showed that more tether breakages could be identified using an increase in inter-screw distance as opposed to angle. The objective of this study is to carry out mechanical testing on the tethers and to define the amount of elongation the tether can undergo before failure, therefore providing a rational definition for tether rupture based on an increase in the inter-screw distance beyond the elongation limit.

Methods: Tensile tests with a 20%/min strain rate were conducted on tether samples from one manufacturer by using a mechanical testing frame. Cauchy stress-stretch curves were investigated.

Results: The mean Cauchy stress and stretch value among the samples at the point of rupture were 282 MPa and 28%, respectively. There was no significant difference between the tether samples tested. The tether applied almost zero reaction force during the first 3%–5% elongation (slack stretch). The standard 450 N applied during the surgery to establish correction was determined to be causing 10%–12% elongation on the tether. A constant modulus of approximately 1 GPa was measured.

Conclusions: Fracture stresses were approximately 50% lower, and stretches were approximately 100% higher than the data in the literature, which indicates the likelihood of a failure under relatively lower loads. Residual stresses on the tether left by the 450 N may lead to creep or fatigue failure. The 5% slack stretch may lead to inadequate correction if not eliminated during the surgery. We calculated that after applying the standard 450 N to the tether, the remaining total stretch (15%–18%) before rupture corresponds to 13%–16% of the inter-screw distance; therefore, we suggest that tether rupture can be defined by an increase in the inter-screw distance beyond this limit. We propose that an increase in the inter-screw distance would make better sense than an increase in inter-screw angle, as rupture may not be associated with a change in angle.

239

Bacterial Presence in Intervertebral Disc: Insights from a Novel Metabolomic Approach

Sri Vijay Anand K. S., S. Rajasekaran, Chitraa Tangavel, Chandhan Murugan, Gowdaman Vasudevan, Murugesh Easwaran

Ganga Medical Center and Hospital, Coimbatore, India

Objective: The presence of bacteria in the intervertebral disc has been refuted as contamination despite the grow-

ing evidence in favor of sub-clinical infection. We utilized a novel approach of metabolomics to probe the presence of bacterial metabolites involved in colonization, survival, and replication in human lumbar intervertebral discs (IVD).

Methods: An observational case-control study where untargeted metabolite profiling was carried out in six discs (three controls from brain dead voluntary organ donors and three cases from patients undergoing surgery for degenerative disc disease) after extraction using methanol: acetonitrile: water (2:2:1) solvent system and acquired through high-performance liquid chromatography with tandem mass spectrometry platform using C18 reversed-phase column. From the total IVD metabolome, microbial metabolites were filtered and mapped against Human Metabolome Database (HMDB), Chemical Entities of Biological Interest Database, SigMol, Siderophore database, ECDMB database, and PaMet databases. The biological functions of the metabolites were then studied by the metabolite set enrichment analysis pipeline from MetaboAnalyst, and the enrichment ratio, *p*-value, and Variably Importance Projection scores of the metabolites calculated. Degeneration responsive changes in the abundance of the microbial metabolites were calculated based on the peak intensities between the control and cases.

Results: Mass spectrometry identified a total of 17,601 and 15,003 metabolites, respectively in the control and diseased discs. Preliminary mapping of the above metabolites against HMDB indicated the multiple sources, and of these, 64 metabolites were of microbial origin, accounting for 1.6% of the total IVD metabolome. Principal component analysis and orthogonal partial least square-discriminant analysis showed distinct clustered patterns between control and disease. After exclusion of metabolites that were also associated with humans, drugs, and food, 39 metabolites specific to bacteria were isolated. Nine were primary, related to bacterial growth and survival, and the remaining 30 were secondary, related to different environmental stress response activities. The three significant pathways ($p<0.001$) which were predominant in the bacterial metabolites were autoinducer-2 biosynthesis, peptidoglycan biosynthesis, and chorismate pathway. A significant fold change of >1.0 was found for nine metabolites which included (S)-14-methyilhexadecanoic acid related to *Propionibacterium acnes*, 9-OxoODE, and 13-OxoODE related to gut flora, vibriobactin—a siderophore, tuberculosinol and iso-tuberculosinol, virulence factors of *Mycobacterium tuberculosis*. There was also upregulation of autoinducer-2, an important 'quorum sensing molecule' involved in bacterial cross-talk.

Conclusions: We identified several bacterial-specific metabolites participating in pathways involved in bacterial growth, survival, and cross-talk upregulated in diseased discs. These findings indicate that the bacterial presence may not be mere contamination but could be colonization with a possible role in infection-mediated inflammation in degenerative disc disease.

163

Lycium Barbarum Extract Can Enhance Functional Recovery after Decompression in a Preclinical Rat Model of Cervical Spondylotic Myelopathy

Kenny Kwan, Kangheng Wang, Rong Lio, Kenneth Cheung, Kwok Fai So, Yong Hu

The University of Hong Kong, Hong Kong

Objectives: While surgical decompression can arrest progression of cervical spondylotic myelopathy (CSM), most patients are left with significant residual neurological deficit and functional impairment. Lycium barbarum polysaccharide (LBP), also known as wolfberry, is a traditional Chinese herb that has been shown to modulate M1/M2 macrophage polarization in acute spinal cord injury with neuroprotection. We hypothesized that Lycium barbarum extract can enhance functional recovery after surgical decompression in an animal model of CSM.

Methods: The spinal cords of female Sprague-Dawley rats were slowly and progressively compressed by the introduction of a water-absorbing polymer under the C5 lamina. At 2 weeks post-surgery when all animals were confirmed to suffer from CSM by neurobehavioral studies, rats were randomly allocated into the following experimental groups: (1) LBP alone, (2) decompression alone, (3) decompression with LBP, (4) no treatment, and (5) sham group (no compression). Decompression was performed at 4 weeks post-implantation by C5 laminectomy and excision of any extradural pathology. Data were analyzed using analysis of variance analysis. The integrity of the spinal cord was evaluated by electrophysiological

studies, neurobehavioral assessments, and histological and immunohistochemical evaluations.

Results: All groups had similar degrees of spinal cord injuries as confirmed by electrophysiological studies. At 8 weeks post-surgery, the LBP and decompression group significantly ameliorated the recovery of hindlimb function of rats compared with the decompression only group, as demonstrated by the Basso, Beattie and Bresnahan (BBB) score. Recovery of somatosensory evoked potential and motor evoked potential latency and amplitude were also enhanced in the LBP and decompression group. Transverse sections of the spinal cord stained with Luxel fast blue showed there was decreased vacuolation of myelin and increased density of myelin staining in the LBP and decompression group. These results suggested LBP decreased intramedullary vacuolization and nerve fiber demyelination that might account for enhanced neurological recovery.

Conclusions: These results demonstrate for the first time that LBP extracted from the Chinese herbal medicine can enhance neurological and functional recovery in a preclinical model of CSM. These results form the basis of a randomized clinical trial to examine the synergistic effects of surgical decompression and LBP in CSM patients.

168

Expression of Sclerostin and Role of Non-Canonical (Protein Kinase C) Signaling in the Intervertebral Disc Cells

Youngmi Kang, Sang-Jun Park, Jae-Won Shin

Department of Orthopaedic Surgery, Yonsei University College of Medicine, Seoul, Korea

Objectives: Disc degeneration (IDD) is caused by an imbalance in the homeostasis of the extracellular matrix such as type II collagen and proteoglycans in the nucleus pulposus (NP), causing low back pain. Activation of protein kinase C (PKC) has been demonstrated to play a role in cell growth and differentiation in the intervertebral disc region. It has also been reported that activation of Wnt signaling suppresses cell proliferation, induces aging, and contributes to IDD in the NP region. However, the association between Wnt signaling and non-standard Wnt signaling in disc (IVD) homeostasis has not been identified. Therefore, the purpose of this study is to evaluate that non-canonical pathways are activated by the Phorbol 12-myristate 13-acetate (PMA) effect on chondrocyte-like cell behavior.

Methods: Human disc tissues were collected during surgery from patients and cultured. The IVD cells were seeded at a cell density of 70 cells cm—1 for protein and RNA isolation in condition treated with PMA (200 nM) for 24 hours. A reverse transcription-polymerase chain reaction was performed to detect expressions of aggrecan, type II collagen glucose transporter 1, GAPDH (glyceraldehyde-3-phosphate dehydrogenase), SOX9, and hypoxia-inducible factor-1α at the messenger RNA (mRNA), and western blot was used for PKC isoforms.

Results: Type II collagen and SOX9 mRNA expression increased in the PMA-treated condition compared to the no PMA-treated condition. In addition, expression of PKC isoforms at the protein level was increased in PMA-treated conditions.

Conclusions: PKC activation stimulates expression of SOX9 and type II collagen and induces expression of PKC isoforms on chondrocyte-like cells in IVD. Therefore, activation of PKC on chondrocyte-like cells affects senescence and dedifferentiation, providing the possibility of turnover of degenerating cell-like cells. Further observations of the relationship between Wnt signaling and its inhibitors and downstream PKC signaling are considered.

Abstracts for Medal Papers Clinical Award Papers

123

Progression of Ossification of the Posterior Longitudinal Ligament in Upper Cervical Spine Following Expansive Open Door Laminoplasty

Hao-Wen Chen, Kuang-Ting Yeh, Ing-Ho Chen, Tzai-Chu Yu, Chia-Ming Chang, Wen-Tien Wu

Department of Orthopaedics, Hualien Tzu Chi Hospital, Hualien, Taiwan

Objectives: Although surgical decompression via laminoplasty has become a popular solution to cervical my-

elopathy resulting from the ossification of the posterior longitudinal ligament (OPLL), the growth in the volume of ossified tissue on the follow-up image still occurred and had not been well-established. Therefore, the main purpose of this study is to investigate the relationship between the progression of OPLL and the clinical results following expansive open-door laminoplasty.

Methods: Forty-three patients under following up for more than 3 years after laminoplasty were included in this retrospective study. Magnetic resonance imaging (MRI) and computed tomography screening of the cervical spine were applied before the surgery, after the surgery, and at the latest follow-up. The extent of the OPLL by measuring the width of ossified ligament on the sagittal view of MRI. The sagittal alignment was also evaluated and compared with the previous image record. Neurological function and symptoms were graded by the Japanese Orthopaedic Association (JOA) myelopathy scoring system. The relationship between the progression of OPLL and the score-based rate of recovery was analyzed.

Results: Twenty-one patients (39.6 %) had a progression of OPLL after laminoplasty. The patients with progression of OPLL were significantly younger (60.9±6.18 years vs. 56.5±4.89 years, $p<0.05$), with higher body mass index (BMI; 24.1±1.35 kg/m^2 vs. 26.9±2.04 kg/m^2, $p<0.05$), and being the mixed type OPLL (18.8% vs. 61.9%, $p<0.05$). The JOA score got significant improvement in both groups at 1 year and tilled the latest follow-up, mostly 3 years after the primary surgery. Despite four cases in the progression group indicating revised decompression for recurrent myelopathy, the JOA scores were only lower but not significantly different in the progression group than in the non-progression group.

Conclusions: According to a recent systemic review, the progression rate of OPLL tends to elevate with time and reaches 60% around 10-years after the original laminoplasty. That may explain the under-estimated lower incidence (39.6%) of progression rate within less than 4 years in this study. Besides, the younger age with higher demand for activity, the higher BMI with increasing mechanical loading, and the mixed type of OPLL with higher junctional shear force may share the collaborative mechanism of dynamic instability, mechanical stress, inducing biochemical response of osteogenic induction and the substantial OPLL formation. The OPLL progression following laminoplasty accounts for 39.6% and may require decompression for the recurrent myelopathy at a midterm follow-up. The younger age, mixed type, and higher BMI, related to mechanical stress, may make risk factors for OPLL progression.

208

Clinical Indicators of Surgical Outcomes after Laminoplasty for Patients with Cervical Ossification of the Posterior Longitudinal Ligament: A Prospective Multicenter Study

Narihito Nagoshi, Toshitaka Yoshii, Morio Matsumoto, Atsushi Okawa, Masashi Yamazaki, Shiro Imagama

Department of Orthopaedic Surgery, Keio University School of Medicine, Tokyo, Japan

Objectives: Although previous studies identified factors that affected the surgical outcomes for patients with cervical ossification of the posterior longitudinal ligament (OPLL), their assessment was mainly based on the Japanese Orthopaedic Association score, which only includes neurologic function. Investigating this pathology through multiple functions and quality of life (QOL) is pivotal to understanding the comprehensive clinical pictures of the cervical OPLL and its therapeutic outcomes. This study aims to evaluate patient-reported outcomes using the Japanese Orthopedic Association Cervical Myelopathy Evaluation Questionnaire (JOACMEQ) and clarify clinical factors that affect the therapeutic effects of patients with cervical OPLL.

Methods: This multicenter prospective study was performed by the Japanese Multicenter Research Organization for Ossification of the Spinal Ligament. A total of 478 patients with myelopathy caused by cervical OPLL from 28 institutions were prospectively registered from 2014 to 2017 and followed up for 2 years. Of the patients, 168 received laminoplasties and fully completed questionnaires. Demographic information, imaging findings, and clinical outcomes were collected. Patients were grouped according to effective or ineffective surgical outcomes as defined by the JOACMEQ using logistic regression analyses.

Results: Laminoplasty resulted in functional improvement in the cervical spine and upper extremity around 40% of the patients, while QOL showed only 21.4% ($p<0.01$). Multivariable analyses revealed that younger age and a

postoperative decrease in arm or hand pain were correlated with significantly improved function of the upper extremities. A reduction in lower limb pain favorably affected the postoperative lower extremity function. A postoperative reduction in upper extremity pain enhanced the QOL recovery.

Conclusions: Surgeons should recognize the diversity of surgical outcomes after laminoplasty and understand the necessity of pain management even after the surgery to enhance bodily functions and QOL in patients with cervical OPLL.

40

Posterior Correction Surgery for Adolescent Idiopathic Scoliosis Lenke Type 2 Using Sublaminar Tape on the Concave Side of the Proximal Thoracic Curve

Kota Watanabe, Mitsuru Yagi, Morio Matsumoto, Masaya Nakamura

Department of Orthopaedic Surgery, Keio University School of Medicine, Tokyo, Japan

Objectives: The risk for postoperative shoulder imbalance is relatively high in adolescent idiopathic scoliosis (AIS) type 2 curves, and the diameter of the pedicle on the concave side of the proximal thoracic (PT) curve is generally narrow. Therefore, we use sublaminar tapes in the area instead of pedicle screws (PSs) to obtain shoulder balance. In this study, we examine the effectiveness of this method in correcting the PT curve and postoperative shoulder balance.

Methods: Sixty female patients who underwent posterior corrective fixation for AIS type 2 followed up for at least 2 years were included in the study. The upper instrumented vertebra was T2 in all patients, and PSs were attempted to be placed on the concave side of the PT curve until 2017 (PS group, 35 patients). Then, sublaminar tapes were placed on the area to correct the PT curve (tape group, 25 patients) from 2018. Generally, PSs were placed on the convex side of the PT curve, and T2 on the concave side. Sublaminar tapes are placed at T3, T4, and T5 where the pedicle diameters are extremely narrow. After placing the rod on the convex side, all screws at T2–5 are pushed down caudally as far as possible. After placing the concave-side rod, tighten the sublaminar tapes and push the T2 screw up toward the caudal. X-ray parameters between the two groups were compared.

Results: The preoperative Cobb angle of the PT curve was similar between the PS group (44.2°±10.0°) and the tape group (45.0°±12.9°) but tended to be better in the tape group at the final follow-up (20.5°±6.4° vs. 18.4°±5.3°). The clavicle angle was also similar preoperatively (2.0°±1.2° vs. 2.1°±1.8°) but smaller in the tape group postoperatively (2.0°±1.5° vs. 1.2°±1.9°). Furthermore, apical translation of the PT curve was similar preoperatively (6±6.8 mm vs. 6.6±7.2 mm) but significantly lower in the tape group postoperatively (5.1±3.5 mm vs. 2.4±2.8 mm).

Conclusions: The vertebrae in the PT curve were effectively translated by the sublaminar tapes, and the craniocaudal motion was not restricted, which resulted in relatively effective control of the vertebral bodies that resulted in better postoperative shoulder balance.

164

Long-Term Quality of Life Outcomes for Thoracic Adolescent Idiopathic Scoliosis Patients with or without Fusion: A Minimum of 15 Year Follow-up Study

Kenny Kwan, Amanda Liu

Department of Orthopaedics and Traumatology, The University of Hong Kong, Hong Kong

Objectives: Patients who underwent thoracic fusion (TF) during adolescence may suffer from immobile spinal segments but were believed to have good long-term quality of life outcomes. Patients who underwent non-operative (NO) treatment and did not reach the surgical threshold at the end of skeletal maturity were believed to have a normal quality of life. The aim of this study was to compare these two cohorts at a minimum of 15-year follow-up and report their quality of life.

Methods: A total of 49 adolescent idiopathic scoliosis (AIS) patients with at least 15 years of follow-up were recruited. Patients were classified into TF group or NO group. Thoracic rotation range of motion (ROM) was measured, and radiographs and eight health-related quality of life ques-

tionnaires were collected.

Results: A total of 28 patients in the TF group had a mean Cobb of 50°±11.7° at the time of surgery, and 21 patients in the NO group had a mean Cobb of 27.7°±10.2° at skeletal maturity. The mean age at recruitment was 34.8 years (range, 24–55 years), and the mean follow-up was 16 years (range, 15–25 years). At final follow-up, the Cobb was 25.8°±11.7° in the TF group, and 34.1°±13.2° in the NO group, indicating a mean of 6.4°±7.2° progression. Standing and supine Cobb (34.5°±13.6° vs. 21.1°±11.9°, p<0.001) in the NO group showed the spine remained mobile. There was no significant difference in clinical thoracic rotation ROM between the two groups. Two patients (7.1%) in the TF group reported limitations to activities of daily living (ADL), while 26 patients (92.9%) reported no limitation to ADL. One patient (4.8%) in NO reported inability to perform ADL, and 20 patients (95.2%) reported no limitation to ADL. TF group exhibited higher Scoliosis Research Society-22 (SRS22) scores compared with the NO group (4.1±0.7 vs. 3.6±0.6, p=0.007). The Quality of Life Profile for Spine Deformities showed a poorer overall quality of life for the TF group (27.4±7.2 vs. 22.4±8, p=0.029). The State Anxiety Scale (S-Anxiety) of the State-Trait Anxiety Inventory showed clinically significant symptoms of anxiety compared with the NO group (44.7±11.7 vs. 35.9±12.8, p=0.017). However, TF patients showed a lower level of misconception scores than the NO group (7.1±2.3 vs. 8.1±2.1, p=0.017).

Conclusions: TF AIS patients had higher SRS22 but a poorer overall quality of life and higher levels of anxiety than NO patients in long-term follow-up.

43

Pre-emptive Analgesia through Erector Spinae Plane Block in Posterior Cervical Spine Surgery: A Prospective Randomized Controlled Study Abstract

Karthik Ramachandran, Rishi Mugesh Kanna

Ganga Medical Centre and Hospital, Coimbatore, India

Objectives: Posterior cervical spine surgery entails significant postoperative pain hampering rehabilitation. So far, there are no clinical trials on the safety and efficacy of erector spinae plane block (ESPB) in posterior cervical spine surgery. The aim of the study is to assess the efficacy of ultrasound-guided erector spinae plane block (US-ESPB) for postoperative analgesia in posterior cervical spine surgery.

Methods: A total of 86 patients requiring sub-axial posterior cervical surgery with or without instrumentation were randomized into two groups—case (multimodal analgesia with US-ESPB) and control (only multimodal analgesia) groups. Demographic and surgical data were assessed. Postoperatively, the Numeric pain Rating Scale (NRS), Modified Observer's Assessment of Alertness, and/or Sedation Scale (MOASS) were recorded.

Results: There were 43 patients in both groups. The intra-operative opioid consumption, blood loss, and muscle relaxant were significantly less in the US-ESPB group (p<0.05). The intra-operative blood loss was significantly less in the case group. In the postoperative period too, the control group's pain score (NRS) was significantly higher in the first 48 hours following surgery. The MOASS score and satisfaction scores were significantly better and the time required to ambulate was less in the case group (p<0.001).

Conclusions: ESPB can be used as an effective and relatively safe component of multimodal analgesia in elderly patients undergoing cervical laminectomy procedures.

42

Clinical and Radiological Subsequence of Percutaneous Endoscopic Surgery Alone to Treat Infectious Spondylodiscitis in the Thoracolumbar Spine: 5-Year Follow-up Cohort Study

ChiaYu Lin, Hsien-Te Chen

China Medical University Hospital, Taichung, Taiwan

Objectives: Percutaneous endoscopic surgery is described herein to be a safe and effective treatment for infectious spondylodiscitis, as well as for cases with epidural or paraspinal abscesses. The surgical outcomes were the same for patients with varying degrees of infection severity. Local kyphotic change may be noted in cases with severe bony destruction. However, some authors have reported satis-

factory short-term outcomes. As our search in PubMed, this study was the longest research on percutaneous endoscopic surgery for infectious spondylodiscitis. We aimed to evaluate the long-term subsequence of clinical and radiological outcomes.

Methods: The design was a retrospective, 5-year follow-up cohort study. A total of 88 patients were treated according to endoscopic surgical protocol and 56 of them had followed up for at least 5 years. A chart review was conducted to evaluate the location, symptom and sign, comorbidity, Visual Analog Scale, and the functional score of Oswestry Disability Index. Laboratory data such as erythrocyte sedimentation rate and C-reactive protein were recorded. All patients underwent a plain film follow-up at 3, 6, 9, 12, 18, and 24 months after surgery. A telephone interview was applied twice per year in the following 3 years to record if this patient received further surgical intervention for the spine or passed away.

Results: There were 35 males and 21 females enrolled in our study (age: 60.71±13.28 years; Charlson comorbidity index: 3.39±2.14). There were five patients (8.9%) received the secondary spinal surgical intervention (group A); 13 patients (23.2%) passed away due to other medical diseases (group B); 38 patients (67.9%) satisfied with the index surgery (group C). In group A, three of them received scheduled operations, and two of them were unexpected. In group C, we found four healing phenomena, first, syndesmophyte formed along the anterior longitudinal ligament; second, paravertebral syndesmophyte linkage; third, intervertebral bone bridging; fourth, bony ankylosis of facet joint. Local kyphosis was noted without affecting daily activities.

Conclusions: Spontaneous spinal arthrodesis stops the progression of kyphosis and restabilized the infected level. Minimally invasive percutaneous endoscopic surgery for infectious spondylodiskitis was not only safe and effective in the short-term outcome but also maintained excellent clinical and radiological consequences after a 5-year follow-up. Only a few patients need internal fixation for the diseased segment.

12

The Role of the Proximal Humerus Ossification System in Guiding Brace Weaning in Adolescent Idiopathic Scoliosis

Jason Pui Yin Cheung, Wing Hang Cheung

The University of Hong Kong, Hong Kong

Objectives: This study aims to assess the relationship of proximal humerus ossification system (PHOS) stages with other commonly used skeletal maturity indices and to investigate the PHOS for determining the correct timing of brace weaning.

Methods: A total of 107 patients who underwent bracing according to the Scoliosis Research Society criteria and have weaned brace-wear at Risser stage 4 or above, no change in height gain, and at least 2 years post-menarche for girls. All patients had compliance ≥16 hours per day prior to weaning, and ≥2 years post-weaning follow-up. Growth parameters and skeletal maturity parameters (Risser staging, Distal Radius and Ulna Classification [DRU], Sanders staging, and PHOS) were measured, along with curve type and coronal Cobb angle. The time of weaning was considered as baseline. An increase in the Cobb angle of more than 5° between baseline and 2-year follow-up was considered curve progression. Associations between curve progression and independent parameters (age, sex, months post-menarche, curve magnitude, major curve magnitude <40° versus ≥40°, and maturity grading at weaning). Logistic regression analyses were performed with significant factors controlled for sex. Adjusted odds ratio (OR) with 95% confidence interval (CI) were determined for risk of curve progression for each maturity grade at weaning.

Results: Of 107 patients, 12.1% (n=13) experienced curve progression after brace weaning. PHOS stages were found correlated to only radius grades of the DRU (G=0.32, p=0.025). No curve progression was observed for Cobb angle <40° when weaned at PHOS stage 5, but a 20% curve progression rate was observed for ≥40°. Number of months post-menarche (p=0.021), Cobb angle at brace weaning (p=0.002), curve magnitude at weaning <40° versus ≥40° (p=0.009), radius grades (p=0.030), ulna grades (p=0.017), and Sanders stages (p=0.003) were associated with post-weaning curve progression. OR for curve

progression when weaned at R9 was 8.53 (95% CI, 1.97–36.94), and at U7 or SS7a was 8.42 (95% CI, 1.84–39.62). Protective effect of OR less than 1 was demonstrated for weaning at ≥R10 (adjusted OR, 0.12; 95% CI, 0.03–0.52; p=0.005), or at ≥U8 (adjusted OR, 0.12; 95% CI, 0.03–0.54; p=0.006) or at SS7b (adjusted OR, 0.12; 95% CI, 0.03–0.54; p=0.006). No curve progression was detected when weaned at R11 or U9 or SS8.

Conclusions: With the convenient viewing of the proximal humeral epiphyses in spine radiographs, PHOS is a useful skeletal maturity indicator for brace-wear weaning. However, patients with larger curves (≥40°) are at risk of progression after weaning despite weaning at skeletal maturity.

216

Comparative Clinical and Radiographic Cohort Study: Uniportal Thoracic Endoscopic Laminotomy with Bilateral Decompression Using One Block Resection Technique and Thoracic Open Laminotomy with Bilateral Decompression for Thoracic Ossified Ligamentum Flavum

Pang Hung Wu, Brian Chin, Hyeun Sung

Ng Teng Feng General Hospital, Singapore

Objectives: Symptomatic thoracic myelopathy secondary to thoracic ossified ligamentum flavum often requires decompression spinal surgery. Comparative clinical and radiological outcomes in uniportal endoscopic versus open thoracic decompression for thoracic ossified ligamentum flavum.

Methods: Retrospective evaluation of patients who underwent uniportal thoracic endoscopic laminotomy with bilateral decompression using one block resection technique (TE-ULBD) compared with thoracic open laminotomy with bilateral decompression (TOL). Radiological outcomes in magnetic resonance imaging (MRI) scans and clinical charts were evaluated.

Results: Thirty-five levels of TE-ULBD were compared with 24 levels of TOL. The overall complication rate of TOL was 15% while TE-ULBD was 6.5%. Both TOL and TE-ULBD cohorts had significantly improved their Visual Analog Scale (VAS), Oswestry Disability Index (ODI), and Japanese Orthopaedic Association (JOA) score after an operation. Comparative analysis of TE-ULBD performed statistically significantly better than TOL in improving the final VAS and JOA score. The mean difference±standard deviation of VAS and JOA improvement in final follow-up compared with the preoperative state of TE-ULBD and TOL were 0.717±0.131 and 1.03±0.2, respectively (p<0.05). The mean Hirabayashi recovery rate was 94.5% (TE-ULBD) and 56.8% (TOL). There was no statistical difference in change in preoperative and final ODI and MRI volume at the upper-end plate, mid disc, and lower-end plate canal cross-sectional area.

Conclusions: Uniportal thoracic endoscopic unilateral laminotomy with bilateral decompression achieved significantly improved pain and neurological recovery with sufficient spinal canal decompression as compared to thoracic open laminectomy for patients with myelopathy secondary to ossified ligamentum flavum in our cohort of patients.

29

Long-Term Clinical Outcomes of Corrective Fusion Surgery from Thoracic Spine to Pelvis for Adult Spinal Deformity: A Comparison by Age

Hideyuki Arima, Tomohiko Hasegawa, Yu Yamato, Yukihiro Matsuyama

Hamamatsu University School of Medicine, Hamamatsu, Japan

Objectives: There are few reports on the long-term results after corrective fusion surgery for adult spinal deformity (ASD). Among patients with ASD, the degree of improvement in postoperative functional disability may differ between patients younger than 60 years and those older than 75 years due to differences in muscle strength and bone quality. The purpose of this study was to compare the clinical outcomes after ASD surgery according to age.

Methods: We retrospectively analyzed patients who underwent corrective fusion surgery from the thoracic spine to the pelvis for ASD aged 40 years or older between 2010 and 2015 and who were followed up for more than 5 years. Patients with neuromuscular disease, infection,

and metastatic tumors were excluded. Radiographic parameters and patient-reported outcomes (Scoliosis Research Society 22r [SRS-22r], Oswestry Disability Index [ODI]) preoperatively and 5 years postoperatively were investigated. The age at surgery was divided into three groups: middle-aged group (n=39) between 40 and 64 years old, young-old group (n=67) between 65 and 74 years old, and old-old group (n=31) over 75 years old.

Results: Among 172 ASD patients who underwent corrective thoracic pelvic fusion over 40 years of age, we analyzed 137 patients (follow-up rate=79%; 85% women; mean age, 67.6 years) who were able to complete preoperative and 5-year postoperative questionnaires. The SRS-22r and ODI improved significantly in all domains at 5 years postoperatively (p<0.001). SRS-22r function improved from 2.8, 2.5, and 2.5 preoperatively (middle-aged, young-old, and old-old groups) to 3.5, 3.2, and 3.1 at 5 years postoperatively; pain from 3.1, 2.9, and 2.7 preoperatively to 3.8, 3.8, and 3.6 at 5 years postoperatively; and ODI from 41, 46, and 49 preoperatively to 41, 46, and 49 at 5 years postoperatively, ODI improved from 41, 46, and 49 preoperatively to 24, 28, and 33 at 5 years after surgery. There was no significant difference in the amount of improvement in SRS-22r and ODI according to age (p>0.05). SRS-22r Satisfaction at 5 years postoperatively was 3.6, 3.5, and 3.3 with no statistically significant difference (p=0.501). The unexpected revision surgery rates up to 5 years after surgery were 38.5%, 41.8%, and 22.6%, respectively (p=0.177).

Conclusions: The long-term clinical outcome of corrective fusion surgery from thoracic spine to pelvis for ASD were good, and the effect on the improvement of function and pain was comparable among the middle-aged, young-old, and old-old groups.

176

Single-Level Endoscopic TLIF Has Reduced Blood Loss, Surgical Duration and Hospital Stay While Obtaining Similar 1-Year Outcomes for Low-Grade Spondylolisthesis Compared to Conventional MIS-TLIF in an Asian Population

David Shaoen Sim, Ayyadarshan Kasivishvanaath, Lei Jiang, Zhixing Marcus Ling

Singapore General Hospital, Singapore

Objectives: Endoscopic minimally invasive transforaminal lumbar interbody fusion (E-TLIF) is a novel technique with smaller skin incision and decreased soft tissue disruption compared to conventional minimally invasive transforaminal lumbar interbody fusion (MIS-TLIF). E-TLIF in this study was performed via uniportal transforaminal approach whilst in MIS-TLIF disc space access was obtained through the posterior-lateral Wiltse approach. E-TLIF aims to further minimize surgical morbidity while achieving neuroforaminal decompression and stabilization. There is limited literature evaluating the use of E-TLIF in Asians. This study presents a single-surgeon experience comparing 1-year outcomes of E-TLIF versus MIS-TLIF in an Asian population.

Methods: A retrospective review was conducted on prospectively collected data of consecutive patients who underwent single-level E-TLIF or MIS-TLIF by a single surgeon in a tertiary spine institution from 2018 to 2021 with a minimum of 1-year follow-up. Inclusion criteria for both procedures were degenerative disc disease with grade I or II spondylolisthesis and mild to moderate central canal stenosis. As E-TLIF largely depends on indirect decompression through the use of expandable cage technology, patients with severe central canal stenosis were excluded from this study. Choice of technique was dependent on the availability of endoscopic technology in later years and surgeon and patient preference. Both E-TLIF and MIS-TLIF techniques were done under general anesthesia and neuromonitoring. This study evaluated inpatient details including operation duration, blood loss, and length of hospital stay (LOS). Patient-reported outcomes were analyzed based on the Visual Analog Scale (VAS) score for lower back pain, North American Spine Society

Neurogenic Symptom Score (NSS), and Oswestry Disability Index (ODI). One-year radiographic parameters were also assessed.

Results: Twelve E-TLIF and 34 MIS-TLIF patients were included. Both groups were similar in age, body mass index, gender, and spinal level at which surgery was performed. E-TLIF had significantly shorter operation duration (165±15 minutes vs. 259±43 minutes for E-TLIF and MIS-TLIF, respectively; $p<0.001$), reduced blood loss (83±75 mL vs. 181±225 mL; $p=0.033$), and decreased LOS (1.8±0.9 days vs. 4.7±2.9 days; $p<0.001$) compared to MIS-TLIF. There was no significant difference in 1-year VAS (1.1±2.0 vs. 0.9±1.9; $p=0.776$), NSS (9.5±12.7 vs. 10.7±12.3; $p=0.826$), and ODI (22.0±10.1 vs. 14.8±11.9; $p=0.130$) between the two groups. No complications were recorded for E-TLIF while MIS-TLIF had a case of dura tear and another case of Meralgia paresthetica. There was no cage subsidence or implant loosening for both groups. Radiographic evidence of fusion was observed at 1-year for all patients.

Conclusions: While study size was limited as E-TLIF is a relatively new technique in our institution, 1-year results are encouraging and demonstrate that in an Asian population, E-TLIF can be a safe and efficacious option that achieves similar results to MIS-TLIF with decreased surgical morbidity.

Course Abstracts for Free

26

Surgical Outcomes of Single versus Double Surgeon Approach in Posterior Spine Surgery

Orland Joshua Alimbuyuguen, Agustin Miguel Morales, Jose Joefrey Arbatin, Oliver Ong

Mariano Marcos Memorial Hospital and Medical Center, Batac, Philippines; Philippine Orthopedic Association, Quezon, Philippines

Objectives: This study aimed to investigate the surgical outcome of patients undergoing posterior spine surgery by comparing a single orthopedic surgeon approach with a double orthopedic surgeon approach.

Methods: The study design was a retrospective cohort design. The study was reviewed by the ethics board of the centers included. A total of 150 patients undergoing posterior spine surgery for deformity, degenerative, infection, trauma, and spine tumor from three centers were included. Patients undergoing anterior spine surgery were excluded from the study. Patients reviewed were grouped into a single surgeon and double surgeon approach groups. Surgical outcomes compared were operative time, blood loss, immediate wound complications, readmissions, and mortality. The study was self-funded with no conflict of interest.

Results: There was a total of 150 patients retrieved with a mean age of 26 years. Fifty-three of the patients were male while 97 were female. Eighty-eight of the 150 cases recorded were deformity, followed by infection and trauma. Forty-seven of the 150 cases recorded utilized a single surgeon approach while 103 cases were under a double surgeon approach. There was a trend for lower blood loss utilizing the double surgeon approach ($p<0.001$). Operative time was also decreased for the double surgeon approach compared to the single surgeon approach ($p=0.005$). Wound complications were decreased in the double surgeon approach but did not reach statistical significance.

Conclusions: A double orthopedic surgeon approach in posterior spine surgery will lead to a statistically significant reduction in operative time and blood loss, both of which are important for a better outcome for patients undergoing these types of surgeries.

75

Prospective Study to Identify the Clinical and Radiological Factors Predictive of Pseudarthrosis Development in Patients with Osteoporotic Thoracolumbar Fractures

Yogin Patel, Vibhu Krishnan

Ganga Medical Centre and Hospitals Pvt. Ltd., Coimbatore, India

Objectives: Although a majority of osteoporotic vertebral fractures (OVF) heal conservatively, most undesirable outcome of conservative treatment is failure to heal. There is a paucity of literature on the prevalence and risk factors of pseudoarthrosis.

Methods: A prospective cohort study involving patients (aged ≥50 years) undergoing conservative treatment of osteoporotic thoracic/lumbar fractures without neuro-deficits (August 2020 to July 2021) was performed. Patients were followed for a minimum of 6 months; and classified into three groups based on fracture healing (group 1: healing without collapse; group 2: healing with collapse; and group 3; pseudoarthrosis). An assessment of all clinical and radiological parameters at the time of injury and at each follow-up was performed; and compared among patients belonging to the groups.

Results: Seventy-seven patients (90 fractures) were prospectively studied. Sixty-six (73.3%), 16 (17.8%), and 28 (8.9%) fractures were classified under groups 1, 2, and 3, respectively. Mean ages of patients in groups 1, 2, and 3 were 67.9±9.1, 70.4±7.6, and 72.3±7.9 years (p=0.08). Sex distribution was 62:15 (female:male); 73 fractures (81.1%) were observed at thoracolumbar junctional level. Stiff spine (p=0.49), ambulatory status (p=0.27), comorbidities (p=0.33), bone mineral density (T-scores; p=0.19), and injury level (p=0.08) were not associated with pseudoarthrosis/collapse. Male sex was associated with pseudoarthrosis (p=0.03). Based on binary regression analysis, initial vertebral-height loss (X-ray; p=0.028), segmental Cobb (X-ray; p=0.019), vertebral comminution (computed tomography; p=0.032), posterior ligamentous complex (PLC) injury (magnetic resonance imaging [MRI]; p=0.048), and pattern of marrow changes (T2-weighted imaging-MRI–Kanchiku classification; p=0.037) were correlated with poorer outcome. Patients with pseudoarthrosis had higher Visual Analog Scale score (p=0.04; final follow-up).

Conclusions: Pseudoarthrosis occurred in 8.9% of OVFs. Male sex, severity of post-injury vertebral deformation (vertebral loss, kyphosis, comminution, and pattern of marrow changes), and presence of PLC injury are significant risk factors for pseudoarthrosis.

107

Mortality in Spine Surgery: A Single Center Retrospective Study

Aditya Vardhan Guduru, Saumyajit Basu

Kothari Medical Centre, Kolkata, India

Objectives: Spine procedures have inherent risks of complications, including mortality despite the best care. Defining these risks is important for patient counseling and improvement in the quality of care.

Methods: Retrospective review of medical records from 2000 to 2021, including pediatric (<21 years) and adult patients (>21 years). Deaths occurring within the period of hospitalization were taken.

Results: A total of 36 mortalities were reported among 9,407 patients (3.82 deaths per 1,000 patients). Based on age, rates of death per 1,000 patients for adult and pediatric patients were 3.4 and 0.4, respectively, and rates of death per 1,000 patients were as follows: 2.1 for degenerative (n=6,493), 4.5 for scoliosis (n=468), 11 for fractures (n=1,452), 1.5 for infections (n=729), and 4.7 for revision surgeries (n=265). The most common cause of mortality included respiratory/pulmonary causes (n=16), cardiac causes (n=11), sepsis (n=3), and stroke (n=2). The mortality reported on specific postoperative day (POD) were POD 0 (n=4), POD 1–3 (n=16), POD 4–14 (n=11), and POD >14 (n=5). Mortality rates were associated with higher American Society of Anesthesiologists score, American Spinal Cord Injury Association score, and implant fixation. Mortality rates increased with age and multiple co-morbidities.

Conclusions: Our study provides rates and causes of mortality associated with spine surgery for a broad range of diagnoses and includes assessments for adult and pediatric patients, which helps in patient counseling and efforts to improve the safety of patient care. The mortality rates are higher in patients with cervical trauma with quadriplegia at presentation, and mortality rates are higher in ankylosing spondylitis patients with fractures, followed by associated comorbidities like diabetes and hypertension.

138

Mini Invasive Anterior Lumbar Interbody Fusion for Lumbar Disc Disease: A Viable Alternative to Transforaminal Lumbar Interbody Fusion

Ameer Theruvath

Rajagiri Hospital, Kochi, India

Objectives: To ascertain the viability and safety of minimally invasive/mini-open anterior lumbar interbody fusion (MIS-ALIF) in the treatment of lumbar disc disease in the Indian context.

Methods: Two patients with lumbar disc disease were selected for the procedure. One patient had a healed infection with angular instability and another had lumbar degenerative disc disease with only axial symptoms without radiculopathy/neurogenic claudication. Table-mounted ring retractor system (MARS-Globus; Globus Medical, Audubon, PA, USA) was used to achieve and maintain access. Interbody PEEK cage (MARS-Globus) filled with demineralized bone matrix was used to perform the fusion. These cages have screw slots through which they could be anchored to adjacent vertebral bodies. Bone morphogenic protein was not used as practiced in the west due to financial concerns. The retroperitoneal route was used which greatly decrease the chances of postoperative ileus as compared to the transperitoneal approach. A separate access surgeon was not involved in the procedure. Both patients had involvement of the L5–S1 disc.

Results: Both patients had good relief of pain and no complications. The average blood loss was 85 mL. Both were mobilized from the first postoperative day without brace support. The postoperative analgesic requirement was minimal, and both were discharged on the third postoperative day. At the short-term follow-up of 3 months, both patients are doing well with regard to pain relief and activity level.

Conclusions: MIS-ALIF is a safe and predictable alternative to transforaminal lumbar interbody fusion (TLIF) in the treatment of diseases affecting the lumbar disc. It circumvents many ill effects of TLIF like paraspinal muscle damage, the potential for nerve root injury due to multiple passages of instruments close to the root, cage subsidence, limited correction of lordosis due to small cage dimension, and so forth. This can be safely performed by a fellowship-trained orthopedic spine surgeon with good knowledge of retroperitoneal anatomy without the assistance of a vascular/access surgeon.

157

Usefulness of O-Arm Navigation in 1,150 Screws Placed across 192 Surgeries: Experience of Tertiary Care Center in India

Alok Gupta

Rajagiri Hospital, Kochi, India

Objectives: Free hand and two-dimensional fluoroscopy-assisted pedicle screw insertion techniques have still been the mainstay of spinal fusion surgeries in developing nations like India, where intraoperative computed tomography-based navigation technology is limited to only a few tertiary centers. However, misplacement rates of the pedicle screws using conventional techniques are very high and range around 5% to 41% in the lumbar spine and 3% to 55% in the thoracic spine. These misplaced screws can result in severe devastating complications including neuro-deficit. Based on the above facts and with an inclination towards safe spinal surgery, many centers in our country are rapidly adopting for O-arm navigation technology. With the study, we have tried to bring out our experience of 1,150 screws placed using O-arm navigation across spinal surgeries performed for varying pathologies in the western part of the Indian subcontinent.

Methods: After approval by the institutional review board, a total of 192 patients operated by a single surgeon using intraoperative O-arm navigation in our institute between June 2020 to January 2022 were retrospectively analyzed. Out of these 170 were primary spine surgeries and 22 were revision spine surgeries. A total of 1,150 pedicle screws have been put in for stabilization in these patients. Screw placement accuracy was calculated using the accuracy of acceptable screw placement.

Results: A total of 51 cervical pedicle screws, 252 thoracic pedicle screws, and 847 lumbar pedicle screws had been placed. The mean age of the patient in our study was 54.47 years (range, 10 to 84 years). There were 86 males and 106 were females. Based on the "All India Institute of Medi-

cal Science (AIIMS)" outcome-based classification, 1,126 screws were type I or acceptable, 24 screws were type II were non-acceptable, while there were no type III screws, i.e., there were no screws that causes neuro-deficit. Screw placement accuracy using AIIMS outcome-based classification was found to be 97.91%.

Conclusions: With the anatomical distortion and changed three-dimensional (3D) spatial orientation of the pedicle across various pathologies, pedicle screw placements can have higher inaccuracies using conventional techniques even in the best of hands. O arm navigation provides an intraoperative live view of the 3D profile of the pedicle and makes it easier to put adequate length and size screws even in the most challenging conditions giving the best of the strength to the fixation construct. This advanced technology is an adjunct to and surely not a substitute for the skill of a spine surgeon.

158

Treatment Strategy for Pedicle Fractures of the C2 Axis

Jong-Beom Park, Sung-Kyu Kim

Department of Orthopaedic Surgery, College of Medicine, The Catholic University of Korea, Seoul, Korea

Objectives: Little information is available about the characteristics and treatment strategy of C2 pedicle fractures (PFs) that can affect patient's outcome. Therefore, we performed the current study to investigate the characteristics of C2 PFs and to propose appropriate treatment strategies.

Methods: A total of 49 patients with C2 PF were included from four national trauma centers in this study. Plain radiographs, computed tomography scans, magnetic resonance imaging, and medical records were retrospectively reviewed. All available data concerning demographics, C2 PF pattern, neurologic status, union status, and complications were extracted. The incidence rates and characteristics of other associated C2 and C2-3 injuries and other cervical injuries were evaluated. In addition, treatment methods and outcomes were analyzed. We divided these patients into two groups, unilateral and bilateral C2 PFs group. We compared these groups to each other for the characteristics of other associated injuries, treatment methods, and outcomes.

Results: Twenty-two patients (44.9%) had unilateral C2 PFs and 27 patients (55.1%) had bilateral C2 PFs. There was no case of C2 PF alone: among the cases of unilateral C2 PF, 22 patients (100%) had one or more other C2 fractures and 20 patients (90.9%) had one or two C2 body fractures, while two patients (9.1%) had C2–3 anterior slip and two patients (9.1%) had other cervical injuries. Meanwhile, among the cases of bilateral C2 PF, 27 patients (100%) had two or more other C2 fractures and all patients (100%) had one or two C2 body fractures, five patients (18.5%) had C2–3 anterior slip, one patient (3.7%) had spinal cord injury (SCI) at C2–3 and six patients (22.2%) had other cervical injuries. In unilateral C2 PFs, 3 patients (13.6%) with C2–3 anterior slip or adjacent cervical spine (C1–3) injury underwent surgery and 19 patients (86.4%) were treated with conservative methods. In bilateral C2 PFs, 3 patients (11.1%) with C2-3 anterior slip or SCI at C2–3 underwent surgery and 24 patients (88.9%) were treated with conservative methods. One patient with bilateral PF, C2–3 anterior slip, and C1 posterior arch fracture developed nonunion after Philadelphia brace application.

Conclusions: Our results showed that C2 PFs do not occur alone and are always accompanied by other associated C2 injuries. In spite of the complex fracture characteristics, most C2 PFs can be managed with conservative treatment. However, surgical treatments should be considered if the C2 PFs are accompanied by the C2–3 anterior slip and adjacent cervical spine injury.

161

Frailty Can Be a Potential Prognostic Factor for Patients with Metastatic Spinal Tumor as Initial Manifestation of Malignancy

Kazuya Kitamura, Akimasa Yasuda, Atsushi Miyake, Taisuke Imai, Michio Susa, Kazuhiro Chiba

Department of Orthopaedic Surgery, National Defense Medical College, Saitama, Japan

Objectives: The purpose of this study was to determine the prognostic factors which can be used at the initial visit of patients who present symptoms of metastatic spinal tu-

mors as the initial manifestation of malignancy.

Methods: This study was a retrospective case-control study including 36 patients (surgical [n=34] and conservative [n=2]) who were treated at our hospital since 2010 for malignancy that manifested itself as metastatic spinal tumors at the initial visit. All patients had no history of malignancy and the sites of primary lesions were detected after the identification of spinal metastasis. Patients who survived longer than one year after the initial visits were grouped into the L group (n=22) and those who survived shorter than one year into the S group (n=14). Demographic characteristics of patients, variables at the initial visit (severity of paralysis using Frankel grades, frailty [modified Frailty Index (mFI-5) ≥2], performance status [PS], spinal instability predicted by Spine Instability Neoplastic Score [SINS; instability, indeterminate instability, stability]), and histological grading of the primary site determined by Katagiri's scoring system (Slow Growth [e.g., hormone-dependent breast and prostate cancer, thyroid cancer, multiple myeloma, malignant lymphoma], Moderate Growth [e.g., lung cancer treated with molecularly targeted drugs, renal cell carcinoma], Rapid Growth [e.g., lung cancer untreated with molecularly targeted drugs, colorectal cancer, cancers of unknown origin]) were compared between the two groups.

Results: No significant differences in sex, SINS, and PS were found. Among the variables at the initial visit, age (63.5 years in the L group vs. 73.4 years in the S group, p=0.03) and the percentage of patients with frailty (29.4% vs. 71.4%, p<0.01) were significantly higher in the S group than in the L group. Regarding the primary site, Slow Growth was significantly more frequent in the L group and Rapid Growth in the S group (Slow Growth: 15 cases in the L group vs. 2 cases in the S group; Moderate Growth: 3 cases vs. 2 cases; Rapid Growth: 4 cases vs. 11 cases; p<0.01). Univariate logistic regression analysis revealed that age (odds ratio [OR], 1.1; 95% confidence interval [CI], 1.00–1.14; p=0.04), frailty (OR, 6.8; 95% CI, 1.80–25.46; p=0.01), and grading of primary site (OR, 27.9; 95% CI, 3.02–257.27; p<0.01) have significant correlation with poor prognosis, shorter than 1 year after the initial visit.

Conclusions: Frailty can be a potential prognostic factor at the initial visit in patients with symptoms of the metastatic spinal tumor as the initial manifestation of malignancy.

170

Comparison of Functional Outcomes in Open versus Minimally Invasive Spine Surgery for Lumbar Degenerative Pathology: A Prospective Analytical Study

Harsh Agrawal, Ayush Sharma, Vijay Sharma, Atif Naseem

Bharat Ratna Dr. Babasaheb Ambedkar Memorial Hospital, Byculla, India

Objectives: The prevalence of disc degeneration is quite high, particularly in the elderly age group. Patients with failed conservative management, neurological compromise, or limitations with the activity of daily living will require surgical intervention to decompress and stabilize the affected segments. Degenerative lumbar spine disease requiring surgical intervention can be done by an open or minimally invasive (MIS) approach. While the result and outcomes of one over another is long debated, we investigated the functional outcomes following open and MIS spine surgeries for degenerative lumbar disease.

Methods: All patients undergoing surgery for degenerative lumbar pathology were prospectively followed for 1 year. Visual Analog Scale (VAS) score and Oswestry Disability Index (ODI) were used to analyze the functional outcome at postoperative period day 1, 2 weeks, 1 month, 3 months, 6 months, and 1 year. Data was divided into an open and MIS group and analyzed. A p-value <0.05 was taken as significant.

Results: A total of 488 patients were included in the final analysis; 164 were from the MIS group and 242 underwent open surgery. Transforaminal lumbar interbody fusion (TLIF) was done in 142 patients of which 56 (39.4%) underwent MIS TLIF. A total of 240 patients were operated for discectomy of which 104 (43.3%) were from the MIS group and 136 (56.6%) underwent open discectomy. While preoperative mean VAS scores were comparable for both the groups. Follow-up VAS scores were significantly better for MIS group at postoperative day 1 (p=0.001), 2 weeks (p=0.001), 1 month (p=0.001), 3 months (p=0.003), and 6 months (p=0.023). Similarly, ODI scores were also significantly better for the MIS group at postoperative day 1 (p=0.004), 2 weeks (p=0.001), and 1 month (p=0.003). No significant difference was found between 1-year VAS

scores between the two groups (p=0.145). Similarly, ODI scores were comparable between the two groups at 3 months, 6 months, and 1 year. Incidence of dural tear was significantly less (6.4%) in the minimally invasive group compared to open surgery (15.7%) (p=0.01).

Conclusions: Functional outcomes of minimally invasive surgery for degenerative lumbar pathology are comparable with open surgery with significantly improved VAS scores up to 6 months and significantly better ODI scores up to 1 month. Dural tears are significantly less in MIS surgery

182

Prenatal Counselling for Spine Anomalies–Algorithm of Management: From the Genesis to Treatment

Hriday Acharya, Abhay Nene

Paras Advanced center of Excellence, Ahmedabad, India

Objectives: Spinal anomalies like scoliosis, kyphosis, hemivertebra, tethered cord anomalies, spina bifida, and many more can be diagnosed even before birth. In this era of early diagnosis and prevention, this could be a boon to spine surgeons to educate and counsel the parents to minimize the physical deformity before correction and prevent the child's problem by proper management. Not only that, since we could now follow up from the very day the child is born, it gives us a lead time in early management of any disorders or complications, which would develop in the life to come. It can provide the child with a better future. Here, we propose an algorithm for the management of these spine anomalies from their diagnosis intrauterine till management after birth.

Methods: We studied over 10,000 fetal scans and the most commonly diagnosed spine anomalies were isolated. The management of each of those anomalies ranging from their intrauterine management, postnatal management, and treatment in early childhood and adulthood were reviewed. An algorithm was formulated by a team of spine surgeon, fetal medicine specialist, and obstetrician which took into consideration the time of diagnosis, follow up till the birth of the fetus, and management of those anomalies.

Results: The algorithm is comprised of a team of spine surgeon, fetal medicine specialist, and obstetrician each of whom have a defined role to play. Early diagnosis of spine anomalies like hemivertebra and other segmentation defects along with spina bifida could be easily diagnosed at 12 weeks. Most other anomalies like tethered cord syndrome, kyphosis, scoliosis, and any other syndromic association or central nervous system anomalies can be identified by 20 weeks. After a primary diagnosis of the fetal spine, by pre-set protocols, by the fetal medicine expert, the parents are counseled by a team of spine surgeons and an obstetrician. The spine surgeon would manage anomalies by either intra-uterine surgery (for spina bifida) or postnatal management as early as possible, in coordination with the obstetrician, to prevent any sequela of the condition.

Conclusions: This algorithm gives us a lead time in diagnosing and management of spinal anomalies. This would help in providing the correct treatment to the child in a structured fashion avoiding the delay in diagnosis due to late presentation of symptoms and thereby preventing related complications. It would also, most importantly, help in making the parents prepared for their child's problems and providing them with an effective plan to manage them.

226

Efficacy of Non-fusion Surgeries in the Management of AO Type C Injuries of the Thoracic and Thoracolumbar Spine: A Retrospective Study

Nishat Ahmed, Chandhan Murugan, Rajasekaran, Ajoy Prasad Shetty

Ganga Medical Centre and Hospitals Pvt. Ltd., Coimbatore, India

Objectives: The initial descriptions of successful management of non-fusion surgeries in the management of unstable burst injuries of the thoracic and thoracolumbar spine (TTLS) were published by Osti in 1987 and Sanderson in 1999. These were further supported by prospective studies and meta-analyses establishing comparable results between fusion and non-fusion surgeries. However, there is a paucity of literature regarding the efficacy of non-

fusion surgeries in the management of AO type C injuries. The study aims to determine the efficacy of open posterior instrumented stabilization without fusion in AO type C injuries of the TTLS.

Methods: Patients with AO type C injuries of the TTLS (T4–L2 levels) with normal neurology who underwent open posterior long segment instrumented stabilization without fusion between January 2015 and June 2018 were included. The regional kyphotic angle, local kyphotic angle, AP (anterior and posterior wall) ratio, and cumulative loss of disc space angle were assessed on radiographs. Functional outcome was assessed using Oswestry Disability Index (ODI) and the AO Spine PROST.

Results: The study included 35 patients with AO type C injury of the TTLS and normal neurology who underwent open posterior instrumented stabilization and had a mean follow-up of 43.2 months (range, 24 to 60 months). The mean preoperative regional kyphotic angle decreased from 19.8°±13.7° to 6.6°±11.3° after surgery but showed an increase to 9.21°±10.5° at final follow-up (p=0.003). The cumulative loss of disc space angle was significant at final the follow-up (2.4°±5°, p=0.002). Twenty-eight of 35 patients had minimal while seven had moderate disability on the ODI score. The AO spine PROST revealed that patients regained 95.7%±4.2% of their pre-injury functional status at final follow-up.

Conclusions: Posterior instrumented stabilization without fusion in the management of AO type C injuries of the TTLS gives satisfactory results with acceptable functional and radiological outcomes.

235

Are Modic Changes Primary Infective Endplatitis? Insights from Multimodal Imaging of Non-Specific Low Back Pain Patients and Development of a Radiological Endplate Infection Probability Score

Chandhan Murugan, Rajasekaran

Ganga Medical Centre and Hospitals Pvt. Ltd., Coimbatore, India

Objectives: There is still controversy over the etiology of Modic changes (MC) with proponents for traumatic, inflammatory, and infective theories. The study aims to probe the etiology of MC by comparing the magnetic resonance imaging (MRI) and computed tomography (CT) findings of patients with MC to the MRI and CT findings in patients diagnosed with documented infection and trauma.

Methods: Nineteen radiological signs found in mild infections and traumatic endplate fractures were identified by MRI and CT, and by elimination, three signs unique to infection and trauma were distilled. By ranking the Z score, a radiological 'Endplate Infection Probability Score' (EIPS) was developed. The score's ability to differentiate between infection and traumatic endplate changes (EPC) was validated in a fresh set of 15 patients each, with documented infection and trauma. The EIPS, erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), and Numeric Pain Rating Scale (NRS) were then compared between 115 patients with and 80 patients without MC.

Results: The three radiological signs distinct for infection were involvement of EPs on either side of the disc, typical erosion patterns, and extensive sclerosis well beyond the margins of the lesion which were given scores of +3, +2, and +1, respectively. Involvement of the superior EP only, single vertebral body edema and absent, or rim sclerosis around the defect, were the three radiological signs that indicated traumatic EPC and were scored -3, -2, and -1, respectively. The confidence of EIPS for having EPC suggesting infection was 66.4% for score 4, 83% for score 5, and 100% for score 6. In step 2, the validity of the EIPS to differentiate between infection and trauma in a fresh set of 30 patients at a score of 4 and above was found to be 100%. In step 3, the mean EIPS was 4.85±1.94 in patients compared to -0.66±0.49 in patients without MC (p<0.001). Seventy-eight patients (67.64%) with MC had a score of 6, indicating a high infection possibility. There was a difference in the NRS (p<0.01), ESR (p=0.05), CRP (p<0.01), and type of pain (p<0.01) between patients with and without MC.

Conclusions: Multimodal imaging showed many radiological signs not easily seen in MRI alone and thus missed in Modic classification. There were distinct radiological differences between EPCs of trauma and infection which allowed the development of an EIPS. The scores showed that 67.64% of our study patients with MC had EPCs resembling infection rather than trauma suggesting the possibility of an infective etiology.

172

Double Door Cervical Laminoplasty with New Type Ceramic Spacer

Takeshi Aoyama, Naoshi Obara, Hirokazu Furukawa, Takahiro Iida

Spine Center, Department of Orthopaedic Surgery, Teine Keijinkai Hospital, Sapporo, Japan

Objectives: Cervical laminoplasty is widely performed in several methods, open door or double door, and using the plate, anchor, spacer, or suturing lamina with muscle to maintain lamina opening. Our method is a double door and fixing ceramic spacer with filament. Many types of spacer with grooves for filament are available in the market, but not always fit for all surgeons' methods. We improved the shape of the ceramic spacer.

Methods: The surgical method was double door laminoplasty. The spacer was applied between opened both side laminae, fixed with two filaments through a long axis hole of the spacer. To prevent rotation, the spacer was tied with two filaments like 8 shapes, or omega shape. The spacer we improved has 4 or 6 notches on each long edge, which can catch filament. Since April 2017, this type of spacer has been used for 30 cases, 83 laminae. The mean age was 69.6±9.2 years. Maintenance of lamina opening and spacer dislocation was retrospectively analyzed.

Results: Follow-up was 15.5±12.0 months. A follow-up cervical X-ray was performed in all 30 cases. Dislocation of the spacer was in no case, and lamina opening was maintained in all 30 cases, 83 laminae. Follow-up computed tomography after 6 months was performed in 13 cases, 36 laminae. Bone fusion at the hinge was confirmed at 34/36 laminae (94%). The two laminae were of 6 months and were expected to fuse in the future. The surgical procedure, i.e., fixing the spacer, was easy, although it was difficult to quantify.

Conclusions: There are many types of the spacer, and the required function is in argues. We postulate spacer is support for opening lamina until bone fusion at the hinge, and a bone fusion between spacer and lamina is not necessary. The stability of the spacer is stiff since tied filament seldom shifts from the notch of the spacer. And it is less expensive than other types using screws, which has an advantage in the point of medical economy. This spacer is useful in double-door laminoplasty.

209

Clinical Correlation with Magnetic Resonance Imaging Findings in Symptomatic Lumbar Canal Stenosis Patients

Pankaj Kumar Sharma

All India Institute of Medical Sciences, Bathinda, India

Objectives: The management of lumbar canal stenosis (LCS) depends on the clinical severity and magnetic resonance imaging (MRI) findings but the correlation between the same still remains unclear. The study aims to assess the correlation between MRI features and clinical severity in patients with symptomatic LCS.

Methods: A prospective observational study including 150 patients with LCS. Data including demographic, anthropometric profile and clinical features, Visual Analog Scale (VAS) score for back pain and leg pain, and modified Oswestry Disability Index (mODI) scores were collected on the initial visit. Schizas 7 grade classification system was used to classify the MRI severity of LCS. Antero-posterior (AP) diameter and cross-sectional area of dural sac for central, diameter of the foramen for foraminal, and height of lateral recess for lateral stenosis were the most commonly used criteria in the diagnosis of LCS.

Results: A total of 87 males and 63 females with a mean age of 56.5±11.3 years were part of the study. The mean VAS score for back and leg pain were 6.3±1.1 and 7.6±1.3, respectively. The mean mODI score was 47±13.8. Central, lateral, and foraminal stenosis were noted in 71, 41, and 38 patients, respectively. Mild, moderate, severe, and extreme stenosis were reported in 63, 42, 28, and 17 patients, respectively. MRI grade of LCS does not correlate with mODI score (p=0.082) or VAS score for back pain (p=0.092) but strong correlation with VAS score for leg pain (p=0.023). Of all the MRI parameters studied, the AP diameter of the bony canal, the diameter of the foramen, height of the lateral recess, and cross-sectional area of the dural sac showed a strong correlation with both the mODI and VAS scores.

Conclusions: Quantitatively on MRI, central spinal canal cross-section (less than 75 mm^2 for central stenosis) and

lateral recesses cross-section (less than 20 mm^2 for lateral stenosis) had the highest sensitivity and specificity for LSS diagnosis in symptomatic patients. Strongest observed correlation was between neurogenic claudication and LSS diagnostic radiological markers. MRI grade of LCS was not correlated with mODI scores or VAS scores for back pain but a strong correlation was observed with VAS score for leg pain.

51

Analysis of the Predictive Factors for Moderate and Severe Pulmonary Impairment among Adolescent Idiopathic Scoliosis Patients with Major Cobb Angle

Sin Ying Lee, Weng Hong Chung, Chee Kidd Chiu, Chris Yin Wei Chan, Mun Keong Kwan

Universiti Malaya, Kuala Lumpur, Malaysia

Objectives: To investigate the independent predictive factors for moderate-severe pulmonary impairment among adolescent idiopathic scoliosis (AIS) patients.

Methods: We retrospectively reviewed 102 AIS patients with major Cobb angle ≥45° from all Lenke curve types, operated between 2015 and 2020. Preoperative pulmonary function tests (PFTs) were reviewed. Patients were subclassified into two groups for each of the parameters of forced vital capacity (FVC) and forced expiratory volume in one second (FEV1). Group 1 were patients with mild pulmonary impairment (FVC or FEV1 ≤80% but >65% of the predicted values [pred%]) whereas group 2 were patients with moderate-severe pulmonary impairment (FVC or FEV1 ≤65% pred%). Preoperative PFTs, clinical, and radiological parameters were analyzed in relation to FVC and FEV1 pred%, respectively. Univariate logistic regression followed by multivariate logistic regression analyses were applied to identify the predictive factors for moderate-severe pulmonary impairment.

Results: The mean age was 16.1±4.3 years. The mean main thoracic (MT) Cobb angle was 61.1°±19.7° with mean flexibility of 54.9%±19.4%. In this study, 41.2% (N=42) of the total patients were classified into group 2 (FVC ≤65% pred%) in relation to FVC. Meanwhile, 52.0% (N=53) of the total patients belonged to group 2 (FEV1 ≤65% pred%) in relation to FEV1. In general, group 2 (FVC or FEV1 ≤65% pred%) had a significantly larger proportion of patients with a major MT curve, more severe MT curve with lower MT flexibility, larger MT apical vertebra translation (AVT), and smaller thoracolumbar-lumbar AVT (p<0.05). In this cohort, the mean absolute values were 2.31±0.62 L and 2.02±0.57 L and mean predicted values were 66.4%±16.1% and 62.9%±16.6% for FVC and FEV1, respectively. In the context of curve severity versus pulmonary function, patients with a more severe MT curve especially Cobb angle of ≥70° were observed to have a moderate pulmonary impairment. Meanwhile, patients with severe scoliosis (Cobb angle ≥90°) experienced moderate to severe pulmonary impairment (approximately 50% of FVC or FEV1 pred%). The multivariate logistic regression for both FVC and FEV1 pred% demonstrated body mass index (BMI) (FVC: adjusted odds ratio [aOR], 0.8; FEV1: aOR, 0.9) and MT Cobb angle (for every 10° increment, FVC: aOR, 1.7; FEV1: aOR, 1.8) as significant independent predictive factors for moderate-severe pulmonary impairment (p<0.05).

Conclusions: In this study cohort, moderate-severe pulmonary impairment was observed among patients with MT Cobb angle ≥70°. MT Cobb angle and BMI are significant independent predictive factors for moderate-severe pulmonary impairment among AIS patients with major Cobb angle ≥45°

71

The Investigation of the Cervical Balance and Clinical Outcome of C1 Laminoplasty on Cervical Myelopathy with Lordotic Alignment: A Retrospective Case Analysis

Hao-Wen Chen, Kuang-Ting Yeh, Ing-Ho Chen, Tzai-Chu Yu, Chia-Ming Chang, Wen-Tien Wu

Orthopaedic Department, Hualien Tzu Chi Hospital, Hualien, Taiwan

Objectives: Laminoplasty over subaxial levels has made an appropriate decompression of cervical myelopathy via posterior shifting of the spinal cord in patients with lordotic cervical alignment. However, controversy still exists regarding the application of laminoplasty over C1 level to restore mobility for specific candidates with inherent

limited range of motion (ROM), such as ankylosing spondylitis extended ossification of the posterior longitudinal ligament, atlas hypoplasia with ossification of transverse atlantal ligament, and adjacent segment disease following subaxial fusion procedures. This retrospective case analysis aimed to investigate the sagittal balance and the clinical outcome of atlantal laminoplasty for cervical myelopathy.

Methods: From 2010 to December 2020, consecutive 20 cervical myelopathy patients with lordotic alignment indicated posterior decompression via expansive open-door laminoplasty over C1 level were contained in this study. The procedures were performed with a modified muscle-preserving approach, deemed to preserve better atlantoaxial stability after C1 laminoplasty. The radiographic parameters measured as sagittal balance, such as C0–2 Cobb angle (CA), C2–7 CA, C0–2 ROM, T1 slope, C1–7 sagittal vertical axis (SVA), C2–7 SVA, and center of gravity of the head (CGH)–C7 SVA. The Japanese Orthopaedic Association (JOA) score, Visual Analog Scale (VAS), and Neck Disability Index (NDI) were also evaluated as the functional outcome postoperatively, 6 months postoperatively, and 1 year postoperatively, respectively.

Results: The patients were divided into two groups according to the existence of subaxial fusion or not. There was no difference between groups in age, gender, BMI, preoperative C0–2 CA, C2–7 CA, T1 slope, C1–7 SVA, C2–7 SVA, CGH–C7 SVA, and chin to brow vertical angle, but significantly higher in the preoperative C0–2 ROM (p=0.011) of the subaxial fusion group than the non-subaxial fusion group. The JOA, VAS, and NDI were improved significantly at 6 months postoperatively and 1 year postoperatively in both groups. According to the multivariate logistic regression analysis, higher preoperative CGH–C7 SVA levels are related considerably to decreases in the lordotic angle (p=0.021), the poor clinical outcome of the JOA score (p=0.036), and NDI (p=0.042).

Conclusions: Application of C1 expansive open-door laminoplasty to C1 stenosis revealed improved clinical outcomes with non-inferior cervical imbalance. With the protective construct and stability-preserved approach, C1 laminoplasty may be an alternative solution over laminectomy with or even without instrumented fusion.

143

Posterior C1–2 Pedicle Screws Fixation for the Treatment of Unstable Complex C2 Fractures: Our Experience

Biswaranjan Nayak, Amit Jaiswal

AMRI Hospital, Bhubaneswar, India

Objectives: To assess the outcome of C1–C2 pedicle fixation for complex C2 fracture with instability and to discuss its clinical results.

Methods: A total of nine patients were included in the study (eight males and one female). Their age ranged from 43 to 76 years. The patients were diagnosed with complex fractures of the axis of the upper cervical spine and underwent posterior C1–2 pedicle screws fixation. The patients underwent a serial postoperative clinical examination at approximately 3, 6, 9 months, and annually thereafter. The Neck Disability Index (NDI) and the range of neck rotary motion were used to evaluate the postoperative clinical efficacy of the patients.

Results: The mean follow-up was 1–3 years. The average operation time and blood loss were 105–150 minutes and 50–75 mL, respectively. The NDI was improving after surgery to a great extent. The patients with myelopathy (specifically in old C2 fracture with cord compression) also showed significant improvement as assessed by Nurick grading.

Conclusions: Posterior screw fixation is a good surgical treatment option for unstable complex C2 fractures.

3

Utilization of Hart-International Spine. Study Group Proximal Junctional Kyphosis Severity Scale to Predict the Prognosis of Proximal Junctional Failure Following Adult Spinal Deformity Surgery

Aditya Raj, Chong-Suh Lee, Jin-Sung Park, Se-Jun Park

Smt. Kashibai Navale Medical College and General Hospital, Pune, India

Objectives: The proximal junctional kyphosis severity

scale (PJKSS) has been validated showing good correlations with a likelihood of revision surgery for proximal junctional failure (PJF) after surgical treatment of adult spinal deformity (ASD). However, if the patient has progressive neurological deterioration, the revision surgery should be considered regardless of the severity based on PJKSS scores. This study aims to re-validate the PJKSS system to assess the predictability of revision surgery for PJF among neurologically intact patients after surgical treatment of ASD.

Methods: A retrospective study was performed. Among 360 patients who underwent more than four-segment fusion including the sacrum, 83 patients who developed PJF without acute neurologic deficit were included. There were 30 patients undergoing revision surgery (R group) and 53 patients without revision surgery (NR group). All components of PJKSS and variables other than PJKSS components were compared between two groups. Cutoff values of PJKSS score to perform revision surgery was calculated under the receiver operating characteristic curve. Multivariate analyses using logistic regression were performed to identify which variables were most predictive for revision surgery.

Results: The mean age at the time of index surgery was 69.4 years and the mean fusion length was 6.1. There were significant differences between the two groups in all components of PJKSS such as focal pain, instrumentation problem, change in kyphosis, uppermost instrumented vertebra (UIV)/UIV+1 fracture, and level of UIV. The average total sum was significantly greater in the R group than in the NR group (6.0 vs. 3.9, $p<0.001$). The cutoff value was calculated as 4.5 where the sensitivity was 70% and specificity was 69.8%. There were no significant differences in variables other than PJKSS in terms of patients, surgical, and radiographic factors. Three factors were significant on multivariate analysis such as instrumentation problem (odds ratio [OR], 8.160; $p=0.004$), change in kyphosis (OR, 4.809; $p=0.026$), and UIV/UIV+1 fracture (OR, 6.462; $p=0.002$)

Conclusions: The PJKSS positively predicts the need for revision surgery in patients with PJF who are neurologically intact. The cut-off value of PJKSS scores to promote revision surgery was calculated as 4.5 with a sensitivity and specificity of 70%. The most responsible factors for revision surgery were bony failure with >20° focal kyphotic deformity. Therefore, early surgical intervention should be considered for these patients even in the absence of neurologic deficit.

17

Delirium Risk Score in Elderly Patients with Cervical Spinal Cord Injury: Analysis of 1,506 Cases from the Japan Association of Spine Surgeons with Ambition Multicenter Registry Data

Koji Tamai, Hidetomi Terai, Akinobu Suzuki, Hiroaki Nakamura

Osaka Metropolitan University, Osaka, Japan

Objective: Applicable standardized screening tools for delirium in elderly patients with cervical spinal cord injury (SCI) and/or cervical fracture are lacking. The aim of this study is to establish a delirium risk score for such patients that can predict delirium regardless of treatment type.

Methods: This is a retrospective cohort study including 1,506 patients aged >65 years with traumatic cervical SCI and/or cervical fracture. The risk factors of delirium according to treatment type (surgical or conservative) were calculated using multivariate logistic regression. A delirium risk score was created using significant variables from the multivariate analyses of the two treatment cohorts, and the predictive value of the scoring system was evaluated by receiver operating characteristic analysis.

Results: Delirium was found in 9.2% and 7.3% of patients in the conservative and surgical cohorts, respectively. High age, hypoalbuminemia, cervical fracture, and major-organ injury were revealed as independent variables related to delirium in the conservative cohort (all $p<0.05$). Additionally, high age, lower activities of daily living (ADL), comorbid diabetes, and cervical fracture were revealed as independent variables related to delirium in the surgical cohort (all $p<0.05$). The delirium risk score was defined using six factors: high age (≥80 years), hypoalbuminemia, cervical fracture, major organ injury, low ADL, and comorbid diabetes. The area under the curve of the delirium risk score for the prediction of delirium in the total cohort was 0.66 ($p<0.001$)

Conclusions: The current study established a screening system using six risk factors, including high age, hypoalbuminemia, cervical spine fracture, major organ injury,

low ADL, and diabetes. When patients had two of these six risk factors, the development of delirium during treatment could be predicted with 78% sensitivity and 46% specificity regardless of the type of therapy. The current screening tool can be applied to patients with cervical SCI and/or cervical fracture using only objective data, before treatment decision-making. These features can enable early intervention for the prevention of delirium in those who most need it.

18

The Validation Study of Three Preoperative Plans for Adult Spinal Deformity Surgery

Shin Oe, Yu Yamato, Tomohiko Hasegawa, Yukihiro Matsuyama

Hamamatsu University School of Medicine, Hamamatsu, Japan

Objectives: The Hamamatsu formula has been used as an indicator of correction goals in adult spinal deformity surgery. However, there are reports that correction according to the Roussouly algorithm and the Global Alignment and Proportion (GAP) Score reduces implant-related complications. The purpose of this study was to validate these three preoperative plans on the incidence of complications.

Methods: Patients who underwent the surgery between 2010 and 2016 were included in the study. Patients who met the postoperative Roussouly algorithm were defined as the restored (R) group and those who did not were defined as the non-restored (NR) group. The GAP score was divided into three groups: proportioned (P), moderately proportioned (MP), and severely proportioned (SP), and the Hamamatsu formula was also divided into three groups: ideal (I), moderate (M), and under (U). Proximal junctional kyphosis (PJK) and rod fracture were investigated.

Results: The Roussouly classification was 102 patients in the R group and 101 patients in the NR group, and the complication rate was R:NR=51%:70% (p=0.005). In particular, PJK was significantly lower in the R group (R:NR=15%:30%) (p=0.010). There were 45 patients in the P group, 71 in the MP group, and 87 in the SP group. There was no significant difference in complications, P:MP:SP=58%:52%:69%. In Hamamatsu formula, there were 51 patients in group I, 108 patients in group M, and 44 patients in group U. There was no significant difference in complications, I:M:U=59%:62%:59%. Logistic regression analysis showed that the odds ratio for complications in the NR group was 2.3 (p=0.006).

Conclusions: Correction according to the Roussouly algorithm is critical for the prevention of mechanical complications.

39

Preoperative Less Right Shoulder Elevation Had a Higher Risk of Postoperative Shoulder Imbalance When Main Thoracic Curve Is Well Corrected Regardless of the Upper Instrumented Vertebra Level for Patients with Adolescent Idiopathic Scoliosis Lenke Type 1

Tomohiro Banno, Yu Yamato, Tomohiko Hasegawa, Yukihiro Matsuyama

Hamamatsu University School of Medicine, Hamamatsu, Japan

Objectives: This study investigated the incidence of and risk factors for postoperative shoulder imbalance (PSI) in patients with adolescent idiopathic scoliosis (AIS) Lenke type 1.

Methods: We retrospectively analyzed the data of AIS patients with Lenke type 1 curves who underwent posterior fusion surgery. PSI was defined as an absolute radiographic shoulder height (RSH) of ≥20 mm 2 years postoperatively. Patients were classified based on the presence of PSI and based on their upper instrumented vertebra (UIV) level (UIV at T2 or T3 [U-UIV] or UIV below T3 [L-UIV]). The radiographic parameters and clinical outcomes were compared, and the cut-off values of risk factors were identified by multivariate analysis.

Results: Of 104 patients, 21 (20.2 %) had left shoulder elevation PSI. The PSI group had a significantly greater preoperative RSH (-5.1 mm vs. -14.3 mm) and main thoracic (MT) curve correction rate (77.3% vs. 69.1%) than the non-PSI group. The PSI incidence did not differ between the U-UIV and L-UIV groups. Multivariate analysis identified preoperative RSH and the MT curve correction rate as independent risk factors for PSI. The receiver operating characteristic curve analysis identified the preoperative RSH cut-off value as -6.5 mm and the MT curve correc-

tion rate cut-off value as 76.9%.

Conclusions: The incidence of PSI was relatively high (20.2%), even in AIS patients with Lenke type 1 curves. Patients with preoperative lower right shoulder elevation (i.e., preoperative RSH >-6.5 mm) had a higher risk of PSI when the MT curve was well corrected (correction rate >76.9%) regardless of the UIV level.

49

Postoperative Shoulder and Neck Balance among Lenke 1 and 2 Adolescent Idiopathic Scoliosis Patients Undergoing Posterior Spinal Fusion Surgery: A Minimum 5-Year Follow-up Analysis

Weng Hong Chung, Chee Kidd Chiu, Mun Keong Kwan, Chris Yin Wei Chan

Universiti Malaya, Kuala Lumpur, Malaysia

Objectives: Postoperative shoulder and neck imbalance is common in adolescent idiopathic scoliosis (AIS) patients. However, the temporal evolution of the medial shoulder and neck, as well as lateral shoulder balance, are not well described. We aimed to report the postoperative shoulder and neck balance among Lenke 1 and 2 AIS patients who had a minimum 5-year follow-up after posterior spinal fusion (PSF) surgery.

Methods: A total of 60 patients were retrospectively reviewed. "Medial shoulder balance" was represented by T1 tilt and was defined as "balanced" (MB) when -3°≤T1 tilt ≤3°. T1 tilt >3° was defined as medial shoulder imbalanced positive (MI+ve) whereas T1 tilt <-3° was defined as MI-ve. "Lateral shoulder balance (LSB)" was represented by clavicle angle (Cla-A) and was defined as "balanced" (LB) when -2°≤ Cla-A ≤2°. LI+ve was Cla-A >2° whereas LI-ve was Cla-A <-2°. The cervical axis (CA) represented "neck balance" and was defined as "balanced" (NB) if -3°≤ CA ≤3°, whereas NI+ve was CA >3° and NI-ve was CA <-3°. Shoulder and neck balance were compared at postoperative 6-month (FU1) and at final follow-up (FU2).

Results: The mean age was 15.6±3.3 years old. At FU1, 31 patients (51.7%) achieved MB, 20 patients (33.3%) had MI+ve while nine patients (15.0%) had MI-ve. Among those with MB at FU1, 90.3% remained MB at FU2. Among patients with MI+ve at FU1, 60.0% would remain MI+ve while only 40.0% achieved MB at FU2. 88.9% of patients with MI-ve at FU1 remained MI-ve at FU2. Only one patient achieved MB. For LSB, 42 patients (70%) had LB, 26.7% had LI+ve and 3.3% had LI-ve at FU1. And 81.2% of patients with LI+ve at FU1 achieved LB during FU2. At FU1, 76.7% of patients had NB, 20.0% had NI+ve and 3.3% had NI-ve. 95.7% of patients who had NB during FU1 remained NB at FU2. However, 41.7% of those with NI+ve at FU1 remained as NI+ve at FU2.

Conclusions: At a minimum of 5-year follow-up, most patients with postoperative MI+ve and MI-ve would remain imbalanced. Similarly, 40% of patients with NI+ve would remain NI+ve at 5-year FU. On the contrary, the majority would achieve LB at 5-year FU. It is important to achieve balanced "medial shoulder and neck" during surgery in Lenke 1 and 2 AIS because spontaneous correction of medial shoulder and neck imbalance over time might not be achieved.

50

Does Preoperative Radiological Shoulder Balance Correlate with Preoperative Clinical Shoulder Balance in Adolescent Idiopathic Scoliosis Patients?

Woon Theng Heng, Chee Kidd Chiu, Mun Keong Kwan, Chris Yin Wei Chan

Universiti Malaya, Kuala Lumpur, Malaysia

Objectives: To determine the correlation between radiological and clinical shoulder balance in adolescent idiopathic scoliosis (AIS) patients.

Methods: Photographs and radiographs of thirty AIS patients with structural main thoracic curves (except Lenke type 5) who underwent posterior spinal fusion were retrieved and analyzed. Radiological parameters were represented by Cobb angle, T1 tilt, first rib angle (FRA), coracoid process height (CPH), clavicle-rib cage intersection (CRCI), clavicle angle (Cla-A), cervical axis (CA), and radiographic shoulder height (RSH). Clinical parameters were inner and outer shoulder height (SHi and SHo), front and back shoulder angle, front and back axilla angle, front and back trapezial angle, front and back trapezium angle ratio, natural logarithm (LN) of trapezial area ratio,

and shoulder area index 1 and 2 (SAI1 and SAI2). The correlation between radiological and clinical parameters was calculated using IBM SPSS ver. 26.0 (IBM Corp., Armonk, NY, USA). Statistical significance was set at 0.05.

Results: Clinical medial shoulder parameters represented by SHi, trapezial angles, and LN of trapezial area ratio correlated well with radiological medial shoulder parameters, i.e., T1 tilt and FRA (SHi: 0.798 and 0.820; front trapezial angle: 863 and 0.850; back trapezial angle: 0.879 and 0.867; LN of trapezial area ratio: 0.761 and 0.758, respectively). Clinical lateral shoulder parameters which were SHo, shoulder angle, axilla angle, trapezium angle ratio, and surface area correlated moderately with radiological lateral shoulder parameters by CPH, CRCI, Cla-A, and RSH. The correlation of SHo with CRCI, Cla-A, and RSH were 0.637, 0.684, and 0.671, respectively. Back shoulder and axilla angle correlated moderately with Cla-A and RSH (back shoulder angle: 0.643 and 0.670; back axilla angle: 0.583 and 0.650, respectively) whereas front shoulder angle correlated well with RSH (r=0.620). Trapezium angle ratio correlated moderately with CPH, CRCI, Cla-A, and RSH (back trapezium angle ratio: 0.661, 0.724, 0.703, and 0.747, respectively; front trapezium angle ratio: 0.639, 0.622, 0.636, and 0.676, respectively).

Conclusions: There was a moderate to a strong positive correlation between radiological and clinical shoulder balance in AIS patients. Medial clinical parameters include SHi, front and back trapezial angle, and trapezial area ratio correlated well with medial radiological parameters such as T1 tilt and FRA.

69

Simultaneous Overcorrection of Lowest Instrumented Vertebral Tilt and Main Thoracic Curve Is Related to Progression of Unfused Residual Lumbar Curve after Posterior Fusion in Adolescent Idiopathic Scoliosis

I-Hsin Chen, Chih-Wei Chen, Ming-Hsiao Hu, Po-Yao Wang, Po-Liang Lai, Shu-Hua Yang

Department of Orthopedics, National Taiwan University Hospital, Taipei, Taiwan

Objectives: To disclose radiographic parameters, including the lowest instrumented vertebral (LIV) tilt, related to the postoperative magnitude and progression of residual lumbar curves (LCs) in adolescent idiopathic scoliosis (AIS) patients who underwent posterior spinal fusion (PSF) with LIV at or above L1.

Methods: Patients with Lenke type 1–4 curves who underwent PSF with LIV at or above L1 with a minimum follow-up of 2 years were evaluated. Multivariate linear regression analysis using selected radiographic parameters helped develop a prediction model for postoperative residual LCs. Subgroup analyses, comparing patients with or without postoperative progression of residual LCs, followed by sensitivity tests, were then performed for variables best predicting the progression of residual LCs.

Results: Overall, 130 patients were included. Multivariate linear regression analysis showed that immediate postoperative LIV-tilt angle was associated with the prediction model for immediate and final postoperative residual LCs, with high accuracy (r=0.93 and r=0.77, respectively). Sensitivity tests revealed immediate postoperative LIV-tilt angle <10° and correction rate of main thoracic curves (MTCs) >53% as predictors for progression of residual LCs, and they reached moderate discrimination when combined together as one criterion (odds ratio, 16.3; 95% confidence interval, 5.3–50.1; sensitivity=89%, specificity=67%, PPV=51%, NPV=94%).

Conclusions: The current study revealed that LIV-tilt, as an operable factor during AIS surgery, is not only a determinant in prediction models showing a high correlation with the magnitude of immediate postoperative LCs but also a predictor for progression of residual LCs. "Immediately postoperative LIV-tilt angle <10° and correction rate of MTC Cobb angle >53%", as a united criterion, could serve as a predictor for postoperative progression of residual LCs.

78

Single Stage Posterior Vertebral Column Resection for the Correction of Rigid and Severe Spinal Deformity: An Analysis of 22 Cases

Sharif Ahmed Jonayed, Shah Alam, Abdullah Al Mamun Chowdhury, OZM Dastagir

National Institute of Traumatology and Orthopedic Rehabilitation, Dhaka, Bangladesh

Objectives: We aimed to assess the outcome as well as efficacy and safety of single-stage posterior vertebral column resection (PVCR) for correction of rigid and severe spinal deformity. Treatment of a severe and rigid spinal deformity due to any cause is always challenging for the treating spine surgeon. Nevertheless, vertebral column resection has evolved over the past century to become a viable last resort for the correction of the most challenging spinal deformities through a single, posterior approach.

Methods: This is a prospective case series of 22 patients either with a severe (Cobb angle >60°) or rigid spinal deformity who underwent treatment for correction of deformity by a single stage PVCR from July 2016 to September 2019.

Results: The mean age of the patient was 30.2 years with a mean follow-up time of 27 months. The average operating time was 420 minutes (range, 320–760 minutes). Overall final postoperative kyphotic Cobb angles correction ranged from 30.4° to 55.9°. Oswestry Disability Index improved from 58.6±6.5 to 10.5±3.2. The Visual Analog Scale was improved from 6.7±0.5 to 1.7±0.8. Neurologic recovery was noted in seven patients. The most frequent complications observed in our series were massive blood loss with a mean of 740 mL (range, 560–1,380 mL), dural tear (8%), thoracic root pain (4%), and neurological deterioration (four cases—three transient and one late onset). The mean recovery period for neurological recovery was 3 months. Surgical site infection rates range from 2.9% to 3.7%.

Conclusions: Although the PVCR is highly technically demanding, exhaustingly lengthy, and associated with a variety of complications but can be performed safely with proper training and patience for correcting severe and rigid spinal deformities for a satisfactory outcome.

93

Pyogenic Spondylodiscitis: Is COVID-19 Infection a Predisposing Factor? Retrospective Single Center Study

Dheeraj Manikanta, Saumyajit Basu

Kothari Medical Center, Kolkata, India

Objectives: Pyogenic spondylodiscitis (PS) is defined as an infection of the intervertebral disc and/or adjacent vertebrae. The incidence of PS appears to be increasing due to the aging population with multiple comorbidities. However, there is a lack of information on coronavirus disease 2019 (COVID19) infection as a predisposing factor for pyogenic spondylodiscitis. Our objective is to describe the clinical, and microbial profile of PS and its possible association with COVID19.

Methods: A retrospective review of our electronic medical records between March 2018 and March 2022 was recorded. Patients were divided into two groups those diagnosed with PS between March 2018–2020 (group 1) and March 2020–2022 (group 2). Data were obtained regarding clinical and microbiological diagnosis and COVID19 status.

Results: A total of 3,570 inpatients (1,987 in group 1 and 1,520 in group 2) were reviewed of which 43 patients had PS. Eighteen patients (0.9%) were in group 1 and 25 patients (1.65%) were in group 2. The mean age at diagnosis was less in group 2 (51 years vs. 56 years). A pre-existing condition causing impaired immunity was more in group 1 (67% vs. 60%). C-reactive protein at presentation was more elevated in group 2 (6 times vs. 3 times). The pain was the most common symptom in both groups. Bacteria were isolated from cultures in 10 patients (55.5%) of which Gram-negative was predominant (60%) in group 1. Bacteria isolated from cultures in 12 patients (48%) and Gram-positive was predominant (58%) in group 2. Subgroup analysis was done on the 25 patients in group 2. Thirteen patients (52%) were COVID 19 positive. The mean duration between COVID19 recovery and onset of symptoms of discitis was 3 months. Eight patients (61.5%) have no comorbidities. Seven patients (53.8%) had a hospital admission for COVID19 pneumonia (mean COVID-19 Reporting and Data System score=28); 8 (61.5%) gives a history of steroid treatment for COVID 19 infection. Neurological deficits were seen in two patients

(15.3%). Bacteria were isolated from cultures in eight patients (61.5%), of which 5 (62.5%) were Gram-positive and 3 (37.5%) were Gram-negative. The most common site of involvement was the lumbar spine. Three patients (23.07%) had received two doses of vaccine at the time of diagnosis.

Conclusions: Cases of pyogenic spondylodiscitis in COVID19 patients have not been reported to date. We hypothesize that patients with COVID19 infection especially those who had steroid intake and were not vaccinated could be an important risk factor for developing pyogenic spondylodiscitis.

137

Development of a Three-Dimensional Spinal Proprioception Assessment for Patients with Adolescent Idiopathic Scoliosis

Kenney Ki-Lee Lau, Kenny Yat-Hong Kwan, Jason Pui-Yin Cheung, Arnold Yu-Lok Wong, Daniel Hung-Kay Chow, Kenneth Man-Chee Cheung

Department of Orthopaedics and Traumatology, The University of Hong Kong, Hong Kong

Objectives: Although it is evident that some patients with adolescent idiopathic scoliosis (AIS) have proprioceptive deficits in peripheral joints, knowledge of the proprioceptive function of the deformed spine is limited. Nonetheless, spinal proprioception in AIS may be affected three-dimensionally, prior studies only focused on evaluating peripheral proprioception in a single plane. Therefore, this study aimed to develop a novel spinal proprioception assessment using three-dimensional motion analysis in patients with AIS.

Methods: Participants were included if they had a primary diagnosis of AIS who did not receive or failed conservative treatments. Three trunk repositioning tests involving flexion-extension, lateral-flexion, and axial-rotation were conducted. Three-dimensional kinematics of the trunk were used as the outcome measures. The proprioceptive acuity was quantified by the repositioning error. The intra-examiner and test-retest reliability were analyzed by the intraclass correlation coefficient (ICC).

Results: Fifty-nine patients with AIS were recruited. Regarding the trunk flexion-extension test, the single measure ICC showed moderate reliability (0.46) and the average measures ICC demonstrated good reliability (0.72). As for the trunk lateral-flexion test, the reliability of single measure and average measures ICC were moderate (0.44) and good (0.70) reliability, respectively. For the trunk axial-rotation test, the single measure ICC indicated fair reliability (0.32), while the average measures ICC showed moderate reliability (0.59).

Conclusions: This is the first study to evaluate the reliability of novel three-dimensional spinal proprioception assessments in patients with AIS. The trunk flexion-extension repositioning test may be a preferable clinical test given its highest reliability.

140

Vertebral Body Tethering Results in Progressive Improvement in Coronal Cobb but Deterioration in Axial Rotation: A Three-Dimensional Analysis

Kwan Tung Teenie Wong, Kenny Kwan, Cheung Pui Yin Jason, Cheung Man-Chee Kenneth

The University of Hong Kong, Hong Kong

Objectives: Vertebral body tethering (VBT) has rising popularity as a non-fusion spinal correction for adolescent idiopathic scoliosis (AIS) patients. VBT has shown progressive improvements in the coronal and sagittal plane, but axial correction overtime has not been assessed. This study aims to use three-dimensional (3D) spine reconstruction to analyze the degree and progression of correction at all spinal planes in VBT surgery.

Methods: Patients with AIS treated with VBT surgery, with a minimum of 1 year of follow-up, and 3D spine reconstructions created from the biplanar imaging system were studied. The measurements in coronal, sagittal, and axial planes were made and compared overtime in preoperative, immediate postoperative, 1-year follow-up, and 2-year follow-up.

Results: Seven patients (six females, one male) with a mean age of 11.1±1.6 years with right thoracic idiopathic scoliosis (mean, 50.2°±8.7°) were assessed. The mean duration of follow-up was 18.6±4.6 months (range, 14 to 24

months). Based on 3D reconstruction results, the mean coronal Cobb angle correction was 29.7°, 21.2°, and 15.5° for immediate postoperative, 1-year follow-up, and 2-year follow-up, respectively. Comparing preop to the latest follow-up, there was minimal change in the thoracic kyphosis and lumbar lordosis, which measured 36.2°, 38.6°, 34.8°, and 40.9° for kyphosis; 47.1°, 44.0°, 41.8°, and 48.5° for lordosis at preoperative, immediate postoperative, 1-year follow-up, and 2-year follow-up. Apical axial rotation improved from preoperative -4.9°±5.0° to immediate postoperative of -0.5°±4.5° and then deteriorated to -2.5°±4.5° at 1-year follow-up.

Conclusions: With 3D reconstructed images of the spine, we are able to assess changes in all three planes, this is the first study to describe a progression of the axial rotation correction despite improvement in coronal curvature and suggests that VBT may not be able to control changes in this plane. More studies with larger sample sizes and longer-term follow-ups are needed to investigate axial correction overtime in VBT patients.

148

Computed Tomography Can Effectively Visualize Tether Breakage after Vertebral Body Tethering Procedures

Matthew Hei Yu Yeung, Sandra Wan, Kenny YH Kwan, Jason PY Cheung, Kenneth MC Cheung

Li Ka Shing Faculty of Medicine, The University of Hong Kong, Hong Kong

Objectives: Vertebral body tethering (VBT) is an effective treatment for adolescent idiopathic scoliosis (AIS). Tether breakage can lead to loss of correction and has been identified in up to 48% of cases in recent clinical studies. In inter-screw angulation, 5° increase is widely used for diagnosis of tether breakage but has been suggested to have low sensitivity. After analyzing computed tomography (CT) images post VBT, we found that tethers could be clearly outlined. This study aims to compare the intactness of tether on CT image versus the current radiological diagnosis of tether breakage.

Methods: A series of nine VBT patients with a minimum 2-year follow-up and a total of 13 postoperative CT scans done at our institution were analyzed. Parameters of CT are the thickness of 0.625 mm, the diagonal field of view of 40 mm, and gantry rotation of 0.5 seconds. Three-dimensional reconstructions were created using an image viewer. Tether breakage was diagnosed by finding of an interruption in the tether continuity and the clear presence of a gap between the two tether ends. On PA standing radiographs of the spine, the inter-screw angle was obtained by measuring the angle between straight lines passing through the mid-point of adjacent screws, immediately postoperative and at the time of CT scanning.

Results: The mean age at surgery was 11.1±1.1 years, and Risser was 0.3±0.6. The number of instrumented levels was 7.9±1, the mean preoperative Cobb was 52°±9°, and at 1-year follow-up was 32°±12°. Amongst 94 measured segments, based on inter-screw angle, there were 12 tether breakages. Whereas based on CT, there were 15 breakages. The 5° rule identified 80% of the true breakages. All tethers, with or without discontinuity, were clearly visualized on coronal reconstructed CTs. Out of the 15 breakages, eight of them demonstrated clean vertical separation, whereas the other seven had one end angulated away from the tether. It was also observed that thoracic breakages were near the screw junction, whereas lumbar breakages were mid-distance between screws.

Conclusions: This is the first study investigating CT as an alternative modality to assess tether integrity in VBT subjects. We can clearly delineate the course of each tether, demonstrating clear breakages. This can be valuable to confirm cases of suspected tether breakage predicted radiographically. Our identification of differences in location of breakage between thoracic and lumbar spine suggests different mechanisms are involved in breakages in these two regions. We propose that CT scans with reconstruction can be used as a definite, alternative non-invasive method of diagnosing tether breakage in the future.

186

Safety of Decompression Laminectomy Using an Ultrasonic Bone Scalpel Compared with High-Speed Burr: Outcomes in 177 Patients

Atif Naseem, Ayush Sharma

Bharat Ratna Dr. Bhimrao Ambedkar Memorial Hospital, Central Railway, Mumbai, India

Objectives: Cervical laminectomy for cervical myelopathy has been performed traditionally with osteotomes and rongeurs and more recently with a high-speed burr (HSB). However, these methods can cause devastating soft tissue injury by direct contact and are difficult to use in areas with an already compressed cord. We evaluated the use of a SONOPET ultrasonic aspirator, for the patients operated for cervical myelopathy and compared the outcomes to those operated with HSB.

Methods: A retrospective analysis was done and patients operated for cervical laminectomy between January 2017 and October 2020 were included. They were divided into two groups based on the device used for laminectomy, i.e., HSB and SONOPET. We compared the demographic, clinical, and functional outcomes for patients for 1 year postoperatively. We used the modified Japanese Orthopaedic Association and Visual Analog Scale score for both arm pain and neck pain and Nurick grading.

Results: A total of 177 patients were included of which 101 were operated with an HSB and 76 by SONOPET. Demographic and baseline parameters were comparable. However, the duration of surgery (p<0.001) and the rates of total complications (p=0.041) were significantly higher in the HSB group. Of note, accidental durotomies were significantly lower in the SONOPET group (p=0.024). Other variables like blood loss, hospital stay, and incision length were similar. Functional outcomes were comparable among the two groups.

Conclusions: SONOPET ultrasonic aspirator has a higher safety margin and helps in achieving a shorter duration of surgery. In particular, the rates of accidental durotomies are significantly less with the use of SONOPET.

160

How Does Adolescent Idiopathic Scoliosis Affect Physical Activities? A Cross-Sectional Study

Kenny Kwan, Chrysanne Chow

The University of Hong Kong, Hong Kong

Objectives: The impact of adolescent idiopathic scoliosis (AIS) on physical activities level is not well documented. The aim of this study was to assess self-reported physical activity (PA) levels in AIS patients.

Methods: A cross-sectional study was performed. All patients diagnosed with AIS who are under observation were consecutively recruited between January and June 2021 and were asked to fill out the validated Paffenbarger Physical Activity Questionnaire. Information regarding stair climbing, city blocks walked, frequency, intensity, and duration were recorded. A Physical Activity Index (PAI) in kcal/wk was calculated, from which the total energy expenditure was estimated. This was correlated with their demographic and radiographic data.

Results: Twenty-seven males (mean age, 14.5±1.81 years) and 86 females (mean age, 13.2±1.38 years) were included in the study. The mean body mass index (BMI) of male patients was 17.3±2.26 kg/m^2 and 18.1± 3.07 kg/m^2 for females. The mean Cobb angle for males was 20.6°±8.6° and 28.2°±10.2° for females. Of the patients, 51.3% reported participation in yearly PA activity excluding physiotherapy and mandatory physical education classes, and 40.7% in weekly PA that caused sweating, increased heart rate, and shortness of breath. Those who did not participate in any PA were asked to provide reasons for their lack of physical activity. Of the patients, 30% reported "lack of time" and 16.3% reported "laziness". No patients attributed their lack of exercise to their AIS. The mean PAI was 2,344.0±4,272.5 kcal/wk. There was no statistically significant correlation between BMI, gender, Cobb, and PAI. World Health Organization (WHO) defines adequate PA as >60 minutes of moderate to vigorous intensity activity daily, which totals 365 hours per year. A local cohort of healthy individuals showed that 10% of adolescents met these guidelines. When comparing this to our collected data, only two patients (1.77%) fulfilled this criterion.

Conclusions: Patients who were diagnosed with AIS

showed a low level of physical activities compared with a local cohort of healthy individuals, and much lower than the WHO recommended guidelines. However, low PA was not related to gender, BMI, or Cobb angle. Further studies to address reasons for inactivity and methods to improve physical activity levels in AIS patients are needed.

2

Outcome of 100 Cases of Decompression and Stabilization of Metastatic Cord Compression

Anto Gopurathingal, Pramod S. Chinder

Healthcare Global, Bangalore, India

Objectives: The aim of this study was to determine whether decompression and stabilization in metastatic spinal cord compression achieve good pain relief, improve neurological function, and overall quality of life assessment.

Methods: Patients with metastatic vertebral lesions were analyzed. Preoperatively, Frankel grading, Eastern Cooperative Oncology Group (ECOG) performance status, Karnofsky Performance Index (KPI), and Oswestry Disability Index score were recorded. Decompression and spine stabilization surgery was performed. Postoperatively same scores were used to assess at regular follow-up and at final follow-up.

Results: A total of 100 patients were included. Preoperatively, 46% had Frankel grade C, and 41% had grade D. There was a significant improvement, postoperatively with 47% to grade D, and 35% to grade E ($p<0.001$). The preoperative ECOG median score was 3, and the postoperative median score was 2, with a p-value of <0.001. KPI preoperative median score was 50% compared to the postsurgery of 70% median score ($p<0.001$). Preoperatively Oswestry score of 46 patients had moderately disabled, followed by 30 with severe disability. Postoperatively, at last follow-up, only 34 patients had a minimal disability, and 39 patients had moderately disabled ($p<0.001$).

Conclusions: Spinal decompression surgeries in metastatic cancer patients result in markedly increased neurological outcomes and good pain relief and improve quality of life.

11

Shoulder Balance Outcome Analysis in Posterior Correction for Patients with Adolescent Idiopathic Scoliosis: C7 Tilt Angle as a Surrogate Parameter for Postoperative Shoulder Balance and Its Clinical Implications for Upper Instrumented Vertebra Level Selection

Jui-yo Hsu, Chih-Wei Chen, Ming-Hsiao Hu, Shu-Hua Yang

Department of Orthopedic Surgery, National Taiwan University Hospital, Taipei, Taiwan

Objectives: This study examines the correlation between the individual vertebral tilt and shoulder balance and specifically aims to identify parameters that may serve as a proxy for shoulder balance in surgical correction of adolescent idiopathic scoliosis (AIS).

Methods: Multicenter retrospective outcome analyses were performed in AIS patients receiving posterior spinal correction and fusion using all pedicle screws with derotation. Individual cervicothoracic vertebral tilt angles from C5–T4 were recorded. Shoulder balance was evaluated with the following parameters: clavicular angle (CA), coracoid height difference (CHD), clavicular tilt angle difference (CTAD), clavicle–rib cage intersection difference (CRID), and first rib angle. Postoperative shoulder imbalance was defined as clinically significant when clavicle angle >2.5°.

Results: A total of 109 patients of AIS patients, who received posterior correction and fusion between January 2012 and June 2018, were recruited for analysis. In postoperative coronal measures, C7 tilt angle has demonstrated moderate to high correlation with all 5 shoulder balance parameters, which was CA ($r=0.496$, $p<0.0001$), first rib angle ($r=0.818$, $p<0.0001$), CHD ($r=0.404$, $p=0.0014$), CTAD ($r=0.348$, $p=0.0002$), and CRID ($r=0.397$, $p=0.0015$). The trend was less obvious in other vertebral tilts proximal or distal to the cervicothoracic junction or with the tilt angle of the upper instrumented vertebra (UIV). Considering C7 as a landmark, the UIV level's proximity to the C7 (C7–UIV distance) ≤2 levels was associated with a lower risk of developing shoulder imbalance (Fisher's exact test; $p=0.0301$). In patients with C7–UIV distance >2 levels, logistic regression

results demonstrated that increased postoperative C7 tilt angle is associated with postoperative shoulder imbalance (odds ratio, 1.12; 95% confidence interval, 1.008–1.237; p=0.0338).

Conclusions: C7 tilt angle demonstrated moderate to high correlation with both medial and lateral shoulder balance parameters postoperatively, and the trend was less significant in other vertebral tilts proximal or distal to the cervicothoracic junction. UIV level's proximity to C7 was associated with a lower risk of developing shoulder imbalance. Our findings showed balanced C7 tilt angle was associated with better postoperative shoulder balance, particularly in patients with C7–UIV distance >2 levels.

24

Life Expectancy Is Poor in Patients with Diffuse Idiopathic Skeletal Hyperostosis-Related Pyogenic Vertebral Osteomyelitis

Kentaro Yamada, Hiroaki Nakamura

Tokyo Medical and Dental University, Tokyo, Japan

Objectives: Pyogenic vertebral osteomyelitis (PVO) is an uncommon but life-threatening infectious disease. Diffuse idiopathic skeletal hyperostosis (DISH) is an age-related disorder and is sometimes problematic in terms of spinal instability or high mortality, especially in cases of DISH-related fracture. However, the impact of DISH on the treatment outcomes of PVO is little known. We hypothesized that PVO occurring at DISH-related segments might contribute to poor clinical results or high mortality rates due to spinal instability. The purpose of this study was to investigate the impact of DISH on mortality after treatment for PVO in a retrospective cohort study.

Methods: This study involved patients who were hospitalized and treated for PVO at a single institution. DISH-related PVO was defined as PVO within a segment ossified by DISH or PVO at the neighboring intervertebral level of the segment ossified by DISH. Differences in mortality between patients with DISH-related and non-DISH-related PVO were investigated including propensity score-adjusted analysis.

Results: This study included 55 patients. DISH-related PVO was observed in 13 patients. The mortality rate was significantly higher in patients with DISH-related than non-DISH-related PVO (62% and 23%, p=0.016). The mean prognosis of DISH-related PVO after admission was 0.7 years: 88% (seven of eight patients) died within 1 year after admission for PVO. The survival probability was significantly shorter in patients with DISH-related than non-DISH-related PVO (p=0.006). Propensity score-adjusted analysis showed that DISH-related PVO was an independent risk factor for mortality (adjusted hazard ratio, 2.79; p=0.034).

Conclusions: DISH-related PVO was associated with a higher mortality rate and shorter life expectancy than non-DISH-related PVO. The results of the present study support our hypothesis because spinal destruction due to infection within the segment ossified by DISH might lead to prolonged healing of PVO due to severe spinal instability in the same manner as the DISH-related fracture. Like advanced age, PVO at the segment ossified by DISH should be recognized as a risk factor for mortality when choosing the optimal treatment strategy.

35

A Novel Technique for Restoring Grasp in Tetraplegics

Sunil Yadav, Vigneswaran V., Praveen Bhardwaj, Raja Sabapathy

Ganga Medical Centre and Hospitals Pvt. Ltd., Coimbatore, India

Objectives: Grasp function is affected in most patients with tetraplegia and it drastically reduces their ability to use the hand hence, limiting functional independence and rehabilitation. Lower-level tetraplegics and those in groups 3–9 generally have sufficient local donor muscle options to restore finger flexion and grasp by existing conventional techniques. However, a high tetraplegic or those in groups 0–2 lack effective options to restore finger flexion and often these patients need to manage with wrist tenodesis induced rudimentary grasp. We present our experience in using the biceps for restoring finger flexion in this group of patients. This novel tendon transfer technique restored effective grasp function and dramatically improved their rehabilitation and functional independence.

Methods: We have performed biceps to flexor digitorum profundus (FDP) transfer in three cases with high-level tetraplegia. Biceps was detached from its insertion and extended with a fascia lata graft of about 20 cm to reach the FDP. The transfer was tunneled under the flexor digitorum superficialis arch in order to prevent the bowstringing. A strong repair was done at either end to allow early active mobilization. At 1-month, patients were trained to actively use their hands for activities in a graded manner. The functional assessment and satisfaction were assessed at a minimum of a 6-month follow-up.

Results: All three cases recovered active finger flexion and could easily power the transfer with moderate functional training. At 6-month they could use their hand for activities to enable their functional independence. They could hold on to eatables and bottles to feed themselves. One patient used his reconstructed hand to mauver his wheelchair, enabling his mobility and independence. None had any minor or major complications or complained of reduced elbow flexion power and all were satisfied with the outcome of the surgery.

Conclusions: Biceps to finger flexion transfer provides a new hope to restore grasp function in patients with high-level tetraplegia who lack the conventional local donor muscles for restoring finger flexion. Improved grasp dramatically improved patients' confidence and perception to face the challenges posed by this life-changing injury.

41

Compensatory Knee Flexion from Sagittal Imbalance Increases Femoral Three-Dimensional Bowing: A Radiographical Study Using the Full-Body Images

Cheng-Li Lin, Chien-Hsiung Lo, Zi-Ping You, Ruey-Mo Lin

National Cheng Kung University Hospital, Tainan, Taiwan

Objectives: The sagittal imbalance (SI) triggers compensatory mechanisms of the lower extremity including hip extension, knee flexion, and ankle extension to restore trunk balance. These compensatory mechanisms cause long-period stress on the femur which may change femoral morphology. The evaluation of whole-body skeleton alignment is allowed by using the slot-scanning EOS imaging system. Therefore, the present study aims to identify the correlations between SI and femoral three-dimensional (3D) bowing.

Methods: Spino-pelvic parameters, including C7–sagittal vertical axis (C7–SVA), T1-pelvic angle (TPA), pelvic incidence (PI), pelvic tilt (PT), sacral slope (SS), knee flexion angle (KA), lumbar lordosis (LL), femoral length (FL), PI–LL, and PT/PI of totally 104 patients with full body image, were measured using EOS imaging system. Femoral bowing was quantified with a 3D radius of femoral curvature (3D RFC), which is mathematically calculated using the spatial coordinates from the EOS biplanar images. These parameters were compared among three subgroups, including SI with KF (TPA >14; KA >5), SI without KF (TPA >14; KA ≤5), and balanced patients (TPA ≤14; KA ≤5). Also, univariate and multivariate correlation analyses between 3D RFC and the spinopelvic parameters were done.

Results: 3D RFC was significantly smaller, indicating increased bowing, in SI patients compared to balanced patients ($p<0.001$). In univariate correlation analysis, 3D RFC was moderately correlated with age and KA ($r=-0.497$ and $r=-0.498$, respectively). Parameters for assessing global alignment including TPA, C7–SVA, and PI–LL had a weak correlation with 3D RFC. Multivariate analysis using stepwise linear regression analysis disclosed that age, FL, and KA explain 34% variability in 3D RFC ($p<0.001$, adjusted $R^2=0.34$), with KA being the strongest independent predictor. Subgroup analysis further revealed significantly smaller 3D RFC, older age, and greater PI and LL mismatch in SI with the KF group compared to the other two subgroups ($p<0.001$). However, no significant difference in 3D RFC was found between subgroups of SI without KF and balanced patients.

Conclusions: The current study revealed that the femoral 3D bowing increased in SI patients with compensatory knee flexion. Also, KA is a significant predictor of 3D RFC, along with other identified factors. Therefore, in orthopedic surgery involving femoral implants, a thorough preoperative full-body radiological evaluation may be helpful, especially for sagittal imbalanced patients.

55

Standalone Cage Versus Anchored Cage for Anterior Cervical Discectomy and Fusion: A Comparative Analysis of Clinical and Radiological Outcomes

Siddharth Aiyer, Niharika Virkar, Shailesh Hadgaonkar, Ajay Kothari

National Cheng Kung University Hospital, Tainan, Taiwan

Objectives: Implants used in anterior cervical discectomy and fusion (ACDF) for cervical disc disease have seen an evolution over time. Standalone cages (SAC) and Anchored cages (AC) have superseded other implants due to reduced operative time and lower incidence of dysphagia. However, there is limited literature available comparing the clinical and radiological outcomes of SAC versus AC with fixing screws.

Methods: A single-center, prospective nonrandomized study of patients undergoing single and double-level ACDF for cervical radiculopathy or myelopathy from January 2019 to January 2021, was carried out. Patients were divided into two treatment groups including the AC group and the SAC group. Clinical outcomes of patients were measured with the modified Japanese Orthopaedic Association (mJOA) for patients with myelopathy, Neck Disability Index (NDI), and Visual Analog Scale (VAS) of arm and neck for radiculopathy. Dysphagia post-surgery was graded as per Bazaz score in both the groups. Radiologically, global cervical lordosis, segmental lordosis, radiological fusion, cage subsidence, and migration were assessed. The clinical and radiological outcomes were assessed preoperatively and at 3 months, 6 months, and 1-year post-surgery.

Results: A total of 62 patients were included in the final analysis with 31 patients in both the AC and SAC groups. There were 47 males and 15 females with a mean age of 47.8 years (range, 17–83 years). The mean preoperative VAS and NDI scores were 7.7 and 27.6, respectively; which improved to 4.4 and 19.8, respectively (p<0.05 for both). In the myelopathy patients, the mean mJOA score improved from 10.8 to 11.8 (p<0.05); however, there was no difference in the AC and SAC group for the VAS, NDI, and mJOA scores. The global cervical spine lordosis improved from 14.45° to 19.02°±1.17° and decreased to 17.39°±1.08° at 1-year follow-up. The mean segmental cervical spine lordosis at operated levels improved from 6.1° to 10.1°. There was no statistically significant difference between the type of implant used, in either global lordosis or segmental lordosis. The subsidence was seen in six patients with 13.7% in the SAC group and 6.8% in the AC group (p<0.05). Cage migration was observed in four cases without clinical impact on outcomes. No significant difference in Bazaz score was noted between the groups for dysphagia.

Conclusions: AC group had lower cage subsidence and migration rates when compared to the SAC group however, the clinical outcomes do not differ significantly between the groups.

59

Is Drain Tip Culture a Good Indicator for Predicting Deep Surgical Site Infection in the Degenerative Lumbar Fusion Surgery? A Prospective Analysis of 614 Cases

Yu Po Huang, Po-Hsin Chou, Yu-Cheng Yao, Shih-Tien Wang

Department of Orthopedics and Traumatology, Taipei Veterans General Hospital, Taipei, Taiwan

Objectives: A large proportion of patients undergoing surgery for different spine and orthopedic conditions will have a surgical drain placed. The most common organism in deep surgical site infection (DSSI) was *Staphylococcus aureus*. Methicillin-resistant *Staphylococcus aureus* (MRSA) was about 45%–61% of *S. aureus* in patients with DSSI. However, the role of the drain tip in predicting DSSI is still elusive. The objectives of the study were to evaluate the prognostic value of drain tip culture for DSSI prediction in degenerative lumbar fusion surgery, the timing of drain removal correlated with positive drain tip culture, and the value for *S. aureus* and MRSA prediction.

Methods: A total of 614 closed drain tip cultures were prospectively investigated after drain removal in selective degenerative lumbar fusion surgery. Prophylactic parenteral antibiotics were administered after index surgery for 72 hours. The drain was removed if the total amount was less than 100 mL a day. The DSSI was diagnosed by mag-

netic resonance imaging scan and computed tomography-guided biopsy for cultures and pathology. Prophylactic intrawound 1 g or 2 g vancomycin powder (VP) mixed with autograft and bone substitutes were randomly administered during the index surgery.

Results: Drain tip cultures were positively cultured in 13 cases (2.1%). True DSSI was investigated in three cases (0.5%), where there were two cases with positive drain tip cultures. The most common organisms cultured from drain tip were Gram-positive cocci (GPC) in groups (n=4) followed by *Staphylococcus* (n=2). The organisms cultured from DSSI were MRSA for 2, *Bacillus cereus* for 1, and *Corynebacterium* for 1, respectively. Regarding DSSI with MRSA, the organisms from the drain tip were MRSA and *B. cereus*, respectively. The drain tip culture for MRSA prediction was 50%. The overall sensitivity and specificity of drain tip culture for predicting DSSI were 66.7% and 98.2%, respectively. The overall positive and negative predictive values were 15.4% and 99.8%, respectively. There was no correlation between the duration of drain removal and drain tip culture results or occurrence of DSSI. Prophylactic intrawound VP did not affect the positive drain tip culture rates.

Conclusions: The high negative predictive value makes routine drain tip line culture clinically significant to exclude the possibility of DSSI. Besides, routine drain tip culture is simple, reproducible, and cost-effective in every medical institution. This useful information could provide physicians for identifying candidates for increased surveillance, enhancing shared decision-making and quality of care.

82

Morphological Characteristics of Diffuse Idiopathic Skeletal Hyperostosis (DISH) in Patients with Ossification of the Posterior Longitudinal Ligament and Its Association with High-Sensitivity C-Reactive Protein: Inflammatory DISH

Hiroto Makino, Canh Tnt, Hiroto Makino, Yasuhito Yahara, Shoji Seki, Hayato Futakawa

University of Toyama, Toyama, Japan

Objectives: To characterize and clarify evidence as to whether the ectopic bone formations of diffuse idiopathic skeletal hyperostosis (DISH) in patients with ossification of the posterior longitudinal ligament (OPLL) are caused by inflammatory or degenerative processes.

Methods: The whole spine computed tomography and serum high-sensitivity C-reactive protein (hs-CRP) levels were obtained from 182 cervical OPLL patients (DISH+, n=104; DISH-, n=78). In the DISH+ group, ectopic bone formations were categorized into flat and jaggy types, then further divided into three subgroups: group 1 (Jaggy-dominant pattern), group 2 (equivalence of pattern), and group 3 (flat-dominant pattern). Data were compared between the DISH+ and DISH– groups, and among the three subgroups.

Results: The upper thoracic spine was most affected by the flat type, whereas the jaggy type was more frequent in the middle and lower thoracic regions. There was no difference in hs-CRP levels between the DISH+ and DISH– groups. Among the three subgroups, hs-CRP levels in group 3 (0.16±0.09 mg/dL) were significantly higher than in group 1 (0.04±0.02 mg/dL) and group 2 (0.08±0.06 mg/dL). Higher levels of hs-CRP were associated with a greater number of vertebral units (VU) with flat type formations (p<0.0001, r=0.73) and with a lesser number of VUs with jaggy type formations (p=0.0014, r=–0.31).

Conclusions: The flat type in DISH might be caused by inflammatory pathogenesis rather than a degenerative process presented in the jaggy type.

86

Is Psoas Muscle Area a Good Prognosticator in Patients Undergoing Surgical Treatment for Spinal Metastasis

Ming-Hsiao Hu, Hung-Kuan Yen, Hsin Chen, Chih-Wei Chen, Wei-Hsin Lin, Shu-Hua Yang

Department of Orthopedics, National Taiwan University Hospital, Taipei, Taiwan

Objectives: Survival estimation for patients with spinal metastasis is crucial to treatment decisions. Psoas muscle area (PMA), a surrogate for total muscle mass, has been proposed as a useful survival prognosticator. However, few studies have validated the predictive value of de-

creased PMA in an Asian cohort or its predictive value after controlling for existing preoperative scoring systems (PSSs). In this study, we aim to answer: (1) Is PMA associated with survival in Han Chinese patients with spinal metastasis? (2) Is PMA a good prognosticator according to concordance index (c-index) and decision curve analysis (DCA) after controlling for six existing and commonly used PSSs?

Methods: This study included 180 adults (≥18 years old) Taiwanese patients with a mean age of 58.3 years (range, 22–85 years) undergoing surgical treatment for spinal metastasis. A patient's PMA was classified into decreased, medium, and large if it fell into the lower (0%–33%), middle (33%–67%), and upper (67%–100%) 1/3 in the study cohort, respectively. We used logistic and cox proportional-hazard regressions to assess whether PMA was associated with 90-day, 1-year, and overall survival. The model performance before and after the addition of PMA to six commonly used PSSs, including Tomita score, original Tokuhashi score, revised Tokuhashi score, modified Bauer score, New England Spinal Metastasis Score, and Skeletal Oncology Research Group machine learning algorithms (SORG-MLAs), was compared by c-index and DCA to determine if PMA was a useful survival prognosticator.

Results: Patients with a larger PMA are associated with better 90-day, but not 1-year, survival. The model performance of 90-day survival prediction improved after PMA was incorporated into all PSSs except SORG-MLAs. PMA barely improved the discriminatory ability (c-index, 0.74; 95% confidence interval [CI], 0.67–0.82 vs. c-index, 0.74; 95% CI, 0.66–0.81) and provided little gain of clinical net benefit on DCA for SORG-MLAs' 90-day survival prediction.

Conclusions: PMA is a prognosticator for 90-day survival and improves the discriminatory ability of earlier proposed PSSs in our Asian cohort. However, incorporating PMA into more modern PSSs such as SORG-MLAs did not significantly improve its prediction performance.

87

Curve Flexibility Assessment in Severe Adolescent Idiopathic Scoliosis: Comparison between Supine Traction Radiographs versus Physician-Supervised Supine Side Bending Radiographs

Josephine Rebecca Chandren, Weng Hong Chung, Chee Kidd Chiu, Mun Keong Kwan, Chris Yin Wei Chan

Universiti Malaya, Kuala Lumpur, Malaysia

Objectives: To compare the efficacy of supine traction radiographs vs. physician-supervised supine side-bending (PSSB) radiographs in assessing curve flexibility in severe adolescent idiopathic scoliosis (AIS) (Cobb angle ≥90°).

Methods: In this retrospective study, AIS patients with severe scoliosis (Cobb angle ≥90°) who underwent posterior spinal fusion and had preoperative anteroposterior, supine traction, and PSSB radiographs were recruited. A total of 51 patients fulfilled the inclusion criteria. Most major curves were in the main thoracic (MT) region (73.6%) and only 14 patients had major curves in the thoracolumbar/lumbar (TL/L) region (26.4%). Demographics and preoperative and postoperative data were collected. Both techniques were compared in terms of the flexibility rate and postoperative correction index. Predictive factors for curve flexibility in supine traction and PSSB radiographs were assessed using univariate and multivariate linear (MLR) regression.

Results: The mean age was 15.4±2.6 years. Most patients had Lenke 2 curves (52.9%). The mean preoperative major Cobb angle was 104.7°±15.0°. The mean flexibility rate in the MT was 37.4%±10.8% vs. 36.0%±12.2% when comparing the supine traction film and PSSB, respectively (p=0.262). In contrast, for major TL/L curves, the mean flexibility rate was 40.8%±10.5% vs. 43.4%±11.0% for supine traction and PSSB, respectively (p=0.119). The mean side bending correction index and traction correction index for MT curves were 1.5±0.3 vs. 1.6±0.5 (p=0.109) and for the TL/L regions was 1.4±0.3 vs. 1.3±0.3 (p=0.106) when comparing the supine traction film and PSSB. Based on the MLR analysis, female gender (β=-10.92; 95% confidence interval [CI], -1.17 to 20.67) and preoperative major Cobb angle (β=-0.32; 95% CI, -0.52 to

-0.13) were the predictive factor for PSSB flexibility. Preoperative major Cobb angle was the only predictive factor for supine traction flexibility (β=-0.19; 95% CI, -0.38 to -0.002).

Conclusions: PSSB and supine traction radiographs were comparable as assessment methods for curve flexibility in severe AIS patients with major Cobb angle ≥90°.

132

Is Pedicle Subtraction Osteotomy a Good Procedure for Correction of Single and Double Level Post-traumatic and Post-tubercular Kyphotic Deformity?

Anowarul Islam, Wayez Mahbub

Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh

Objectives: A disorder of increased natural curvature in the sagittal plane of the spine resulting in a hunchback deformity. Post-tubercular and post-traumatic kyphotic deformity makes a sagittal imbalance of the spine as well as presents with pain and some neurological manifestations. Pedicle subtraction osteotomy is one of the methods of surgical treatment for correction of the post-traumatic and post-tubercular kyphotic deformity. We aimed to see the degree of correction of deformity by pedicle subtraction osteotomy.

Methods: Thirty patients with kyphotic deformity were treated by pedicle subtraction osteotomy in Bangabandhu Sheikh Mujib Medical University and other private hospitals in Dhaka city from January 2015 to December 2021. Patient satisfaction was assessed and correction of K angle was measured. The postoperative radiological and functional outcomes were assessed.

Results: The mean postoperative follow-up was 24 months. The measurement shows a mean preoperative K angle of 60.55°±6.64° which was significantly decreased to 5.12°±2.26° postoperatively. Patients' satisfaction was good. A very few patients developed transient neurological manifestation which was recovered within few weeks of treatment.

Conclusions: Pedicle subtraction osteotomy is an excellent surgical procedure for the correction of kyphotic deformity with good functional and neurological outcomes.

136

Sarcopenia as a Risk Factor of Proximal Junctional Kyphosis and Proximal Junctional Failure Following Adult Spinal Deformity Surgery

Jin Seong Park, Kyu-Jung Cho

Department of Orthopaedic Surgery, Inha University, Hospital, Incheon, Korea

Objectives: The aim of this study was to investigate the risk factors of proximal junctional kyphosis (PJK) and proximal junctional failure (PJF), including muscle degeneration, and to compare the difference in muscle degeneration in the lower back between PJK and PJF.

Methods: Eighty-four consecutive patients who underwent a long-instrumented fusion for adult spinal deformities with a minimum of least 2-year follow-up were included in this study. The surgical, radiological, and patient factors were evaluated. Sarcopenia is known to be a loss of muscle volume and function. The muscle volume was measured as the muscle/vertebra ratio and the muscle function as the fatty degeneration in multifidus (MF), erector spinae (ES), and psoas (PS) muscle at the L4–5 level.

Results: PJK occurred in 13 patients (15.6 %) and PJF in 12 patients (14.4%). The mean duration to onset was 15.7 months in PJK patients and 1.7 months in PJF patients. Univariate analysis showed that the development of PJK and PJF was influenced by the severity of preoperative sagittal imbalance (greater preoperative & postoperative PI–LL, greater preoperative sagittal vertical axis, lesser preoperative & postoperative LL, lesser preoperative & postoperative TK, lesser preoperative & postoperative PJK angle). When comparing back muscle degeneration between PJK and PJF groups, a smaller volume of the back (MF, ES, PS) was shown in the PJK & PJF than in the control group. Paravertebral muscle (ES) atrophy and fatty degeneration tended to be more severe in the PJF group than in the PJK group. By multivariable analysis, MF muscle atrophy was associated with the development of PJK & PJF, and ES muscle atrophy was significantly associated with the development of PJF.

Conclusions: This study showed a much earlier time for the development of PJF compared to PJK. Muscle atrophy and fatty degeneration in the lower lumbar region were found to be risk factors of PJF. The possibility of develop-

ing PJF should be kept in mind when planning long-level fusion in patients with the sagittal imbalance and muscle atrophy/fatty degeneration.

214

Remodeling Pattern of Spinal Canal after Full Endoscopic Uniportal Lumbar Endoscopic Unilateral Laminotomy for Bilateral Decompression: One-Year Repetitive Magnetic Resonance Imaging and Clinical Follow-up Evaluation

Pang Wu, Hyeun Sung Kim

Ng Teng Feng General Hospital, Singapore

Objectives: There is limited literature on repetitive postoperative magnetic resonance imaging (MRI) and clinical evaluation after uniportal lumbar endoscopic unilateral laminotomy for bilateral decompression.

Methods: Clinical Visual Analog Scale (VAS), Oswestry Disability Index (ODI), McNab's criteria evaluation, and MRI evaluation for patients with single level uniportal lumbar endoscopic unilateral laminotomy for bilateral decompression were performed. MRI evaluation measured the axial cut spinal canal area of the upper endplate, mid disc, and lower endplate. From the evaluation of the axial cut MRI, four types of patterns of remodeling were identified: type A: continuous expanded spinal canal, type B: restenosis with delayed expansion, type C: progressive expansion, and type D: restenosis.

Result: A total of 126 patients with single-level uniportal lumbar endoscopic unilateral laminotomy for bilateral decompression were recruited with a minimum follow-up of 26 months. 36 type A, 50 type B, 30 type C, and 10 type D patterns of spinal canal remodeling were observed. All four types of patterns of remodeling had a statistically significant improvement in VAS at the final follow-up compared to the preoperative state. There was a statistically significant improvement in ODI at final follow-up. MRI evaluation showed there was significant different in increment of spinal canal area at upper endplate at postoperative day 1 and 1 year with type A (39.16±22.73, 28.00±42.57), B (47.42±18.77, 42.38±19.29), C (51.45±18.16, 49.49±18.41), and D (49.10±23.05, 38.18±18.94), respectively (p<0.05). A similar significant finding was found at mid-disc at postoperative day one, 6 months, and 1 year with type A (55.16±27.51, 37.23±25.88, 44.86±25.73), B (72.83±23.87, 49.79±21.93, 62.94±24.43), C (66.85±34.48, 54.92±30.70, 64.33±31.82), and D (71.65±16.87, 41.55±12.92, 49.83±13.31) and lower endplate at postoperative day 1 and 1 year with type A (49.89±34.50, 41.04±28.56), B (63.63±23.70, 54.72±24.29), C (58.50±24.27, 55.32±22.49), and D (81.43±16.81, 58.40±18.05) at postoperative day 1 and 1 year, respectively (p<0.05).

Conclusions: After full endoscopic lumbar decompression, despite achieving sufficient decompression immediately postoperatively, varying severity of asymptomatic restenosis was found in postoperative six months MRI without clinical significance. Further remodeling with varying degrees of increment of spinal canal area occurs at postoperative 1 year with overall good clinical outcomes.

229

Dysregulation of Inflammatory Pathways in Adult Spinal Deformity Patient with Frailty

Tomohisa Tabata, Mitsuru Yagi, Morio Matsumoto, Masaya Nakamura, Kota Watanabe

Department of Orthopedic Surgery, Keio University School of Medicine, Tokyo, Japan

Objectives: We hypothesized that frailty affected postoperative inflammation differently following adult spinal deformity (ASD) surgery. An important aspect of the pathophysiology of frailty seems to be the dysregulation of inflammatory pathways and of the coagulation system. However, an objective assessment of the impact of frailty on recovery kinetics from surgery is not fully studied. This single-center retrospective case series sought to assess how frailty affects the recovery kinetics in ASD surgery using blood biomarkers.

Methods: A total of 153 consecutive ASD patients (age, 64±10 years; 93% female) who had corrective spine surgery and reached 2-year follow-up were included. The subjects were stratified by frailty using modified frailty index-11 (robust [R] group or prefrail and frail [F] group). Results of commonly employed laboratory tests at base-

line, 1, 3, 7, and 14 postoperative days (POD) were compared. Further comparison was performed in propensity-score matched 39 paired patients between the groups by age, curve type, and baseline alignment. Correlation between health-related quality of life (HRQOLs), major complications, and biomarkers was performed.

Results: Among the propensity-score matched groups, C-reactive protein (CRP) was significantly elevated in F group at POD1, 3 (POD1: 5.3±3.1 vs. 7.9±4.7, p=0.02; POD3: 6.6±4.6 vs. 8.9±5.2, p=0.02). Transaminase was also elevated in F group at POD3 (aspartate aminotransferase [AST]: 36±15 U/L vs. 51±58 U/L, p=0.03; alanine aminotransferase [ALT]: 32±16 U/L vs. 47±55 U/L, p=0.04). Interestingly, moderate correlation was observed between transaminase at POD1 and 2-year Scoliosis Research Society-22 (AST: function r=-0.37, mental health r=-0.39, satisfaction r=-0.28, total r=-0.40; ALT: function r=-0.37, satisfaction -0.34, total r=-0.39).

Conclusions: Frailty affected the serum CRP and transaminase differently following ASD surgery. Transaminase at early POD was correlated with 2-year HRQOLs. These findings support the hypothesis that there is a specific physiological basis to the frailty that is characterized in part by increased inflammation that these physiological differences persist.

231

A Comparative Study of Anterior Cervical Discectomy and Fusion and Posterior Decompression for Cervical Stenosis with Unilateral Proximal Upper Limb Muscle Weakness

Reo Shibata, Narihito Nagoshi, Junichi Yamane, Morio Matsumoto, Masaya Nakamaura, Kota Watanabe

Department of Orthopaedic Surgery, Keio University School of Medicine, Tokyo, Japan

Objectives: Although there are several reports which examined surgical outcomes for cervical spondylosis, few studies have evaluated the impact of surgical techniques on patients with unilateral upper extremity muscle weakness. The purpose of this study is to compare the clinical outcomes between anterior cervical decompression and fusion and posterior decompression in cervical spondylosis with unilateral proximal muscle weakness.

Methods: A total of 45 patients with cervical spondylotic amyotrophy (CSA) and cervical spondylotic radiculopathy (CSR) with proximal muscle weakness in the unilateral upper extremity were included. Twenty patients with CSA and five with CSR underwent anterior decompression and fusion (anterior group), and 16 patients with CSA and four patients with CSR underwent posterior decompression with foraminotomy (posterior group). A manual muscle test (MMT) score was analyzed in the muscle which showed maximum recovery after surgery. Pre- and postoperative MMT score, Japanese Orthopaedic Association (JOA) score, and imaging findings were evaluated statistically.

Results: The mean age at surgery was 63.2 years in the anterior group and 61.3 years in the posterior group (p=0.31). There was no significant difference in preoperative MMT (2.00 vs. 2.10, p=0.75), JOA score (13.9 vs. 13.5, p=0.60), and preoperative C2–C7 angle (2.28° vs. -0.87°, p=0.55) in both groups. There were no significant differences in operative time (137.5 minutes vs. 110.4 minutes, p=0.10) and blood loss (21.2 mL vs. 62.1 mL, p=0.11). The final postoperative observation period was not significantly different between the two groups (24.6 months vs. 20.8 months, p=0.32), and the postoperative C2–C7 angle was comparable (2.98° vs. 3.90°, p=0.78). The postoperative JOA score was not significantly different between the two groups (15.6 vs. 15.1, p=0.19). The MMT score significantly improved in both groups (p<0.01). The amount of change in MMT before and after surgery tended to improve in the anterior group but was not significantly different (2.48 vs. 1.90, p=0.06).

Conclusions: Although anterior decompression and fusion tends to have better outcomes, posterior decompression with foraminotomy was also useful for cervical spondylotic diseases to promote the improvement of motor weakness in the upper extremity.

232

Effect of Posterior Crack Osteotomies on Coronal and Sagittal Balance in Fused Scoliosis Deformity Caused by Previous Surgery: Mid-Term Results

Yunjin Nam, Jae Hyuk Yang, Sung Cheol Park, Hong Jin Kim, Dong-Gune Chang, Seung Woo Suh

Department of Orthopaedic Surgery, Korea University Guro Hospital, Seoul, Korea

Objectives: After the scoliosis surgery, due to decompensation, progressive imbalance in the coronal and sagittal plane and neurological symptoms, revisional surgery might be required. However, few studies have investigated revisional scoliosis surgery with the fusion mass using osteotomy due to the difficulty of instrumentation for fixation and correction. This study aimed to analyze the mid-term effect of posterior crack osteotomy on coronal and sagittal balance in patients with the fusion mass over the spine caused by previous surgery.

Methods: Patients who underwent revisional scoliosis correction surgery due to nonunion, implant failure, or adding-on phenomenon and who followed up for more than 5 years were enrolled. All patients were treated using posterior crack osteotomy. For radiological evaluation, preoperative, postoperative, and final operative Cobb angle, and coronal and sagittal balance factors such as sagittal vertical axis (SVA), thoracic kyphosis (TK), and lumbar lordosis (LL) were used.

Results: Eighteen patients (11 males and seven females) were enrolled. The average follow-up period was 7.2±2.7 years. Pre- and postoperative Cobb angles were 60.5°±21.8° and 31.0°±19.6° (p=0.001) and the final follow-up Cobb angle was measured as 35.3°±14.5. There was no statistical difference between postoperative and final follow-up Cobb's angles (p=0.19). In the pre- and postoperative evaluation of sagittal balance, mean SVA, TK, and LL were measured as 20.7±24.3 mm and 10.8±14.5 mm, 29.7°±30.9° and 31.4°±18.1°, and 37.1°±40.3° and 46.3°±21.1° (p=0.02, 0.74, 0.33). At final follow-up, all values for sagittal balance were maintained without statistical difference with postoperative results (p=0.22, 0.87, 0.36). The coronal balance before and after surgery was 15.9±18.4 mm and 9.3±12.9 mm, and the difference between the two groups was statistically significant (p=0.005). At final follow-up, radiographic signs of nonunion such as screw and rod breakage, screw loosening, and decompensation were not observed in all cases.

Conclusions: Posterior crack osteotomy provides a substantial and lasting improvement in overall radiologic alignment outcomes over 5 years after surgery. Posterior crack osteotomy can be used effectively in fused scoliosis deformity caused by previous surgery.

166

Which Radiographic Parameter Can Aid in Deciding Optimal Allograft Height Used for Anterior Cervical Discectomy and Fusion?

Sehan Park, Jae Jun Yang

Department of Orthopedic Surgery, Dongguk University Ilsan Hospital, Goyang, Korea

Objectives: Along with the polyetheretherketone cage, the allograft is a commonly used interbody spacer used for anterior cervical discectomy and fusion (ACDF). However, allograft height selection mostly relies on intraoperative assessment and the surgeon's subjective judgment. If the preoperative radiographic parameter is correlated to optimal allograft height that can result in a high fusion rate and less subsidence, it would be an objective guide for allograft height selection. Furthermore, surgeons would also understand how much distraction should be made during the operation. Therefore, the present study was conducted to determine the radiographic parameter than can help surgeons select optimal allograft height for ACDF which could result in improved outcomes. We hypothesized three reference radiographic parameters: (1) uncinate process height; (2) adjacent disc space height; (3) 2 mm larger than preoperative disc height could aid in allograft height determination.

Methods: A total of 101 patients (163 segments) who underwent ACDF using allografts and were followed up for more than 1 year were retrospectively reviewed. Segments were divided into two groups according to whether inserted allograft height is within 1 mm from reference radiographic parameters. Fusion rates, subsidence, segmental lordosis, and foraminal height were compared between

the two groups for all three reference parameters. Logistic regression analysis was performed to evaluate operative factors associated with fusion.

Results: Segments with allograft height ≤1 mm from uncinate height demonstrated a significantly higher fusion rate than segments with allograft height >1 mm from uncinate height. However, subsidence, segmental lordosis, and foraminal height did not significantly differ between the two groups at all time points when segments were divided according to uncinate height. When segments were divided according to whether allograft height is within 1 mm from adjacent segment height, there were no significant intergroup differences in fusion rate, subsidence, segmental lordosis, and foraminal height. Furthermore, in the case of using 2 mm greater than preoperative disc height as a reference value, no significant results were demonstrated. Multivariate logistic regression analysis demonstrated that using allograft with height within 1 mm from uncinate height, and amount of subsidence were correlated with fusion.

Conclusions: The results of the present study demonstrated that selecting an allograft height that is similar to an uncinate height could lead to a higher fusion rate. Distracting the disc height according to uncinate height would restore the physiological mechanical loading of the segment since uncinate height would represent the normal undegenerated segmental height of the individual. Therefore, uncinate height could be used as a preoperative radiographic guide for allograft height selection that can result in an enhanced fusion rate.

105

Compensatory Mechanism after Long Instrumented Fusion for Treating Multilevel Cervical Spondylotic Myelopathy Combined with Kyphotic Deformity during Midterm Follow-up

Kuang-Ting Yeh, Wen-Tien Wu, Chia-Ming Chang, Hao-Wen Chen, Ing-Ho Chen, Tzai-Chiu Yu

Department of Orthopaedics, Hualien Tzu Chi Hospital, Buddhist Tzu Chi Medical Foundation, Hualien, Taiwan

Objectives: The surgical treatment of cervical kyphotic deformity (CKD) remains challenging, especially it combined with multilevel cervical spondylotic myelopathy (MCSM). As the important structure for horizontal gaze, cervical sagittal alignment (CSA) affects the life quality of the patients. Surgical consideration should include adequate spinal cord decompression and restoration of better CSA. Solid posterior instrumented fusion structure is important for the prevention of failure in some situations. This study is aimed to evaluate the sagittal alignment change of adjacent levels of the cervical spine after long instrumented corrected fusion of CKD during a 24-month follow-up postoperatively.

Methods: We included 42 patients who underwent the afore-mentioned surgical methods for MCSM combined with CKD from January 2017 to December 2019. The minimum follow-up period was 24 months. Comparative analysis was performed to compare the preoperative and postoperative functional outcomes, including a visual analog scale for neck pain, Neck Disability Index, the Japanese Orthopedic Association cervical myelopathy score, and the Nurick score, as well as the CSA radiographic outcomes, including individual segmental angle from C0–T2, the chin-brow to vertical angle, the occipito-cervical angle, C2–7 Cobb angle, C2–7 sagittal vertical axis, and C7 slope.

Results: Improvements in functional outcomes were considerable in all the patients. The change in CSA was positively related to the age and the corrected Cobb angles. However, these changes were not significantly correlated with the functional outcomes at the last follow-up.

Conclusions: Adjacent segment alignment changes were related to the degrees of the corrected angles of long instrumented fusion for MCSM with CKD but these changes were not correlated with the functional recovery in 2-year follow-up.

68

Sex Differences between Whole Body Sagittal Alignment and Trunk Muscle Mass in the Elderly

Koichiro Ide, Yu Yamato, Tomohiko Hasegawa, Go yoshida, Tomohiro Banno, Yukihiro Matsuyama

Department of Orthopaedic Surgery, Hamamatsu University School of Medicine, Hamamatsu, Japan

Objectives: Few studies have investigated the relationship

between trunk muscle mass, aging, and whole-body sagittal alignment. This study aimed to clarify sex differences in the relationship between whole-body sagittal alignment, aging, and trunk muscle mass.

Methods: Subjects aged 60–89 years who underwent musculoskeletal screening in 2018 were included. Subject demographics, trunk muscle mass (TMM) measured by bioelectrical impedance analysis with a MC-780A Body Composition Analyzer (Tanita Co., Tokyo, Japan), and spinopelvic and lower extremity alignment parameters measured from standing radiographic images were investigated. In addition, TMM was corrected for body mass index (BMI) TMM (TMM/BMI). The relationship between trunk muscle and whole-body sagittal alignment was analyzed for each age group (young-old group [60–74 years] and old-old group [>75 years]) and sex.

Results: A total of 305 volunteers were enrolled in this study; however, 24 were excluded. Finally, 281 subjects were included in the final study sample (mean age, 75.4±6.7 years; 100 males and 181 females). In the overall cohort, the mean age was 75±6.7 years, and 64.4% of subjects were female. The average TMM and TMM/BMI was 21.4±3.7 kg and 0.950±0.171 kg/BMI, respectively. TMM was significantly decreased in both males (p<0.001) and females (p<0.001). In contrast, there was no significant difference in TMM/BMI in males (p=0.050), but it declined significantly with age in females (p=0.002). TMM/BMI was significantly correlated with SVA (males: r=-0.275, p=0.006; females: r=-0.300, p<0.001) and KF (males: r=-0.305, p=0.002; females: r=-0.362, p<0.001) in both males and females. In females, TMM/BMI was significantly correlated with thoracic kyphosis in the young-old group (r=-0.417, p<0.001), whereas in the old-old group, TMM was correlated with SVA (r=-0.315, p=0.002), PI–LL (r=-0.301, p=0.003), and KF (r=-0.381, p<0.001).

Conclusions: TMM affected trunk anteversion and lower extremity alignment in both sexes. However, the impact of TMM on alignment differs between sexes. Thoracic hyperkyphosis in young-old adults indicated a decrease in muscle mass, which could be a sign of future malalignment.

58

Surgical Sequence in Anterior Column Realignment with Posterior Osteotomy Is Important for Correction Degree of Adult Spinal Deformity

Sung-Min Kim, Yong-Chan Kim, Ki-Tack Kim, Kee-Yong Ha, Qiang Luo, Xiongjie Li

Department of Orthopedic Surgery, Kyung Hee University Hospital at Gangdong, Seoul, Korea

Objectives: We aimed to determine if pre-anterior column realignment (ACR) posterior osteotomy allows for greater change of spinopelvic parameters following adult spinal deformity correction and to find what a better indication is.

Methods: A total of 219 patients (184 women and 35 men) underwent ACR with posterior instrumentation for adult spinal deformity. Of the patients, 41 patients (AP group) underwent an anterior-posterior surgical sequence without a pre-ACR posterior osteotomy, and 178 patients (PAP group) underwent a posterior-anterior-posterior sequence with a pre-ACR posterior osteotomy. Pre- and postoperative free-standing sagittal radiographs were obtained and measured standard spinopelvic sagittal parameters. Comparisons between the two groups were analyzed and investigations within the AP group were performed.

Results: The PAP group showed significantly higher changes in the C7 sagittal vertical axis (C7SVA: 201.9 mm vs. 148.1 mm, p<0.05), thoracolumbar kyphosis (TLK: 20.4° vs. 10.3°, p<0.05), lumbar lordosis (LL: 56.9° vs. 39.9°, p<0.05), motion segmental angle (L2–3: 18.4° vs. 9.1°; L3–4: 14.8° vs. 9.4°; L4–5: 14.8° vs. 11.5°; p<0.05), and pelvic tilt (PT: 31.3° vs. 20.4°, p<0.05) compared to the AP group. The patients with less correction (>10° in PI–LL mismatch) in the AP group had moderate to severe grading scale of facet joint arthritis, severe osteoporosis, and <10°of flexibility in more than 80%.

Conclusions: PAP sequence may provide the greater correction of lumbar lordosis due to a higher change of motion segmental angle, compared to AP sequence. Especially, we suggest this surgical sequence for severe facet joint arthritis, severe osteoporosis, and rigid lumbar disease.

97

Efficacy and Complications of Halo Vest Immobilization in Pediatrics and Adolescent Age Group for Various Pathologies: Retrospective Single Center Study

Piyush Joshi, Saumyajit Basu

Kothari Medical Centre, Kolkata, India

Objectives: A halo vest is a device that restrains the cranium to the trunk. It provides the most rigid form of external immobilization for the upper cervical spine. Halo vest immobilization (HVI) is used in the definitive treatment of upper cervical injuries, cervical tumors and infections, and postoperative adjuvant stabilization. We aimed to evaluate the efficacy and complications of halo immobilization in pediatric and adolescent patients with different cervical pathologies.

Methods: A retrospective evaluation of patients treated at a single center by a single surgeon with HVI from 2005 to 2021 was performed. Demographic information, level and type of pathologies, duration of treatment, and complications incurred were recorded. The data was analyzed to find out the efficacy and safety of HVI.

Results: A total of 26 patients are treated with HVI of which 12 (46.15%) are males and 14 (53.84%) are females. The average age was 10.5 years (range, 3–18 years). Three patients (11.53%) had upper cervical injuries, 10 (38.46%) had tuberculosis, and 13 (50%) had maintenance of deformities correction. The mean duration of HVI was 2.8 months (range, 3 weeks to 6 months). There were improvements in the 12-item Short Form Survey score (47±2 to 58±2) at a recent follow-up. Complications were recorded in 10 patients (38.46%) which include loose pins in six patients (23.07%), pin site infections in two patients (7.69%), brain abscess in one patient (3.84%), and expiration in one patient (3.84%).

Conclusions: HVI can be used in a variety of spinal pathologies in the cervical spine with satisfactory outcomes, although potential complications are to be kept in mind.

104

Pedicle Subtraction Osteotomy for Treatment of Severe Cervical Kyphotic Deformity of Ankylosing Spondylitis

Wen-Tien Wu, Kuang-Ting Yeh, Chia-Ming Chang, Hao-Wen Chen, Ing-Ho Chen, Tzai-Chiu Yu

Department of Orthopaedics, Hualien Tzu Chi Hospital, Buddhist Tzu Chi Medical Foundation, Hualien, Taiwan

Objectives: Ankylosing spondylitis (AS) is an autoimmune disease, mainly involving the whole spine, sacroiliac, and hip joints. Chronic inflammation determines degeneration of the affected joints and induces fusion and ankyloses. Severe AS with hyperkyphotic deformity is vulnerable to vertebral fracture and the following spinal cord injury. However, the frequently delayed diagnosis of cervical fracture may bring more risk of permanent neurologic deficit and the progression of the deformity.

Methods: There were six cases of patients with underlying AS suffering from the progression of cervical kyphotic deformity resulting from either traffic accident or minor trauma. Persistent neck pain, progressive dysphagia, and neurologic deficit occurred under conservative treatment indicate surgical management in most of the cases. They all received the strategy of staged surgery started with closed reduction and alignment protection of the cervical curvature with a halo vest fixation system. The cervical kyphotic deformities, including cervical lordosis, chin to brow vertical angle, occiput-to-wall distance, C2–C7 sagittal vertical axis, C7 slope, and neck tilt, were assessed. Advanced radiological investigations such as computed tomography and magnetic resonance imaging were also performed for preoperative and postoperative evaluations.

Results: In the first staged surgery, nearly 40% of the correction in our cases resulted from the reduction of the post-traumatic lordosis loss. The pedicle subtraction osteotomy (PSO) over the appropriate level may gain the other 60% of the correction. Transient upper limb weakness was noted in five patients (5/6). Full recovery of the neurogenic status of was noted in two patients during 1-year follow-up (2/5). Gradually recovery was also noted in the other three patients. So far, no other surgery-related complications occurred in the midterm follow-up and most of the patients mentioned the improvement of neck

pain, dysphagia, and myelopathy.
Conclusions: AS commonly affects the axial skeleton, less leading to cervical deformity than thoracic deformity but devastating. This deformity is functionally and psychologically disabling. Therefore, surgical intervention should be adopted to correct deformity, help the patient walk erect, and improve balance and gait efficiency. Transient radiculopathy was the commonest complication after this correction surgery, and the cause may be temporary tethering of the nerve roots. Preoperative communication with the patients about this complication was important and future studies may focus on aggressive prevention of this condition. Despite that, the strategy of staged PSO was still secure and effective for the management of underlying AS with progressive cervical kyphotic deformity.

108

L5 Closing-Opening Wedge Osteotomy as a Salvage Procedure for Post-fusion Failed Back Surgery Syndrome

Chia-Ming Chang, Wu Wen-Tien

Hualien Tzu Chi Hospital, Buddhist Tzu Chi Medical Foundation, Hualien, Taiwan

Objectives: Fixed sagittal spinal malalignment is a common problem in post-fusion failed back surgery syndrome (PFFBSS). Pedicle subtraction osteotomy is an effective technique to restore a large amount of lordosis in patients with fixed sagittal deformity and has mostly been used at L3 or L4 levels. However, when the apex of kyphosis is located at the L5 level, the L5 osteotomy is needed. While the L5 vertebral body height is frequently less than that of L3 or L4, which may reduce the amount of correction, so we performed the closing-opening wedge osteotomy (COWO) at the L5 level to get more correction and prevent dura kinking from over posterior compression.
Methods: Consecutive PFFBSS patients with symptomatic and rigid kyphosis at L5 in whom sagittal malalignment had been treated with L5 COWO at our institution between 2015 and 2018 were analyzed and those with a minimum 2-year follow-up were included in the study. Radiographic analyses included assessments of preoperative and postoperative L4-S1 segmental lordosis, lumbar lordosis (LL), pelvic tilt, pelvic incidence (PI), and sagittal vertical axis (SVA) on standing radiographs. Complications were also analyzed for the entire group.
Results: There were five cases in this study. Overall, the average postoperative increases in L4–S1 segmental lordosis and LL were 34° and 37°, respectively. The average SVA improvement was 9 cm. The amounts of correction at the L5 level were amazing, and there was no neurologic deficit after these surgeries. One patient required additional surgery for rod breakage 18 months after surgery, but solid union in good sagittal alignment was achieved eventually.
Conclusions: L5 COWO seemed to be an effective technique to correct fixed sagittal kyphosis at the L5 level in post-fusion failed back surgery syndrome. In comparison to traditional pedicle subtraction osteotomy techniques, L5 COWO may allow greater focal correction with comparable complication rates.

179

Is the Degree of Thoracolumbar Kyphosis Proportional to Low-Back Pain and Disability? A Retrospective Observational Study

Rudra Prabhu, Tushar Rathod

Lokmanya Tilak Municipal Medical College and General Hospital, Mumbai, India

Objectives: To determine whether the degree of thoracolumbar kyphosis in conservatively managed patients with Koch's spine, fracture spine, and spinal deformity, as measured by the Cobb's angle has any correlation with the patient's low-back pain as determined by the Visual Analog Scale (VAS) score and disability as determined by the Oswestry Disability Index (ODI).
Methods: A retrospective analysis of radiographs and magnetic resonance imaging (MRI) of conservatively managed patients with Koch's spine, fracture spine, and spinal deformity was done. The patients managed over a period of 5 years from 2015 to 2020 and had a minimum of 1 year of follow-up were included. Patients aged more than 20 years and those having thoracolumbar kyphosis greater than or equal to 20° due to pathology between D8 to L3 were included. The Cobb's angle was calculated

using standing lateral radiographs or MRI. The ODI and VAS scores at the time of presentation, at follow-up of 6 months, and 1 year were taken into consideration. The level of significance was set at 0.05.

Results: The average age of the patients was 34 years, with a range from 20 to 73 years. There were 20 males and 21 females. The average kyphosis angle was 34°. The patients were divided into two groups as per the kyphosis angle: group A had 22 patients with an angle less than 35°, while group B had 19 patients with an angle more than 35°. The average angle in group A was 25.61°, while the average angle in group B was 43°. At a follow-up of 6 months, the mean ODI score in group A was 49.91, while that in group B was 58.58 (p=0.002). At a follow-up of 1 year, the mean ODI score in group A was 10.32, while that in group B was 27.53 (p<0.001). At a follow-up of 6 months, the mean VAS score in group A was 5.59, while that in group B was 6.79 (p<0.001). At a follow-up of 1 year, the mean VAS score in group A was 2.41, while that in group B was 4.58 (p<0.001).

Conclusions: The degree of thoracolumbar kyphosis has a significant correlation with the patient's low-back pain and disability. Patients having a greater degree of thoracolumbar kyphosis suffer from a greater severity of low-back pain and disability.

233

Surgical Results of Posterior Correction and Fusion Surgery for Adult Patients with Residual Adolescent Idiopathic Scoliosis Lenke Type 5

Reo Shibata, Mitsuru Yagi, Narihito Nagoshi, Morio Matsumoto, Masaya Nakamura, Kota Watanabe

Department of Orthopaedic Surgery, Keio University School of Medicine, Tokyo, Japan

Objectives: The strategy for treating adult patients with residual adolescent idiopathic scoliosis (AIS) Lenke type 5 (type 5 AdIS) is still unclear. The purpose of this study was to compare the radiographic findings and surgical outcomes of type 5 AdIS with those of type 5 AIS to help determine the strategy of the treatment.

Methods: Thirty-three patients who were diagnosed with type 5 AIS before 18 years old and underwent posterior correction and fusion surgery (PSF) after the age of 20 were classified as AdIS group. As a control, 58 patients with type 5 AIS who underwent PSF by the age of 19 were included in the AIS group. Pre- and postoperative radiographic findings and surgical outcomes were compared between the groups.

Results: The mean age at surgery was 29.4±1.8 years in the AdIS group and 15.0±0.3 years in the AIS group (p<0.01). In the preoperative findings, both the Cobb angle of the lumbar curve and flexibility index in AdIS group were significantly lower compared to the AIS group (Cobb angle: 49.1°±1.6° vs. 43.7°±1.2°, p<0.01; flexibility index: 64.0±2.3 vs. 69.1±2.5, p<0.01). Although there was no significant difference in intraoperative blood loss between the two groups (212±35 mL vs. 158±15 mL, p=0.41), the intraoperative time and the number of fused vertebrae in AdIS group were significantly longer compared to the AIS group (operating time: 124±10 minutes vs. 94±3 minutes, p<0.05; number of fused vertebrae: 5.2±0.3 vs. 4.3±0.1, p<0.05). The Cobb angle of the lumbar curve after surgery in AdIS group was significantly larger than that in the AIS group at follow-up (17.6°±1.2° vs. 14.4°±1.1°, p<0.05).

Conclusions: The preoperative Cobb angle and flexibility index were significantly lower in AdIS group. Similar to these results, the operative time and number of fused vertebrae in AdIS group were significantly longer compared to the AIS group. Surgical invasiveness increased and the correction rate worsens in type 5 AdIS. The results may be useful in determining the timing of surgery.

63

Preoperative Computed Tomography Hounsfield Unit at L1 Level Is a Reliable Parameter to Predict Screws Loosening and Cages Subsidence in Transforaminal Lumbar Interbody Fusion

Chao Hsien, Kun-Yu Kao, Yu-Cheng Yao, Po-Hsin Chou, Ming-Chau Chang, Shih-Tien Wang

School of Medicine, National Yang Ming Chiao Tung University, Taipei, Taiwan

Objectives: The purpose of this investigation is to determine whether preoperatively obtained computed tomography (CT) Hounsfield unit (HU) was an appropriate

predicting parameter for screws loosening and cages subsidence in transforaminal lumbar interbody fusion (TLIF).
Methods: From October 2016 to February 2020, 198 patients treated with 1- or 2-level TLIF were enrolled in this retrospective study. Patient demographics and surgical parameters were collected through chart review. Radiographic parameters were collected at preoperative and postoperative 1, 3, 6 months, and 2-year follow-up, including L1 CT HU, segmental lumbar lordosis, disc height, segmental disc angle, and cage position. Screw loosening, cage subsidence, and fusion status were assessed by plain radiographs at each follow-up visit. Clinical outcomes were recorded using the Visual Analog Scale and Oswestry Disability Index scores.
Results: A total of 198 patients with a total of 258 levels and 930 screws were analyzed. The average follow-up duration was 25.3±11.0 months; 32 (16.2%) and 49 (24.7%) patients had cage subsidence and screw loosening, respectively. Ten patients received revision surgery due to nonunion or screws loosening. The overall fusion rate was 82.1%. There were lower L1 HU, higher body mass index (BMI), more diabetes mellitus, and more multi-level TLIFs found in patients with screws loosening or cage subsidence. A cut-off value of preoperative L1 HU for predicting screw loosening or cage subsidence wase 117 (Se, 67%; Sp, 64%; p<0.001). After multivariate logistic regression analysis, patients with preoperative L1 HU <117 had 4.1 times risks and BMI >25.0 kg/m^2 had 2.6 times risks of screws loosening or cage subsidence. Further univariate logistic regression analysis of data from patients was concurrently BMI >25.0 kg/m^2 and preoperative L1 HU <117 and showed they were 4.3 times more likely to experience screws loosening or cage subsidence. The fusion rate and clinical outcome were comparable in patients with screw loosening or cage subsidence.
Conclusions: Preoperative L1 HU is a good predictor of cage subsidence or screw loosening. Lower L1 HU (<117) and higher BMI (>25.0 kg/m^2) were two independent risk factors for screw loosening or cage subsidence in TLIF.

169

Transforaminal Lumbar Interbody Fusion in Degenerative Lumbar Spondylolisthesis: A Technical Note with Pearls and Pitfalls

O. Z. M. Dastagir

National Institute of Traumatology and Orthopedic Rehabilitation, Dhaka, Bangladesh

Objectives: A transforaminal lumbar interbody fusion (TLIF) procedure allows to insert bone graft and cage into the disc space without forcefully retract the nerve roots, which reduce injury and scarring around the nerve roots and reduce intraoperative bleeding. TLIF fuses the anterior (front) and posterior (back) columns of the spine through a single posterior approach. It is one of the treatment options of degenerative spondylolisthesis, which can restore the disc and foraminal height and gives immediate stability. This study aimed to evaluate the clinical and functional outcomes of transforaminal lumbar interbody fusion (TLIF) using cage and bone graft combined with stabilization in lumbar spondylolisthesis.
Method: A prospective observational study was conducted at NITOR, Dhaka, from July 2018 to June 2021. Degenerative spondylolisthetic patients aging above 30 years were included in this study. Surgery was done by posterior decompression & transforaminal lumbar interbody fusion using cage, bone graft and stabilization by pedicle screws and rods. Preoperative and postoperative pain status was recorded by self-evaluated Visual Analog Scale (VAS) score and disability by Oswestry Disability Index (ODI). Preoperative and postoperative disc height, foraminal height, angle of total lumbar lordosis and slip reduction was measured in standing lateral view X-ray films. Hackenberg criteria were used for assessment of bony fusion. The overall functional outcome was assessed by Macnab's criteria.
Results: Total number of patients were 28, male was 11 (39.3 %) and female 17 (60.7%) and mean age group was 40±7.1 years. Sixteen patients (57%) had spondylolisthesis at L4/L5 level and 12 (43%) had at L5/S1 level. Regarding clinical assessment, the ODI percentage has been decreased from 58%±1.5% to 17.87%±4.56%, VAS for back pain has come down from 7.1±0.46 to 2.2±0.56 and VAS for leg pain has come down from 6.6±0.51 to 1.27±0.46

six months after surgery. At last follow-up, 23 (82%) patients were excellent and only 5 (18%) found good according to Macnab criteria. Regarding radiological variables, total lumbar angle, disc height and foraminal height increased significantly and mean slip angle, slip percentage decreased significantly. Fusion rate was 100%.

Conclusions: Degenerative spondylolisthesis lumbar spine can be treated with posterior decompression & transforaminal lumbar interbody fusion (TLIF) and spinal stabilization. This method enhances neurological recovery, reduce pain and improve working status with early rehabilitation.

112

Spinal Tuberculosis Controversies of Treatment Modalities: Experience of 762 Patients

Shah Alam, Sarwar

Bangladesh Spine & Orthopedic Hospital (BSOH), Dhaka, Bangladesh

Objectives: Tuberculosis of the spine is a common form of tuberculosis infection for 50% to 60% of osseous tuberculosis. Although uncommon, spinal tuberculosis still occurs in both developed and developing countries. The diagnosis of spinal tuberculosis is difficult and it commonly presents at an advanced stage. Delays in establishing diagnosis and management result in complications such as spinal cord compression and spinal deformity.

Methods: A total of 762 patients with tuberculosis of the cervical, thoracic, and lumbar spine with moderate to severe cord compression were studied. Variable degrees of the neurological deficit with deformity were treated from January 2003 to July 2021. Thoracotomy along with anterolateral decompression and autogenous strut bone grafting with simultaneous fixation by screws and rods were done in 79 cases. Posterior decompression, posterior interbody, and posterolateral fusion by bone graft with stabilization by transpedicular screws and rods were done in 601 cases, whereas 82 cases of cervical tuberculosis were operated by either anterior approach or both anterior and posterior approaches. Appropriate anti-tuberculosis drugs were given to all patients for 12–18 months. The follow-up period was 3 months to 10 years.

Results: The average age was 47 years (range, 9–85 years). All patients survived the surgery. There were 10 cases of superficial infections (1.3%) while there were five cases (0.7%) of deep infections. Revision surgery was performed in eight patients (1.0%). Implant failure occurred in five cases (0.7%) while malposition of screws occurred in 16 cases (2.1%). Perioperative bleeding complications were reported for five patients (0.7%). Neurological improvement occurred in all patients except for nine cases (1.1%). Preoperatively, the majority of patients (n=281, 37%) were classified with class B on the American Spinal Injury Association neurological impairment scale. This was significantly reduced postoperatively to 0.3%.

Conclusions: For patients with spinal tuberculosis, anterior debridement, autograft bone fusion, and anterior or posterior fixation appear to be effective in arresting disease, correcting kyphotic deformity, and maintaining correction until solid spinal fusion.

162

The Risk Factors for Early-Onset Adjacent Segment Disease in Patients with Spondylolytic Spondylolisthesis Who Underwent Single-Level Posterior Lumbar Interbody Fusion

Kazuki Takeda, Satoshi Suzuki, Masahiro Ozaki, Morio Matsumoto, Masaya Nakamura, Kota Watanabe

Department of Orthopaedic Surgery, Shizuoka Red Cross Hospital, Shizuoka, Japan

Objectives: The risk factors for radiographical adjacent segment disease (ASD) in patients with degenerative spondylolisthesis have been reported. However, reports on patients with spondylolytic spondylolisthesis who underwent single-level posterior lumbar interbody fusion (PLIF) are few. This study aims to investigate the risk factors for radiographical ASD in patients with L5–S1 spondylolytic spondylolisthesis who underwent single-level PLIF.

Methods: This study retrospectively reviewed 135 consecutive symptomatic L5–S1 spondylolytic spondylolisthesis (91 males and 44 females) who underwent single-level PLIF. The mean age at surgery and mean follow-up period were 58.5±15.0 years and 30.3±10.1 months, respectively. Radiographical ASD was defined as disc height loss (>3

mm), posterior angulation increase (>5°), or progression of slippage for anterior translation (>3 mm) between the pre- and postoperative radiographs. Disc degeneration was evaluated using Pfirrmann's classification. The changes between the pre- and postoperative values were evaluated in each non-ASD and ASD group. We compared radiographical parameters between the non-ASD and ASD groups. A binary logistic regression model was conducted to evaluate the adjusted associations between each potential explanatory variable and ASD development. The pre- and postoperative (at the final follow-up) global sagittal alignment, % slip, sacral slope, lumbar lordosis (LL), pelvic tilt, pelvic incidence (PI), PI minus LL (PI–LL), lumbosacral angle, C7 sagittal vertical axis, and thoracic kyphosis on the standing radiographs were measured.

Results: Radiographical ASD incidence was 11%. Also, 60.0% of the patients with ASD had radiographical ASD 1 year after the initial surgery and all cases of radiographical ASD in this follow-up period occurred within 3 years after the initial surgery. The mean period of ASD occurrence after initial surgery was 21.7±12.6 months. No patients required reoperation for radiographical ASD. Multivariate analysis revealed that preoperative PI–LL ≥15° (odds ratio [OR], 5.9; 95% confidence interval [CI], 1.2–28.9; p=0.03) and postoperative PI–LL ≥15° (OR, 6.5; 95% CI, 1.2–34.5; p=0.03) were the risk factors for radiographical ASD.

Conclusions: The current study identified that the pre- and postoperative PI–LL mismatch ≥15° were the independent risk factors for early-onset radiographical ASD in patients with L5–S1 spondylolytic spondylolisthesis who underwent single-level PLIF. Therefore, the sagittal alignment, particularly the risk factor identified in the present study, should be taken into consideration when surgeons decide on the surgical approach for L5–S1 spondylolytic spondylolisthesis.

99

Type I Arnold Chiari Malformation with Syringomyelia and Scoliosis: Radiological Correlations Between Tonsillar Descent, Syrinx Morphology, and Curve Characteristics

Nimish Rai, Ajoy Prasad Shetty

Ganga Medical Centre and Hospitals Pvt. Ltd., Coimbatore, India

Objectives: To evaluate characteristics and assess the relationship between the morphology of syrinx/Arnold Chiari malformation (ACM) and deformity, analyze the effect of posterior fossa decompression (PFD), and evaluate the overall outcome.

Methods: The data regarding patients who underwent PFD for type I ACM (ACM-I) presenting with syringomyelia (SM) and scoliosis at our institution between January 2009 and December 2018 were retrospectively collected. Only patients who had complete clinico-radiological records with a minimum follow-up of 2 years were included. On plain radiographs, characteristics of deformity on coronal/sagittal planes; and sagittal spino-pelvic parameters were assessed. On magnetic resonance imaging (MRI), symmetry, size, and extent of tonsillar descent, as well as morphology (configuration/deviation) and extent of the syrinx (maximal syrinx/cord [S/C] ratio/length), were measured.

Results: A total of 42 patients (20 females; mean age, 14.2±5.8 years) were included. Thirty-five patients (83.3%) had atypical curve patterns. Mean preoperative coronal Cobb was 57.7°±20.9°. Twelve patients (28.6%) had a significant coronal imbalance. The tonsillar descent was classified as grade 1, 2, and 3 in 16 (38.1%), 11 (26.2%), and 15 (35.7%) patients, respectively. Thirty-five patients (83.3%; 29 right-sided) had asymmetric tonsillar descent. Seventeen (40.4%), 3 (7.1%), 16 (38.1%), and 6 (14.4%) patients presented with circumscribed, moniliform, dilated, and slender patterns of the syrinx. Nine (21.4%), 12 (28.6%), and 21 (50%) of syrinx were right-sided, left-sided, or centric in location. There was no significant relationship between the side of tonsillar dominance (p=0.31), grade of descent (p=0.30), and convexity of deformity. There was a significant association between the side of syrinx deviation and the convexity of scoliosis (p=0.01). All patients underwent PFD and 23 underwent surgical

deformity correction. There were no neurological complications. In curves with a magnitude ≤40°, PFD alone could significantly stabilize scoliosis progression (p=0.02). There was a significant reduction in the S/C ratio following PFD, as compared with preoperative status (pre-PFD 0.76 vs. post-PFD 0.53, p<0.001).

Conclusions: Eighty-three percent of patients with ACM-I and SM present with atypical curve patterns, and the side of syrinx deviation significantly correlates with the convexity of scoliosis. PFD causes a significant reduction in the size of the syrinx. In curves with a magnitude >40°, PFD may not play a significant role in the stabilization of scoliosis.

192

Comparative Analysis of Accuracy of Thoracolumbar Pedicle Screws Using O-Arm Based Navigation in a Single Center of over 2,200 Pedicle Screws in Indian Population with Robot Guided, Navigated and Free Hand Technique in Literature

Raj Sakhrekar

Schoen Klinik, München, Germany

Objectives: To estimate the accuracy rate of placement of pedicle screws using intraoperative O-Arm-based navigation and compare with robot-guided, navigated, and freehand techniques in published literature.

Methods: We studied the records of 229 patients who underwent placement of pedicle screws using O-arm-based navigation. The accuracy of screw placement was analyzed based on intraoperative computed tomography (CT) scans acquired after pedicle screw insertion. Screw placement accuracy was assessed by two independent observers on postoperative CTs according to the A to D Rampersaud criteria.

Results: Of 2,224 pedicle screws included, 22 had pedicle violations noted on intraoperative CT. According to Rampersaud, patients were categorized into four groups from A to D (A: completely in the pedicle, B: <2 mm breach, C: 2–4 mm breach, D: >4 mm breach). 99% screws were placed completely within the pedicle margins (grade A) (p>0.05). Of the screws, 1% were considered misplaced (grades B and C). Oversized screws touching both medial and lateral cortices were still considered to be part of group A unless the breach was >2 mm. The rate of accuracy of pedicle screw fixation was 99%. This study compared screw accuracy with robot-guided, navigated, and freehand techniques and found no statistically significant difference in the different techniques.

Conclusions: The precision, reliability, accuracy, and safety of pedicle screw placement can be improvised with the help of O-arm-based intra-operative three-dimensional scans for navigation. Pedicle breach and implant-related neurovascular complications can be reduced and better surgical outcomes can be achieved. This study also compared screw accuracy with robot-guided, navigated, and freehand techniques and found no statistically significant difference in the different techniques.

196

Intramedullary Spinal Cord Abscess Mimicking Intramedullary Spinal Cord Tumor

Siddharth Katkade, Ajay Kothari

Sancheti Institute of Orthopaedics and Rehabilitation, Pune, India

Objectives: To learn unusual radiological presentation of chronic intramedullary spinal cord abscess (IMSCA) mimicking intramedullary spinal cord tumor (IMST). Chronic intramedullary spinal cord abscess is a rare entity. Intramedullary spinal cord tumors are also rare presentations. Rarely, radiological presentations of both might mimic each other.

Methods: A 33-year-old female with low back pain and bilateral lower limb radiculopathy since 3 months presented with recent onset bilateral ankle weakness. Magnetic resonance imaging (MRI) suggestive of well-defined mildly enhancing intramedullary lesion revealed possibly conus medullaris neoplasm most, probably myxopapillary ependymoma. In view of neurodeficit, posterior midline dorsolumbar durotomy was performed with evidence of only purulent material. The postoperative patient had complete neurological recovery within 24 hours. The sample was sent for pyogenic, tubercular, and fungal culture. Pus culture report came positive for *Staphylococcus aureus*

sensitive to flucloxacillin. Accordingly, intravenous and oral antibiotics were given for a total of 6 weeks. The patient was followed up at 6 weeks, 3 months, 6 months, and 8 months with complete symptomatic relief, neurological recovery, and no signs of clinical or radiological recurrence on repeat MRI.

Results: At an 8-month follow-up, complete neurological recovery with no clinical and radiological signs of recurrence.

Conclusions: Chronic IMSCA at conus medullaris can radiologically mimic IMST of conus and create a diagnostic dilemma. MRI shows decreased signal intensity with peripheral enhancement on T1-weighted images after gadolinium injection. Though this finding remains indistinguishable from some spinal neoplasm, it may help to raise suspicion about chronic IMSCA. Hence, this case report teaches the unusual radiological presentation of chronic IMSCA and the importance of having detail knowledge about various conus lesions and their distinguishing radiological appearances to avoid misdiagnosis and mismanagement.

101

Does Spinal Cord Drift Predict Functional Recovery in Degenerative Cervical Myelopathy? A Comparative Matched Cohort Study between Cervical Laminoplasty and Laminectomy/Fusion

Kushal Gohil, Saumyajit Basu

Kothari Medical Centre, Kolkata, India

Objectives: To compare spinal cord drift between cervical laminoplasty (LP) and laminectomy with lateral mass screw fixation (LF) in patients with degenerative cervical myelopathy (DCM). To examine the relationship between preoperative cervical alignment, postoperative cord drift, functional outcome, and occurrence of C5 palsy.

Methods: Patients in LP (n=20) and LF (n=22) were prospectively followed and assessed at 1-year follow-up (FU). Pre- and postoperative cervical alignment at 1-year FU was measured using the Cobb angle (C2–C7). Both groups were further subclassified into lordotic (Cobb angle >10°), straight (0°–10°), and kyphotic (<0°), and subgroup analyses were performed. This stratification yielded 12 lordotic (LP–L) and eight straight (LP–S) in the LP group and nine lordotic (LF–L) and 13 straight (LF–S) in the LF group. Spinal cord position was measured on sagittal and axial T2-weighted magnetic resonance imaging of the cervical spine preoperatively and postoperatively at 1-year FU and spinal cord drift was measured by subtracting preoperative values from the postoperative values. Neurological recovery (modified Japanese Orthopaedic Association [mJOA] score, mJOA recovery rate [RR]), and C5 palsy in the patients were recorded and compared.

Results: There were no differences in age, gender, duration of symptoms, surgery duration, blood loss, hospital stay, affected levels, and baseline mJOA between both groups. Mean spinal cord drift was higher in the LF group compared to the LP group (2.66±0.77 mm vs. 2.16±0.80 mm, p=0.049). Subgroup analyses yielded significantly higher in cord drift observed in the lordotic subgroups (LP–L vs. LP–S, p=0.0001; LF–L vs. LF–S, p=0.0003 and LP–L vs. LF–L, p=0.006; LP–S vs. LF–S, p=0.03). There was a strong positive correlation between preoperative Cobb angle (C2–C7) and cord drift (Spearman's ρ=0.7143). Both groups showed significant improvement in mJOA scores at 1-year FU compared to their preoperative values (LP, +6.3, p<0.001; LF, +7.8, p<0.001). However, there was no difference in mJOA score and mJOA-RR between both groups (p=0.115). Subgroups analyses revealed significant improvement in mJOA-RR in the lordotic subgroup as compared to the straight subgroup (LP–L vs. LP–S, p=0.048; LF–L vs. LF–S, p=0.045). Spinal cord drift and mJOA-RR showed a strong positive correlation (Spearman's ρ=0.6053). Patients demonstrating cord drift >2.5 mm (n=24) had a significantly higher mJOA-RR as compared to those with <2.5 mm cord drift (n=18) (p=0.0001). There was no significant difference in the occurrence of C5 palsy in LP and LF groups and within subgroups; LP–L, LP–S, LF–L, and LF–S was 1/8 (12.5%), 2/12 (16.66%), 2/13 (15.38%), and 2/9 (22.22%), respectively (p>0.05).

Conclusions: Comparative data between LP and LF groups showed better spinal cord drift in the LF group but failed to show any significant difference in RR and occurrence of C5 palsy. Preoperative lordotic cervical alignment in both groups correlated well with cord drift which in turn correlated with RR.

84

Effect of Intraoperative Whole Spine X-P in Adult Scoliosis Surgery

Keiichi Nakai, Yu Yamato, Yukihiro Matsuyama

Hamamatsu University School of Medicine, Hamamatsu, Japan

Objectives: In adult spinal deformity surgery, patients with postoperative coronal malalignment often complain of body trunk tilt, and because of long fusion, postoperative compensatory mechanisms are less, so it is important to provide the optimal intraoperative correction. Intraoperative whole spine X-P was introduced in our hospital in 2018. Intraoperative whole spine X-P is a single image consisting of two to three images, which allows intraoperative confirmation of the alignment from the pelvis to the thoracic spine. The purpose of this study was to evaluate the effectiveness of intraoperative whole spine X-P.

Methods: Forty-nine patients (four males and 45 females; mean age, 69 years) who underwent thoracic to pelvic corrective fusion for adult spinal deformity with a Cobb angle of more than 20° in the lumbar spine curve from 2018 to 2020 and used intraoperative whole spine X-P were included in this study. The frontal view of the supine whole spine X-P after intraoperative rod fixation showed L3 tilt, L4 tilt, T10 rod tilt (RT) (angle between the line connecting the midpoint of the T10 pedicle screw and the midpoint of the S1 pedicle screw and the line connecting the iliac crest), T12 RT, upper instrumented vertebra (UIV) RT was measured. Oblique take-off (OT) was defined as C7–central sacral vertical line of 25 mm or more, and the patients were divided into two groups: the OT group and the non-OT group.

Results: Postoperative OT was present in 11 patients (22%), and all were tilted to the convex side of the lumbar curve. The mean age was significantly higher in the OT group (74 and 68 years) (OT and non-OT groups), and the UIV was significantly more cephalad (T7 and T8) (p<0.05). Mean intraoperative parameters were L3 tilt 5°, 7°, L4 tilt 6°, 8°, T10 RT 3°, 0°, T12 RT 4°, 2°, and UIV RT 3°, 0°, with significant differences for T10 RT and UIV RT (p<0.05).

Conclusions: In order to prevent OT, it is necessary to consider not only local but also global alignment. In this study, UIV RT and T10 RT were significantly bigger in the OT group. However, only about 2/3 of the conventional intraoperative lumbar spine X-P included T10, and the incidence of OT was 26%. Intraoperative whole spine X-P can evaluate up to T10 and UIV in the same image, which may reduce OT.

Abstracts for E-Posters

4

Relationship between Sagittal Acetabular Orientation and Sacropelvic Parameters: Computed Tomography Analysis

Joe Baker

Waikato Hospital, Hamilton, New Zealand

Objectives: The relationship between hip joint morphology and spinopelvic parameters is of interest given the increased risk of dislocation of total hip arthroplasty in patients with previous spinal fusion. Understanding the relationship between the orientation of the acetabulum and spinopelvic parameters is desirable to determine how acetabular orientation may change with changes in spinopelvic parameters following spine surgery.

Methods: Computed tomography scans obtained for blunt trauma were analyzed: sagittal orientation of the acetabulum (ASA) determined angle subtended by a line along the anterior pelvic plane and a line connecting the anterior and posterior horns of the acetabulum, the sagittal acetabular version (SA) determined by the angle subtended by a line along the sacral endplate and a line connecting the anterior and posterior horns of the acetabulum, pelvic incidence (PI), sacral anatomic orientation (SAO), and pelvic thickness (PTH).

Results: A total of 100 scans were analyzed (62% male). Mean±standard deviation (SD) age was 48.2±18.0 years; mean±SD values were: right ASA 62.1°±9.1°, left ASA 63.9°±8.4°, right SA 67.2°±12.0°, left SA 65.4°±11.6°, PI 50.5°±10.1°, SAO 50.7°±8.4°, and PTH 106.4±6.9 mm. Correlation analysis demonstrated substantial association between PI and SA and between SAO and SA. Stepwise linear regression analysis was performed with SA best

predicted by the model: SA=81×SAO+0.36×PI.

Conclusions: SA, measuring the orientation of the acetabulum in relation to the sacral endplate in the sagittal plane was better correlated with established static spinopelvic parameters than was ASA which relates the orientation of the acetabulum to the anterior pelvic plane, a traditional reference for analyzing version. This study further supports the notion that reorientation of the sacrum following surgery to the spine may alter acetabular orientation and affect hip joint mechanics.

139

Oblique Corridor to Lumbar Spine-Minimally Invasive Solution Offering Clear Benefits: Our Experience So Far

Ameer Theruvath

Rajagiri Hospital, Kochi, India

Objectives: To study the usefulness, safety, and outcome of oblique corridor for lumbar interbody fusion.

Methods: Three patients (five levels) were surgically treated by lumbar interbody fusion for various indications utilizing the oblique corridor or anterior to psoas (ATP) approach. The first patient had prolapsed intervertebral disc (PIVD) at L4–5 with radiculopathy. Supplemental posterior fixation with pedicle screws was done along with tubular micro-decompression on the side of radiculopathy. The second patient had a recurrent disc herniation at L3–4 following an open discectomy performed at another center 8 months ago. This patient also underwent direct decompression through a tubular approach and supplemental pedicle screw fixation. The third patient was diagnosed with degenerative lumbar scoliosis with significant back pain and severe neurogenic claudication and underwent surgery at three levels (L2–3, L3–4, and L4–5). This patient underwent posterior percutaneous pedicle screw fixation from L2 to L5 after 5 days. The patients were followed up for symptom relief and complications.

Results: All three patients had excellent relief of their presenting symptoms—back and leg pain. The first two patients had lumbar plexus palsy which recovered gradually. The first patient was noted to have buckling of the left knee indicating quadriceps weakness on attempted mobilization on the first postoperative day. But he managed to walk with walker support. His weakness completely resolved in 8 months. The second patient had bothersome new onset paresthesia and pain in the left thigh following surgery without any observable weakness in limbs. He was managed with neurotrophic medications (Pregabalin 75 mg daily). His sensory disturbances improved but he is still worried about them at a 7-month follow-up. The third patient with degenerative scoliosis had complete symptom relief without any motor or sensory deficits post-surgery. The experiences from the first two cases gave us a few lessons on how to handle the psoas muscle without injuring the lumbar plexus.

Conclusions: The oblique corridor or ATP approach is a useful technique that can come in handy in a few scenarios. This includes revision disc surgeries and adult deformity corrections. In revision surgery, it provides a minimally invasive virgin path avoiding posterior scarred tissues. In adult degenerative scoliosis, this approach provides excellent indirect decompression and coronal as well as sagittal profile restoration retaining all the benefits of minimally invasive surgery. Lumbar plexus injury is a potential complication (among a variety of other visceral and vascular complications) of this approach. Refinements in technique and experience can help reduce the incidence of such complications over time.

89

Morphometric Variations of the Lumbosacral Canal in the Adult Malaysian Population

Paul Boon King Tan, Chee Kidd Chiu, Weng Hong Chung, Chris Yin Wei Chan, Mun Keong Kwan

Universiti Malaya, Kuala Lumpur, Malaysia

Objectives: To determine the incidence of different morphometries of the lumbosacral canal to aid in the safe application of pedicle screws.

Methods: This was a retrospective study on the normal lumbosacral spine of patients aged 18–80 years old who had lumbosacral computed tomography (CT) scans performed from January 2015 to December 2019. These CT scans were traced from the online radiological database and were done for various reasons. The exclusion crite-

ria were patients who had spinal deformities (scoliosis, kyphosis, or spondylolisthesis), congenital vertebrae abnormalities, fractures, tumor or metastasis, and significant degenerative changes of the lumbosacral canal which could prevent accurate analyses. The lumbosacral canal was classified into oval/round, triangle, and trefoil shapes based on the following parameters: (1) transverse distance: widest distance between the medial surfaces of pedicles at mid-pedicle level of the axial slices on CT scan; (2) mid-sagittal distance: the distance between median point posterior surface of the vertebrae body to most concave part of the inner lamina surface at mid-pedicle level of the axial slices on CT scan; and (3) presence of a protuberance: defined as the presence of the perpendicular distance from a line drawn connecting the most concave part of the inner lamina to the most lateral part of the canal and the apex of protuberance of more than 1 mm.

Results: A total of 648 vertebral canals from 108 patients were obtained and measured. The prevalence of trefoil-shaped canals was 11.7%. The prevalence of trefoil canals by the vertebral level at L3 was 2.8%, L4 was 14.8%, L5 was 36.1%, and S1 was 16.7%. L5 vertebra had the highest prevalence of trefoil canals followed by S1 and L4. There were no trefoil canals at L1 and L2 vertebra. The prevalence of triangular-shaped canals was 35.6%. Triangular canals were found from L3–S1 with the highest prevalence at the S1 vertebra (83.3%). There were no triangular canals at L1 and L2. Oval/round shape canals were found at L1 to L4 vertebrae with a total prevalence of 52.6%. L1 and L2 vertebral canals were all oval/round shaped (100%). There were no oval/round canals at L5 and S1.

Conclusions: Trefoil-shaped canals can be found from L3 to S1 vertebrae with the highest prevalence at L5. Triangular-shaped canals can be found from L3 to S1 with the highest prevalence at S1. Oval/round-shaped canals can be found from L1 to L4 vertebrae. All L1 and L2 vertebral canals were oval/round.

125

Gait Differences by Sex of Elderly: Analyses with KINECT

Yuh Watanabe, Yu Yamato, Hideyuki Arima, Yuki Mihara, Koichiro Ide, Yukihiro Matsuyama

Department of Orthopedic Surgery, Hamamatsu University School of Medicine, Hamamatsu, Japan; Department of Orthopedic Surgery, Narita Memorial Hospital, Toyohashi, Japan

Objectives: The objectives of this study are to investigate the gait differences by sex in the elderly and the effects of trunk muscles on gait.

Methods: From May 2019 to December 2019, of the 117 elderlies who joined preventing care training meetings at local residents' meeting places in a mountainous local town, 84 elderlies who performed gait and trunk muscle mass amount evaluations were included in this study. A gait analyses machine "AKIRA (System Friend, Hiroshima, Japan)" equipped with "KINECT ver. 2 (Microsoft Corp., Redmond, WA, USA)" was used to measure the 5 m natural straight gait of the subject elderlies with infrared rays (markerless gait analyses). A body composition meter "MC-780A (TANITA, Tokyo, Japan)" was used to measure each subject elderly' trunk muscles amount with bioelectrical impedance analysis method. The effects of trunk muscle mass, age, height, weight, and body mass index (BMI) on gait elements (length, width, speed, trunk tilt angle) were statistically analyzed.

Results: The total of 84 subjects consisted of 30 men and 54 women, and the average age was 78 years old. The average data (men/women) of the subjects were as follows: age was 77 years/78 years, height was 161.2 cm/148.8 cm, weight was 62.9 kg/51.6 kg, and BMI was 24.2 kg/m^2/23.3 kg/m^2. The average data of gait elements and muscle mass amount (men/women) were as follows: the length was 0.55 m/0.55 m, the width was 0.15 m/0.13 m, speed was 67.8 m/min/71.8 m/min, and trunk muscle mass amount was 25.3 kg/19.1 kg. There were significant differences (Mann-Whitney U test) between men and women in height (p=0.000), weight (p=0.000), gait width (p=0.006), and trunk muscle mass amount (p=0.000). Regarding the correlation (Spearman) of the investigated variables, a significant correlation was found between gait length and speed (r=0.838, p=0.000), gait length and trunk muscle mass (r=0.346, p=0.001), and trunk sagittal plane tilt range

angle on gait and trunk muscle mass (r=-0.252, p=0.021). Multiple regression analyses by men and women specimens showed that trunk muscle mass affected gait speed in both sexes (men: p=0.027, women: p=0.029).

Conclusions: Both men and women were affected by trunk muscle mass amount in the gait of the elderly. Trunk muscle mass is important to the gait of the elderly.

181

A Case of Cervical Ossification of the Posterior Longitudinal Ligament and Diffuse Idiopathic Skeletal Hyperostosis Mimicking Stroke

Rudra Prabhu, Tushar Rathod

Lokmanya Tilak Municipal Medical College and General Hospital, Mumbai, India

Objectives: To highlight the rare presentation of acute worsening of neurology in patients with ossification of the posterior longitudinal ligament (OPLL).

Methods: A 51-year-old diabetic, hypertensive male presented with a sudden onset of motor impairment involving the left upper and lower limbs following an episode of fall due to dizziness. A neurological examination revealed brisk deep tendon reflexes and a positive Babinski's sign bilaterally. The patient had grade 0 power in all muscles of the left upper limb and moderate weakness in the form of grade 4 power in the left hip, knee, and ankle. Considering the acute nature of the case, a magnetic resonance (MR) angiogram of the brain was performed in view of hemiparesis that showed no evidence of a bleed or thrombus. A computed tomography (CT) scan showed a mixed type of ossification in the cervical canal that was continuous from C2 to C5 and segmental at the level of C6 and C7. Anteriorly, ossification from C2 to C7 due to diffuse idiopathic skeletal hyperostosis was seen on the CT scan. A magnetic resonance imaging (MRI) revealed a significant compression on the spinal cord due to the OPLL mass causing effacement of the anterior thecal sac and spinal canal narrowing at the level extending from C2 to C7. Due to the presence of a positive K Sign, multiple-level OPLL, and an adequate cervical lordosis, the patient was managed with laminectomy and posterior fusion. The laminectomy extended from the foramen magnum to C1–C6 and was accompanied by more extended bilateral foraminotomies at the C4/C5 level to help avoid postoperative C5 palsies. Lateral mass screws were then placed bilaterally in C1, and C3–C6, while bilateral pedicle screws were affixed to C2. The construct was completed with rods and bone graft fusion was achieved from C1 to C6.

Results: One year later, the patients' modified Japanese Orthopaedic Association score improved to 13, and the MRI showed adequate cord decompression with a reduction of the intrinsic cord myelomalacia.

Conclusions: Patients with cervical myelopathy due to OPLL rarely present about 5% of the time with the acute onset of neurological deficit following minor trauma. Certainly, one must consider high cervical OPLL as responsible for hemiparesis in a patient whose brain MR has ruled out a stroke.

184

Are We Our Own Patients? Neck Pain in Spine Surgeons: Prevalence and Risk Factors

Hriday Acharya, Abhay Nene

Paras Advanced Center of Excellence, Ahmedabad, India

Objectives: The prevalence of neck pain has been reported in various medical sub-specialties including laparoscopy surgeons, dentists, plastic surgeons, ophthalmologists, urologists, and orthopedic surgeons. However, the literature is lacking on the prevalence and risk factors for neck pain in spine surgeons. This survey amongst spine surgeons aimed to determine the prevalence of neck pain and identify the associated risk factors.

Methods: A survey questionnaire containing demographic, neck pain, and work practice details was administered to 300 members of an online spine surgeons' group via text message and e-mail. A total of 180 surgeons responded to the survey (response rate=60%).

Results: The 1-month prevalence rate of neck pain was 74%. A total of 117 surgeons (89.5%) reported only neck pain, and 14 surgeons (10.5%) had neck pain with radicular arm pain. Only 20.5% of surgeons used a loupe, 18% of surgeons used a microscope, and 24% of surgeons used optimum operating table height during surgery. There was no significant difference between the mean age (p=0.88),

work experience (p=0.44), time spent in surgery (p=0.08), use of visualization tools (p=1.00), and operating table height preference (p=0.71) when symptomatic and asymptomatic groups were compared. However, a significantly greater percentage of surgeons had a sedentary lifestyle (p=0.009). There was a significant correlation between the surgeon's lifestyle and the incidence of neck pain. When comparing using loupes and microscope, in surgeons using magnification; surgeons with loupe were at a risk.

Conclusions: Spine surgeons have a higher prevalence of neck pain than general populations and surgeons from other specialties. The most common cause is a sedentary lifestyle and preference for loupes over microscopes. Considering the high prevalence of neck pain, general health, work, and ergonomic guidelines and recommendations must be formulated to help prevent and decrease the burden of neck pain among spine surgeons.

185

A Case of an Irreducible Posteriorly Displaced Type-2 Odontoid Fracture Managed with an All-Posterior Approach and Fixation

Rudra Prabhu, Tushar Rathod

Lokmanya Tilak Municipal Medical College and General Hospital, Mumbai, India

Objectives: To highlight the reduction technique utilized for management of an irreducible posteriorly displaced type-2 odontoid fracture.

Methods: A 58-year-old male presented with a history of falls in the bathroom 10 days back. He complained of severe neck pain, and tingling numbness involving all extremities and had a normal neurological examination except for a grade four power in bilateral shoulders and hyperreflexia involving all limbs. Radiographs showed the presence of a posteriorly displaced type-2 odontoid fracture. A computed tomography (CT) scan of the cervical spine demonstrated the displaced odontoid fragment with a preserved relationship between the odontoid fragment and the anterior C1 arch. A magnetic resonance imaging scan showed the fragment impinging on the spinal cord and leading to cord compression. A CT angiogram revealed the presence of a left-sided dominant vertebral artery. After three unsuccessful attempts at closed reduction, the modality was abandoned and an open reduction using the posterior approach was planned. The procedure was performed under general anesthesia with somatosensory-evoked potential. A posterior midline longitudinal incision was taken. Bilateral lateral mass screws were initially passed in C1. Rods were attached to the screws. The preserved relationship between the odontoid fragment and the anterior C1 arch indicated that the ligaments were intact. A Penfield retractor was passed on the right side between the C1 and the C2 pedicles to correct the dislocation between C1 and C2 by using a cantilever mechanism, as the patient had a rudimentary vertebral artery on the right side. At the same time, vertical traction was given to correct the overriding at the fracture site and an anterior force was applied to the rods from the posterior aspect to push the posteriorly displaced fragment anteriorly. The reduction was confirmed under fluoroscopy and then bilateral pedicle screws were passed in C2 followed by a C1–C2 fusion.

Results: There was an improvement in the patient's neck pain post-surgery. Immobilization in the form of a soft cervical collar was given for 3 months. Radiographs at follow-up of 1 year showed healing at the fracture site and arthrodesis of the C1–C2 joint.

Conclusions: Irreducible type-2 odontoid fractures with posterior displacement require open reduction using a combination of different techniques. The technique highlighted here has not been described in the literature previously.

130

Endplate and Disc Changes Following AO Spine Type A Thoracolumbar Fracture: Computed Tomography and Magnetic Resonance Imaging Analysis

Yogin Patel, Preetish S.

Ganga Medical Centre & Hospitals Pvt. Ltd., Coimbatore, India

Objectives: This is a retrospective-cum-prospective analytical type of study. In compression fractures, the injury not only affects the vertebral body but also the intervening disc. There is a paucity in the literature about the effect of

thoracolumbar trauma on the disc and the endplate.

Methods: We performed a two-part study of AO spine type A thoracolumbar fractures: (1) part one (retrospective study): all spine trauma patients from January 2018 to June 2019; (2) part two (prospective study): patients attending the emergency department from June 2019 to December 2020. In all 21 patients, spine-trauma protocol was performed using a 1.5T scanner. All magnetic resonance imaging (MRI) and computed tomography (CT) scans were screened for the presence of AO spine type A thoracolumbar fractures, disc morphology (classified with Pfirrmann's and Oner's classification), and endplate morphology (classified with Rajasekaran et al.). Picture Archiving and Communication System was used to analyze the sagittal and coronal images. The patients were followed up at 4 weeks, 6 months, and 1 year following the injury. Serial roentgenograms were performed during the follow-up period, and CT scan and MRI were performed at the end of 1-year follow-up.

Results: Twenty-one patients (25 AO type A fractures) between the age group of 18 and 60 years (mean age, 38.9±11.3 years) were enrolled. Sex distribution was 41:29 (male:female); 40% of the fractures were at L1 level, 24% T12 and L2 each, and 3% were at T11 vertebra. The mean (±SD) local kyphosis was 12.4°±5.5° at the time of injury. The cranial disc showed significant change in morphology and the caudal disc showed no a significant change in morphology at the index vertebra according to both Pfirrmann's and Oner's classification. The superior endplate had a mean score of 3.6±1.5 at the time of injury and 3.92±1.7 at 1-year post-trauma follow-up at the index vertebra. The inferior endplate had a mean score of 2.1±1.0 at the time of injury and 2.04±1.3 at 1-year post-trauma follow-up. There was a significant association between cranial disc morphology and superior endplate injury at 1-year follow-up.

Conclusions: There was dissimilarity in endplate morphology at the index and adjacent vertebral levels and there was a significant worsening of the degeneration of cranial disc at the end of 1 year compared with immediate post-injury status. There was a statistically significant correlation between the degenerative status of the cranial disc and the degenerative status of the endplate of the index vertebra.

44

A Mechanistic Based Analysis of Clinicoradiological and Functional Outcome in C7–T1 Translational Injury

Karthik Ramachandran, Ajoy Prasad Shetty

Ganga Medical Centre & Hospitals Pvt. Ltd., Coimbatore, India

Objectives: C7–T1 translational injuries are highly unstable injuries, associated with significant neurological impairment. The study aims to discuss the mechanism of injury based on Allen and Ferguson's classification and highlight the surgical management and clinic-radiological outcome of the patients who presented with C7–T1 translational injury.

Methods: This is a retrospective study conducted after obtaining institutional review board approval. Patients presented with C7–T1 translational injury from January 2009 to January 2019 were identified. Patient demographic data, mechanism, mode of injury, details of surgery, complications, and associated injuries were obtained. The initial neurological status was recorded as the American Spinal Injury Association grade. All the injuries were classified as per Allen and Ferguson's classification. Stage 4 compressive extension injury was further classified into stage 4a and stage 4b according to Rebich et al. Fracture-related data like unilateral or bilateral facetal dislocation, facetal fracture, and associated C7 vertebral arch fracture was also recorded.

Results: Among 44 patients, 40 were male and four were female, and the mean age was 47.8 years. The most common mode of injury was falling from a height, seen in 22 patients (50%), followed by a road traffic accident in 17 patients (38.6 %). The most common mechanism of injury was compressive extension (CE) injury seen in 27 patients (61.4%) followed by distractive flexion (DF) in 16 patients (36.4%) and compressive flexion (CF) in one patient (2.2%). And 14/ 27 patients (51.85%) with CE injury had a neurological deficit at the time of presentation which was statistically less (p<0.001) when compared to 12/16 patients with DF injury. The neurological recovery at the final follow-up was comparable between the two groups. We had one patient in the CE injury group with implant loosening at a 1-month follow-up who underwent additional posterior fixation. There was 1 patient in both

the groups with delayed wound healing and hoarseness of voice which were managed conservatively.

Conclusions: Compressive extension injury is more common among C7–T1 translational injuries than distractive flexion injury. The incidence and severity of neurological deficit are comparatively less in CE injury due to associated posterior vertebral arch fracture. Henceforth, Allen and Ferguson's classification aids in better understanding of the mechanism of injury and predicting the neurological status at the time of injury in patients with C7–T1 translational injury.

45

Radiological Predictors of Spinal Cord Injury in C7–T1 Translational Injury

Karthik Ramachandran, Ajoy Prasad Shetty

Ganga Medical Centre & Hospitals Pvt. Ltd., Coimbatore, India

Objectives: Cervicothoracic junctional injuries are highly unstable injuries, associated with significant neurological impairment due to the small diameter of the canal and precarious blood supply. The main purpose of the study is to determine various radiological parameters predicting the incidence of spinal cord injury (SCI) in patients with C7–T1 translational injury and compare the difference between compressive extension (CE) and distractive flexion (DF) injury.

Methods: This is a retrospective study including 44 patients who underwent surgical stabilization for C7–T1 translational injury over 10 years. Computed tomography scan was used to measure various parameters like amount of anterior translation, local kyphotic angle, residual canal diameter at injury level/cranial level/caudal level, maximum canal compromise (MCC), and presence of neural arch fractures. Magnetic resonance imaging scan was used to assess the presence of traumatic disc prolapse, maximum spinal cord compression (MSCC), and length of cord contusion.

Results: The average anterior translation was 8.3 mm which had a direct correlation with the incidence of neurological injury. There was a significant correlation between residual canal diameter at injury level and caudal level with the American Spinal Injury Association (ASIA) grade at the time of presentation, whereas there was no correlation between residual canal diameter at the cranial level and ASIA grade. The average residual canal diameter in all patients at injury level was 8.9 mm (range, 2–13.8 mm). The average residual canal diameter in all patients at the cranial level was 14.7 mm (range, 10–21.3 mm) and the caudal level was 12.56 mm (range, 8.3–18.6 mm). The average MCC was 30.2 mm which had a significant correlation to the ASIA grade. The average local kyphosis angle at the injury level was 13.5° (range, 1.6°–34.2°) which did not correlate with ASIA grade. The average MCC was 30.2 mm, and the average MSCC was 22.9 mm, which had a significant correlation to the ASIA grade.

Conclusions: The incidence of SCI was higher in patients with a greater amount of translation and lesser residual canal diameter at the injury and caudal levels. DF injury is associated with a higher incidence of SCI due to significant canal compromise at the cranial level in addition to the injury level. CE injury is associated with a less incidence of SCI than DF injury due to auto decompression of the spinal cord resulting from posterior vertebral arch fractures.

240

Can SERPINs Be a Potential Target for Molecular Blockade of Intervertebral Disc Degeneration?

Sri Vijay Anand K. S., S. Rajasekaran

Ganga Medical Centre & Hospitals Pvt. Ltd., Coimbatore, India

Objectives: The etiopathogenesis of disc degeneration has not been elucidated yet. Irrespective of its etiology a critical event in disc degeneration is the breakdown of the extracellular matrix brought about by proteases. Unregulated proteolytic activity is kept in check by regulators such as serine protease inhibitors (SERPINs). In this context, we did a systematic study using high throughput proteomics with appropriate healthy control discs and elucidate their role in intervertebral disc (IVD) degeneration.

Methods: After ethical committee approval and consent, twelve intervertebral nucleus pulposus (NP) tissues each from (1) normal organ donor volunteers without any sign

of low back pain (ND), and patients with (2) herniated discs (DH), and (3) degenerated discs (DD) were harvested under sterile operating conditions and subjected to proteomic analysis. Further validation of findings was performed by Immunohistochemistry (IHC).

Results: Mass spectrometry identified a total protein of 2,164 in ND, 1,734 in DH, and 2,394 in DD groups, respectively. We shortlisted 14 SERPINs, eight in ND, 12 in DH, and 13 in DD group, respectively, with a stringent cut-off. Seven SERPINs were common to all three groups, including SERPINA1, A3, A5, A8, C1, E2, and G1. SERPINA1, A5, E2, and G1 showed higher expression in healthy control NP discs (ND) compared to diseased discs—DH and DD. SERPINs A1 and E2 play a protective role in maintaining disc homeostasis by inhibiting proteases such as matrix metalloproteinases (MMPs). Validation of selected SERPINA1 and E2 IHC staining in the healthy ND and diseased DH and DD IVD confirmed their expression.

Conclusions: SERPINs A1 and E2 with their inhibitory effects on MMPs could be utilized as a potential target to halt or arrest disc degeneration.

241

Radiological Phenotyping and Functional Outcomes of Chronic Coccydynia: A Prospective Analysis of 168 Patients

Sri Vijay Anand K. S., S. Rajasekaran, Manikandan, Pushpa B. T., Ajoy Shetty, Rishi Kanna

Ganga Medical Centre & Hospitals Pvt. Ltd., Coimbatore, India

Objectives: To document the morphological phenotype of the coccyx in chronic coccydynia patients, identify radiological markers for chronic coccydynia, and assess the functional outcomes of conservative management in chronic coccydynia patients.

Methods: In our prospective study, we recruited 168 patients who visited the spine outpatient department in our hospital with pain in the coccyx region for more than 2 months. Among these, 106 females and 62 males were evaluated with dynamic (sitting and standing) lateral radiographs, where the morphology of the coccyx was assessed, and various radiological parameters were measured. All patients were treated conservatively with analgesics, U pillow, and pelvic floor strengthening exercises. Baseline Visual Analog Scale (VAS) and Oswestry Disability Index (ODI) scores were documented at the first visit and at the 6-month follow-up. Out of these 168 patients, 48 with persistent pain in the coccyx region were analyzed with magnetic resonance imaging (MRI) and computed tomography scans of the coccyx to rule out bony and soft tissue abnormalities and treated with the same conservative management. The outcomes were categorized into clinically excellent, good, fair, and poor outcomes.

Results: In our study, chronic coccydynia is more predominant in females, and obesity is a major risk factor. Among the morphological types, type 2 and type 4 morphology was the most common. The radiological parameters correlated with clinical outcomes had no significance except angle of inclination (p=0.003) and pelvic tilt (p=0.03). The traumatic group has good clinical outcomes in comparison to idiopathic coccydynia with statistical significance (p=0.007). In MRI, bursitis and signal intensity changes (mention percentage) were seen in chronic coccydynia patients. The functional outcomes with VAS scores have been statistically significant, whereas ODI scores had no significance.

Conclusions: In conclusion, type 2 and 4 is the most common types of chronic coccydynia, where body mass index and radiological parameters measured in coccydynia patients had no significance with correlation to clinical outcomes. The traumatic group has excellent outcomes compared to the idiopathic group in coccydynia. MRI is helpful in chronic coccydynia to identify pathologies such as bursitis.

203

Efficacy of Posterior Cervical Laminectomy for Multilevel Cervical Ossification of Posterior Longitudinal Ligament

Abhijith Shetty, S. Rajasekaran, Manikandan, Pushpa B. T., Ajoy Prasad Shetty, Rishi Kanna

Ganga Medical Centre & Hospitals Pvt. Ltd., Coimbatore, India

Objectives: The purpose is to determine the efficacy of posterior cervical laminectomy for multilevel cervical os-

sified posterior longitudinal ligament (OPLL). Laminectomy has been a preferred surgical treatment for multilevel cervical OPLL for a long time. Because of the risk associated with progressive kyphosis, the trend is shifted from laminectomy alone to laminoplasty and laminectomy with fusion. The data regarding the efficacy of laminectomy alone in terms of clinical and radiological parameters are scanty.

Methods: We reviewed 82 patients with multilevel cervical OPLL who underwent posterior cervical laminectomy from January 2008 to December 2014. Patients with age ≥45 years, C2–C7 Cobb's angle ≥10°, compression at ≥3 levels, and a minimum of 5 years of follow-up were included in the study. Demographics, pre- and postoperative clinical parameters, radiological parameters, perioperative parameters, complications, and recovery rate were evaluated.

Results: There was significant improvement (p<0.05) in the Visual Analog Scale (3.6±1.4 to 1.8±0.8), Nurick's grading (3.2±0.9 to 1.9±0.6), and modified Japanese Orthopaedic Association score (8.4±1.4 to 13.8±1.9). C2–C7 Cobb's angle increased from −14.4°±1.7° preoperatively to −8.2°±1.5° postoperatively and C2–C7 sagittal vertical axis from 18.4±12.5 to 29.8±15.8 mm. Intraoperatively four patients had a dural tear. Three patients showed neurological deterioration postoperatively and three had unilateral C5 palsy which improved within a period of 6 months.

Conclusions: Multilevel cervical laminectomy is an effective surgical procedure in properly selected patients with multilevel OPLL. The outcomes are satisfactory in terms of radiological and clinical parameters. The risk of postlaminectomy kyphosis is not too high, and we found no correlation between kyphosis with clinical affection.

1

Traumatic Cervical Spinal Epidural Hematoma: A Case Report

Teck Siang Lim, Cheong Wan Lye

Hospital Pengajar Universiti Putra Malaysia, Serdang, Malaysia

Objectives: Spinal epidural hematoma is a rare cause of spinal cord compression. However, prompt recognition and treatment are vital as the prognosis is worse with delayed management. Magnetic resonance imaging is the modality of choice for the identification of spinal epidural hematoma. Emergent surgical decompression is advocated, as chances of neurological recovery are better with earlier surgery. We presented a 30-year-old male who developed progressive weakness and sensory loss 7 hours after the initial trauma. Computed tomography did not show an associated fracture. A magnetic resonance imaging (MRI) of his spine revealed an epidural hematoma at the level of C5 to T2. He underwent an urgent decompression and stabilization of his cervicothoracic spine. Following surgery, his neurology improved markedly.

Methods: A 30-year-old male presented with a neurological deficit after the initial trauma. It was a deceleration injury when the patient had to abruptly stop his motor vehicle at a high speed. He was well and returned home. Seven hours later, he developed progressive numbness and weakness of bilateral lower limbs and priapism.

Results: Upon assessment, his muscle power was 3/5 over bilateral C8 to T1 myotome and 0/5 over L2 to S1. The sensation was reduced 1/2 over bilateral T3 dermatome, and 0/2 from T4 downwards. Lower limb deep tendon reflexes were absent, plantar reflexes were upgoing. A computed tomography scan of his spine showed no fracture. An MRI of his spine was performed which confirmed the presence of an epidural hematoma compressing the spinal cord with cord edema at C5 to T2 levels. He underwent a surgical decompression at about 12 hours from the onset of neurological symptoms. Laminectomy of C6 to T1 was done with posterior instrumentation of C5 to T2. Intraoperatively, the organized hematoma was seen over the epidural space. Immediately after the decompression, his sensation returned normal. His power gradually improved.

Conclusions: In conclusion, spinal epidural hematoma should be considered in patients who presented with neurological deficit following a trauma, especially when there is no evidence of osseous fracture. Diagnosis can be made with an MRI scan and urgent surgical decompression should be initiated.

100

Assessment of Preoperative Pain Sensitivity in Predicting the Postoperative Pain Severity and Analgesic Requirement after Single Level Lumbar Fusion Surgeries

Nimish Rai, Ajoy Prasad Shetty

Ganga Medical Centre & Hospitals Pvt. Ltd., Coimbatore, India

Objectives: To study the correlation between preoperative pain sensitivity, postoperative pain, and analgesic requirements after single level lumbar fusion surgeries.

Methods: Between November 2020 to August 2021, 60 patients who underwent single-level lumbar fusion surgeries were assessed. Pressure pain threshold measurements with the help of a digital algometer, thermal component by Neuro Touch instrument, psychological assessment by Hospital Anxiety Depression Scale (HADS) scores, and functional assessment by Oswestry Disability Index (ODI) were done. All the patients were assessed by the Visual Analog Scale (VAS) preoperatively at four different instances. The patients reported the VAS score at three instances of needle prick (phlebotomy, glucometer blood sugar, intradermal antibiotic test dose) and during the range of movements of the lumbar spine region. Postoperative VAS score and postoperative breakthrough analgesic requirements were recorded in all these patients from day 0 to day 3.

Results: The average age of the patients was 51.11±13.467 years and 70% were females. Algometer averages were divided into three groups with 38.33.% of the patients in between 60–70 N/sec group, 46.6% of the patients in between 71–80 N/sec group, and 15% of the patients in between 81–90 N/sec group. There was no correlation between age and algometer average (p>0.891). A lower algometer average was associated with higher HADS scores (p<0.0016), higher ODI scores (p<0.001), and female gender. Patients with lower preoperative VAS scores, lower algometer average, and with higher Neuro Touch scores showed lower postoperative VAS scores at different time periods. There was a significant correlation between algometer average scores, and thermal Neuro Touch scores with the breakthrough analgesics with highly significant (p<0.000) for algometer and (p<0.073) for Neuro Touch.

Conclusions: Preoperative assessment of pain sensitivity can predict postoperative analgesic requirements and aid in early recovery. Patients with a lower pain threshold can be identified preoperatively and receive a better titration of analgesics perioperatively.

8

Severe Dysphagia after a Posterior Cervical Spine Fusion at the C1–C3 Level and Its Improvement after the Malalignment Correction Surgery

Siravich Suvithayasiri, Payothorn Decharin, Warayos Trathitephun

Department of Orthopedics, Chulabhorn Royal Academy, Bangkok, Thailand

Objectives: Unlike the posterior upper cervical spine fixation procedure that included the occiput, the development of dysphagia and trismus following posterior C1–C3 fusion surgery is rare and scarcely being reported. We aim to demonstrate a rare complication following the upper cervical spine fusion—even sparing the occipital bone, the importance of surgical malalignment correction to cure the symptoms, and the possibility of prevention.

Methods: We report the case of a 75-year-old man who developed severe dysphagia and trismus immediately after C1–C3 fusion surgery, which dramatically improved following a malalignment correction surgery. We obtained the patient's medical record from our hospital (Chulabhorn Hospital, Bangkok, Thailand) database. The patient had an epidural soft tissue mass compressing the spinal cord at his C1/C2 level. He developed severe dysphagia and trismus immediately after undergoing the tumor resection and instrumented fusion procedure at his C1–C3 level.

Results: The postoperative radiograph showed that the occiput–C2 and C1–C2 angles were -1.8° and -25.1°, respectively. The craniovertebral fixation angle was 81.1°. We operated to adjust the C1 and C2 screw position—to be relatively more extended—on the 8th day after the first surgery. After surgery, the occiput–C2 and C1–C2 angles were -13.7° and -32°, respectively. The craniovertebral angle decreased to 76°. Consequently, the patient's symptoms resolved instantly after surgery.

Conclusions: Even the excluding the occipital bone in the

upper cervical spine fixation component, dysphagia could still occur. When the C1–C2 segment is in a relative kyphosis position, it could still further push the skull to be flexed and limit its micromotion, which is necessary for the swallowing process. Subsequently, this could result in trismus and dysphagia to occur.

13

The Proximal Femur Maturity Index: A Novel Tool for Staging Skeletal Growth in Patients with Scoliosis

Jason Pui Yin Cheung, Wing Hang Cheung

The University of Hong Kong, Hong Kong

Objectives: For growing patients, it is ideal to have a growth plate visible in routine radiographs for skeletal maturity assessment without additional radiation. The proximal femoral epiphyseal ossification is in proximity to the spine; however, whether it can be used for assessing a patient's growth status remains unknown.

Methods: Two hundred and twenty sets of radiographs of the spine and the left hand and wrist of patients with idiopathic scoliosis were assessed for skeletal maturity and reliability testing. Risser staging, Sanders staging (SS), distal radius and ulna classification, the proximal humeral ossification system (PHOS), and the novel proximal femur maturity index (PFMI) were used. The PFMI was newly developed on the basis of the radiographic appearances of the proximal femoral head, greater trochanter, and triradiate cartilage. It consists of 7 grades (0 to 6) associated with increasing skeletal maturity. The PFMI was evaluated through its relationship with pubertal growth (i.e., the rate of changes in standing and sitting body height [BH] and arm span [AS]) and with established skeletal maturity indices. Longitudinal growth data and 780 corresponding spine radiographs were assessed to detect peak growth using receiver operating characteristic (ROC) curve analysis.

Results: The PFMI was found to be correlated with chronological age (τb=0.522), growth rates based on standing BH (τb=-0.303), and AS (τb=-0.266) (p<0.001 for all). The largest growth rate occurred at femoral grade 3, with mean±standard deviation standing BH growth rates of 0.79±0.44 cm/mo for girls and 1.06±0.67 cm/mo for boys. Growth rates of 0.12±0.23 cm/mo (girls) and 0±0 cm/mo (boys) occurred at femoral grade 6, indicating growth cessation. Strong correlations were found between PFMI gradings and Risser staging (τb=0.743 and 0.774 for girls and boys), Sanders staging (τb=0.722 and 0.736, respectively), and radial (τb=0.792 and 0.820) and ulnar gradings (τb=0.777 and 0.821), and moderate correlations were found with PHOS stages (τb=0.613 and 0.675) (p<0.001 for all). Femoral gradings corresponded to as young as SS1, R4, U1, and PHOS stage 1. Substantial to excellent interrater and intrarater reliabilities were observed. Femoral grade 3 was most prevalent and predictive of peak growth based on ROC results.

Conclusions: The PFMI demonstrated clear pubertal growth phases with satisfactory reliability. Grade 3 indicates peak growth and grade 6 indicates growth cessation.

15

Equipoise for Lateral Access Surgery: The Asia Pacific Spine Society Members' Experience

Jason Pui Yin Cheung, Wing Hang Cheung, Reuben Soh, Jacob Oh

The University of Hong Kong, Hong Kong

Objectives: To report the results of the Asia Pacific Spine Society (APSS) questionnaire on lateral access surgery in particular related to the rate of use, surgeons' views regarding the advantages and disadvantages of lateral access surgery compared with other techniques, and the surgical strategies of lateral access surgery, including indirect decompression, order of levels to operate on in multi-level surgery, and implant-related factors.

Methods: A questionnaire was distributed to members of the APSS to collect the surgeons' thoughts on lateral access surgery. The questionnaire consisted of several themes. First, the surgeons were asked about their past experiences with lateral access surgery. Second, a series of questions were asked regarding the advantage and disadvantages of lateral access surgery compared with other techniques. Third, the participating surgeons were asked about their specific surgical strategies for lateral access surgery, including indirect decompression, choices

in implant-related factors, preoperative imaging choices, order of levels to operate on in multi-level reconstruction surgery, assistance from vascular access surgeons, intraoperative neuromonitoring, side of the operation, anterior drains, postoperative complications, and corset use after the operation.

Results: Among the 102 participants who responded, 69 surgeons (67.6%) had performed lateral access surgery before. Lack of experience is the most common reason for not performing the surgery and is not associated with years of surgical experience or country of origin. Currently, anterior to psoas is the most popular technique (43/96, 44.8%), followed by open (34/96, 35.4%), mini-open (32/96, 33.3%), and transpoas techniques (25/96, 26.0%). Fifty-six participating surgeons (54.9%) agreed that anterior column reconstruction via lateral access is most of the time superior to transforaminal lumbar interbody fusion and other techniques. Regarding the patients unsuitable for this surgery, vascular concerns, severe osteoporosis, and significant comorbidities were the main concerns. Surgeons would consider laminectomy instead of indirect decompression in the presence of severe central or lateral recess stenosis, thickened ligamentum flavum, and facet joint hypertrophy. For the order of level to operate in multiple level reconstruction for deformity, 1 stands for L3/4 or higher, 2 stands for L4/5, and 3 stands for L5/S1. The three major orders were 2-1-3 (28/95, 29.5%), 1-2-3 (26/95, 27.4%), and 3-2-1 (21/95, 22.1%).

Conclusions: Lateral access surgery is not commonly performed amongst APSS members. However, most consider it to be superior to posterior interbody fusions. Vascular anatomy and severity of spinal stenosis on magnetic resonance imaging are the main considerations for choosing alternative options.

23

Surgical Outcomes of a Technique Using a Convex Rod Rotation Maneuver for Adolescent Idiopathic Scoliosis

Shinji Takahashi, Hidetomi Terai, Koji Tamai, Hiroaki Nakamura

Osaka City University, Osaka, Japan

Objectives: This retrospective cohort study aims to reveal the surgical outcomes of a convex rod rotation maneuver (RRM) with direct vertebral rotation (DVR) for the correction of adolescent idiopathic scoliosis (AIS). Most surgeons use rod rotation on the concave side for Lenke type 1 and 2 curves due to AIS. However, accurate placement of pedicle screws within dysplastic pedicles, especially on the concave side is sometimes difficult. On the other hand, there is a concern that apical rotation might be exacerbated after convex RRM because the rod is rotated in the same direction as vertebral rotation.

Methods: Fifty-nine patients with Lenke type 1 and 2 AIS were analyzed. All patients underwent posterior surgery with convex-RRM with DVR. Vertebral rotation was measured using computed tomography (CT).

Results: Among the 59 patients, 52 (88%) were female and 47 (80%) had Lenke type 2 curves. The average patient age was 15.3 years and the average duration of follow-up was 2.8 years. The correction rate of the main thoracic curve in Lenke type 1 and 2 AIS was 75.1% and 65.0%, respectively. Thoracic kyphosis in Lenke type 1 and 2 curves also improved from 14.7° to 21.1° and from 20.8° to 22.7°, respectively. Rotation improved significantly in both types of Lenke curves. The absolute values of the change in apical vertebral rotation between pre- and postoperative CT scans in Lenke type 1 and 2 curves was 4.8°and 4.2°, respectively.

Conclusions: The convex rod rotation maneuver improved vertebral rotation in Lenke type 1 and 2 AIS. This procedure should be considered one of the surgical options for AIS, especially in patients with a narrow pedicle width on the concave side.

47

Cervical Canal Morphology: Computed Tomography Study of Maaori, Pacifica, and European Patients

Joe Baker, Dan Goddard-Hodge

Waikato Hospital, Hamilton, New Zealand

Objectives: Reduced cervical spinal canal sagittal diameter and sagittal-transverse diameter ratio have been linked to the development of spinal cord injury (SCI) and myelopathy. This is of particular interest to spine surgeons in New

Zealand given our unique socioethnic makeup. Our study aims to assess variation in cervical spinal canal dimensions between ethnicities by conducting a cohort study using normal cervical computed tomography (CT) scans.

Methods: A total of 670 human sub-axial cervical vertebrae were analyzed radiographically using 0.5mm computed tomography. CT images were obtained from trauma scans that showed no acute pathology with respect to the cervical spine. Exclusion criteria included fracture or dislocation, incomplete imaging of the cervical spine, congenital abnormalities (e.g., block vertebrae), deformity, and advanced degenerative changes. Raw CT data was reformatted in Picture Archiving and Communication System image viewing software allowing multi-planar reconstruction. Axial CT slices were obtained that were parallel to the superior endplate at each vertebral level. Maximal canal diameter was measured in the sagittal and transverse planes. Statistical analysis was performed using the analysis of covariance to control for other variables (age and gender) within the cohorts.

Results: Of the total, 250 vertebrae were Maaori, 250 New Zealand European (NZ European), and 170 Pacifica. There were 455 male vertebrae and 215 female vertebrae. Statistically significant differences were found in sagittal canal diameter between all ethnic groups, at all levels. At C3, NZ European had an average anteroposterior canal diameter of 15.2±1.42 mm vs. 13.9±2.21 mm (p=0.021) for Maaori and 13.0±2.01 mm (p=0.036) for Pacifica; differences in sagittal diameter between ethnic groups were consistent throughout the sub-axial C-spine. Although transverse canal diameters alone were not different between ethnic groups, the ratio of sagittal:transverse diameter was significantly different at all spinal levels except C3. Subjective morphological differences in the shape of the vertebral canal were noted, with Maaori and Pacifica patients tending towards a flatter, curved canal shape.

Conclusions: Our study, utilizing a non-SCI patient cohort, confirms earlier suggestions that ethnic differences are present within our population and are likely reflective of real variation between ethnic groups with application to the wider population appropriate. This has value when determining who may or may not have stenosis as different ethnic groups need different normative values applied. Future research using geometric morphometric analysis to explore the canal and spinal cord morphology may offer further insight into differences between these populations and explain any predisposition to spinal cord pathology.

53

Psychological Effects of Bracing among Adolescent Idiopathic Scoliosis Patients and Their Coping Strategies

Lip Siang Tan, Weng Hong Chung, Chee Kidd Chiu, Chris Yin Wei Chan, Mun Keong Kwan

Universiti Malaya, Kuala Lumpur, Malaysia

Objectives: To compare the psychological well-being and coping strategies among adolescent idiopathic scoliosis (AIS) patients undergoing a brace treatment and AIS patients under observation.

Methods: This is a cross-sectional, questionnaire-based study design, and 50 AIS patients treated with brace and 50 AIS patients under observation were recruited from the outpatient scoliosis clinic in a tertiary institution. Data were collected from a self-report questionnaire derived from Hospital Anxiety and Depression Scale (HADS), revised Scoliosis Research Society-22r (SRS-22r), Spinal Appearance Questionnaire (SAQ), and Brief Coping Orientation to Problems Experienced Questionnaire (Brief COPE). The data were analyzed statistically with a chi-square test and independent t-test.

Results: The mean age for the brace group and non-brace group was 13.6±1.6 years and 15.1±2.3 years (p<0.001). Most patients in both groups were females. The mean Cobb angle during an interview for the brace and non-brace group was 29.4°±9.4° and 27.3°±11.8°, respectively (p=0.313). The prevalence of anxiety disorder for the brace group and non-brace group was 38% and 22%, respectively (p=0.126). The prevalence of the depressive disorder in the brace group and non-brace groups was 12% and 16%, respectively (p=0.774). The quality of life (SRS-22r) mean scores for *function* (p=0.028), *self-image* (p=0.002), and *satisfaction* (p=0.026) were significantly different between the brace and non-brace groups. Respondents in the non-brace group fared better than its counterpart in terms of *function* and *self-image*. The assessment of the quality of life by *patients' perception of current body shape* (p=0.258) and their *expectations* (p=0.164) using the SAQ questionnaire was insignificant between these two groups. Patients in the brace group practiced *denial* (p=0.001) and *venting* (p=0.003) as their coping mechanisms throughout their brace treatment. When we sub-analyzed the coping

strategies among bracing respondents, respondents without anxiety had better *active coping* (6.4±1.4 vs. 5.3±1.5, p=0.013) if compared to respondents with anxiety. Bracing respondents with depression had higher scores for *denial* (p<0.001), *behavioral disengagement* (p<0.001), and *self-blame* (p=0.017). Bracing respondents without depression practiced more *positive reframing* (p=0.014).

Conclusions: Anxiety and depression are not uncommon among AIS patients. Patients in braces had poorer quality of life. AIS patients on brace embraced *denial* and *venting* as their primary coping strategies. Among brace patients, those without anxiety or depression practiced more *active coping* and *positive reframing*. Psychological health status among AIS patients on brace should be recognized so that appropriate psychiatric referral and consultation can be initiated throughout the course of brace treatment.

54

Risk of Aortic Injury due to Left-Sided Pedicle Screws Insertion in Adolescent Idiopathic Scoliosis

William Liong, Weng Hong Chung, Chee Kidd Chiu, Chris Yin Wei Chan, Mun Keong Kwan

Universiti Malaya, Kuala Lumpur, Malaysia

Objectives: To evaluate the risk of aortic injury of left-sided pedicle screws with different sizes, lengths, and trajectories at various levels of the thoracic and lumbar vertebra for corrective spinal surgery instrumentation in adolescent idiopathic scoliosis (AIS).

Methods: The computed tomography images of 40 Lenke 1 and 2 AIS patients were obtained. Simulation of left-sided pedicle screw insertion of various sizes, lengths, and trajectories was superimposed onto the axial slices of the vertebra from T4 to L3. The screw sizes simulated were diameters of 4.5 mm, 5.5 mm, and 6.5 mm. The screw lengths simulated were from 25 to 50 mm with 5 mm increments. The screw trajectories simulated were angles -30° (direct laterally) to +30° (direct medially) from the vertebral axis with 5° increments. The simulated screws were classified into two groups based on whether any part of the screw touches the aorta (risk of aortic injury) or not. The risk of aortic injury was graded as low (≤20%), moderate (>20%–40%), high (>40%–60%), very high (>60%–80%), and extremely high (>80%).

Results: Different screw sizes (diameter 4.5, 5.5, and 6.5 mm) had negligible influence on the risk of aortic injury. For 5.5 mm diameter screws in the thoracic region, T5–T8 25 mm screws had high to very a high risk of aortic injury (48%–75%) laterally (-30° to -5°). T5–T10 30–50 mm screws had high to extremely high risk (53%–100%) laterally (-30° to -5°). T4 and T11 35–45 mm screws had high to extremely high risk (48%–100%) central-laterally (-15° to 0°). T12 40–45 mm screws high to very high risk (48%–68%) central-laterally (-10° to 0°). T4, T5, and T11 50 mm screws had very high to extremely high risk (70%–93%) central-laterally (-15° to 0°). T12 50 mm screws had a very high risk of aortic injury (68%–80%) centrally directed (-5° to 5°). Medially directed screws generally had low-moderate to no risk in the thoracic region. In the lumbar region, L1 45 mm screws had a high risk (48%) centrally (0°), L1 50 mm screws had a high risk (53%–55%) central-medially (0° to 5°) and L2 50 mm screws had high risk (45%) medially (5° to 10°).

Conclusions: The risk of aortic injury was greatly dependent on screw trajectory, vertebral level, and screw length. Laterally directed midthoracic and centrally directed upper and thoracolumbar screws 30mm or longer had a higher risk of aortic injury.

60

Posterior Reduction and Fixation of Reducible Atlantoaxial Dislocation: A Case Series and Review of Literature

Jian Yuan Chua, Wen-Tien Wu

Hualien Tzu Chi Hospital, Hualien, Taiwan

Objectives: The causes of atlantoaxial dislocation (AAD) can be attributed to traumatic, degenerative, congenital, and pathologic causes. AAD can result from a traumatic odontoid fracture, transverse ligament attenuation or rupture, congenital occipital cervical junction abnormalities, and other pathologic lesions such as infection or tumors of the atlas or axis. Furthermore, AAD can be classified into reducible and irreducible types.

Methods: We report our experience in the diagnosis and

treatment of patients with reducible AAD. These patients present with neck pain and movement restriction, limbs weakness and numbness, long tract signs, and so forth. Each patient's neurological symptoms and image studies were thoroughly evaluated. After the surgical indication was determined, these selected cases underwent surgery at our hospital with posterior reduction and fixation with a C1–C2 screw and rod system. The preoperative and postoperative Japanese Orthopaedic Association (JOA) score, JOA recovery rate, radiographic reduction parameters (ADI), and perioperative complications were examined.

Results: There were eight consecutive patients who underwent posterior reduction and fusion in our case series. No perioperative neurovascular injury occurred. The mean JOA score improved from preoperative 12.1 to postoperative final follow-up 14.8. While the measured mean ADI was decreased from preoperative 6.8 mm to final follow-up 2.7 mm.

Conclusions: The atlantoaxial fusion techniques for the surgical treatment of AAD can be broadly divided into anterior and posterior approaches. Each technique has its own indications, contraindications, risks, and technical difficulties. The posterior C1–C2 screw and rod system was utilized in our case series because it provides reliable stability and reduction maintenance of the atlantoaxial joint for reducible AAD. AAD is an uncommon but potentially debilitating condition. Despite the high neurovascular risks, surgical treatment offers the best chance to halt the progression of the disease. Our method of posterior fusion with C1–2 screw instrumentation provides a reliable reduction and fixation method to treat the reducible AAD.

63

Preoperative Computed Tomography Hounsfield Unit at L1 Level Is a Reliable Parameter to Predict Screws Loosening and Cages Subsidence in Transforaminal Lumbar Interbody Fusion

Chao Hsien, Kun-Yu Kao, Yu-Cheng Yao, Po-Hsin Chou, Ming-Chau Chang, Shih-Tien Wang

School of Medicine, National Yang Ming Chiao Tung University, Taipei, Taiwan

Objectives: The purpose of this investigation is to determine whether preoperatively obtained computed tomography (CT) Hounsfield unit (HU) was an appropriate predicting parameter for screws loosening and cages subsidence in transforaminal lumbar interbody fusion (TLIF).

Methods: From October 2016 to February 2020, 198 patients treated with 1- or 2-levels TLIF were enrolled in this retrospective study. Patient demographics and surgical parameters were collected through chart review. Radiographic parameters were collected at preoperative and postoperative 1, 3, 6 months, and 2-year follow-up including L1 CT HU, segmental lumbar lordosis, disc height, segmental disc angle, and cage position. Screw loosening, cage subsidence, and fusion status were assessed by plain radiographs at each follow-up visit. Clinical outcomes were recorded using the Visual Analog Scale and Oswestry Disability Index scores.

Results: A total of 198 patients with a total of 258 levels and 930 screws were analyzed. The average follow-up duration was 25.3±11.0 months, and 32 (16.2%) and 49 (24.7%) patients had cage subsidence and screw loosening, respectively. Ten patients received revision surgery due to nonunion or screws loosening. The overall fusion rate was 82.1%. There were Lower L1 HU, higher body mass index (BMI), more diabetes mellitus, and more multi-level TLIFs were found in patients with screws loosening or cage subsidence. A cut-off value of preoperative L1 HU for predicting screw loosening or cage subsidence was 117 (sensitivity=67%, specificity=64%; $p<0.001$). After multivariate logistic regression analysis, patients with preoperative L1 HU <117 had 4.1 times the risks and BMI >25 kg/m^2 had 2.6 times the risks of screws loosening or cage subsidence. Further univariate logistic regression analysis of data from patients was concurrently BMI >25 kg/m^2 and preoperative L1 HU <117 and showed they were 4.3 times more likely to experience screws loosening or cage subsidence. The fusion rate and clinical outcome were comparable in patients with screw loosening or cage subsidence.

Conclusions: Preoperative L1 HU is a good predictor of cage subsidence or screw loosening. Lower L1 HU (<117) and higher BMI (>25) are two independent risk factors for screw loosening or cage subsidence in TLIF.

72

Different Permutation and Possibilities of Cement Leakage Following Balloon Kyphoplasty in Various Indications with Various Complications: A Case Series and Literature Review

Harsh Singh

Park Hospital, New Delhi, India

Objectives: Cement leakage is a commonly seen complication following balloon kyphoplasty reported in various studies. A multi-centric, multi-surgeon analysis was the need of the hour for the standardization of results.

Methods: Randomly selected 20 cases with various indications such as osteoporosis, fresh wedge compression fracture, old trauma with progressive kyphosis, stable burst fractures, and spinal tumors besides other morphologies were selected as the target population. Written informed consent was obtained before all procedures. Early and delayed complications were noted. Electro-diagnostic studies were conducted in cases with neurological deficits. Parameters such as indication, surgical technique, early and delayed complications, the direction of cement leak were evaluated and the average follow-up was kept at 6 months. Results were evaluated using Nurick grading and modified Japanese Orthopaedic Association scoring. Results were compared to similar cases reported in the literature by other surgeons.

Results: All recorded data were tabulated in an Excel sheet. Results from previous studies in standard literature were analyzed for comparison.

Conclusions: Balloon kyphoplasty is a commonly done procedure with relatively few complications. Cement leakage can happen relatively more common than previously thought. Different types of cases have different propensity and directions of cement leakage with different types of possible complications which affect the outcome. Thorough knowledge in this regard can give more targeted outcomes.

73

The Comparisons of the Cervical Balance and Clinical Outcome between the Atlantoaxial Level-Involved Laminoplasty and Subaxial Laminoplasty in Cervical Myelopathy with Lordotic Alignment: A Retrospective Cohort Study

Hao-Wen Chen, Kuang-Ting Yeh, Ing-Ho Chen, Tzai-Chu Yu, Chia-Ming Chang, Wen-Tien Wu

Orthopaedic Department, Hualien Tzu Chi Hospital, Hualien, Taiwan

Objectives: Subaxial laminoplasty has made an appropriate solution for cervical myelopathy with lordotic alignment. However, controversy still exists regarding the C1 laminoplasty to restore mobility for central stenosis involving the atlantoaxial level (C1–C2 level). This retrospective cohort aimed to investigate the difference in sagittal balance and the clinical outcome between atlantoaxial level-involved laminoplasty and subaxial laminoplasty.

Methods: From 2016 to 2021, 10 cases of cervical myelopathy with lordotic alignment were enrolled for expansive open-door laminoplasty (EODL) over the C1 level without any fusion procedure. The control group was selected under the 1:4 propensity score matching by age, sex, preoperative C0–2 Cobb angle (CA), C2–7 CA, C2–7 sagittal vertical axis (SVA), center of gravity of the head (CGH)–C7 SVA, and the chin-brow vertical angle from 184 patients underwent multilevel subaxial EODL. The radiographic parameters and functional outcomes, such as the Japanese Orthopaedic Association (JOA) score, Visual Analog Scale, and Neck Disability Index (NDI) were evaluated preoperatively, 3 months, and 6 months postoperatively.

Results: There was no difference in the age, gender, and preoperative radiographic parameters between groups. The CGH–C7 SVA of the C1–C2 EODL group was significantly larger than the subaxial EODL group at 3 months and 6 months postoperatively. The JOA score and NDI improved significantly in both groups at 6 months postoperatively but were not significantly different between groups. The hyperextension of the upper cervical spine may occur to compensate and maintain the visual balance.

Conclusions: Despite a relatively poor radiographic bal-

ance index, EODL may be a solution to cervical myelopathy with atlantoaxial stenosis, providing a comparable functional and theoretical benefit from restoring mobility at the axial level.

74

Comparison of Conventional Midline Approach versus Paraspinal Muscle-Preserving Osteotomy Approach in the Expansive Open-Door Laminoplasty for the Treatment of Multi-Level Cervical Spondylotic Myelopathy

Hao-Wen Chen, Kuang-Ting Yeh, Ing-Ho Chen, Tzai-Chu Yu, Chia-Ming Chang, Wen-Tien Wu

Orthopaedic Department, Hualien Tzu Chi Hospital, Hualien, Taiwan

Objectives: Expansive open-door laminoplasty (EODL) has provided a solution for cervical myelopathy with lordotic alignment. However, postoperative axial neck pain and concern of progressive kyphotic change remain unsolved issues. This study compared the clinical outcome between the conventional midline approach and the paraspinal muscle-preserving osteotomy approach in patients with multi-level cervical spondylotic myelopathy.

Methods: From 2016 to 2021, 50 patients underwent EODL with a conventional midline approach while the other 50 patients with a paraspinal muscle-preserving osteotomy approach were enrolled. The cross-sectional area (CSA) over C3/4, C4/5, and C5/6 of the posterior cervical extensor muscles including multifidus, semispinalis cervicis, and semispinalis capitis muscles were measured on magnetic resonance imaging (MRI) within 3 months both preoperative and postoperatively. The clinical outcomes were the Japanese Orthopaedic Association (JOA) score, the Visual Analog Scale (VAS), and Neck Disability Index (NDI) at preoperative, postoperatively, 3 months postoperatively, 6 months postoperatively, and 1 year postoperatively.

Results: The demographic data was no significant difference in age, gender, body mass index, and the preoperative VAS between groups. The NDI and JOA score revealed no significant difference between groups at postoperative, 3 months postoperatively, 6 months postoperatively, and 1 year postoperatively. The VAS score in the muscle-preserving osteotomy group showed no difference in postoperative and 3 months postoperatively but significantly lower in the 6 months and 1 year postoperatively compared to the conventional midline group. The CSA of the multifidus and semispinalis capitis were found a significant decrease in the postoperative MRI in the conventional midline approach group (78.3%, p=0.043 and 81.6%, p=0.047). While the CSA of the multifidus, semispinalis cervicis, and semispinalis capitis were found at a similar level before and after muscle-preserving EODL (92.5%, p=0.773; 90.8%, p=0.721; 89.8%, p=0.656). In the subgroup analysis, a significant difference was found between groups on the CAS at the C3/4 and C4/5 levels.

Conclusions: Benefit from the procedure of spinous process osteotomy, the hinged site could be theoretically easier exposed with the multifidus and semispinalis capitis preserving. Thus, the paraspinal muscle-preserving technique may be an alternative solution to the conventional midline approach by providing an improved clinical outcome with a non-inferior sagittal balance.

76

A Retrospective Study on Paravertebral Muscle Quality with Age: Magnetic Resonance Imaging Analysis Using T2 Weighted Images

Shashidhar Narra, Sreeramalingam Rathinavelu

Ortho One Orthopaedic Specialty Centre

Objectives: The purpose of this study is to identify which muscle group among the paravertebral muscles is more subjected to age-related myosteatosis and sarcopenia, which will further help us to focus on the particular muscle group during the rehabilitation of the spine in the elderly population. This study is done using magnetic resonance imaging (MRI; T2 images with proton density-weighting sequence) imaging.

Methods: An MRI-based retrospective study done over 3 months from December 2021 to February 2022, on patients who came to the out-patient department, with complaints of low backache was performed. A total of 90 subjects were included in this study. Three groups of 30 each were made based on their age. The age range of the groups was 20–30 years (group A), 40–50 years (group B),

and 60–70 years (group C). In the MRI, mean pixel values of erector spinae, multifidus, and psoas muscles were measured using Picture Archiving and Communication System-based software provided by STRADUS in sagittal sections at L4–L5 vertebral levels in T2W images and analyzed. The increase in pixel density correlates with the amount of myosteatosis and sarcopenia. Exclusion criteria were patients diagnosed with spondylolisthesis, spinal stenosis, neuromuscular disorders, demyelinating lesions, malignancies, spondyloarthropathies, congenital spinal lesions and deformities, spinal instability, and postoperative patients.

Results: The mean pixel values of three muscles in various groups were collected and data were analyzed. The analysis of variance (ANOVA) test for the pixel values in group A is not significant ($p>0.05$), the ANOVA test in groups B and C was found to be significant ($p<0.05$). The mean pixel values of each muscle group in groups A and B, and in groups A and C were compared using the Student *T*-test and were found to be significant.

Conclusions: Among the paravertebral muscles, the multifidus group undergoes maximum myosteatosis and sarcopenia with age and the least affected muscle is the psoas. The worsening happens maximum between middle age to old age than from young age to middle age, showing that myosteatosis does not follow a progressively increasing pattern with age. Hence, rehabilitation focused on the multifidus group should give the maximum benefit to the patient.

77

Incidences and Risk Factors of Superior Facet Articular Surface Violation at L4 And L5 Levels in Transforaminal Lumbar Interbody Fusion: Open versus Minimally Invasive Techniques

Po-Chun Liu, Chen-Pang Huang, Yi Lu, Ming-Chau Chang, Shih-Tien Wang, Po-Hsin Chou

School of Medicine, National Yang Ming Chiao Tung University, Taipei, Taiwan, R.O.C.

Objectives: Transforaminal lumbar interbody fusion (TLIF) is commonly performed at L4 to S1 levels. Screw-related facet articular surface violation (FASV) at the superior level is one of the potential risk factors for adjacent segment diseases. The objective of the study was to investigate incidences and risk factors of screw-related superior FASV and optimal pedicle screw angles (PSAs) to avoid superior FASV at L4 and L5 levels in TLIF with either open surgery (OS) or minimal invasive (MIS) techniques with three-dimensional C-arm navigation.

Methods: In the OS and MIS groups, 111 and 110 screws were included at the L4 level, and 114 and 110 screws at the L5 level, respectively. Postoperative computed tomography examined screw-related superior FASV at L3–4 and L4–5 facet levels. To maximize the sample size, each pedicle screw along one side of the vertebrae was treated as one observation. Stratified analyses were performed of the factors associated with superior FASV at L3–4 and L4–5 facet levels. Multivariate logistic regression was used to estimate the magnitude of the causal effect on superior FASV of the OS technique, insertion at L5, and PSA. Receiver-operating characteristic curve analyses were conducted to illustrate the performance of PSA in distinguishing superior FASV.

Results: The OS technique and insertion at the L5 level increased the likelihood of superior FASV 2.56 and 1.81 times, respectively. Multivariate logistic regression analysis determined PSA was a significant factor associated with superior FASV. Pearson's *r* between PSA and the distance between midline and entry point was 0.905 ($p<0.0001$). Adding one degree of convergence in PSA led to a mean 0.87 lower odds of a superior FASV event, regardless of surgical techniques. 90% of patients with superior FASV had PSA <11.9° and <15.9° at the L4 level, and <15.9° and <21.8° at the L5 level.

Conclusions: PSAs played an important role in superior FASV. MIS allowed greater PSAs and resulted in fewer incidences of superior FASV. To avoid 90% of superior FASV events, the PSAs might be at least 11.9° and 15.9° at the L4 level; and 15.9° and 21.8° at the L5 level for OS and MIS techniques, respectively.

79

Efficacy, Safety, and Reliability of High versus Low Dosages Form of Tranexamic Acid Used in Adolescent Idiopathic Scoliosis Surgery

Sharif Ahmed Jonayed, Shah Alam, Abdullah Al Mamun Chowdhury, O. Z. M. Dastagir

National Institute of Traumatology and Orthopedic Rehabilitation, Dhaka, Bangladesh

Objectives: This study aimed to quantify blood loss and transfusion requirements for high-dose and low-dose tranexamic acid (TXA) dosing regimens in pediatric patients undergoing spinal fusion for correction of idiopathic scoliosis. Tranexamic acid is a synthetic lysine-analogue antifibrinolytic agent that is used for the reduction of intraoperative blood loss. Its routine use in adolescent idiopathic scoliosis (AIS) surgery has already been documented. However, the dosing regimens vary widely, and the optimal dose has not been yet established.

Methods: It was a quasi-experimental study in which of 92 patients with AIS from July 2015 to June 2020 were included. Patients were selected by purposive sampling & allocated into two equal groups (n=46). Group A (high does) received 50 mg/kg of tranexamic acid administered over 30 minutes before skin incision and continued at the rate of 5 mg/kg/hr until the end of the procedure and group B (low does) received 10 mg/kg of tranexamic acid over 30 minutes before skin incision and continued at the rate of 1 mg/kg/hr until the end of the procedure. Estimated blood loss and transfusion requirements were compared between the two-dosing group.

Results: Patient characteristics were nearly identical between the two groups. Compared with the low-dose TXA group, the high-dose TXA group had decreased estimated blood loss (540 mL vs. 875 mL, p=0.01), and a decrease in both intraoperative (0.2 vs. 0.8 units, p=0.01) and whole hospitalization (0.3 vs. 1.0 units, p=0.04) red blood cell transfusion requirements. The higher-dose TXA was associated with decreased intraoperative (p=0.01), and whole hospital transfusion (p=0.01) requirements, even after risk adjustment for potential confounding variables. No complications or side effects from tranexamic acid use were noted.

Conclusions: High-dose TXA is more effective than low-dose TXA in reducing blood loss and transfusion requirements in idiopathic scoliosis patients undergoing surgery. Further investigation is required regarding the safety of TXA before it can be generalized in the use of idiopathic scoliosis surgery.

80

Efficacy, Safety, and Reliability of Single Posterior Approach for Unstable Thoracolumbar Burst Fracture Treated with Anterior Reconstruction and Posterior Instrumentation

Sharif Ahmed Jonayed, Shah Alam, Abdullah Al Mamun Chowdhury, O. Z. M. Dastagir

National Institute of Traumatology and Orthopedic Rehabilitation, Dhaka, Bangladesh

Objectives: The purpose of this study is to evaluate the neurological, functional, and radiological outcome of the anterior reconstruction of the spine by a single posterior approach in cases of unstable thoracolumbar burst fractures. Management of unstable thoracolumbar burst fracture is still a controversial issue. Fracture morphology, neurologic status, and surgeon preference play major roles in deciding the appropriate approach. Though the combined anterior and posterior instrumentation provides the most stable repair, optimizing neural decompression and stable internal fixation using a single approach over the least number of spinal segments is the goal. Moreover, the use of both approaches on a trauma patient may increase morbidity. Anterior reconstruction of the spine through only one approach can provide an effective outcome.

Methods: Sixteen patients with acute unstable thoracolumbar burst fractures (T-11 to L-4) with neurological deficit in the age group of 16–60 years with McCormack's score of six or more and thoracolumbar injury severity score (TLISS) five or more were included. Neurological status, Visual Analog Scale (VAS), angle of kyphotic deformity, McCormack's score, and TLISS score were evaluated.

Results: The mean duration of surgery was 255 minutes. The mean blood loss was 440 mL. The mean improvement of the American Spinal Injury Association scale was 1.67 in a patient with incomplete spinal injury whereas pa-

tients with complete spinal injury remain the same at the last 6-month follow-up. The mean preoperative kyphotic angle was improved from 25° to 5° postoperatively. VAS score improved from 6.1 to 1.7.

Conclusions: A single posterior approach is a safe, cost-effective, and reliable surgical approach for the reconstruction of all the columns of the spine. It reduces the operative time, blood loss, and morbidity associated with a combined approach with a good outcome.

81

Efficacy, Safety, and Reliability of Single Posterior Approach for Unstable Thoracolumbar Burst Fracture Treated with Anterior Reconstruction and Posterior Instrumentation

Sharif Ahmed Jonayed, Shah Alam, Abdullah Al Mamun Chowdhury, O. Z. M. Dastagir

National Institute of Traumatology and Orthopedic Rehabilitation, Dhaka, Bangladesh

Objectives: To compare intra- and postoperative parameters, surgeons' satisfaction, and cost-effectiveness between general anesthesia (GA) and spinal anesthesia (SA) on patients undergoing surgery in the lumbar spine. Surgery on the lumbar spine is the commonest surgical procedure among all spinal surgical practices. Both the GA and SA are shown to be suitable techniques for performing the surgery safely. GA is used most frequently. But SA became increasingly more popular because it allows the patient to self-position thereby reducing various complications associated with GA in a prone position (quasi-experimental design).

Methods: A total of 164 patients from June 2016 to July 2021 who underwent either discectomy, laminectomy, or lamino-foraminotomy for herniated lumbar disc or canal stenosis in 1 or 2 levels were included. During the study period, 82 patients were non-randomly selected for each of the GA and SA groups. The heart rate (HR), mean arterial pressure (MAP), blood loss, total anesthetic time, surgeons' satisfaction, analgesic requirements, cost of the procedure, and hospital stay were recorded and compared.

Results: In the context of demographic characteristics, baseline HR, or MAP, no significant differences were noted between SA and GA groups. Mean anesthetic time, mean post-anesthesia care unit time, mean doses of analgesic requirement, cost of anesthesia, and the surgeon's satisfaction was significantly lower in the SA group ($p<0.05$). The blood loss, duration of operation, and hospital stay were not significant too. No major intra- and postoperative complications were reported nor were significant differences found in either series.

Conclusions: The safety and efficacy of SA in comparison to GA were similar for the patients undergoing surgery on the lumbar spine. Notable advantages of SA include shorter anesthesia duration, fewer drug requirements, relative cost-effectiveness, and fewer complications rate. Successful surgery can be performed using either anesthesia type.

90

Does Preoperative Radiological Shoulder Balance Correlate with Preoperative Clinical Shoulder Balance in Lenke 5 Adolescent Idiopathic Scoliosis Patients?

Tian Fu Chin, Weng Hong Chung, Chee Kidd Chiu, Chris Yin Wei Chan, Mun Keong Kwan

Universiti Malaya, Kuala Lumpur, Malaysia

Objectives: This study aimed to determine the correlation between preoperative radiological and clinical shoulder balance in Lenke 5 adolescent idiopathic scoliosis (AIS) patients.

Methods: Preoperative clinical pictures and radiographs of 22 Lenke 5 AIS patients who underwent posterior spinal fusion were retrieved and analyzed. Radiological parameters were represented by Cobb angle, T1 tilt, first rib angle (FRA), coracoid process height, clavicle-rib cage intersection (CRCI), clavicle angle, cervical axis, and radiographic shoulder height. Clinical parameters include inner and outer shoulder height (SHi and SHo), front and back shoulder angle, front and back axilla angle, front and back trapezial angle, front and back trapezium angle ratio, natural logarithm (LN) of trapezial area ratio, and shoulder area index 1 and 2 (SAI-1 and SAI-2). The correlation between radiological and clinical parameters was calculated using IBM SPSS ver. 25.0 (IBM Corp., Armonk, NY, USA). Statistical significance was set as 0.05.

Results: The study population comprised of 20 (90.9%) female, 2 (9.1%) male patients. The mean age was 16.2±4.8 years. For medial shoulder balance, radiological parameters such as T1 tilt and FRA both correlated with SHi (T1: r=0.687, p<0.001; FRA: r=0.726, p<0.001), front trapezial angle (T1: r=0.664, p=0.001; FRA: r=0.706, p<0.001), back trapezial angle (T1: r=0.765, p<0.001; FRA: r=0.789, p<0.001), and LN of trapezial area ratio (T1: r=0.742, p<0.001; FRA: r=0.797, p<0.001). For lateral shoulder balance, CRCI is the only radiological parameter which correlated with clinical parameters including SHo (r=0.687, p<0.001), back shoulder angle (r=0.658, p=0.001), back axilla angle (r=0.666, p=0.001), and SAI-2 (r=0.615, p=0.002). However, both T1 tilt and FRA had positive correlation with lateral shoulder parameters which included outer shoulder height (T1: r=0.763, p<0.001; FRA: r=0.738, p<0.001), back shoulder angle (T1: r=0.605, p=0.003), SAI-1 (T1: r=0.794, p<0.001; FRA: r=0.781, p<0.001), and SAI-2 (T1: r=0.835, p<0.001; FRA: r=0.819, p<0.001).

Conclusions: There was a moderate to strong correlation between radiological and clinical shoulder balance in Lenke 5 AIS patients. Medial shoulder radiological parameters (T1 tilt and FRA) correlated with medial shoulder clinical parameters (SHi, front and back trapezial angle, and LN of trapezial area ratio) while lateral shoulder radiological parameters (CRCI) correlated with lateral shoulder clinical parameters (SHo, back shoulder and axilla angle, and SAI-2). However, medial shoulder radiological parameters (T1 tilt and FRA) also correlated with lateral clinical parameters (SHo, back shoulder angle, SAI-1 and 2).

91

Relationship between Clavicle Chest Cage Angle Difference and Preoperative Radiological Parameters in Lenke 1 and 2 Adolescent Idiopathic Scoliosis Patients

Janice Ying Qian Ong, Weng Hong Chung, Chee Kidd Chiu, Chris Yin Wei Chan, Mun Keong Kwan

Universiti Malaya, Kuala Lumpur, Malaysia

Objectives: To investigate the relationship between the clavicle chest cage angle difference (CCAD) and preoperative radiological parameters in Lenke 1 and 2 adolescent idiopathic scoliosis (AIS) patients.

Methods: This is a retrospective study of 111 AIS patients with Lenke 1 and 2 curves who underwent posterior spinal fusion (PSF) surgery with pre-operative and good radiographic imaging were recruited. CCAD was measured using whole spine erect anterior-posterior (AP) radiographs according to the criteria described by Yagi and his colleagues. CCAD was graded into three grades: grade A: no imbalance (<0°); grade B: mild imbalance (0°–10°); and grade C: significant imbalance (>10°). We had divided Cobb angle into three groups which were 50°–69°, 70°–89°, and ≥90° where each group consisted of 37 patients with nine patients with Lenke 1 and 28 patients with Lenke 2 curves. The Cobb angle and Lenke curves were used to stratify recruitment in each group of patients using the stratified random sampling method. Patient demographics and radiological data were analyzed to determine the factors affecting CCAD. The potential risk factors included Cobb angle, T12 translation, Lenke modifier, the apical vertebra of the main thoracic curve, clavicle angle, cervical axis, T1 tilt, and radiographic shoulder height. T12 translation is the distance in millimeters from the mid-point of the T12 vertebrae body to the central sacral vertical line (CSVL) or C7 plumb line (C7PL). Statistical significance was set at 0.05, and the correlation between CCAD and radiological parameters was calculated by using IBM SPSS ver. 25.0 (IBM Corp., Armonk, NY, USA).

Results: The mean age was 13.9±1.9 years. The mean follow-up duration was 51.2±20.4 months. Of all 111 patients, there were 24.3% of Lenke 1 and 75.7% of Lenke 2 curves. CCAD had a moderate positive correlation with Cobb angle (r=0.510, p<0.001). There was a strong positive correlation between T12 translation and CCAD when T12 translation was measured using CSVL (r=0.795, p<0.001) and C7PL (r=0.876, p<0.001). Preoperative cervical axis and pre-operative T1 tilt showed a weak positive correlation with CCAD (r=0.371, p<0.001 and r=0.286, p=0.002, respectively). Lenke AL and AR curves significantly affected CCAD grade B and C compared to Lenke B and C curves (p=0.037 and p=0.013 in grade B, respectively; p=0.017 and p<0.001 in grade C, respectively).

Conclusions: AIS patients with larger Cobb angle would have greater CCAD. T12 translation and Lenke modifier played important roles in CCAD. The cervical axis and T1 tilt were weakly correlated with CCAD.

92

Utilization of WhatsApp in Adolescent Idiopathic Scoliosis Surgery

Yu Jie Lee, Weng Hong Chung, Chee Kidd Chiu, Chris Yin Wei Chan, Mun Keong Kwan

Universiti Malaya, Kuala Lumpur, Malaysia

Objectives: This study aimed to report the use of WhatsApp in the perioperative management of adolescent idiopathic scoliosis (AIS) patients.

Methods: This was a retrospective study which included AIS patients who were planned for posterior spinal fusion in 2019. In our center, all AIS patients who were planned for surgery would have a WhatsApp group created among two consultant spine surgeons, patients as well as patients' parents. The chat history between the consultant spine surgeons, patients as well as patients' parents were reviewed. The outcomes of the study were to describe the frequency of correspondences in preoperative utilization, intraoperative utilization, and postoperative utilization. Correspondences in this study was defined as initiation on a conversation until the end of the discussion of the same issue.

Results: One hundred and thirty-five WhatsApp groups were reviewed, 84.4% (n=114) was female with a mean age of 15.6±4.7 years. Less than half of them (44.4%, n=60) were staying <50 km away and 10 (7.4%) were from overseas. A total of 3,331 correspondences were reviewed in this study. We observed that 3,144 (94.4%) of the correspondence are relevant to patients' care. Total preoperative utilization of WhatsApp was 1,559 (49.6%). There were 278 correspondences (17.8%) that were related to preoperative optimization. The most common reason for correspondence was for logistic arrangements and insurance reimbursement (32.2%, n=502 and 24.6%, n=384, respectively), whereas intraoperative updates on surgery progress comprised 4.2% of WhatsApp usage. Almost all (98.5%, n=133) patients had intraoperative utilization. And 1,451 correspondences (46.2%) were recorded postoperatively, 550 (37.9%) was about clarification on postoperative care, and 4.6% (n=67) was related to the detection of possible postoperative complications. The peak usage happened at 1,100–1,359 hours (25.4%, n=847).

Conclusions: Our study is the first study to demonstrate the utilization of WhatsApp in AIS patient care. Preoperative utilization is most commonly compared to intraoperative or postoperative usage. Communication with patients/parents was useful in preoperative optimization as well as early detection of possible postoperative complications.

95

A T6 T7 Vertebrectomy Along with Wide Excision of Right T6 to T8 Ribs in a Single Block for Malignant T6T7 Sarcoma Involving T6 to T8 Ribs Causing Spinal Stenosis: A Rare Case Report

Chee Seiang Wang, Sze Wei Lim, Chung Chek Wong, Narasimman Sathiamurthy, Brian Teo Yian Young

Universiti Malaya, Kuala Lumpur, Malaysia

Treatment for Sarcoma involving thoracic spine causing spinal stenosis and cord compression with involvement of thoracic ribs require multi-modality approach consisting of surgery, radiation therapy or chemotherapy. Complete wide excision of the tumor is preferred and has been shown to reduce the risk of local recurrence in the literatures. We present this rare and complex surgical case report where the whole tumor within T6T7 vertebrae along with right T6 to T8 ribs is excised *en bloc* without breach of tumor margin with preservation of spinal cord. **A** 65-year-old gentleman presented with recurrent lumbar soft tissue sarcoma since 2017 where local wide excision was done 3 times. The tumor recurs in 2021 despite radiotherapy in December 2020. This time he felt the lump over his right posterior T6 to T8 ribs region. Magnetic resonance imaging was done to review the T6T7 bone tumor causing spinal canal stenosis with extension, involving the right T6 to T8 ribs. No distant metastasis was noted. T6T7 *en bloc* vertebrectomy along with right T6 to T8 ribs wide excision in a single block was then planned as 2-stage surgery in anticipation of excessive blood loss exceeding 4–5 L. The first stage involved partial excision of the tumor and posterior instrumentation from T3 to T10 followed by second stage surgery 6 days later to complete excision of the entire tumor from T6T7 vertebrae along with right T6 to T8 ribs in a single block while preserving the spi-

nal cord. This surgery was performed by a team of three orthopedic spine surgeons and a thoracic surgeon. The total duration of combined surgery was 12.5 hours, and total blood loss was estimated at 6 L. Total blood products transfused included 12 pints of the packed cell, 6 units of fresh frozen plasma, and 4 units of platelets. The patient was able to stand with support on day 2 postoperatively and walk with a walking frame on day 3. The wound was well healed and his neurological function remained intact at the 3-month follow-up. The histopathology report from the excised specimen revealed a clear margin. *En bloc* vertebrectomy is an extremely difficult and complex surgery. It is indicated in a radio-resistant tumor without distant metastasis, with a favorable outcome of longer survival and tumor-free period. The surgery was challenging as the tumor involved two levels of vertebrae extending to the ribs with spinal canal stenosis.

96

Biportal Endoscopic Posterior Cervical Foraminotomy for Cervical Radiculopathy Compared with Uniportal Endoscopic Surgery: Ipsilateral and Contralateral Approach

Ting Chun Huang

Department of Orthopaedic Surgery, National Taiwan University BioMedical Park Hospital, Chutung, Taiwan

Objectives: Posterior cervical foraminotomy (PCF) is aimed at widening the cervical intervertebral foramen while preserving segmental motion and stability and is indicated for cervical spondylotic radiculopathy caused by foraminal stenosis (without instability) or herniated disc. PCF can preserve a range of motion and disc pressure and facet joint contact pressure (anterior cervical discectomy and fusion [ACDF] increased) and stability at lateral bending and posterior extension (ACDF decreased) and can enlarge foramen compared with ACDF (even with uncovertebral joint resection). The complication of C5 palsy is comparable to ACDF and has acceptable endoscopy-related complications. Microendoscopic (MED) PCF has been proved to be superior to open PCF, and uniportal endoscopic PCF has been proved to be non-inferior to MED-PCF in literature. Biportal endoscopic PCF is just starting to gain evidence compared to uniportal endoscopic PCF but has already revealed some promising features.

Methods: This is a literature review of open, MED, and uniportal/biportal endoscopic PCF in regards to both clinical and biomechanical aspects using the keyword "posterior cervical foraminotomy" OR "posterior cervical discectomy/diskectomy" with the filter of English and keyword in the title/abstract and manual screen for endoscopy related articles in PubMed from 2019–2021 and 29 vs. 19 results were found. This report also includes a uniportal/biportal endoscopic PCF case series of a single surgeon in a regional hospital from January 2019 to December 2021. The patients were in a prone position with silicon facial support or using a Mayfield fashion head clamp. Somatosensory evoked potentials and motor evoked potentials were used in the first case and case with multiple levels but were not used routinely. Irrigational pumping tubes were used intraoperatively but the pressure was kept below 30 mm Hg. Bipolar was set at 30 mA. Mini-Hemovac was inserted in every approach and was removed if the drain amount is below 30 mL/day or on day 3. A soft collar was applied postoperatively only and the patient starts walking on postoperative day 1.

Results: Video included uniportal ipsilateral approach (n=3), uniportal contralateral approach (n=1), biportal ipsilateral approach (n=4), and biportal contralateral approach (n=6). Pre- and postoperative Visual Analog Scale, Japanese Orthopaedic Association score, and EuroQoL 5-dimensions were included and obvious improvements were noted. Patients could turn their necks with minimal discomfort on postoperative day 1. Blood loss was minimal. Operative time was average of around 65 minutes per level. No dural tear nor complications were noted.

Conclusions: Posterior endoscopic cervical foraminotomy could be used to treat radiculopathy related to foraminal stenosis or herniated intervertebral disc at the foraminal area. Uniportal posterior cervical foraminotomy is not inferior to MED posterior cervical foraminotomy and is superior to open posterior cervical foraminotomy. Biportal posterior theoretically is not inferior to uniportal cervical foraminotomy and has some advantages. The ipsilateral approach is adequate for disc removal, and the contralateral approach is adequate for foraminal decompression and can preserve more facets than the ipsilateral approach.

109

Radiological Outcomes Following Free-Hand Pedicle Subtraction Osteotomy in the Lumbar Spine for Sagittal Deformities

Yuan-Shun Lo, Chung-Wei Lin, Michael Jian-Wen Chen, Hsien-Te Chen

China Medical University Hospital, Taichung, Taiwan

Objectives: Rigid adult spinal deformity (ASD) with sagittal imbalance cases are challenging and many of them require a three-column osteotomy for correction. Pedicle subtraction osteotomy (PSO) is one of the robust operative techniques which could achieve up to 40° of focal lordosis. Various PSO techniques have been proposed for better correction including extended PSO, closing-opening wedge osteotomy, and asymmetric PSO. Traditionally, a PSO is performed under C-arm fluoroscopy to verify the amount of osteotomy and the position of osteotome in relation to the anterior cortex of the vertebral body. In this series, we presented our experiences and focused on the radiological outcomes of free-hand PSO for sagittal alignment correction.

Methods: We conducted a retrospective review of patients with symptomatic ASD with sagittal malalignment who underwent PSO between January 2018 to March 2021 at two hospitals. The surgery was performed by a senior spine surgeon who specialized in spine deformity correction. Baseline demographic data, the preoperative and postoperative radiographic parameters including pelvic incidence (PI), sacral slope (SS), pelvic tilt (PT), lumbar lordosis (LL), thoracic kyphosis (TK), T1 pelvic angle (TPA), and sagittal vertical axis (SVA) were well documented.

Results: A total of 12 consecutive patients with a mean age of 59.5±18.81 years were enrolled. Two-thirds of them were female. The mean body mass index was 27.68±4.5 kg/m^2, and 75% of the etiology was postoperative flatback. The number of fused segments was 6.9±1.29. The operation time was 468.88±102.62 minutes. The estimated blood loss was 992±513.8 mL. The mean PI was 46.4°±11°. SS was changed from 15.78°±13.82° to 29.94°±6.34°. PT was changed from 30.63°±9.56° to 16.39°±7.8°. LL improved from -13.31°±30.34° preoperatively to -41.17°±15.2° postoperatively. The upper lumbar (L1–L4) curve was 6.7°±19.24° preoperatively and -16.17°±7.72° postoperatively. The lower lumbar curve (L5–S1) was -25.56°±19.44° preoperatively and -33.89°±14.03° postoperatively. The PI–LL improved from 33.52°±26.37° to 5.18°±12.96°. TPA improved from 31.86°±14.9° to 14.7°±9.28° and SVA improved from 94.64±95.55 to 32.72±46.31 mm. There was no intraoperative neurological or vascular complication.

Conclusions: Free-hand PSO could provide an effective and significant correction of fixed sagittal imbalance regarding the radiological outcome as traditional PSO.

110

Time-Dependent Changes in Stiffness-Related Functional Disability after Long Segmental Fusion in Elderly Patients with Adult Spinal Deformity: Minimum 2-Year Follow-up Results

Aditya Raj, Chong-Suh Lee, Se-Jun Park, Jin-Sung Park

Smt. Kashibai Navale Medical College and General Hospital, Pune, India

Objectives: There have been many scoring systems that quantify the extent of stiffness-related functional disability (SRFD) like the Lumbar Stiffness Disability Index (LSDI) and Specific Functional Disability Index (SFDI). However, these scores have been previously reported at a single point in time and we do not know whether SRFD remains constant after surgery or is expected to show any change. The main purpose was to evaluate the time-dependent trend of SRFD after surgery and the second aim was to understand if there were any specific components of the SFDI that will change with time and the duration till when this change can be expected.

Methods: A retrospective analysis of 350 patients who underwent more than 4 level spinal instrumentation extending to the sacrum for adult spinal deformity. Patients with neuromuscular scoliosis and ankylosing spondylitis were excluded. Patients with proximal junctional failure or those who underwent revision surgery for any reason were excluded from the study, but patients with asymptomatic proximal junction kyphosis

were included. The SFDI scores taken at 3 months, 1 year, 2 years postoperatively, and at the last follow-up were used for the analysis. The changes in scores for each item, category, and the total sum of SFDI were evaluated at these time intervals.

Results: A total of 116 patients were included in the final study sample. Among the four categories of SFDI, the sitting on the floor category showed the highest scores (highest disability) followed by lower body activities, sanitation activities, and moving activities at all time points of the study. The sitting on the floor disability category showed no improvement during follow-up. Among the 12 items of SFDI, eight showed significant improvements at the last visit when compared to scores at 3 months and this change was most pronounced between 3 months and 1 year postoperatively. Patients with a lower American Society of Anaesthesiologists grades experienced significant improvement in SFDI scores in terms of moving activities and total sum. All sagittal parameters such as LL, SS, PT, TK, and SVA significantly improved at 3 months postoperatively, but a significant loss of correction was observed in all sagittal parameters at 1 year.

Conclusion: SRFD was highest at three months postoperatively, but it improved over time until the last follow-up except for sitting on the floor category. The improvement was found greatest between 3 months and 1 year postoperatively. The radiographic parameters underwent significant correction loss post operatively and the changes in the radiographic parameters did not correlate with the improvement of SRFD.

119

Giant Sacrococcygeal Chordoma in an Indian Patient with Post-polio Residual Paralysis: An Extremely Rare Case Report

Sandeep Yadav, Prabodh Kantiwal

All India Institute of Medical Sciences, Jodhpur, India

Objectives: Chordoma is a relatively uncommon tumor that accounts for 1% to 4% of all malignant bone tumors and has an annual incidence of 0.1 per 100,000 people. The sacrum is the most commonly affected site, although giant sacrococcygeal chordoma has rarely been reported in Indian literature with none in patients with post-polio residual paralysis (PPRP).

Methods: A huge dorsal sacral mass was discovered in 31-year-old male suffering from PPRP with the main complaint being swelling for the past 3 years and pain and discomfort in sitting for the past 1 year. The sacrococcygeal tumor was considered to be a chordoma based on the imaging results and preoperative histopathology. The lesion extended superiorly up to the lower border of the S2 vertebra, destroying the sacrococcygeal vertebrae, and inferiorly up to the level of the anal verge and down to the skin and subcutaneous tissue. It displaced, abutting the rectum anteriorly, with abnormal fat plane loss along the right posterolateral aspect of the rectum. The blood supply for the lesion came from branches of the bilateral internal iliac arteries.

Results: The patient underwent wide margin resection—middle sacrectomy with R0 margins—with preservation of both S2 and right S3 roots. Hypotensive anesthesia and local vasoconstrictors were used to control intraoperative bleeding and only 1 unit of packed red blood cells was required to be transfused postoperatively. Post-resection, bilateral sacro-illiac joints were found to be stable. A postoperative biopsy confirmed the diagnosis of a sacral chordoma which weighed up to 1.5 kg and was measured as 19.2×14.8×11 cm (3,125 cm^3). At 15 days following surgery, the patient was discharged uneventfully. The pain was relieved postoperatively and the patient recovered well, maintaining the bowel and bladder control weakly without any new sensory motor deficit. In the 3 months of follow-up, no evidence of recurrence or neuro compromise was found and bladder and bowel control improved.

Conclusions: Giant sacrococcygeal teratomas are extremely rare entities and need special consideration in treatment. Loss of bowel and bladder control in a patient with PPRP can be extremely debilitating. The risk of having such complications along with other common complications associated with chordomas in this region such as heavy blood loss, hematoma formation, wound necrosis and bowel perforation can be prevented with proper planning.

120

Giant Sacrococygeal Chordoma: Our Experience of Three Cases

Sandeep Yadav, Prabodh Kantiwal

All India Institute of Medical Sciences, Jodhpur, India

Objectives: Sacral chordoma is a locally aggressive malignant tumor originating from ectopic notochordal cells. The natural history of sacral chordoma is a slow-growing tumor arising at the midline of the lower sacrum that can invade the sacrum and progressively increase in size expanding cranially and anteriorly.

Methods: Here we are sharing our experience of treating these rare entities in three patients presenting with a large sacral mass with burning pain in the gluteal region. The first patient was having a very large size tumor creating difficulty while sitting and activities of daily living with normal bowel and bladder. A second young female patient presented with sacral pain with perineal hypoesthesia and occasional urinary incontinence. A third elderly male patient came with bowel and bladder involvements. All the patients underwent Histopathological examination at our institute only.

Results: All three patients underwent wide margin resection in form of sacrectomy with R0 margins. In the first patient, we were able to preserve the right side S3 root while in the second patient bilateral S 3 root were preserved. In the third patient, all roots below S2 were engulfed in tumor mass which cannot be preserved in order to achieve *en bloc* resection. In the first two patients, postoperatively bowel and bladder were normal while in the third patient bowel and bladder does not improve.

Conclusions: Sacral chordoma treated with wide *en bloc* resection and sacrectomy associated with complications of this complex surgery. Nevertheless, surgery is still worthwhile to improve the quality of life and prevent complications secondary to prolonged immobilization. A multidisciplinary approach is ideal and team members need to be prepared to address the complications once they arise.

124

Successful Salvage Surgery for Chronic Cauda Equina Syndrome Caused by Retropulsed PLIF Cage with Intradural Migration: A Case Report and Cause Analysis

Erh-Ti Lin, Yuan-Shun, Pan-Hsuan, Hsien-Te

China Medical University Hospital, Taichung, Taiwan

Spinal fusion is a common surgery to fuse the vertebrae for restoring the stability of the spine and eliminating painful motion. The interbody cage aids in achieving fusion. However, cage-related complications occasionally occur and are sometimes difficult to deal with. A 44-year-old male represented our spine center with paraplegia and cauda equina syndrome for 2 years and 4 months after a series of lumbar spine surgeries. A structural allograft kidney-shaped cage was found within the dura at the level of the L3 vertebra. Durotomy, retrieval of the cage, and pedicle screw fixation from L2 to L4 vertebra were performed. The patient was significantly relieved from numbness in bilateral lower limbs. Two weeks postoperatively, he could partially control urinary behavior and bowel movement. Five months postoperatively, standing was achievable with slight assistance. Intradural cage migration is rare and a critical complication. Even in the condition of delayed treatment, surgical intervention is required to salvage remaining neurologic function, and possibly gain recovery.

133

Incidence of Dural Tears in Spine Surgery in a Tertiary Care Center of North India

Jagdeep Singh

Guru Gobind Singh Medical College and Hospital, Faridkot, India

Objectives: To Find out the incidence of dural tear in various spine surgery along with its risk factor and management of dural tears.

Methods: We retrospectively reviewed 300 consecutive cases involving patients who underwent a surgical procedure for the treatment of various spinal problems at our

institution between January 2015 and December 2017. All the records collected from the CR office and main OT data entry register for intraoperative dural tear along with its risk factors and compared with the previous literature. The authors also noted the type of management done for dural tear along with its associated complication if any occurred postoperatively.

Results: In 300 operations (126 women and 174 men; mean age, 58.9 years; range, 19–83 years), an incidental dural tear (in 5% of cases) was either identified intraoperatively or suspected retrospectively. The bulk of involved procedures were discectomy followed by, traumatic spine fixation, decompression, and fusion and performed either at two levels or more or a single-level and caries spine.

Conclusions: In conclusion, the reported incidence of dural tear in spine surgery was 5% in our study. Risk factors included older age, increased comorbidities, and high hospital caseload. Dural tear increased the rate of in-hospital complications and mortality and health care burdens.

144

Clinical Outcome of Single-Stage Decompression and Posterior Stabilization in Thoracolumbar Spinal Tuberculosis

Biswaranjan Nayak, Amit Jaiswal

AMRI Hospital Bhubaneswar, Bhubaneswar, India

Objectives: To assess the clinical outcome of single-stage decompression and posterior stabilization in thoracolumbar spinal tuberculosis.

Methods: All patients aged between 18 and 70 years with clinically and radiologically proven symptomatic thoracolumbar spinal tuberculosis who failed with conservative treatment for 4 weeks or developed neurologic weakness between the treatments are included in this study. All patients were offered decompression and posterior stabilization with transpedicular screws and rods after explaining the above procedure. Clinical outcome was measured by modified Frankel grading; American Spinal Injury Association (AIS) impairment score grade; and pain assessment done with Visual Analog Scale pre- and postoperatively and at 3, 6, and 9 months of interval.

Results: The postoperative pain relief, neurologic improvement as per modified Frankel grade, AIS grade, and improvement in erythrocyte sedimentation rate and C-reactive protein were significant as compared with the preoperative status. The surgical interventions thus prove to have adequate relief to the patient and arrest the disease progression. The surgical outcome has very minimal intra- and postoperative complications.

Conclusions: Single-stage decompression and posterior stabilization in thoracolumbar spinal tuberculosis is safe, effective, and results in good clinical outcomes. The advantages of surgery include thorough debridement, decompression, and achievement of spinal stabilization.

145

Results of Early versus Delayed Decompression for Traumatic Cervical Spinal Cord Injury: A Single Center Prospective Study

Biswaranjan Nayak, Amit Jaiswal

AMRI Hospital Bhubaneswar, Bhubaneswar, India

Objectives: This study was done with the aim to compare the clinical outcome and patient's quality of life between early (within 24 hours post-injury) versus delayed (after 24 hours to 7 days) surgically treated patients with acute cervical spinal cord injury. The current study was based on the hypothesis that early surgical decompression and fixations in acute cervical spinal cord trauma are safe and are associated with improved outcomes as compared with delayed surgical decompression.

Methods: A total of 54 patients were recruited and divided into early decompression surgery group A (operated within 24 hours of trauma; n=25) and late/delayed decompression surgery group B (operated between 24 hours and 7 days of trauma; n=29). The patients in both groups were followed up, and comparative differences were noted in the neurological outcome, quality of life, and bony fusion.

Results: The early surgery group had lesser postoperative complications. In group A, 54.17% of patients had 1 American Spinal Injury Association Impairment Scale (AIS) grade improvement, while 29.17% experienced >2 AIS grade improvement (p=0.015). In group B, the neurological improvement was 50 and 21.43%, respectively (p=0.003). There was a significant improvement in the

postoperative quality of life scores in the early surgery group.

Conclusions: Early surgery in patients with acute cervical spinal cord injury should be considered strongly in view of the lesser complications, better neurological recovery, and reduced mortality.

147

Investigating the Influence of Body Mass Index on Measuring and Monitoring the Sagittal Alignment from Surface Contour Detected by a Novel Image Processing Algorithm

Ogulcan Guldeniz, Jack Z. Wei, Kenneth M. C. Cheung

Department of Orthopaedics & Traumatology, The University of Hong Kong, Hong Kong

Objectives: There are various medical devices (Spinal Mouse, SpineScan, etc.) and methodologies (Biophotogrammetry, Surface Topography, Infra-red Motion Analysis, Free-Point Ultrasound System, etc.) in use that claims to offer a radiation-free alternative to measure the sagittal alignment through topographical skin measurements. However, the effect of subcutaneous fat on the accuracy of the sagittal alignment measurements by these devices is not known. We developed a novel algorithm to measure the skin contour from sagittal radiographs and compared these with radiographic sagittal alignment stratified according to their body mass index (BMI).

Methods: A total of 93 subjects were included. We divided them into three BMI groups: low: 13–16 (0%–33%), normal: 16–19 (33%–66%), and high: 19–28 (66%–99%). Sagittal skin curves (6th-degree polynomial) were assigned to the skin contours of the baseline and follow-up (17±10 months) radiographs by using a novel image processing algorithm. Thoracic kyphosis (TK) and lumbar lordosis (LL) derived from the skin curve were compared with those directly measured from the spinal images. The accuracy of the skin curves against the skin contour was assessed by root mean square error (RMSE). The correlation between the skin curve and the sagittal alignment was assessed for different BMI groups by Pearson's correlation analyses. The changes between baseline and follow-up angles were compared to assess the monitoring accuracy.

Results: The mean RMSE between the skin curve and the skin contour was 12.5%. The correlations between the baseline skin curves and the sagittal images were 0.80 for TK and 0.86 for LL for the low BMI group. The same values were 0.60 and 0.55 for the normal, and 0.61 and 0.57 for the high BMI group, respectively. The monitoring accuracy was 0.48, 0.35, and 0.31, for the TK, and 0.85, 0.72, and 0.60 for the LL of low, normal, and high BMI groups, respectively.

Conclusions: The novel algorithm proved to be reliable to identify the skin contour from sagittal images (X-rays, conventional camera images, etc.). Skin contour's accuracy to predict the sagittal alignment of the spine decreases with increasing BMI. Skin contour was only observed to be reliable to monitor the LL of patients that falls into low and normal BMI groups. Therefore, careful consideration of our findings is suggested before employing topographical skin measurement devices.

149

Revision Strategy for a Neurofibromatosis Type 1 Scoliosis Case with O Arm Navigation Assistance: A Case Report

Cheng-Hung Chiang, Yuan-Shun Lo, Chien-Ming Chen, Shiau-Tzu Tzeng

Department of Orthopedics Surgery, China Medical University Hospital, Taichung, Taiwan

Objectives: Neurofibromatosis type-1 (NF-1) is an autosomal dominant genetic disorder, with the cutaneous manifestations and scoliosis deformity, often found in their first decade. In accordance with the shape of scoliosis, NF-1 scoliosis could be categorized into two types—dystrophic and non-dystrophic. The former is more resistant to correction, which needs early surgical correction and stabilization to prevent the deterioration of the skeletal structure and cardiopulmonary function. Therefore, it is necessary for the patients to receive early diagnosis and treatment. We reported a 13-year-old male patient initially presented NF-1 dystrophic scoliosis, shift to the left, and was diagnosed at age of 9 years. The patient received several times surgery due to correction failure with screws loosening

and infection. Worst of all, the patient's skeletal structure became worse than before.

Methods: The patient came to China Medical University Hospital in 2019, at age of 13 years, with a height of 140 cm and 37 kg. General scanography, computed tomographic (CT) three-dimensional (3D) reconstruction, and magnetic resonance imaging images were all assessed to draw up plans. A 3D printed spine model was made before the surgery on the basis of the CT image. We scheduled the operation and adopt CT guide system, the O-arm navigation (Medtronic), which provided a timely and accurate image and location. Posterior column osteotomies were conducted from T12 to L5 and then applied posterior instrumentation and fusion from T8 to pelvis with hybrid pedicle screws, especially extra-long S2AI screws to make a stronger anchor to the pelvis. Sublaminar wires and chopped autograft and allograft were applied for further fusion and reconstruction of ion angular stability.

Results: During the 15 hours of surgery, the major drive curvature and compensated one were generally corrected and the patient didn't have any neurologic complications. He was also discharged at the 8th day after the operation. Regularly image follow-up with X-ray and gross appearance on post-operation 6, 9, and 12 months showed the acceptable good result and alignment. The patient had fair daily activities and function results and the appearance was also corrected into an acceptable shape.

Conclusions: With the assistance of the O arm navigation system, not only the coronal deformities but the circumferential fusion could be done precisely and avoid deformities progression. Most important of all, the surgeon could perform an effective and safe operation with timely surveillance and avoid neurovascular intraoperative complications under O arm navigation system assistance.

151

Prevalence of Neck and Back Pain among Nurses: A Cross-Sectional Study of 2,240 Nurses

Abhishek Soni, Manoj Kumar Ramachandraiah, Thomas Joseph Kishen

Manipal Hospital, Bengaluru, India

Objectives: Neck and back pain has reached pandemic proportions leading to prolonged suffering for the afflicted and significant direct and indirect costs to individuals and societies. Nurses are traditionally considered to be at high risk for developing neck and back pain. This study was conducted to ascertain the prevalence of neck and back pain among nurses and analyze the associated risk factors.

Methods: **A total of** 2,240 out of 3,437 nurses working across eleven hospitals participated in a cross-sectional questionnaire-based survey to ascertain the prevalence of neck and back pain and analyze the potential associated risk factors. The questionnaire sought demographic, anthropometric, and educational information including age, gender, height, weight, highest educational qualification, participation in sports and exercises, mode of travel to work, duration of travel, the prevalence of sadness, neck pain, and back pain in the last 6 months. The results were tabulated and analyzed.

Results: **O**f the respondents, 22% reported low back pain most of the time and 4% reported low back pain all the time while 13% reported neck pain most of the time and 2% reported neck pain all the time over the last 6 months. There was no association between low back and neck pain with age, sex, body mass index, educational qualification, duration of travel to and from work, participation in sports/exercises, and area of work in the hospital. Self-reported sadness/depression showed a significant correlation with low back pain ($p<0.001$; relative risk [RR], 3.46) and neck pain ($p<0.001$; RR, 4.24).

Conclusions: The prevalence of low back and neck pain is high among nurses. The presence of mental health issues correlates with the severity of neck and back pain. Hence assessment and treatment of mental health issues should form a part of the multi-disciplinary management of chronic neck and back pain.

152

Challenges in Occipito-Cervical Fusion in a 9-Month-Old Infant: A Case Report and Review of Literature

Abhishek Soni, Balamurugan Thirugnanam, Thomas Joseph Kishen

Manipal Hospital, Bengaluru, India

Traumatic cranio-cervical junction injuries in infants

are rare and require early surgical stabilization and arthrodesis. In view of the unique and crowded anatomy of the occipito-cervical junction in infants, the creation of a fusion construct that is both safe and biomechanically sound is challenging. We present a technical report of a 9-month-old infant with displaced odontoid synchondrosis fracture with combined occipital-cervical and atlantoaxial dissociation, who underwent surgical stabilization. A 9-month-old male unrestrained infant involved in a high-speed motor vehicle accident presented with weakness in both upper limbs. Multi-modality imaging revealed a displaced odontoid synchondrosis fracture with combined occipito-cervical and atlantoaxial dissociation. In view of the unstable nature of the injury, surgery in the form of occiput to C2 arthrodesis using dual distal radius locking plates and autologous full thickness calvarial bone graft held in place with sutures and mini fragment screws was performed. Minerva Jacket was applied at the end of the surgery. A computed tomography scan obtained 12 weeks after surgery demonstrated bony fusion from the occiput to C2. The Minerva jacket was well tolerated and the child made a complete neurological recovery. In this report we would like to highlight a rare injury in an infant which underwent stabilization with dual distal radius plates and fusion achieved using full thickness autologous calvarial grafts and immobilized in a Minerva jacket.

153

Tumor Induced Osteomalacia: A Study of 12 Cases

Abhishek Soni, Balamurugan Thirugnanam, Thomas Joseph Kishen

Manipal Hospital, Bengaluru, India

Objectives: Tumor-induced osteomalacia is a paraneoplastic syndrome resulting from increased production of fibroblast growth factor-23. Since the symptoms are nonspecific, a high degree of suspicion and awareness is necessary to recognize the persistent hypophosphatemia and low or normal vitamin D levels which are biochemical hallmarks of this condition.

Methods: A retrospective review of twelve patients diagnosed with adult-onset tumor-induced osteomalacia was conducted. All the patients presented with clinical features of osteomalacia and biochemical studies revealing hypophosphatemia managed initially with oral phosphorous, calcium, and calcitriol. A failure resolution of symptoms led to suspicion of tumor-induced osteomalacia followed by ordering serum fibroblast growth factor-23 (FGF-23) levels in these patients. Successful treatment was defined as alleviation of symptoms and normalization of serum phosphorus levels. Localization of tumors was done through Ga 68-DOTANOC-positron emission tomography–computed tomography (PET/CT) and 18F-FDG PET/CT and all patients underwent tumor excision.

Results: The most common symptoms were back pain, ankle pain, and bilateral flank pain in absence of antecedent trauma in all 12 patients. Proximal muscle weakness was reported in eight patients. Five patients presented with difficulty in walking unassisted. Vertebral fractures were noted in six patients and insufficiency fractures in the femoral neck in four patients without antecedent trauma. The tumor was localized in regions including, the ethmoid sinus, nasal cavity, thigh and femur, tibia, calcaneum, and foot. Serum phosphorous levels were low in all patients (median, 0.50 mmol/L; normal range, 0.8–1.6 mmol/L). Serum calcium was normal in 11 patients and mildly reduced in one patient (median, 2.32 mmol/L; normal range, 2.20–2.65 mmol/L). Serum alkaline phosphatase (median, 161.5 IU/L; normal range, 15–112 IU/L); serum parathyroid hormone (median, 57.85 pg/mL; normal range, 15–65 pg/mL); 25-hydroxyvitamin D3 (median, 14.13 ng/mL; normal range, 20–40 ng/mL); and 24-hour urinary phosphorous (median, 4.4 mg/day; normal range, 0.9–1.3 mg/day). Serum FGF-23 level was raised in all twelve patients (median, 232 RU/mL; normal range, 0–150 RU/mL). The mean follow-up period was 6.83±5.96 months (range, 3–24 months). Bone pains and muscle weakness subsided completely and third-month serum phosphorous values were normal in all patients (median, 0.96 mmol/L; normal range, 0.8–1.6 mmol/L).

Conclusions: This case series discusses the salient clinical features and laboratory parameters leading to the diagnosis and management of tumor-induced osteomalacia. Low serum phosphorus in the presence of normal renal function should raise the suspicion of this condition and a raised FGF-23 level confirms the diagnosis. Functional and anatomical imaging helps in tumor localization and surgical excision with wide margins is curative.

165

Does Presence of Developmental Canal Stenosis Impact Outcome in Patients with Degenerative Canal Stenosis Treated with Decompression Alone? A Prospective Study

Pramod Bhilare, Rahul Jaiswal, Shailesh Hadgaonkar, Ajay Kothari, Siddharth Aiyer, Parag Sancheti

Sancheti Institute of Orthopaedics and Rehabilitation, Pune, India

Objectives: To compare the clinical and radiological (spinopelvic parameter) outcomes post-lumbar decompression alone in two groups, i.e., DegLCS alone as group A and DegLCS with DevLCS as group B.

Methods: A prospective study of 120 degenerative lumbar canal stenosis patients treated with lumbar decompression alone and minimum 1-year follow-up were conducted. Patients were divided based on sagittal body width (SBW)/pedicle width (PW) using lateral lumbar X-ray into two groups, i.e., DegLCS (SBW/PW <2.8) alone and DegLCS with DevLCS (SBW/PW >2.8). Clinical outcomes were measured using Visual Analog Scale (VAS) score, Oswestry Disability Index (ODI) score, and 36-item Short Form Survey (SF-36) questionnaire. Improvements in spinopelvic parameters (pelvic tilt, pelvic inclination, sacral slope, and lumbar lordosis) were used for radiological outcome.

Results: A statistically significant improvement in VAS score, ODI score, and SF-36 was observed postoperatively in both groups. Although these clinical outcomes didn't differ significantly in the two groups. The mean lumbar lordosis in group A and group B improved (42.21° to 46.13° in group A and from 44.92° to 47.65° in group B) post-decompression in both groups; however, differences in the two groups were statistically insignificant. Also, no correlation could be demonstrated between functional outcome and improvement in spinopelvic parameters.

Conclusions: DevLCS commonly exists in the background of DegLCS. The presence of DevLCS doesn't impact the outcome in DegLCS in short-term follow-up.

215

Safe Route for Cervical Approach: Partial Pediculotomy, Partial Vertebrotomy Approach for Posterior Endoscopic Cervical Foraminotomy and Discectomy

Pang Hung Wu, Hyeun Sung Kim

Ng Teng Fong General Hospital, Singapore

Objectives: Cervical radiculopathy is a common cervical spine condition. There is a paucity of literature discussing the effect of partial pediculotomy and partial vertebrotomy for posterior endoscopic cervical foraminotomy (PPPV PECF) on cervical radiculopathy. We investigate the radiological and clinical outcomes of this approach.

Methods: Retrospective evaluation of 30 cases with cervical radiculopathy underwent PPPV PECF. Preoperative and postoperative roentgenogram for evaluation of stability, computer tomography (CT) evaluation of foraminal dimensions and area in sagittal view was performed. Three-dimensional (3D) reconstruction areas of decompression evaluations were performed. Clinical outcomes of the Visual Analog Scale (VAS), Oswestry Disability Index (ODI), and MacNab's score were evaluated.

Results: There was no complication and recurrence in our PPPV PECF cohort during the study period. At preoperative, 1 week postoperative, 3 months postoperative, and final follow-up, the mean VAS had significant improvement with scores of 7.6, 3.0, 2.1, and 1.7 respectively (p<0.05), and the mean ODI scores of 73.9, 28.1, 23.3, and 21.5, respectively (p<0.05). MacNab's criteria showed all patients scoring well and excellently. The radiological result showed PPPV PECF had a significant increase in decompression in the foramen area in all CT measured parameters, as compared to the mean preoperative values: (1) sagittal area increased 60.1±23.1 mm^2, (2) CT craniocaudal length increased 4.0±1.54 mm, (3) CT ventrodorsal length increased 4.0±1.97 mm, and (4) 3D CT scan reconstruction decompression area increased 996±266 mm^2 (p<0.05).

Conclusions: PPPV PECF is a safe route of decompression of the cervical spine with good clinical and radiological outcomes.

88

The Importance of Postoperative Lumbar Lordosis in Adolescent Idiopathic Scoliosis Patients: Health-Related Quality of Life Assessment and Distal Disc Degeneration at Minimum 10-Year Follow-up

Thean Sim Yee, Chris Yin Wei Chan, Chee Kidd Chiu, Weng Hong Chung, Mun Keong Kwan

Universiti Malaya, Kuala Lumpur, Malaysia

Objectives: To investigate the correlation between postoperative lumbar lordosis (LL) and health-related quality of life (HRQOL) and distal disc degeneration on follow-up magnetic resonance imaging (MRI) among adolescent idiopathic scoliosis (AIS) patients who had undergone posterior spinal fusion (PSF) with a minimum follow-up of 10 years.

Methods: This was a cross-sectional study of 48 AIS patients who underwent PSF with a minimum follow-up of 10 years. Revised Scoliosis Research Society-22 (SRS-22r), 36-item Short Form Survey (SF-36), and Oswestry Disability Index (ODI) questionnaires were administered during the final follow-up and an MRI of the lumbosacral spine was arranged to evaluate for distal disc degeneration using the Pfirmann classification. The ideal LL was calculated using three formulas: Schwab, Hamamatsu, and Lafage's age-adjusted formula. Patients were then stratified into two groups (using each of the formula) as to whether their ideal LL was achieved postoperatively: m*atched (ideal LL achieved) vs. mismatched*.

Results: The mean follow-up duration was 17.8±6.4 years. The current mean age was 33.7±8.8 years old with a mean age of 16.4±7.0 years old at the time of operation. The mean postoperative LL was 48.7°±14.5°. Following Schwab's formula, 23 patients were matched while 25 were not whereas only 15 patients were matched using the Hamamatsu formula. Using Lafage's age-adjusted prediction, 20 patients (±10° of prediction) were matched. There was no significant correlation between SRS-22r scores comparing matched vs. mismatched groups when using Schwab, Hamamatsu, and, Lafage formula (p>0.05). ODI scores were comparable in both groups when the prediction was carried out using all three formulas. For SF-36 scores, the mismatched group did not have poorer scores compared to the matched group. Interestingly, mean Pfirmann scores at the L4/5 disc level were significantly higher in the mismatched group when using Schwab and Lafage age-adjusted formula.

Conclusions: Postoperative sagittal parameters in AIS patients did not significantly affect their HRQOL scores at a minimum follow-up of 10 years. However, the mismatch between ideal LL and postoperative LL might have an influence on distal disc degeneration at the L4/5 level. Longer follow-up studies would be needed to evaluate the importance of postoperative sagittal parameters in AIS patients.

187

Safety, Efficacy, Surgical and Radiological Outcomes of Short Segment Occipital Plate and C2 Transarticular Screw Construct for Occipito-Cervical Instability

Mani Kant Anand, Vishal Kundnani

Bombay Hospital, Mumbai, India

Objectives: This was a retrospective analysis of prospectively collected data. Our study aims to assess the safety, efficacy, clinicoradiological, functional, neurological outcomes, and complications of posterior occipito-cervical fixation using an occipital plate and C1–2 transarticular screw (TAS) construct.

Methods: Data of 27 patients who underwent occipital plate and C1–2 TAS construct at a single institute from 2010 to 2015 were collected and analyzed. Demographics, clinical parameters (Visual Analog Scale score, Oswestry Disability Index, and modified Japanese Orthopaedic Association score), radiological parameters (mean atlantodens interval, posterior occipito-cervical angle, and occipitocervical2 angle), surgical parameters (operative time, blood loss, hospital stay, and fusion), and complications were evaluated.

Results: The mean age of the patients was 54.074±16.52 years (18–81 years), the mean operative time was 116.29±12.23 minutes, and the mean blood loss was 196.29±38.94 mL. The mean hospital stay was 5.22±1.28 days. The mean±standard deviation follow-up duration was 62.52±2.27 months. There was a significant improve-

ment in clinical parameters and radiological parameters postoperatively. One patient with implant failure, one patient with pseudoarthrosis, one with neurological deterioration, two wound complications, and two dural tears were noted.

Conclusions: Posterior occipitocervical reconstruction with OC12 TAS constructs provided excellent clinical outcomes, radiological outcomes, optimal correction of malalignment in the occipitocervical region, and biomechanically sound fixation. Extending the instrumentation into the subaxial spine will lead to a decrease in the range of motion, increased surgical time, blood loss, more extensive muscle damage, and increase costs.

201

En Bloc Excision for Residual Giant Cell Tumor with Chest Wall Reconstruction: Case Report of a Novel Technique

Vijay Kumar Loya, Charanjit Singh Dhillon

Malla Reddy Medical College, Hyderabad, India

Objectives: **A** **g**iant cell tumor is a locally aggressive primary bone tumor that commonly afflicts the epiphyseal region but can affect the axial skeleton in 10% of cases. Recurrence up to 70% and malignant transformation up to 2%–3% have been reported in the literature. Giant cell tumor of the thoracic spine usually entails *en bloc* resection and chest wall reconstruction may be needed if the tumor is large.

Methods: We report a 28-year-old gentleman who presented with pain in his back within a month after initially being operated on for a locally aggressive lytic lesion of thoracic vertebra T8–T9. Imaging workup has shown a localized eccentric lesion involving posterior elements and body of T8–T9 vertebra with a large paraspinal component encasing exiting nerve root at the corresponding levels. Preoperatively selective arterial embolization of feeder vessels was done using polyvinyl alcohol particles. The patient underwent long-segment posterior stabilization with costo-transversectomy at 8 levels on either side with *en bloc* resection of the tumor and chest wall reconstruction with titanium mesh. Anterior column reconstruction with cage and cement. The wound was closed by a plastic surgeon with a pedicled latissimus dorsi transposition flap.

Results: Histological examination was suggestive of a giant cell tumor with negative margins. Postoperatively patient is on denosumab and is symptom-free and with no imaging evidence of recurrence on follow-up for 9 months.

Conclusions: The novelty of the present case is chest wall reconstruction with titanium mesh. Ours is probably the first case of residual **g**iant cell tumor where chest wall reconstruction was done. This case also highlights the importance of multi-disciplinary surgical management for spinal tumors.

205

Multilevel Decompression Surgery for Degenerative Lumbar Spinal Canal Stenosis Is Similarly Effective with Single-Level Decompression Surgery

Tatsuya Yamamoto, Mitsuru Yagi, Jun Ogawa, Morio Matsumoto, Masaya Nakamura, Kota Watanabe

Department of Orthopaedic Surgery, Japanese Red-cross Shizuoka Hospital, Shizuoka, Japan

Objectives: The clinical outcomes of multilevel decompression surgery for degenerative lumbar spinal stenosis (LSS) are still controversial because previous studies have not been designed to randomize or adjust the patient background. The purpose of this study was to investigate the outcome of multilevel posterior decompression surgery for LSS compared with single-level surgery.

Methods: A retrospective review of prospectively collected data from 659 surgically treated patients with LSS who had a 2-year follow-up visit was performed. Among them, we compared baseline and 2-year postoperative patient-reported outcomes (PROs) including Visual Analog Scale (VAS) and Japanese Orthopaedic Association Back Pain Evaluation Questionnaire (JOABPEQ) scores of 122 patients who underwent three or more levels of surgery (M group) and 304 patients who underwent a single level surgery (S group). Further analyses were performed on 116 paired patients from both groups who were propensity score matched by age and baseline PROs.

Results: The number of perioperative complications in-

cluding extradural hematoma, surgical site infection, and spinal fluid leakage (M group 10 [8%] vs. S group 19 [6%], p=0.47), and frequency of revision surgery (5 [4%] vs. 23 [8%], p=0.10) were similar between the two groups. In the analysis of 116 pairs of propensity score matched patients, there were comparable improvements in the VAS score for lower back pain (2.6 vs. 2.4, p=0.55), buttock-leg pain (3.1 vs. 3.4, p=0.48), and buttock-leg numbness (2.9 vs. 2.9, p=0.77) in both groups. There were also similar improvements in the JOABPEQ scores including lower back pain, lumbar function, walking ability, and mental health domains, except for the social life function domain (20.7±26.5 vs. 28.0±27.5, p=0.04).

Conclusions: Despite the longer surgical time and larger volume of estimated blood loss, multilevel decompression surgery showed similar improvement to that of single-level surgery in terms of recovery of PROs and frequency of revision surgery. Multilevel decompression surgery provides good clinical outcomes with acceptable complication and revision rates when selecting appropriate patient and spinal levels.

238

Does Increasing Age Deter Outcomes of Spinal Interbody Fusion in the Elderly? Comparative Clinico-Radiological Results of Young versus Elderly at 2-Year Follow-up

Mani Kant Anand, Vishal Kundnani

Bombay Hospital, Mumbai, India

Objectives: Will my surgery be successful? Am I prone to higher complications and morbidity? Does my age (74 years) pose a problem with healing, recovery, and overall outcome? We aimed to study the effect of age on outcome in spine surgery and compare the outcome with the control group.

Methods: Transforaminal lumbar interbody fusion (TLIF) was done in all cases by a single surgeon. We performed a retrospective analysis of data collected prospectively (2009–2015). This case-control cohort study was performed on consecutive patients with degenerative lumbar spine pathology (n=142; L4–5/L5–S1 levels).

Results: A total of 142 patients were divided into the elderly group (>65 years) and the young group (<65 years). The results of this study are as follows: mean±standard deviation age, 71.033±5.313 years in the elderly group and 40.54±9.558 years in the young group; gender, 35 males and 26 females in the elderly group and 44 males and 37 females in the young group; body mass index, 23.64±2.498 kg/m^2 in the elderly group and 23.24±2.113 kg/m^2 in the young group; follow-up duration, 43.312±11.39 months in the elderly group and 44.22±11.5 months in the young group; surgical time, 154.84±42.21 minutes in the elderly group and 135.68 ± 34.39 minutes in the young group; blood loss, 311.47±108.16 mL in the elderly group and 201.23±58.08 mL in the young group; and length of stay, 5.92±1.86 days in the elderly group and 3.54±0.59 days.

Conclusions: Increasing age does not hamper the overall outcome of fusion surgery (TLIF) in the elderly, with no added risk of untoward complications. Judicious patient selection and conservative surgery. Medical comorbidities need long-term preoperative optimization. Conservative surgery in elderly age with surgery aimed at symptom relief and successful results. Elderly patients are no different and can be treated as normal. Conservative surgery is the key. Complications are known in spine surgery. Increasing age has no role to play.

116

Isolated Ossified Ligamentum Flavum: A Rare Cause of Spinal Stenosis

Vishnu Senthil Kumar

Government Royapettah Hospital, Chennai, India

Ligamentum flavum hypertrophy and ossification is a diagnosis of exclusion. We report such a case of isolated flavum hypertrophy causing dorsal spinal canal stenosis. A 40-year-old male presented with pain in the upper back for a 6-month duration with radiation to the right lower limb. He presented with claudication and an abnormal gait. Activities of daily living were restricted. Right side power L2, L3, L4, L5, and S1 were 3/5. The sensation was reduced in L3 and L4 regions with preserved deep tendon reflex and tone. Radiological investigation in computed tomography showed ossification causing bony canal stenosis. Differential diagnosis was tumor, cyst, interverte-

bral disc prolapses, and ligamentum flavum hypertrophy. The final diagnosis was isolated ossified ligamentum flavum causing spinal stenosis at D10–D11 with incomplete neurological deficit. A literature review showed immediate surgical intervention and rehabilitation and improvement of functional outcomes. One study found that thoracic ossification of ligamentum flavum forms a rare cause of thoracic myelopathy and early decompression improved clinical outcomes. We proceeded with a posterior approach and posterior decompression, and laminectomy was done at D10–D11. Ligamentum flavum was excised and sent for biopsy. Biopsy showed a fibro-cartilaginous area admixed with a focal area of calcification. Postoperative computed tomography and magnetic resonance imaging showed good decompression. Recovery was seen at 5 days. At 1-year follow-up, power regained to 4/5 in L3, 4, 5, and S1 with a good functional outcome. Thoracic ossification of ligamentum flavum causes a diagnostic dilemma in thoracic spine pathology. Early diagnosis and sufficient surgical decompression improve functional outcomes in thoracic ossification of ligamentum flavum.

117

Traumatic Lumbosacral Spondylolisthesis: A Rare Case with Reduction Technique

Vishnu Senthil Kumar

Government Royapettah Hospital, Chennai, India

Traumatic Spondylolisthesis is a rare injury. This injury results from a complex high-energy mechanism including hyperextension, hyperflexion, and compression stress or tangential force. We report a case of traumatic lumbar spondylolisthesis, treated using the posterior approach with stable three column fixation and solid inter-body fusion. A 38-year-old male, presented with the American Spinal Injury Association (ASIA)-grade A (paraplegia) following a traumatic injury by fall from 8 feet height (from the tree). Bladder sensation, perianal sensation, and tone were lost. X-ray showed grade-2 spondylolisthesis of L5 over S1. Magnetic resonance imaging demonstrated traumatic spondylolisthesis with cauda equine syndrome. The patient was posted on an emergency basis. Under general anesthesia, a posterior approach with exposure of L4, L5, and S1 pedicles was done. The bilateral pars interarticularis, inter-spinal ligaments, and flaval ligaments of L5–S1 were completely destroyed. L5 annulus disrupted. Pedicle screws were inserted in L4, L5, and S1 pedicles. L5 over S1 was reduced under C-arm with help of McDonald spine dissector. Posterior decompression was done, and the left L5 nerve root was damaged with dural thecal sac damage. L5–S1 disc was removed with inter-body fusion. Bone grafting from the posterior iliac crest was harvested and added. The procedure lasted 2.5 hours with an intraoperative loss of 500 mL and no intraoperative complications. At a 2-year follow-up, lower limb function regained. Bilateral quadriceps was 5/5, left L4 4/5, and L5 3/5. Right L4 and L5 were 5/5. Perianal sensation and tone regained but bladder function is yet to regain. Surgical management was the treatment of choice in our case with ASIA–grade A (paraplegia). The literature search revealed cases managed with various approaches. In our case, the posterior approach was selected to reduce listhesis with stabilization and fusion. The posterior approach is safe and easy, and the rod-pedicle system resulted in perfect reduction and 3 column fixations. Our case is rare, and early diagnosis and treatment with posterior stabilization have provided satisfactory functional outcomes.

118

Prevalence of Vitamin D Deficiency in Patients with Chronic Low Back Ache: A Retrospective Cohort Study in South Indian Population

Vishnu Senthil Kumar

Government Royapettah Hospital, Chennai, India

Objectives: Vitamin D is the most studied hormone of the 21st century. It is commonly associated with various pain syndromes and chronic inflammatory conditions. In our study, we wanted to find out the prevalence of vitamin D insufficiency and deficiency in patients presenting to the outpatient department with chronic low back aches. This study was exclusively conducted in South India which has a tropical climate with adequate sunlight exposure and not much seasonal variation.

Methods: **A r**etrospective cohort study in patients present-

ing with chronic low back ache and fulfilling the inclusion and exclusion criteria. Vitamin D level and other blood parameters were assayed in a standard manner as per institutional protocol. The data was analyzed in various age groups with various levels of vitamin D.

Results: Prevalence of vitamin D insufficiency and deficiency was found more in the younger age group of 31–50 years which forms the working class of the society contributing to the economic growth. Pearson coefficient between various blood parameters showed a strong correlationship between C-reactive protein and vitamin D deficiency.

Conclusions: Vitamin D deficiency should be considered as an etiological factor in idiopathic chronic low back pain and supplementation is needed in preventive and curative doses.

227

Missed Multifocal Non-contiguous Spinal Tuberculosis (Steroid Misuse in COVID-19 Pandemic): Rare Case with Literature Review

Vishnu Senthil Kumar

Government Royapettah Hospital, Chennai, India

Spinal tuberculosis (TB) contributes to 5% of extrapulmonary TB. The thoraco-lumbar region is the most commonly affected with the cervical spine least affected. Skipped lesions contribute to 7% of spinal TB cases. We report such a rare case and its management. A 39-year-old male presented with neck and back pain with radiation to the bilateral upper and lower limb. Loss of weight and appetite for 6-month duration. Steroid must be taken for 6 months because of coronavirus disease 2019 (COVID-19). On examination, power was 3/5 in all four limbs, deep tendon reflex reduced, decreased sensation in the bilateral upper and lower limb, and ankle clonus was presented with normal bladder and bowel sensation. Radiological evaluation showed C6–C7, D7, and L4 spondylodiscitis, vertebra collapse, and cord compression. Computed tomography chest showed a consolidated mass in the right apical lobe. Other screening was normal. We proceeded with an open biopsy and anterior cervical corpectomy with fusion (mesh cage and plating). Biopsy suggested a granulomatous lesion probably TB. The patient was started on anti-tubercular treatment with symptomatic improvement in the upper limb compared to the lower limb. At 1-month follow-up, the D7 lesion regressed and the L4 lesion persisted with significant cord compression. Open biopsy with decompression and posterior stabilization with pedicle screws in L2, L3, and L5 levels. Histopathological evaluation proved caseating granulomatous lesion. At 1-year follow-up, neurology completely recovered with resumed activities of daily living. Skipped multifocal extensive spinal TB is very rare with six cases reported so far. The rarity of this disease makes the diagnosis difficult and management challenging. Careful physical examination, sequential radiographs, and whole spine magnetic resonance imaging plays an important role in early diagnosis and treatment to prevent neurological deterioration. Decompression should be done from top to bottom with immune suppression and the human immunodeficiency virus playing an important role in extensive non-contiguous spinal TB. This case is reported because of its rarity and dilemma in clinical presentation. It can be mistaken for metastasis because of the skip lesions. Th advent of COVID-19 and misuse of steroids can exacerbate mild infections.

197

Perioperative Complications in Obese Patients with Ossification of the Thoracic Spinal Ligaments

Kanji Mori, Takafumi Yayama, Shinji Imai

Shiga University of Medical Science, Otsu, Japan

Objectives: To investigate perioperative complications of obese patients with body mass index (BMI) exceeding 30 kg/m^2 among patients with ossification of the thoracic spinal ligaments.

Methods: Among the consecutive 13 cases (eight males and five females) in which surgical treatment was performed for ossification of the thoracic spinal ligaments at our institute, obese cases with a BMI of 30 kg/m^2 or more were employed. One male patient had undergone five surgeries during the study period, but the study was investigated as five independent surgical cases. We investigated

the presence or absence of complications, neurological deteriorations, and other perioperative complications including wound infection and skin disorders.

Results: The mean age and mean BMI of the patients were 55.6 years and 35.3 kg/m^2, respectively. Comorbidities were observed in all patients, with diabetes mellitus in three cases, hypertension in 11 cases, and hyperlipidemia in seven cases. Perioperative complications were found in three cases, including skin disorders (pressure ulcer) in two cases, superficial surgical site infection in one case, and neurological deterioration in one case. All were completely cured by conservative therapy. It has been reported that obese cases have more perioperative complications than non-obese cases. Although it was intended that pressure ulcers such as the chest, ilium, and knees, which were compressed in the prone position, had been adequately treated, skin disorders in the chest were observed in two cases.

Conclusions: In surgical treatment for obese patients with ossification of the thoracic spinal ligaments, not only neurological complications but also attention to skin disorders is important.

228

Vacuum-Assisted Closure: A Panacea in Recalcitrant Postoperative Spinal Infections

Ashish Naik, Sri Vijay Anand, S. Rajasekaran, Ajoy Prasad Shetty

Ganga Hospital, Coimbatore, India

Objectives: The standard treatment of postoperative deep surgical site infection is debridement and intravenous antibiotics. However, infections may persist despite the best debridement efforts. Our study aimed to review the efficacy of the wound vacuum-assisted closure (VAC) system in treating deep surgical site infection after instrumented spine surgery.

Methods: We retrospectively reviewed 29 patients who underwent vacuum-assisted closure for postoperative spinal infections following spinal instrumentation between 2016–2020. The patient's demographic details and biochemical parameters were noted from the hospital information system and imaging was analyzed by Picture Archiving and Communication System.

Results: The study population included 15 females and 14 males. Twenty patients had lumbar spine instrumentation, and nine patients had thoracic surgery. All patients had VAC application following debridement of the wound. Twelve had positive bacterial cultures, and the rest were culture negative. A mean of 2.5 cycles of VAC application, each lasting 5–9 days, was applied before wound closure. One patient died due to an unrelated cause, and one patient had an increased bleeding episode following VAC. All the patients had good healing of wounds with a minimum follow-up of 12 months. All patients except one had retained the implants.

Conclusions: The VAC system is a valuable tool in managing postoperative spinal infections. It allows for the retention of the instrumentation and the maintenance of spinal correction. In addition, it is reliable and easy to use.

178

Prevalence and Characteristics of Diffuse Idiopathic Skeletal Hyperostosis in Indian Population: A Whole Spine Computed Tomography-Based Study

Owais Ahmed, Ajoy Prasad Shetty, S. Rajasekaran, Pushpa B. T.

Ganga Hospital, Coimbatore, India

Objectives: Diffuse idiopathic skeletal hyperostosis (DISH) is characterized by anterior longitudinal ligament ossification. Diagnosis is mainly by plain radiographs based on the diagnostic criteria given by Resnick and Niwayama. Recently, computed tomography (CT) scan has been more reliable for diagnosis. Prevalence and characteristics of DISH have not been documented among the Indian population. We aimed to identify the prevalence and characteristics of DISH in the Indian population and its association with ossified posterior longitudinal ligament (OPLL), ossified ligamentum flavum (OLF), aortic calcification, co-morbidities like obesity (body mass index [BMI]), diabetes mellitus (DM), hypertension (HTN), and ischemic heart disease (IHD).

Methods: A total of 1,815 whole-spine CT scans of polytrauma patients over 20 years of age, between 2015–2021

were reviewed for the study. Diagnosis of DISH was made based on modified Resnick criteria. Overall and age-specific prevalence of DISH, its characteristics, and the presence of OPLL, OLF, and aortic calcification were evaluated. Demographic data, including age, sex, BMI, DM, HTN, and IHD were analyzed.

Results: The overall prevalence of DISH was 19.1% (347 of 1,815 cases). Prevalence of DISH among individuals above 80 years was 45.5% and in individuals of 7th, 6th, 5th, 4th, and 3rd decades were 45.2%, 39.4%, 29.6%, 13.1%, and 1.1%, respectively. The average number of vertebrae involved was 9.4 and the most common inter-vertebral level involved was T8–T9 (95.1%, 330 of 347) followed by T9–T10 (89.9%). On evaluating axial images of the spine at T9 we found that the right anterior aspect of the vertebral body was most commonly involved in DISH. Statistically, a significant difference was found for aortic calcification, BMI, DM, HTN, and IHD among DISH and non-DISH groups ($p<0.05$).

Conclusions: The prevalence of DISH in the Indian population is 19.1% with a progressive increase in prevalence rate with increasing age. DISH most commonly occurs at the T8–T9 level and over the right anterior aspect of the vertebral body. There is a strong association between DISH and conditions like obesity, DM, HTN, IHD, and aortic calcification.

33

Burden of Cervical Spinal Injury in India: The Untold Story

Bhavya Pahwa, Deepak agrawal

University College of Medical Sciences and Guru Teg Bahadur Hospital, New Delhi, India

Objectives: Cervical spinal injuries are the most severe of all spinal cord injuries. High cervical spine injuries may require lifelong ventilatory support leading to a huge burden to the healthcare system as well as the society. We aimed to assess the magnitude as well as the epidemiology of cervical spine injuries in a tertiary care center in India over 1 year.

Materials: A retrospective study was conducted at Jai Prakash Narayan Apex Trauma Center, All India Institute of Medical Sciences, New Delhi over the period from 1st January 2019 to 31 December 2019. All patients with C-spine injury getting admitted to the neurosurgery department were enrolled in this study. Patients' clinical, radiological, and surgical details were evaluated. Telephonic follow-up was done for all patients after a minimum period of 12 months from injury.

Results: A total of 166 patients were treated for a C-spine injury in the study period. Of these 141 were males and 25 were females with a mean age of (male, 34 years and female, 35 years). The mean interval for presentation in the emergency department (from injury) was 7.20 hours. And 77 patients had complete spinal cord injury (SCI) (American Spinal Injury Association [ASIA] grade A), 56 had an incomplete injury (ASIA B–D) while 33 were ASIA E. The cause of injury in 61.45% of cases (n=102) was a fall from height, 38% (n=63) were road traffic injuries and one case was due to assault. Sixty-one patients (36%) required intubation and ventilation. Follow-up was available in 37 patients (22%) at a mean of 24 months. 27% (n=15) of incomplete SCI patients and 11.5% (n=9) of complete SCI had improvement in ASIA grade at the last follow-up. The overall mortality was 29% (n=48). Of these 45 patients died in hospital and three died after discharge.

Conclusions: This is one of the largest series from a single center over 1 year and shows the enormity of the problem and the high mortality associated with such injuries.

9

Minimum 3-Year Experience with Vertebral Body Tethering for Treating Scoliosis: A Systematic Review and Single-Arm Meta-Analysis

Xin Qiu, Feng Zhu, Shunan Liu, Kenneth Man-Chee Cheung

Department of Spinal Surgery, The University of Hong Kong-Shenzhen Hospital, Shenzhen, China

Objectives: To systematically review the efficacy and safety of vertebral body tethering (VBT) for treating scoliosis.

Methods: PubMed, Web of Science, Embase, and the Cochrane Library were searched for studies on VBT treatment of scoliosis published up to November 2021.

Two researchers independently screened the literature, extracted data, and assessed the risk of bias in included studies. Data on clinical efficacy, unplanned reoperations, and complications were extracted. The meta-analysis was performed with R ver. 4.1.0 (The R Foundation for Statistical Computing, Vienna, Austria).

Results: Twenty-six studies involving 1,045 patients with scoliosis were included in the meta-analysis. The application of VBT has gradually expanded from simple lumbar curve to lumbar curve, double major curve, and double-sided VBT of double adolescent idiopathic scoliosis curves. VBT has also been extended to skeletally mature idiopathic scoliosis patients and syndromic scoliosis patients. The correction rate of the major curve immediately post-operation was 46.6%±13.8% (16%–69%) and that at final follow-up was 53.2%±17.9% (16%–79%). The single-arm meta-analysis results of all included studies showed that VBT was effective in general. The overall clinical success rate was 73.02% (95% confidence interval [CI], 68.31%–78.05%). The pooled overall unplanned reoperation rate was 8.66% (95% CI, 5.53%–13.31%). The incidence rates of different UPROR types were calculated. The top three were conversion to posterior spinal fusion (PSF) (3.51%; 95% CI, 2.45%–5.01%), tether removal (2.3%; 95% CI, 1.47%–3.58%), and tether replacement (1.09%; 95% CI, 0.57%–2.08%). The overall incidence rate of complications was 36.8% (95% CI, 23.9%–49.7%). The incidence rates of the different complication types were calculated. The top three were curve progression with tether breakage (16.79%; 95% CI, 7.43%–26.15%), pulmonary complications (6%; 95% CI, 4.66%–7.68%), and overcorrection (4.55%; 95% CI, 3.4%–6.06%). The subgroup analysis based on follow-up time indicated that patients with follow-up time >36 months had increased clinical success rate, unplanned reoperation rate, and incidence rate of complications compared with those with <36 months' follow-up time. The preliminary results showed that after 36 months of follow-up, only 7.17% (95% CI, 4.81%–10.55%) of patients required PSF surgery, and nearly 93% of patients avoided spinal fusion surgeries.

Conclusions: The current evidence from at least a 3-year follow-up in different countries indicates that VBT is an effective surgical approach for treating scoliosis, with 73.88% of patients achieving clinical success. Nevertheless, about one in seven patients (15.8%) required unplanned reoperations, but only 7.17% required PSF. About half (52.17%) of the patients experienced complications. Due to the limitation of the study number and quality, our conclusion may be biased and requires verification by further studies with longer follow-up times.

171

Vacuum Phenomenon Upregulate Pain-Related Molecules in Human Degenerated Intervertebral Discs

Masayuki Miyagi, Kentaro Uchida, Sho Inoue, Akiyoshi Kuroda, Gen Inoue, Masashi Takaso

Department of Orthopedic Surgery, Kitasato University School of Medicine, Sagamihara, Japan

Objectives: The vacuum phenomenon (VP) in degenerated intervertebral discs (IVDs) was reported to be associated with lumbar spinal instability, potentially leading to low back pain (LBP). We hypothesized that VP leads to the up-regulation of pain-related molecules and contributes to discogenic LBP's patho-mechanism. This study aimed to elucidate the relationships among VP, clinical findings, and pain-related-molecule expression in human degenerated IVDs.

Methods: We harvested degenerated-IVD samples from 35 patients (23 men and 12 women) including 19 with lumbar spinal stenosis, 10 with adult spinal deformity, and six with IVD herniation during spinal interbody fusion surgery. Harvested IVD-derived mononuclear cells were obtained and pain-related molecules, including tumor necrosis factor alpha (TNF-α), interleukin (IL)-6, calcitonin gene-related peptide (CGRP), microsomal prostaglandin E synthase-1 (mPGES1), and nerve growth factor (NGF), were determined, using real-time polymerase chain reaction. We also recorded preoperative clinical findings, including the Oswestry Disability Index (ODI) and Visual Analog Scale (VAS) of LBP, and the presence of VP in computed tomography scan images. Further, we compared pain-related molecule expression and clinical findings between the VP (–) and (+) groups and evaluated the correlations among clinical findings and each pain-related molecule expression.

Results: In the VP (+) group, mPGES-1 levels were significantly higher than in the VP (–) group. Additionally, mPGES-1 expression was significantly correlated with CGRP

and NGF expression (r=0.56, r=0.39; p<0.05). In addition, NGF expression was significantly correlated with TNF-α and IL-6 expression (r=0.88, r=0.42; p<0.05). However, clinical findings including ODI and VAS of LBP were not associated with the presence of VP and any pain-related molecule expression.

Conclusions: Because the patho-mechanism of LBP might be multifactorial, LBP scores have not been associated with the presence of VP as well as any pain-related molecule expression in the present study. On the other hand, the presence of VP might be associated with the up-regulation of mPGES1 in IVDs. mPGES1 potentially leads to the expression of CGRP and NGF, and NGF also leads to the expression of inflammatory cytokines in human degenerated IVDs, potentially leading to chronic discogenic LBP.

6

Analysis of Upper Cervical Spine Measurements in the Uninjured Pediatric Spine

Joe Baker

Waikato Hospital, Hamilton, New Zealand

Objectives: Only a small number of studies have offered normative data for the upper cervical spine in children and with some variation in findings. The aim of this study was to determine normal values for upper cervical spine measurements used in the assessment of upper cervical spine trauma in the pediatric population.

Methods: **A total of** 100 computed tomography scans of the cervical spine on children aged ≤16 years were included for analysis. All children were cleared of spinal injury. Anterior atlanto-dens interval (ADI), posterior atlanto-dens interval (PADI), basion-dens interval (BDI), Power's ratio, condylar-C1 interval (CCI), and lateral mass interval (LMI) were measured on the relevant sagittal or coronal images. Measurements for CCI and LMI were taken on each side.

Results: Mean age was 111 months (range, 11–196 months), and 62 were male. Mean values (and ranges) of the measurements were: BDI: 7.1 mm (range, 3.6–12.2 mm); ADI 2.8 mm (range, 0.8–4.8 mm); PADI 18.7 mm (range, 14.1–23.2 mm); Power's ratio 0.72 (range, 0.59–1.0); CCI 2.0 and 2.0 (range, 0.5–4.2), and; LMI 3.2 mm and 3.3 mm (range, 1.7–4.8 mm). BDI (r=-0.488), ADI (r=-0.201), PADI (r=0.264), and CCI (r= -0.468 and -0.454) all showed significant correlation with age. Power's ratio was the most stable measurement across all age groups.

Conclusions: Normal values were reported from a local pediatric population with a wide age range. Current radiographic measures used to assess for possible ligamentous injury in the pediatric upper cervical spine correlate with age although may vary throughout childhood. Caution must be held when analyzing the upper cervical spine across a range of age groups in children.

48

Planned Two-Stage Surgery Using 3-Column Osteotomy in Adult Spinal Deformity Surgery

Yu Yamato, Tomohiko Hasegawa, Go Yoshida, Yukihiro Matsuyama

Hamamatsu University School of Medicine, Hamamatsu, Japan

Objectives: Vertebral osteotomies (3-CO) for adult spinal deformities are invasive and have been reported to cause high complications. To reduce the invasiveness of surgery, a planned two-stage surgery (the first surgery: posterior deployment, screw placement, and intervertebral fixation except for the osteotomy site; the second surgery: corrective fusion with osteotomy from the same skin incision) is used. Complications and surgical outcomes of planned two-stage surgery were compared with those of the conventional one-stage method.

Methods: A single-center, retrospective study of the patient background, surgical invasiveness, and perioperative complications up to 3 months after surgery were retrospectively investigated in patients who underwent corrective fusion from thoracic spine to pelvis using 3-CO for adult spinal deformity from 2012 to 2020. The "two-stage group" underwent planned two-stage surgery, and the "one-stage group" underwent conventional one-stage surgery. Perioperative complications were defined as intraoperative and medically necessary complications, and postoperative mechanical complications were excluded. The Oswestry Disability Index (ODI) at 1 year preopera-

tively and 1 year postoperatively was also investigated.
Results: There were no significant differences in background between the two groups: 20 patients (mean age, 66.5 years) in the two-stage group and 68 patients (mean age, 69.2 years) in the one-stage group. The total operating time was 566 minutes in the two-stage group (252 minutes in the first stage and 314 minutes in the second stage) and 435 minutes in the one-stage group, which was significantly longer in the second stage group. The mean intraoperative blood loss was 678 mL in the 2nd stage group (678 mL in the 1st stage and 1,056 mL in the 2nd stage, total 1,734 mL) and 2,017 mL in the one-stage group, with no significant difference between the two groups. The complication rate was 40% in both groups, but serious complications such as postoperative hematoma, disseminated intravascular coagulation, and permanent neurological complications were not seen in the two-stage group. ODI was 41% in the two-stage group and 47% in the one-stage group before surgery but improved to 18% and 32% at 1 year after surgery, significantly better in the two-stage group.
Conclusions: Although the total operation time was longer in the two-stage surgery, intraoperative blood loss was less, and the incidence of serious complications was lower in the two-stage surgery.

61

Advantages of L5 Lamina Hook in Surgical Correction for Adult Spinal Deformity and Its Indications

Sung-Min Kim, Yong-Chan Kim, Ki-Tack Kim, Kee-Yong Ha, Qiang Luo, Xiongjie Li

Department of Orthopedic Surgery, Kyung Hee University Hospital at Gangdong, Seoul, Korea

Objectives: We aimed to determine the advantages and indications of L5 lamina hook using on long segmental instrumentation and fusion forsurgical correction against adult spinal deformity (ASD) patients.
Methods: 56 ASD patients who underwent long segmental instrument and fusion from the thoracic spine to L5 at a single institution were retrospectively analyzed according to radiographic spinopelvic sagittal parameters and L5-S1 disc degeneration using radiographic classification system modified from that described by Weiner et al. 32 patients (group I) used L5 lamina hook for surgery and 24 patients (group II) didn't. The receiver operating characteristic (ROC) curves were plotted to evaluate the cut-off value of C7 sagittal vertical axis (C7SVA) and pelvic incidence - lumbar lordosis mismatch (PI-LL). Additional statistical analysis was performed only in group I to verify the indications for use of L5 lamina hook.
Results: The preoperative C7SVA (174.6 mm vs. 52.9 mm, p=0.011), lumbar lordosis (LL;-11.6° vs. -22.8°, p=0.029) and pelvic incidence - lumbar lordosis mismatch (PI-LL; 44.4° vs. 29.1°, p=0.041) of group I was significantly greater than group II. The group I showed significantly higher changes in C7SVA (136.21 mm vs 29.31 mm, p=0.018), LL (40.5° vs. 25.4°, p=0.031), and PI-LL (40.5° vs 24.8°, p<0.034) compared to the group II at immediate postoperative. By latest follow-up, subsequent advanced L5-S1 disc degeneration developed in 7 of 32 patients (21.9 %) in group I and 18 of 24 patients (75%) in group II. The cut-off value was 15.8cm (95% CI, p=0.001) and 40.8° (95% CI, p=0.012) in C7SVA and PI-LL respectively. The patients with exacerbated L5-S1 degeneration in group I showed significantly higher body mass index (BMI), preoperative C7SVA, and preoperative PI-LL than others.
Conclusions: L5 lamina hook may provide the greater correction in C7SVA and lumbar lordosis and reduce L5-S1 degeneration. We suggest the following indications for use of L5 lamina hook; low BMI, healthy L5-S1 disc, PI-LL mismatch of less than 40.8°, and C7SVA ofless than 15.8cm.

62

Surgical Strategy-Oriented Classification for the Patients with Severe Dynamic Sagittal Imbalance

Sung-Min Kim, Yong-Chan Kim, Ki-Tack Kim, Kee-Yong Ha, Qiang Luo, Xiongjie Li

Department of Orthopedic Surgery, Kyung Hee University Hospital at Gangdong, Seoul, Korea

Objectives: To analyze the characteristics of the patients with severe dynamic sagittal imbalance (DSI), develop a

comprehensive classification, and raise optimal surgical strategy for each condition.

Methods: Prospectively, 193 patients with a mean age of 65.2 years (range, 62–84 years) from 2017 to 2019 were tracked after surgical treatment for severe dynamic sagittal imbalance that was defined as C7 sagittal vertical axis (C7SVA) becomes greater than 20 cm within 30 seconds after walking or standing in addition to rigid lumbar curve less than 10° in dynamic lateral radiographs and more than 75.3° of pelvic incidence (PI)–lumbar lordosis (LL) in previous our study. The characteristic is mainly based on radiographic findings. It is classified according to three criteria: the location of the apex, depending on combined compression fracture, and stiffness of apex segment. The receiver operating characteristic curves were plotted to evaluate the cut-off value of compression rate (CR) of vertebral body. The patients were categorized into one of three groups according to the surgical strategy (anterior column realignment [ACR], posterior spinal fixation [PSF], and pedicle subtraction osteotomy [PSO]) implemented: ACR+PSF, ACR+PSO+PSF, and PSO+PSF. Time-dependent radiographic analysis with spinopelvic sagittal parameters from each group was assessed and compared with each other using analysis of variance.

Results: The patients with severe dynamic sagittal imbalance can be mainly divided into two types according to the location of the apex: type I (thoracolumbar; T12, L1, or L2), type II (lumbar; L3, L4, or L5), and the following modifiers were identified as potentially influencing the choice of surgical strategy: A: CR ≤60% in thoracolumbar or ≤30% in lumbar and B: >60% in thoracolumbar or >30% in lumbar based on the cut-off value of CR of vertebral body (95% confidence interval, $p<0.001$) and rigid or fused of apex segment (- or +). Either type I or type II is further divided into four subtypes: type IA-, type IA+, type IB-, type IB+, type IIA-, type IIA+, type IIB-, and type IIB+. A surgical strategy was proposed to deal with each situation combining the different patterns and their modifiers by an expert's opinion consensus. At final follow-up, C7SVA (p=0.121), LL ($p=0.665$), pelvic tilt ($p=0.096$), and PI–LL mismatch ($p=0.701$) were similar among three groups according to surgical strategy.

Conclusions: This surgical strategy-oriented classification can be used effectively to decide preoperative surgical planning for the patients with severe dynamic sagittal imbalance. Further research may be needed to validate the classification.

106

The Correlation between the Sagittal Alignment and the Functional Outcomes in Three-Level Anterior Cervical Discectomy and Fusion

Yan-Jyun Chen, Kuang-Ting Yeh, Tzai-Chiu Yu, Ing-Ho Chen, Wen-Tien Wu

Hualien Tzu-Chi Hospital, Hualien, Taiwan

Objectives: Restoration of sagittal alignment with neurogenic decompression in cervical spine surgery has been recognized as an important surgical goal. However, its influence on clinical outcomes following anterior decompressive procedures remains debatable. This study aimed to determine the change in the cervical sagittal balance following three-level anterior cervical discectomy and fusion (ACDF) and whether the degree of change was associated with improvement in Neck Disability Index (NDI) score and the pain related score.

Methods: Patients who underwent primary three-level ACDF for cervical spondylotic myelopathy with kyphosis. Radiographic measurements included cervical lordosis (CL), cervical sagittal vertical axis (CSVA), and C7 slope (C7S), and functional outcomes included the NDI scores, Japanese Orthopedic Association (JOA) score, Nurick grade, and Visual Analog Scale (VAS) for neck pain and arm pain were collected preoperatively and postoperatively.

Results: In total, 38 patients were included. Significant improvement in the NDI score, JOA score, Nurick grade, and VAS was achieved and remained well at postoperative 3 and 12 months, respectively. CL and C7S gradually increased from postoperative 3 months to 12 months. CSVA did not change significantly. The change of NDI score has a significantly negative correlation with the change of CL at postoperative 3 months, but there was no correlation at postoperative 12 months. The change in all four functional and pain scores seemed to be not related to the change in CSVA and C7S.

Conclusions: Three-level ACDF restored segmental and global CL, but changes in cervical sagittal alignment did not correlate with the magnitude of improvement in the functional and pain score. Adequate decompression with solid fusion remains fundamental to achieving good clinical outcomes in patients with degenerative cervical disease.

217

Uniportal Thoracic Endoscopic Decompression Using One Block Resection Technique for Thoracic Ossified Ligamentum Flavum Technical Report

Pang Wu, Brian Chin, Hyeun Sung Kim

Ng Teng Fong General Hospital, Singapore

Objectives: There is a paucity of literature on the application of endoscopic spine surgery in the thoracic spine for ossified ligamentum flavum. We aim to evaluate the clinical and radiological outcomes uniportal thoracic endoscopic laminotomy with bilateral decompression using one block resection technique (TE-ULBD) for thoracic ossified ligamentum flavum in our cohort of patients.

Methods: A Retrospective evaluation was performed for all patients who underwent TE-ULBD for thoracic ossified ligamentum flavum. Pre- and postoperative parameters of axial cut spinal canal area in upper, middle, and lower disc, Visual Analog Scale (VAS), Oswestry Disability Index (ODI), and Japanese Orthopaedic Association (JOA) at preoperative, postoperative 1 week, 6 months, and final follow-up were compared.

Results: A total of 35 levels of TE-ULBD were performed in 28 patients. The complication rate of TE-ULBD was 2.8%. In our TE-ULBD cohort, there was significant clinical improvement in VAS, ODI, and JOA scores in postoperative 1 week, 6 months, and final scores. The mean difference as compared to preoperative VAS in postoperative final follow-up (4.80, $p<0.05$). The mean difference as compared final follow-up (40.8, $p<0.05$). The mean as compared to preoperative JOA in final follow-up (2.57, $p<0.05$). MacNab score showed 11 good and 17 excellent scores in 28 patients. There was a significant statistical increase in decompression cross section spinal canal area dimension in postoperative compared to preoperative magnetic resonance imaging scan with a mean increase of (1) upper disc 30.81 mm^2, (2) middle disc 34.68 mm^2, and (3) lower disc 26.18 mm^2 ($p<0.05$).

Conclusions: TE-ULBD was able to achieve adequate spinal canal decompression with significantly improved pain, functional status, and neurological recovery in our cohort of patients

219

Changes of Surgical and Radiographic Parameters and Self-Administered Questionnaire after Correction and Fusion Surgery for Adult Patients with Residual Adolescent Idiopathic Scoliosis Lenke 1

Yasuhiro Kamata, Morio Matsumoto, Masaya Nakamura, Kota Watanabe

Department of Orthopedic Surgery, Keio University School of Medicine, Tokyo, Japan

Objectives: Lenke type 1 is the most common type of adolescent idiopathic scoliosis (AIS). There are many reports on the surgical outcome for AIS Lenke 1. On the other hand, the surgical outcome for adult patients with residual AIS (AdIS) Lenke 1 is not clear as its reports are still limited. The aim of this study was to evaluate surgical and radiographic parameters and the results of a self-administered questionnaire in AdIS patients and to clarify the characteristics of this pathology by comparing the results with those of AIS patients.

Methods: The subjects were 35 AdIS patients (two males and 33 females) with a major curve in the thoracic spine operated on after the age of 20 years (AdIS group). The mean age at surgery was 24.7±5.6 years. As a control group, 84 patients (mean age, 15.6±1.8 years; 5 males and 79 females) who were operated on at the age of under 19 years were included in the AIS group. The clinical outcomes of these patients were evaluated using surgical and radiographic parameters and a self-administered questionnaire (the Scoliosis Research Society-22 [SRS-22] and the 8-item Short Form [SF-8]) before and after surgery, and compared between the groups.

Results: Preoperative Cobb angle of the main thoracic curve (55.4° vs. 51.2°, $p=0.03$), fusion level (8.14 vs. 7.12 $p=0.04$), operative time (116 minutes vs. 141 minutes, $p=0.01$), and postoperative hospital days (11.2 days vs. 9.76 days, $p<0.01$) were significantly larger in the AdIS group. In the preoperative SRS-22, the AdIS group was significantly lower in mental health at 3.78 compared to 4.20 in the AIS group ($p=0.004$). In the preoperative SF-8, the AdIS group was significantly lower than the AIS group in two domains: 50 for the AdIS group and 54.5 for the AIS group in "overall health" and 49.7 for the AdIS group

and 52.7 for the AIS group in "mental health" (p=0.007, p=0.031). Postoperative SRS-22 and SF-8 were comparable between the two groups.

Conclusions: The preoperative thoracic main curve, fusion level, operative time, and postoperative hospital stay were significantly higher in the AdIS group. The AdIS group had significantly lower mental domains in both the preoperative SRS-22 and SF-8 compared to the AIS group, as assessed by a self-administered questionnaire. Postoperatively, both SRS-22 and SF-8 improved as much in the AdIS group as in the AIS group.

236

Radiological Improvement of Vertebral Body Height by a Typical Index Screw Instrumentation in Thoracolumbar Spine Trauma

Manu Sasidhar Reddy Gade, Raju Iyengar, Dinesh Ranjan

Nizam's Institute of Medical Sciences, Hyderabad, India

Objectives: To evaluate radiological outcome by assessing sagittal index and anterior body height compression, kyphotic deformity correction by measuring Cobb's angle on radiographs for a gain of vertebral height.

Methods: A total of 45 patients were evaluated retrospectively in our study at our institute who were diagnosed with thoracolumbar burst fractures treated by short segment instrumentation and index level vertebra screw fixation and were evaluated for the radiological outcomes. Anterior body compression (ABC%) was calculated by dividing the anterior body height of the fractured vertebral body by the mean anterior body height of the intact vertebral bodies above and below the fractured vertebra: ABC%=[b/([a+c]/2)×100].

A Review of 45 Cases: Thoracolumbar spine trauma is on the rise due to increasing vehicular accidents and falls from height. The opinion is divided on whether to do anterior surgery or posterior surgery and to do short segment versus long segment fixation. Recently, the literature supports short segment fixation with a short screw in the fractured vertebra obviates the need for long segment fixation and an anterior surgery to the spine. Short segment pedicle screw fixation by fixing one level above and one below the fracture site was the traditionally followed method. Placing a pedicle screw in the fractured vertebra is a recent advance. The intermediate index screw increases the strength of the construct, increases the vertebral height, takes the anterior load on the vertebra, acts as an anti-rotation screw and helps in achieving better deformity correction, better postoperative Cobb's angle, and offers improved biomechanical stability. Cantileverage with rods on either side with an index screw also helps in regaining the lost anterior vertebral height. Most of the time, one of the two pedicles of a fractured vertebra remains intact which can be used for pedicle screw fixation. However, the characteristics of this index screw are poorly defined in the literature. Literature defines the index screw to be short. We have found better results, typically when the index monoaxial screw is of adequate diameter, occupying the entire pedicle and covering almost the vertebral body, giving better purchase, restoring the better height of the vertebral body. Cantileverage with rods by placing an index screw leads to tensioning of both the anterior and posterior longitudinal ligaments, forcing them to act like splints leading to restoration of the fractured vertebra to its near normal shape and height.

Conclusions: Thoracolumbar fractures treated by short segment fixation along with typical Index vertebra screw had good deformity correction and achieved substantial vertebral height.

115

Clinical and Functional Outcomes of Surgically Treated Aggressive Vertebral Hemangiomas with Myelopathy and Neurological Deficit

Aju Bosco, Nalli Ramanathan Uvaraj

Orthopedic Spine Surgery Division, Institute of Orthopedics and Traumatology, Madras Medical College, Chennai, India

Objectives: Aggressive vertebral hemangioma (AVH) of the spine presenting with neurological deficits is rare (0.9%–1.2%). The management of AVH presenting with neurological deficits is challenging. Despite the availability of various treatment modalities, there is no consensus yet on an optimal treatment strategy. Because of the relative infrequency of these lesions and sparse reporting in the

literature, there are few studies with a long-term follow-up that directly compare different treatment modalities. We present our experience in treating AVHs in patients presenting with neurological deficits, with the aim of proposing an effective treatment strategy for the same.

Methods: We retrospectively analyzed the clinical, functional, and radiological outcomes of 14 patients with biopsy-proven AVHs with myelopathy and neurological deficit, between 2008 and 2016. After a detailed clinical and radiological evaluation, all patients were treated with preoperative embolization followed by posterior stabilization and decompression, with or without vertebroplasty. Outcomes were analyzed with respect to the Visual Analog Scale (VAS) score for back pain, Oswestry Disability Index (ODI), Nurick grading for myelopathy, American Spinal Injury Association (ASIA) scale for neurological improvement, and radiological assessment. Adequacy of decompression was assessed with a postoperative computed tomography (CT) scan. Magnetic resonance imaging was done annually to assess tumor progression and any evidence of recurrence.

Results: Fourteen patients (eight males and six females) with AVH of the dorsal spine presented with back pain and neurological deficit (ASIA D [n=6], ASIA C [n=5], ASIA B [n=3]). Nine patients presented with myelopathy (Nurick 2 [n=3], Nurick 3 [n=4], Nurick 4 [n=2]). The mean age at presentation was 36.4±7.4 years (range, 16 to 48 years). The mean operating time and intraoperative blood loss were 150±25 minutes (range, 155 to 200 minutes) and 360±70 mL (range, 350 to 600 mL). At a mean follow-up of 27.6±2.2 months, all patients showed significant improvement in VAS (preoperative: 7.8±0.9 [7 to 9] vs. postoperative: 2.1±0.6 [1 to 3]), ODI (preoperative: 71.1±5.7 [62 to 80] vs. postoperative: 18.0±3.1 [14 to 22]), ASIA grade, and Nurick grade (p<0.05). Nine patients showed complete neurological recovery at the final follow-up. There was no neurological deterioration in any patient. Complications observed were: excessive intraoperative bleeding requiring multiple blood transfusions (n=3); transient neurological worsening in the immediate postoperative period (n=1); superficial wound infection (n=2); and tumor progression (n=1). Tumor progression was managed with corpectomy reconstruction with a cage. In all, 12/14 patients (85.7%) returned to their jobs.

Conclusions: The presented strategy is effective in the management of AVH as evidenced by the good clinical and functional outcomes and an 85.7% return to work status at a mean follow-up of 27.6±2.2 months.

193

Feasibility, Safety, and Outcomes of Treatment of Neglected Post-Traumatic AO Type F4 Injuries of the Subaxial Cervical Spine Using the Anterior-Posterior-Anterior Approach

Aju Bosco, Nalli Ramanathan Uvaraj

Orthopedic Spine Surgery Division, Institute of Orthopedics and Traumatology, Madras Medical College, Chennai, India

Objectives: The management of neglected post-traumatic facet dislocations (AO type F4 injury) of the sub-axial cervical spine presenting beyond 3 weeks since injury is challenging, due to the difficulty in achieving the reduction of the subluxated or dislocated facets. Though different surgical strategies have been described in the literature for the management of post-traumatic cervical facet dislocations of the subaxial cervical spine presenting at or beyond 3 weeks since injury none are effective in all scenarios. These techniques have varying rates of success in achieving the reduction of facet dislocation. We describe an effective surgical treatment algorithm for the management of neglected post-traumatic sub-axial cervical facet dislocations and have analyzed its efficacy, safety, and outcomes.

Methods: This is a retrospective review of 24 patients (11 males, 13 females) with a mean age of 42.6±14.5 years (range, 36–53 years), with neglected facet dislocations of the sub-axial cervical spine. Following a trial of closed reduction, open reduction was carried out as a three-stage procedure (anterior-posterior-anterior approach) under a single anesthesia. Outcomes were assessed with respect to Visual Analog Scale (VAS) and Neck Disability Index (NDI) scores, satisfactory reduction, and maintenance of alignment on radiographs, with evidence of fusion on radiographs at follow-up.

Results: Patients presented at a mean of 7.1±6.7 weeks (range, 3 to 36 weeks) since the injury. Fall from height was the most common mode of injury. In total, there were 21 bifacetal and three unifacetal dislocations. The mean follow-up was 27.5±2.4 months (range, 25 to 42 months). Twenty patients had complete pain relief at the final

follow-up. All six patients who presented with neurodeficit, showed complete neurological recovery. There was no neurological deterioration in any patient. Radiographs showed a satisfactory reduction in 22/24 patients (91.7%). Radiological evidence of fusion was seen at a mean of 9.2±1.4 months. The spinal alignment was well maintained in all cases at final follow-up. There was one case of superficial wound infection which recovered with antibiotics. One patient with pull-out of screws during follow-up had an uneventful clinical course with a fused well-aligned cervical spine. No revision surgeries were needed. VAS and NDI scores showed significant improvement at the final follow-up (p<0.05).

Conclusions: The single stage, the anterior-posterior-anterior approach is an effective and safe surgical strategy in the management of neglected AO-F4 injuries of the subaxial cervical spine, as evidenced by a 91.7% success rate in achieving reduction, and satisfactory spinal alignment and fusion with good clinical and functional outcomes, at a mean follow up of 27.5±2.4 months.

195

Tracheoesophageal Fistula Complicating a Global Stabilization Surgery for Cervicodorsal Junctional Tuberculosis: The First Case Report

Aju Bosco, Nalli Ramanathan Uvaraj

Orthopedic Spine Surgery Division, Institute of Orthopedics and Traumatology, Madras Medical College, Chennai, India

Objectives: We present the challenges in the diagnosis and management of a case of tracheoesophageal fistula complicating a cervicodorsal spine surgery for tuberculous spondylodiscitis of the cervicothoracic junction and its resourceful management.

Methods: A 23-year-old female with D1–D2 tuberculous spondylodiscitis with neurodeficit (American Spinal Injury Association-C grade) was managed with posterior instrumented stabilization followed by anterior debridement and reconstruction with clavicle autograft through a medial clavicle resecting approach. From the fourth postoperative day onwards, the patient developed recalcitrant cough following oral intake, dysphagia, and hoarseness of voice. A computed tomography (CT) of the chest, oesophagoscopy, and bronchoscopy revealed a tracheoesophageal fistula situated 18 cm distal to the pharyngeal opening. To prevent aspiration of feeds and pneumonitis the patient was managed with a feeding jejunostomy and kept on total parenteral nutrition. Feeds and antitubercular chemotherapy were given through the feeding jejunostomy for 5 months, which allowed for healing of the fistula. Feeding jejunostomy was removed by the end of the fifth month. Patient was gradually transitioned from Ryle's tube feeding to oral feeds. The patient was followed up at regular intervals while on antitubercular chemotherapy (for 14 months).

Results: After 8 months of antitubercular chemotherapy, a CT scan of the thorax, oesophagoscopy, and bronchoscopy revealed complete healing of the fistula. After 14 months of chemotherapy, plain radiographs, and a CT scan of the cervicodorsal spine revealed complete healing of the lesion with complete neurological recovery.

Conclusions: Esophageal injury (0.25%) and tracheal injury are rare complications following anterior cervical spine surgery. However, tracheoesophageal fistula following cervical spine surgery has not been previously reported in the literature. We report the first case of a tracheoesophageal fistula following cervicodorsal spine surgery and its resourceful management.

174

Slump Sitting X-Ray: A Screening Tool in Degenerative Lumbar Spine

Manan Paneliya, Sanjay Dhar

Patil Hospital & Research Centre, Pune, India

Objectives: The purpose of this study is to introduce a new slump sitting radiograph while screening degenerative lumbar spine disorders and compare it with the conventional flexion view in terms of displacement and angular range of motion.

Methods: A single-blinded randomized prospective study was conducted by a single unit of the department of orthopedics between 2019–2021. After approval from the ethics committee, 60 patients were enrolled in the study with written informed consent. Patients were randomly

allocated into two groups, the first group underwent the slump view, and then, the conventional flexion view while the second group underwent the conventional flexion view followed by the slump view. All patients were then subjected to the extension radiograph as part of the protocol to determine dynamic instability if any. Segmental angular measurements and displacement in the lumbar spine were calculated and compared.

Results: Out of 60 patients, 40 patients were found unstable on the slump view whereas only 26 patients demonstrated instability on conventional flexion radiographs. When slump and conventional flexion radiographic methods were compared, the lumbar flexion demonstrated via the slump view was higher. There was an additional 22.35° of global flexion (L1/S1) (p<0.0001) on slump radiographs when compared with conventional flexion radiographs. An increase in global flexion using the slump method was due to the increased flexion at each segment with a statistically significant increase at L4/L5 (5.23°, p<0.001) and L5/S1 (7.41°, p<0001). There was no significant difference between the two radiographic methods in terms of displacement.

Conclusions: The slump sitting view in lumbar spine instability effectively demonstrates the increase in global flexion and a significant increase in segmental flexion of the lower lumbar segments and was superior to the conventional forward flexion view thereby proving its usefulness as a screening tool in determining instability at segments which contribute to the maximal mobility of the lumbar spine. However, in terms of displacement, the slump sitting view is similar to the conventional view.

175

Epidural Abscess during the COVID Pandemic

Taarini Johri, Sanjay Dhar, Rohan Gala

Patil Hospital & Research Centre, Pune, India

Objectives: To report an unusually high number of epidural abscesses in coronavirus disease 2019 (COVID-19) patients.

Methods: We retrospectively assessed five consecutive COVID-19 patients with a primary spinal epidural abscess that we surgically managed over an 8-month period. These cases were analyzed and carefully reviewed in terms of their clinico-radiological profile, perioperative details, and functional outcome.

Results: The abscesses were primary in three cases whereas it was secondary to spondylodiscitis in two cases. Obesity was a risk factor and was reported in one patient. The preferred localizations were mainly lower dorsal and dorsolumbar junctions spanning at least two spinal segments. Two patients also had a family history of tuberculous infection. All five cases were reported to be tuberculous in origin with no rifampicin resistance on GeneXpert and culture. All patients had come with either Frankle A or B and the average time of recovery by at least three grades was at least 5 months.

Conclusions: We report the increased frequency of this uncommon disease in such a short period. To our knowledge, cases of spinal epidural abscess presenting as spinal tumor syndrome in COVID-19 patients have not been reported from our region. We hypothesize that in our patients, this could be attributed to the use of steroids and the endemicity of the disease in our country even in the immunocompetent population.

121

Gorham-Stout Disease of Thoraco-Lumbar Spine: A Case Report and Management Strategies in a 10-Year Follow-up Study

Sharan Achar T., Umesh Kanade, Vigneshwara M. Badikillaya, Sajan K. Hegde

Apollo Hospitals, Chennai, India

The Gorham-Stout disease is an extremely rare disorder of unknown etiology characterized by progressive and massive osteolysis of bones and lymphatic proliferation of soft tissues. Since the initial description of the disease by Gorham and colleagues (1954) and by Gorham and Stout (1955), 65 years have elapsed but still the precise etiology of Gorham's disease remains poorly understood and largely unknown. To date, only 200 cases of Gorham's-Stout disease (GSD) have been described in the literature out of which 49% of the cervical spine and 46% of the thoracic spine were most commonly involved. Other areas affected by GSD are the pelvis, skull, clavicle, and jaw. The clinical

presentation of Gorham's disease is variable and depends on the site of involvement. It often takes many months or years before the offending lesion is correctly diagnosed. Although GSD can involve any spinal level, involvement of the D-L junction is rare. As this is the junctional area of the vertebral column, progressive osteolysis at this region is associated with severe devastating complications such as subluxation, dislocation, kyphosis, kyphoscoliosis, myelopathy, and paraplegia and may occur with spinal cord compression. The disease has an indolent course progresses slowly and has an unpredictable course. The medical treatment for Gorham's disease includes radiation therapy, anti-osteoclastic medications (bisphosphonates), and alpha-2b interferon. Surgical treatment options include resection of the lesion and reconstruction using bone grafts and/or prostheses. We report a case of a 24-year-old policeman who presented with complaints of chronic mid-back pain for 18 months and progressively increasing deformity of the mid-back for 6 months. On examination, there was kyphotic deformity at the dorsolumbar junction (D-L), spinous process defect at D-L junction, and intact neurology. Alkaline phosphatase level was elevated. X-ray suggestive of kyphosis at D-L junction with retrolisthesis of D12 over L1 vertebra. Computed tomography scan suggestive of the extent of osteolysis. Magnetic resonance imaging is suggestive of bright intensity on T2W from D10 to L2 vertebra with compression of the spinal cord and high intensity on T1W images. Isotope bone scan was normal. The patient was operated on with posterior stabilization from D8 to L5 and anterior reconstruction using an expandable cage filled with an autologous iliac crest bone graft. Posterior fusion attempted with allograft femoral head and iliac bone marrow. H&E-stained slides showed intracellular dilated vascular channels lined by endothelial cells consistent with GSD. Over a 10-year follow-up, the patient had 3 times rod breakage and revision surgery.

14

Utility of the Novel Supine Correction Index for Predicting Brace Outcomes in Adolescent Idiopathic Scoliosis

Jason Pui Yin Cheung, Lester Po Kwan Wong, Prudence Wing Hang Cheung

The University of Hong Kong, Hong Kong

Objectives: To assess the predictive ability of morphological predictors in predicting brace outcome in patients with adolescent idiopathic scoliosis (AIS) and to establish a novel supine correction index for guiding brace treatment.

Methods: A prospective cohort of braced patients with AIS between December 2016 and December 2018 was recruited and followed up until weaning. Patients were braced according to the Scoliosis Research Society bracing criteria. Patients who were lost to follow-up or had incomplete radiographic records were excluded. Baseline radiological data were obtained from pre-brace standing posteroanterior and lateral whole-spine radiographs, supine radiographs, and immediate in-brace posteroanterior and lateral standing radiographs. Cobb angles, supine flexibility, and in-brace correction rate were obtained and used to predict curve progression at the end of follow-up, defined by ≥5° increase of Cobb angle via univariate and multivariable logistic regressions. The supine correction index (SCI) was defined as the ratio between correction rate and flexibility. Receiver operating characteristic (ROC) curve analysis was performed to assess the optimal thresholds for flexibility, correction rate and SCI in predicting lower risk of progression, defined by a change in Cobb angle ≥5° or incidence of surgery. Odds ratios (ORs) and 95% confidence intervals (CIs) were reported where appropriate.

Results: A total of 207 patients, with mean±standard deviation age of 12.8±1.2 years at recruitment, were included. The baseline Cobb angle was similar (p=0.374) between progressed (32.7°±10.7) and stable patients (31.4°±6.1). High supine flexibility (OR, 0.947; 95% CI, 0.910–0.984; p=0.006) and correction rate (OR, 0.926; 95% CI, 0.890–0.964; p<0.001) were significantly predictive of lower incidence of progression after adjusting for Cobb angle, Risser sign, curve type, menarche status, distal radius, and ulna

grading and brace compliance. Factors related to shoulder imbalance and coronal imbalance were not significantly predictive of brace outcomes. ROC curve analysis identified a cut-off of 18.1% for flexibility (sensitivity=0.682, specificity=0.704) while a cut-off of 28.8% is found for correction rate (sensitivity=0.773, specificity=0.691) in predicting lower risk of curve progression. Cut-off for SCI was found to be 1.21 by ROC curve analysis (sensitivity=0.583, specificity=0.591), and an SCI greater than 1.21 is significantly predictive of a lower risk of progression (OR, 0.4; 95% CI, 0.251–0.955; p=0.036).

Conclusions: High supine flexibility (18.1%) and correction rate (28.8%) predict a lower risk of curve progression. An SCI of 1.21 was found predictive of bracing outcomes in patients with AIS. This is a guide for achieving the target correction rate during brace fabrication to optimize brace outcomes.

111

Factors Affecting Stiffness-Related Functional Disability after Long Segmental Fusion in Patients with Adult Spinal Deformity

Aditya Raj, Chong-Suh Lee, Se-Jun Park, Jin-Sung Park

Smt. Kashibai Navale Medical College and General Hospital, Pune, India

Objectives: In general, stiffness-related functional disability (SRFD) is expected to increase with longer fusion length, but there have been no studies on factors affecting SRFD, besides fusion length. To identify the factors affecting SRFD after long segmental fusion in patients with adult spinal deformity (ASD).

Methods: We retrospectively reviewed the patients who underwent ≥4-segment fusion including sacrum for ASD. The severity of SRFD was evaluated using the Specific Functional Disability Index (SFDI). The SFDI was measured 2 years after surgery. Factors affecting SRFD were analyzed.

Results: A total of 148 patients were included in the study. The mean score of each SFDI category was highest in sitting on the floor (9.9) followed by lower body activities (7.6), sanitation activities (6.0), and moving activities (5.9). The total sum was 29.3 points. The total sum of SFDI was significantly higher in the female sex, patients with higher American Society of Anesthesiology (ASA) grade, and longer fusion length. However, any sagittal parameters did not affect the total sum score of SFDI.

Conclusions: This study showed that female sex, higher ASA grades, and longer fusion length influenced SRFD after long segmental fusion for ASD. Sagittal parameters related to the degree of deformity correction did not significantly affect SRFD.

20

Selective Angiography Detecting Anterior Spinal Artery Occlusion in Thoracic Ossification of Posterior Longitudinal Ligament

Go Yoshida, Tomohiko Hasegawa, Yu Yamato, Yukihiro Matsuyama

Hamamatsu University School of Medicine, Hamamatsu, Japan

Objectives: Surgery for thoracic ossification of the posterior longitudinal ligament (T-OPLL) has a high risk of neurological complications, which might be associated with insufficient spinal cord blood flow. We aimed to investigate anterior spinal artery (ASA) status using preoperative selective angiography in patients undergoing surgery for T-OPLL.

Methods: This study prospectively examined nine T-OPLL patients who underwent posterior thoracic decompression with kyphosis correction and instrumented fusion at Hamamatsu University School of Medicine between 2017 and 2019. All underwent preoperative selective angiography to detect and evaluate the Adamkiewicz artery and ASA. Intraoperative neuromonitoring and Doppler ultrasonography were performed to analyze neurological complications and spinal cord blood flow.

Results: All nine patients showed ASA stenosis in the area of T-OPLL. In all patients, the Adamkiewicz artery was located between T7 and L2, and the area of ASA stenosis corresponded to the level of T-OPLL and greatest spinal cord compression; intraoperative Doppler ultrasonography confirmed the ASA defect at the same spinal level. The number of spinal levels from the Adamkiewicz artery to the most compressive OPLL lesion was greater in the

two patients who developed postoperative neurological deficit compared to those who did not (5.5 vs. 2.3, p=0.014).

Conclusions: This is the first study to report the detection of ASA stenosis in patients with T-OPLL. Maintaining spinal cord blood flow is important in these patients to avoid neurological deterioration.

25

Concerning Postoperative Life Prognosis in Patients with Elderly Spinal Deformity Surgery

Tomohiko Hasegawa, Yu Yamato

Department of Orthopedics, Hamamatsu University School of Medicine, Hamamatsu, Japan

Objectives: In Japan, spinal corrective surgery is performed on relatively elderly patients with spinal deformities. In elderly patients, comorbidities and age-related changes may affect postoperative outcomes and, by extension, causes of death, but postoperative survival rates and causes of death have not been investigated. This time, we report the postoperative survival rate and cause of death of elderly spinal deformity surgery patients.

Methods: From 2010 to 2015, out of 135 patients aged 70 years or older who underwent spinal deformity correction surgery in our department, XP 5 years after surgery, whether questionnaire evaluation was possible or death was confirmed by 5 years, only 100 cases were targeted. Preoperative endpoints include age, gender, body mass index, smoking, drinking, Oswestry Disability Index (ODI), causes of deformity, American Society of Anesthesia (ASA)-physical status (general condition classification), complications, surgical procedure, presence or absence of pelvic fixation, surgical complications, the number of fatal cases, the time of death, and the cause of death were considered, and each item was compared between the surviving cases and the dead cases.

Results: The 5-year follow-up rate was 74%. The average age was 74.7 years old, the oldest was 84 years old, and 9% were over 80 years old. Drinking 14%, smoking 9%, and preoperative average ODI was 50.2. The composition of spinal deformities was kyphoscoliosis 57%, post-vertebral fracture 25%, iatrogenic 4%, and neuromuscular disease 14%. Preoperative comorbidities were hypertension in 50% and diabetes mellitus in 20%. Surgical complications occurred in 51%. There were 10 deaths, 75.0 years old at the time of surgery, six males and four females. The 5-year mortality rate was 30% for males and 5% for females (p=0.001; chi-square test), and the mortality rate was 60% for 2–5 years, not within 1 year after surgery. There were no deaths due to surgical complications, and the cerebrovascular accident was the most common cause of death in three cases. Comparing the dead and surviving cases, the preoperative ASA (2.2 vs. 2.0, p=0.03) drinking history (40% vs. 12.5%, p=0.01).

Conclusions: In elderly spinal deformity surgery patients, males, with poor ASA, and drinking history had a poor life prognosis.

56

Evaluation of Thoracic Cage Deformity in Adolescent Idiopathic Scoliosis: Thoracic Lordosis Is Accompanied by Thoracic Cage Deformity

Yuki Mihara, Tomohiko Hasegawa, Yu Yamato, Yukihiro Matsuyama

Hamamatsu University School of Medicine, Hamamatsu, Japan

Objectives: It has been reported that reduction of thoracic kyphosis is associated with respiratory dysfunction in adolescent idiopathic scoliosis. However, there are few reports on what kind of thoracic deformity occurs with the decrease in thoracic kyphosis. The purpose of this study is to investigate the relationship between thoracic kyphosis, thoracic cage deformity, and respiratory function in adolescent idiopathic scoliosis (AIS) surgery cases.

Methods: The subjects were cases of AIS Lenke type 1 and 2 in our department from 2016 to 2021 in which chest computed tomography (CT) was taken preoperatively. Thoracic cage deformity was evaluated in axial slices at the lowest end of the sternum level using thoracic CT. The distance between the center of the anterior wall of the vertebral body and the posterior surface of the sternum was defined as short axis length, and the sum of the distances from the outermost ends of the left and right lung

fields to the extension of the short axis longitudinal line was defined as long axis length. Cobb angle and thoracic kyphosis (TK) were measured in standing whole spine radiographs. The forced expiratory volume in 1 second and % vital capacity (VC) was measured using a pulmonary function test. The low TK group was defined as TK less than 10°, and the control group was defined as TK 10° or higher.

Results: A total of 49 cases (seven males, 42 females; average age, 15.1 years) were included. There were 14 patients (29%) in the low TK group and 35 patients (71%) in the control group. The preoperative Cobb angles of the low TK group and control group were 49°, 44°, TK 0°, 19°, short axis length 63 mm, 77 mm, long axis length 234 mm, 234 mm, and short axis length/long axis length 0.27, 0.33. The forced expiratory volume in 1 second was 88% and 88%, and the % VC was 86% and 86%. The low TK group tended to have significantly smaller short axis length/long axis length (p=0.003). Using the receiver operating characteristic (ROC) curve, the cut-off value for short axis length/long axis length at which % VC is less than 80% was calculated to be 0.3014 (area under the ROC curve: 0.701, sensitivity 66.7%, specificity 68.7%).

Conclusions: The low TK group tends to have a flattened thoracic cage. And flattened thoracic cage was associated with restrictive ventilatory impairment.

70

Spontaneous Lumbar Correction in Selective Thoracic Fusion for Patients with Adolescent Idiopathic Scoliosis: Does Lumbar Flexibility Affect the Correction Rate?

I-Hsin Chen, Chih-Wei Chen, Ming-Hsiao Hu, Po-Yao Wang, Po-Liang Lai, Shu-Hua Yang

Department of Orthopedics, National Taiwan University Hospital, Taipei, Taiwan

Objectives: The purpose of the study is to reveal the relationship between the flexibility of unfused lumbar curves (LCs) and the spontaneous lumbar correction rate (SLCC) and to testify to the hypothesis that the rigidity of LCs does not preclude the effects of selective thoracic fusion (STF) in adolescent idiopathic scoliosis (AIS) patients.

Methods: A multicenter retrospective analysis was performed on patients receiving STF. Patients classified as Lenke 3/4 were chosen and patients classified as Lenke 1/2 with preoperative Cobb angle of major thoracic curves (MTCs) over 40° were then selected for the patient-matched cohort. The chi-square test and Mann-Whitey U test were utilized for comparison between the two groups.

Results: A total of 38 patients were included in the study of which 21 patients were in group 1 (Lenke 1/2) and 17 patients were in group 2 (Lenke 3/4). There was no difference in demographic data and preoperative variables except for a higher preoperative bending angle of LCs in group 2 (15.7°±5.9° vs. 31.8°±5.9°, p<0.0001). After the operation, there was no statically significant perioperative change of Cobb angle of LCs noted between the two groups, no matter whether presented as a number (24.1°±5.4° vs. 23.0°±7.1°, p=0.79), or as a percentage (55.1%±10.4% vs. 50.4%±12.9%, p=0.25).

Conclusions: SLCC after STF in AIS patients is not significantly interfered with by the flexibility of LCs and the preoperative bending angle of LCs should not be regarded as the main determinant when making a decision about whether to perform STF in AIS patients

94

Image Results in the Elder Patients with Vertebral Compression Fracture Who Received High Viscosity or Low Viscosity Cement for Verteboplasty

Chien-Ying Lai, Chien-Chun Chang, Yen-Jen Chen, Hsien-Te Chen

Orthopedic Department, China Medical University Hospital, Taichung, Taiwan

Objectives: A vertebral compression fracture is a very common fracture in elderly people who have osteoporosis. Vertebroplasty is the famous treatment for vertebral compression fracture, and it is useful for pain relief. Because low cement viscosity is one of the risks of cement leakage after vertebroplasty, high viscosity cement is devised to reduce the risk. Furthermore, we want to know if there is any other benefit of high viscosity cement for vertebroplasty in image finding.

Methods: We collected the elderly patients with single-level vertebral compression fractures who received vertebroplasty in China Medical University Hospital from January 2018 to December 2021 by two orthopedic doctors. All these patients received preoperative spine X-ray and magnetic resonance imaging survey, and an osteoporotic compression fracture was diagnosed. Postoperative X-ray was taken after vertebroplasty for every patient. These patients are divided into two groups according to the cement viscosity which patients had taken. There are 18 patients who received high viscosity cement, and 18 patients who received low viscosity cement for vertebroplasty. We reviewed the preoperative and postoperative spine lateral plain film to measure the anterior body height and kyphotic angle change. We also checked if there is any cement leakage from the postoperative plain film.

Results: There is no statistical difference between the two groups in age, gender, operation time, and blood loss. The postoperative increased anterior body height is 6.22 mm in the high viscosity cement group and 2.93 mm in the low viscosity cement group, and the *p*-value is 0.0221 (<0.05). On the other hand, the postoperative kyphotic angle change is 11.19° in the high viscosity cement group and 4.44° in the low viscosity cement group, and the *p*-value is 0.0013 (<0.05). There is no statistical difference in cement leakage rate between the two groups (0.50 in the high viscosity cement group, 0.61 in the low viscosity cement group), but still mild higher in the low viscosity cement group.

Conclusions: The increased anterior body height and kyphotic angle change are better in the high viscosity group. Because it may have less leakage risk during vertebroplasty, the surgeon could use a higher volume of cement in the vertebral body. High viscosity cement is safer and less leakage rate. In our study, it could get more vertebral body correction in images. And it is also a good choice for vertebroplasty if there is no contraindication for the patient.

103

The Difference between Central Window and Lateral Window for Multi-Level Fusion Including L5/S1 through Oblique Lumbar Interbody Fusion Surgery

Ming-Ching Chen, Kuang-Ting Yeh

Department of Orthopedics, Hualien Tzu Chi Hospital, Buddhist Tzu Chi Medical Foundation, Hualien, Taiwan, R.O.C.

Objectives: When a patient required multi-level anterior fusion, there are two approaches to access the L5/S1 disc, one approach is a central window (between great vessel bifurcation), and another approach is a lateral window between the lateral border of the left common iliac vein and psoas muscle. The purpose of our study is to compare the central window and lateral window in patients with multi-level fusion including L5/S1 oblique lumbar interbody fusion (OLIF) approach.

Methods: A total of 90 patients who underwent multi-level OLIF including L5/S1 were included. There were two groups, one was the lateral window group (n=43), and the other was the central window group (n=47). The operation time, estimated blood loss, Visual Analogue Scale, fusion rate, radiologic alignment, and complications were evaluated. The radiographic alignments included disc height, anterior disc height, and L5/S1 disc angle. The fusion status and subsidence rates were evaluated at least 6 months postoperatively.

Results: All patients underwent OLIF between January 1, 2018 and October 30, 2021. For disc height restoration, 7.62±2.86 mm (p<0.001) in the lateral window and 7.43±3.18 mm (p<0.001) in the central window. For anterior disc height restoration, 7.57±3.31 mm (p<0.001) in the lateral window and 9.18±3.57 mm (p<0.001) in the central window. For L5/S1 disc angle restoration, 7.67±3.64 mm (p<0.001) in the lateral window and 8.37±3.90 mm (p<0.001) in the central window. About the operation time, 485.49±126.75 minutes in the lateral window and 594±185.51 minutes in the central window.

Conclusions: We performed anterior approaches through OLIF for multi-level interbody fusion including L5/S1, by the central window or lateral window. Both methods achieved the significant restoration of disc height, anterior disc height, and L5–S1 disc angle. The central window

group got more anterior disc height restoration may be due to anterior longitudinal ligament release. The lateral window group had a shorter operation time may be due to the same operation space in multi-level fusion. However, we need more follow-up time to evaluate the postoperative fusion rate and complications.

141

Thoracolumbar Spinal Fusion Terminating at L4 or L5 for Adult Symptomatic Lumbar Deformity Patient: Mean 7-Year Follow-up

Mitsuru Yagi, Satoshi Suzuki, Yohei Takahashi, Morio Matsumoto, Masaya Nakamura, Kota Watanabe

Keio University Hospital, Tokyo, Japan

Objectives: The long-term surgical outcome for thoracolumbar spinal fusion terminating at L4 or L5 (TLF) for the adult symptomatic lumbar deformity (ASLD) will be favorable with less complication and revision rate in a selected ASLD population. The long-term outcome of TLF for ASLD has not been fully identified while short-term outcomes have been described. The purpose of the multicenter retrospective case series was to report the long-term clinical and radiographic outcomes of TLF in ASLD patients.

Methods: Sixty-eight consecutive ASLD patients (>50 years) who had TLF (lowest instrumented vertebra; L5 or L4) at three different hospitals and reached 5-year follow-up were included: follow-up rate, 97%; mean follow-up, 7.3 years; age, 65±9 years; 97% female; level fused, 8±3; and Schwab-Scoliosis Research Society SRS classification, D29: L26: N13. The radiographic and clinical outcomes were analyzed. The disc angle and degeneration of L5–S was assessed using Weiner grades and grade 2–3 were considered disc degeneration (DD). The risk analysis of mechanical failure (MF) was performed using receiver operating characteristic (ROC) analysis.

Results: The SRS-22 improved at 2 years and was maintained until to final follow-up (baseline 2.8±0.7 vs. 2 years vs. 3.8±0.6 vs. final 3.9±0.6). Sagittal alignment improved significantly postoperative and spinopelvic alignment was consistent after 2 years, while thoracic kyphosis was significantly increased (C7 sagittal vertical axis: baseline 60 mm vs. 2 years 49 mm vs. final 43 mm; pelvic incidence–lumbar lordosis: baseline 26° vs. 2 years 10° vs. final 13°; thoracic kyphosis: baseline 22° vs. 2 years 28° vs. final 34°). L5–S disc angle decreased 3°±2°, and the prevalence of DD increased at final follow-up (38% to 46%). Coronal balance also slightly worsened at final follow-up (central sacral vertical line: baseline -3 mm vs. 2 years -8 mm vs. final -9 mm; L4 tilt: baseline 23° vs. 2 years 10° vs. final 14°). The overall major complication rate was 43% and the late complication developed at 9%. MF developed 19% (n=13) and the overall revision rate was 16% (n=9). Two late revisions (3%) were required due to distal junctional kyphosis (DJF), while the vast majority developed within 2 years (n=7, 10%). Proximal junctional failure developed in three cases and rod fracture (RF) developed in five cases, while three RFs developed at a late stage did not require revision. DJF developed three cases and all required pedicle subtraction osteotomy. The ROC analysis indicated that higher body mass index (BMI, 22.9 kg/m^2; sensitivity=0.73, specificity=0.8; older age, 71 years; sensitivity=0.73, specificity=0.74; and frailty [modified frailty index], 0.14; sensitivity=0.6, specificity=0.76) were the risk of MF following TLF for ASLD.

Conclusions: Long term surgical outcome of TLF for ASLD was favorable with less complication and revision rate in selected ASLD patients. Higher BMI, older age, and advanced frailty were identified as the risk of long-term MF following TLF for ASLD.

142

Tether Breakage in Vertebral Body Tethering Is Better Explained by Inter-Screw Distance Than Inter-Screw Angle

Hiu-Tung Sandra Wan, Ogulcan Guldeniz, Matthew Yeung Hei-Yu, Jason P. Y. Cheung, Kenny Y. H. Kwan, Kenneth M. C. Cheung

LKS Faculty of Medicine, The University of Hong Kong, Hong Kong

Objectives: Tether breakage in vertebral body tethering (VBT) has been defined as a 5° increase in inter-screw angle. However, a sensitivity of 56% has been reported. As tensile tests in the literature suggest that tether breakage occurs when it elongates more than 13%–15% of its origi-

nal length, we aim to validate that our proposed inter-screw index is a more rational indicator of tether breakage.

Methods: This is a prospective cohort study in patients with idiopathic scoliosis who underwent VBT at our center between February 25, 2019 and December 29, 2020. To test our hypothesis, routine computed tomography (CT) scans of nine subjects were reviewed to confirm tether status and compared with radiographic inter-screw angle and distance. Four subjects who met our definition of breakage had second CT scans taken. Sensitivity between inter-screw angle and distance were compared, with our proposed definition of breakage as follows: recent inter-screw distance: postoperative inter-screw distance ≥1.13.

Results: Nine subjects with 13 CT scans were included in the study. The mean age at surgery was 11.1±1 years and the mean number of instrumented levels was 7.9±1. The mean preoperative Cobb was 52°±9° and at 1-year follow-up was 32°±12°. Of 94 segments reviewed on CT, tether breakage was observed in 15 unique segments. Under coronal and lateral views, our definition correctly identified 14 broken segments (93%), whereas ≥5° increase in inter-screw angle was observed in 12 broken segments (80%) as this method failed to identify two breakages from consecutively broken segments. In plain radiographs taken ≥6 months prior to CT confirmation, our new definition was able to correctly predict seven broken segments, while only five segments had ≥5° increase in inter-screw angle.

Conclusions: As tethers elongate under creep fatigue, an increase in inter-screw distance precedes tether breakage and may act as a predictor, whereas an increase in inter-screw angle occurs afterward due to segmental loss of correction. Moreover, unpredictable screw tilting in consecutive breakages reduces the diagnostic accuracy of inter-screw angle. Thus, an increase in inter-screw distance is a more sensitive measure of tether breakage. Our proposed inter-screw index serves as a less-invasive method for identifying tether breakage compared to CT and revision surgery, is able to consider screw displacement in two planes, and has the potential to identify more cases earlier on than by the use of inter-screw angle.

196

Intramedullary Spinal Cord Abscess Mimicking Intramedullary Spinal Cord Tumor

Siddharth Katkade, Ajay Kothari

Sancheti Institute of Orthopaedics and Rehabilitation, Pune, India

Objectives: To learn unusual radiological presentation of chronic intramedullary spinal cord abscess (IMSCA) mimicking intramedullary spinal cord tumor (IMST). Chronic intramedullary spinal cord abscess is a rare entity. Intramedullary spinal cord tumors are also rare presentations. Rarely, radiological presentations of both might mimic each other.

Methods: A 33-year-old female with low back pain and bilateral lower limb radiculopathy since 3 months presented with recent onset bilateral ankle weakness. Magnetic resonance imaging (MRI) is suggestive of well defined mildly enhancing intramedullary lesion possibly conus medullaris neoplasm most probably myxopapillary ependymoma. In view of neurodeficit, posterior midline dorsolumbar durotomy was performed with evidence of only purulent material. The postoperative patient had complete neurological recovery within 24 hours. The sample was sent for pyogenic, tubercular, and fungal culture. Pus culture report came positive for *Staphylococcus aureus* sensitive to flucloxacillin. Accordingly, intravenous and oral antibiotics were given for a total of 6 weeks. The patient was followed up at 6 weeks, 3 months, 6 months, and 8 months with complete symptomatic relief, neurological recovery, and no signs of clinical or radiological recurrence on repeat MRI.

Results: At the 8-months follow-up, complete neurological recovery was confirmed with no clinical and radiological signs of recurrence.

Conclusions: Chronic IMSCA at conus medullaris can radiologically mimic IMST of conus and create a diagnostic dilemma. MRI shows decreased signal intensity with peripheral enhancement on T1-weighted images after gadolinium injection. Though this finding remains indistinguishable from some spinal neoplasm, it may help to raise suspicion about chronic IMSCA. Hence, this case report teaches the unusual radiological presentation of chronic IMSCA and the importance of having detail knowledge about various conus lesions and their distin-

guishing radiological appearances to avoid misdiagnosis and mismanagement.

198

Less Invasive Modified O-Arm Navigated Delta Fixation in Osteoporotic High-Grade Spondylolisthesis: A Limo Delta Technique

Siddharth Katkade, Shailesh Hadgaonkar

Sancheti Institute of Orthopaedics and Rehabilitation, Pune, India

Objectives: To introduce a newly modified less invasive O-arm navigated technique: a less invasive modified O-arm (LIMO) Delta technique; to study the operative parameters (incision length, blood loss, and operative time); to study the pre- and postoperative spinopelvic parameters; to study the functional outcome in form of Oswestry Disability Index (ODI) and Visual Analog Scale (VAS) score for low back pain.

Methods: Nine patients of Meyerding grade 2, 3, and 4 managed with LIMO Delta technique by a single experienced surgeon from the period of January 2021 till date were reviewed. Preoperative and postoperative spinopelvic parameters, ODI score, VAS score for low back pain (LBP), blood loss, incision length, and operative time were assessed. Radiographs were evaluated to identify any screw misplacement or instrumentation failure.

Results: Nine patients were reviewed with an average follow-up of 6 months (range, 4–8 months). There was no significant difference between pre- and postoperative spinopelvic parameters. Intraoperative average blood loss was 75 mL (range, 50–100 mL). Length of incision of 5–6 cm with two paraspinal 1 cm incisions for TPTDTC screws. Patients were mobilized on postoperative day 2 or 3. There was a statistically significant improvement in mean ODI and VAS for LBP and no intra- or postoperative complication was observed till the latest follow-up.

Conclusions: LIMO Delta technique is a newly modified version of the conventional TPTDTC technique which was performed initially by the primary author. Minimal incision decreased blood loss and operative time with *in situ* three columns rigid fixation under O-arm Navigation minimizing the risk of complications makes this novel technique safer, simpler, and more effective.

204

Surgical Outcomes of Posterior Trans-Facetal Decompression and Stabilization in Tuberculous Spondylodiscitis with Neurodeficit

Abhijith Shetty

Bombay Hospital and Research Institute, Mumbai, India

Objectives: The purpose of this retrospective study is to evaluate the functional, neurological, and radiological outcomes of posterior trans-facetal decompression and stabilization in tuberculous spondylodiscitis patients with neuro-deficit. Spinal tuberculosis mainly involves the anterior column and for that anterior approach has been the most frequently used surgical technique in the past as it allows direct access to the infected tissue providing a good decompression. However, anterior surgery is associated with higher morbidity which can be reduced by a posterior trans-facetal approach.

Methods: The study included 100 tuberculous spondylodiscitis patients with neuro-deficit who underwent posterior trans-facetal decompression and stabilization from 2009 to 2014. Demographic data, clinical parameters (back pain score—Visual Analog Scale [VAS], Oswestry Disability Index [ODI]), neurological status (Frankel's grade), radiological parameters (kyphosis angle), and complications were evaluated.

Results: Out of the total 100 patients, there were 58 males and 42 females, and 84 patients had thoracic and 16 had thoracolumbar region involvement. The mean age of the patients was 34.7 years. The extent of fixation was two segments in 52 patients and >2 segments in 48 patients. Postoperatively significant improvement in VAS (preoperative 6.5±0.65 to postoperative 1.73±0.64) and ODI (preoperative 76.54±6.96 to postoperative 30.5±6.56) were noted. The mean kyphosis angle was corrected from 22.33±5.59 to 5.14±1.32. Eighty-six patients showed at least 1 grade of improvement in neurology (Frankel's grading) and there was no deterioration in any patient. Three patients developed a superficial infection and two had an intraoperative dural tear. Ninety-four patients showed bony fusion at a 2-year follow-up.

Conclusions: Posterior trans-facetal decompression and stabilization is an effective procedure in the management

of thoracic and thoracolumbar tuberculous spondylodiscitis patients with neuro-deficit. It offers circumferential decompression with stabilization and maintains kyphosis correction.

218

A Novel Classification Based on the Osteotomized Debridement Range of Lesion in Treating Active Thoracolumbar Tuberculosis: A Multicenter Study

Kai Cao, Shengbiao Ma, Zhenhai Zhou, Zhaohui Ge, Yingsong Wang, Wenbing Wan

The First Affiliated Hospital of Nanchang University, Nanchang, China

Objectives: Osteotomized debridement (OD), a modified technique in treating thoracolumbar tuberculosis (TB), was advocated by us in the past decade, which can achieve complete lesion removal in a posterior-only approach. Its superiorities over traditional curetted debridement (CD) were elaborated in a recent study, including shorter fusion time, lower recurrence rate, and so forth. However, according to the variations of the TB lesions range, patients treated with different extent of OD yielded various operative invasions and clinical outcomes. In this study, we proposed an intuitive classification of OD, which helps to better understand the features of diverse ranges of spinal TB and provides corresponding surgical guidance.

Methods: The proposed classification included six grades of OD for TB focus: grade 0, only intervertebral disc and superficial adjacent endplates involved; grade 1, adjacent endplates and vertebral bodies but without pedicle involved; grade 2, adjacent endplates and vertebral bodies with a lower or upper pedicle involved; grade 3, adjacent endplates and vertebral bodies with lower and upper pedicles involved; grade 4, an entire vertebral body with an adjacent lower or upper pedicle involved; grade 5, two continuous entire vertebral bodies. A total of 205 patients with active thoracolumbar TB who underwent OD surgery were included, and the ODs of these cases were classified. The reliability of this classification was evaluated twice by 10 readers with a 2-week interval, and Fleiss kappa coefficients were calculated.

Results: In the 205 patients, 208 ODs were reviewed (three patients had two isolated focuses). Grade 2 OD was the commonest type (98/208, 47.1%) for focus clearance, followed by grade 1 (50/208, 24.0%), grade 3 (26/208, 12.5%), grade 0 (20/208, 9.6%), grade 4 (8/208, 3.8%), and grade 5 (6/208, 2.9%). The intra-rater reliability for the classification was "almost perfect agreement" with a Fleiss kappa coefficient average of 0.92 (range, 0.82–0.96). The inter-rater reliability was "almost perfect agreement" with a coefficient average of 0.89 for the two readings.

Conclusions: The proposed classification of OD based on vertebral anatomy can describe the main active spinal TB. The results revealed excellent intra- and inter-rater reliability for the grading of OD, demonstrating that the use of OD classification is reliable and practical. The graded scale of OD can provide a common frame for the assessment of invasiveness in treating thoracolumbar TB and allow comparative analysis of different grades.

220

Ball Tip Technique for S2-alar-iliac Screw Placement in Sacropelvic Fixation: A Comparative Study with Conventional Freehand Technique

Kai Cao, Zhenhai Zhou, Honggui Yu, Jiachao Xiong, Zhiming Liu, Shengbiao Ma

The First Affiliated Hospital of Nanchang University, Nanchang, China

Objectives: The S2-alar-iliac (S2AI) technique was initially used for pediatric and adult deformity patients. However, the free hand technique of S2AI is technically demanding in some cases, particularly for less experienced surgeons. This study is to evaluate the efficiency of the ball tip technique for S2AI screw placement and introduce this technique.

Methods: Sixty-three patients who underwent pelvic fixation with S2AI screws were retrospectively reviewed. Among these patients, 35 patients received the ball tip technique and 28 patients received the conventional freehand technique. The ball tip technique was used in the ball tip technique group. After a pedicle probe just penetrated the sacroiliac joint, a ball-tipped probe consisting of a ball-shaped metal tip with a flexible shaft was malleted to make a guide track within the ilium. This ball-tipped probe could bend automatically away from the cortex and

forward through the cancellous bone when the tip met the cortical lamina of the ilium, which can avoid penetration. After repeating the procedures, a guide hole was gradually formed. S2AI screw was inserted along the guide hole after tapping. In the conventional freehand group, the S2AI screw was placed according to the conventional method. Postoperative computed tomography was used to assess the accuracy of screws. The time cost of screw insertion and screw-related complications were recorded. An independent *t*-test was used to compare the time cost between the ball tip group and the conventional freehand group. A chi-square test was used to compare the accuracies of the ball tip group with the conventional group.

Results: There were 35 patients (70 S2AI screws) in the ball tip group and 28 patients (56 S2AI screws) in the conventional freehand group. No screw-related complication occurred in all patients. Time costs were 9.8±4.5 minutes in the ball tip group and 20.2±8.6 minutes in the conventional freehand group, respectively ($p<0.05$). Four screws penetrated the iliac cortex in the ball tip group vs. 10 screws in the conventional freehand group (5.7% vs. 17.9%) ($p<0.05$).

Conclusions: The ball tip technique for S2AI screw placement is not only a reliable but also a practical technique. This technique significantly enhances the accuracy of S2AI screw placement and improves the efficacy by reducing the time cost for S2AI screw placement in spine surgery involved in sacropelvic unit compared with conventional freehand technique.

221

Global Spinal Realignment after Osteotomized Debridement in Lumbar Tuberculosis: Correlation with Patient-Reported Outcomes

Kai Cao, Zhenhai Zhou, Honggui Yu, Jiachao Xiong, Junlong Zhong, Shengbiao Ma

The First Affiliated Hospital of Nanchang University, Nanchang, China

Objectives: Osteotomized debridement (OD) has been proven to be highly effective in treating active thoracolumbar tuberculosis (TB); however, no research investigated how OD affects spinal alignment. The goal of this study was to explore the global alignment compensatory mechanism after lumbar OD, as well as the correlation between spinopelvic parameters and patient-reported outcomes (PROs).

Methods: Forty patients with lumbar spinal TB who underwent posterior OD, bone grafting, and instrumentation were included. Patients' pre- and postoperative spinopelvic parameters (C2–7 Cobb angle [C2–7 CA], sagittal vertical axis [SVA], proximal thoracic kyphosis [PTK], thoracic kyphosis [TK], lumbar lordosis [LL], sacral slope [SS], pelvic tilt [PT], pelvic incidence [PI], spinosacral angle [SSA], and pelvic incidence minus lumbar lordosis [PI–LL]) and PROs (Oswestry Disability Index [ODI] and Visual Analog Scale [VAS]) were reviewed, and the correlation between global sagittal alignment and PROs was evaluated.

Results: Compared with preoperatively, C2–7 CA, PTK, TK, LL, SS, and SSA significantly increased, while SVA, PT, and PI–LL significantly decreased at the final follow-up. ODI and VAS decreased from preoperative 33.7±11.5 and 5.5±1.6 to 9.8±3.5 and 1.3±0.6 at final follow-up, respectively ($p<0.05$). The changes in C2–7 CA, SVA, LL, and PI–LL were found to be correlated with the improvement of VAS ($r=0.557$, $r=0.478$, $r=0.727$, and $r=0.368$, respectively). The changes in C2–7 CA, SVA, and LL were found to be correlated with the improvement of ODI ($r=0.341$, $r=0.321$, and $r=0.449$, respectively). The multiple stepwise regression analysis showed LL was an independent factor for PROs.

Conclusions: Surgical treatment is gaining importance in the management of spinal TB due to the incapacity of anti-TB drugs in controlling vertebral body collapse and the overlong period of drug treatments. The fundamental goals of surgical interventions include radical focal clearance, deformity correction, restoration of spinal stability, and improvement of overall life quality. It has been proven that OD from the posterior approach is a good method in treating thoracolumbar TB, which can reconstruct the local alignment and achieve significant improvement in PROs. In this study, we found that the whole spine and pelvis are involved in the realignment after lumbar OD, which is closely related to PROs. The parameter of LL is an independent factor related to the improvement of PROs, enlightening spine surgeons to pay more attention to restoring the lumbar lordosis in patients with lumbar spinal TB.

222

Osteotomized Debridement versus Curetted Debridement in Posterior Approach in Treating Thoracolumbar Tuberculosis: A Comparative Study

Kai Cao, Zhenhai Zhou, Zongmiao Wan, Pingguo Duan, Sheng Huang, Shengbiao Ma

The First Affiliated Hospital of Nanchang University, Nanchang, China

Objectives: Spinal tuberculosis (TB) is the most common pattern of extrapulmonary TB. For indicated patients, it is generally agreed that surgery is necessary, although chemotherapy drugs are the cornerstone of the treatment. We introduced the osteotomized debridement (OD) technique for the treatment of active thoracolumbar TB and compared the follow-up data with those who were treated with one-stage posterior curetted debridement (CD) to evaluate the efficacy of the two surgical methods.

Methods: A total of 188 patients were diagnosed with active thoracolumbar TB and underwent one-stage posterior surgery at our institution. Of the 188 patients, 85 patients were treated with OD, and 103 patients were treated with CD. The patient information, laboratory results, imaging findings, and clinical effectiveness were, respectively, compared between the two groups.

Results: Group OD consumed less operation time and blood loss than group CD ($p<0.05$ for both values). The values of C-reactive protein and erythrocyte sedimentation rate in both groups returned to the normal range within 1 month postoperatively. All patients had significant improvement in the Visual Analog Scale and Oswestry Disability Index postoperatively. The mean fusion time in group OD was shorter than that in group CD ($p<0.05$). Group OD showed less correction loss than group CD at the final follow-up ($p<0.05$). The rate of recurrence and surgery-related complications in group OD was lower than those in group CD.

Conclusions: Spine surgeons increasingly prefer to adopt one-stage posterior surgery for the treatment of spinal TB as it can provide acceptable access to perform debridement and reconstruction with less trauma and complications. However, it is known that the most obvious disadvantage of traditional posterior surgery is that CD cannot achieve radical clearance of the infectious nidus, and infection may spread from the anterior column to posterior areas, leading to the resurgence of spinal TB. In this study, we adopted the posterior approach with OD for the treatment of thoracolumbar TB and achieved satisfactory clinical outcomes, indicating that posterior OD, reconstruction with titanium mesh cages, and instrumentation are feasible and effective in treating thoracolumbar TB. Compared with the traditional CD, OD can achieve radical lesion removal, with more effective kyphosis correction, lower recurrence rate, and fewer complications.

65

Latest Advances in Minimally Invasive Spine Surgery for Treatment of Infectious Spondylitis

Chao Hsien, Tsung-Ting Tsai, Yu-Cheng Yeh, Po-Liang Lai, Tsai-Sheng Fu, Chi-Chien Niu

Department of Medical Education, Chang Gung Memorial Hospital, Taoyuan, Taiwan

Objectives: In this article, we would review recent options of minimally invasive (MIS) techniques to treat infectious spondylitis and provide a series of cases from our department to discuss the outcome of MIS.

Methods: From January 2020 to September 2021, 21 patients are enrolled in this retrospective analysis. Demographic characteristics and preoperative clinical status were recorded. Pre- and postoperative X-rays were used to assess surgical correction angles. Fusion status was assessed by plain radiography according to Brantigan, Steffee, and Fraser criteria. Dosages of intramuscular injection morphine were recorded as the objective index of the pain degree.

Results: Of the 21 patients, six males and 15 females were analyzed. The mean duration of surgery was 274.8±125.9 minutes. Mean blood loss was 690.5±655.7 mL. Total hospitalization lasted 24.14±18.7 days. Overall positive culture results accounted for 47.6% (10 of 21). There were no operation-related complications. Spine levels most commonly infected were L2/3/4, L2/3, and T12/L1 (three patients). *Mycobacterium tuberculosis* complex is the most common pathogen. Screw loosening was detected in one patient. One patient encountered recurrent infection and

received revision surgery. As for fusion status, 17 patients (81.0%) were radiographic solid fusion in 6 month, and four patients (19.0%) were partial.

Conclusions: In our case series, there was a good treatment response, including improvement in symptoms, a significant reduction in Visual Analog Scale score (from 6.79 preoperative to 2.33 postoperative), white blood cell (from 8.4 preoperative to 7.1 postoperative), and C-reactive protein (from 44.6 preoperative to 18.9 postoperative) levels. Patient satisfaction and a high fusion rate without perioperative complications were also noted. However, the culture rate was relatively low (47.6%). We reasonably suspect it due to several patients not receiving open anterior bone fusion, which prevents surgeons from complete debridement of infected areas, leading to fewer specimens obtained. Overall, the outcome is still satisfactory.

156

Senile Thoracolumbar Tuberculosis with Kyphosis and Severe Osteoporosis Treated with Polymethylmethacrylate-Augmented Screw Fixation

Yogesh Kumar

Soundarapandian Bone and Joint Hospital, Chennai, India

Objectives: To the safety and outcome of using polymethylmethacrylate (PMMA)-augmented pedicle screws for the treatment of senile thoracolumbar tuberculosis combined with severe osteoporosisand kyphosis.

Methods: A 78-year-old woman presented with mid-back pain, progressive kyphotic deformity, and neurological deficits. Magnetic resonance imaging reported infective spondylitis T12 and L1 vertebral body destruction and kyphosis. She underwent single-stage PMMA-augmented screw fixation T9–L4 and anterior reconstruction with cage and bone grafting. Biopsy reported tuberculosis spine for which anti-tubercular treatment was given followed by once weekly teriparatide dose of 60 μg for 6 weeks.

Results: Post-surgery, clinically she had significant pain relief from instability with improved neurology. Cancellous and cortical bone clearly increased, with enhanced stability in computed tomography, after 6 weeks of treatment. We have never before observed bone formation this quickly in a patient undergoing posterior spinal fusion alone.

Conclusions: It was found that for elderly patients with thoracolumbar tuberculosis and severe osteoporosis, PMMA-augmented screw fixation was safe and effective.

19

Short-Term Follow-up of Accidental Removal of Anomalous Furcal Nerve during Transforaminal Endoscopic Spine Surgery: A Case Study

Rajagopalan Dhanasekaran, Dhanasekaran Rajagopalan

Government Medical College and Hospital Krishnagiri, Kurubarapalli, India

Objectives: Short-term functional assessment and clinical outcomes of accidental removal of furcal nerve root during transforaminal endoscopic lumbar discectomy in a case of L4–L5 disc prolapse with right-sided radiculopathy and to create awareness of furcal nerve existence near disc space and its chances of damage.

Methods: A postoperative follow-up study of pain relief and functional disability of accidental removal of furcal nerve evaluated using the Visual Analog Scale and Oswestry Disability Index, postoperative motor, sensory, and radiological examination. The patient was a follow-up for 3 months and the result of furcal nerve damage is published. A single case study of L4–L5 disc prolapse with central and paracentral stenosis with severe back pain underwent transforaminal endoscopic discectomy using the inside-out technique. During retrieval of the disc, accidental removal of the furcal nerve in proximity to the L4 exiting nerve was confirmed and documented.

Results: Despite accidental removal of anomalous furcal nerve root which is commonly located superior and ventral to the L4 nerve root and runs beside it in the intervertebral foramen and connecting lumbar, obturator, and lumbosacral plexus, its damage doesn't have a significant disability to the patient and the functional outcome was very good in terms

of transforaminal endoscopic discectomy.
Conclusions: Although the furcal nerve existence which produces atypical symptoms not related to radiological findings when accidentally removed during transforaminal endoscopic discectomy, it didn't have any significant clinical effect, and the surgery has improved clinical outcomes in terms of endoscopic discectomy.

189

Does Teriparatide Improve Fusion? A Retrospective Radiological Outcome Study of Teriparatide Use in Elderly Patients Undergoing Minimally Invasive Transforaminal Lumbar Interbody Fusion for Degenerative Lumbar Disease

Raj Sakhrekar

Schoen Klinik, München, Germany

Objectives: Teriparatide was approved by the U.S. Food and Drug Administration in 2002 at a dose of 20 mcg/day for 18 and 24 months. For primary indications like postmenopausal osteoporotic women, males with primary or hypogonadal osteoporosis and osteoporosis secondary to systemic glucocorticoid therapy later it was allowed to use for fracture healing, dental stability, hypoparathyroidism, and hypocalcaemia enhancing bone graft union and osseo-integration of implants, accelerate bone graft union and reduce the incidence of pedicle screw loosening after lumbar spinal fusion surgeries. Aims and objectives of the study was to study radiographic results associated with teriparatide as adjunct therapy to achieve solid fusion mass in patients that had undergone monosegmental minimally invasive transforaminal lumbar interbody fusion (MIS TLIF) in Indian population.
Methods: Patients were examined with history, clinical examination, pain by the Visual Analog Scale and Oswestry Disability Index scores, X-ray, magnetic resonance imaging, and dual-energy X-ray absorptiometry scan for 2 years with a minimum follow-up period of 2 years. A sample size of 64 was selected with 30 patients in group 1 (experimental/teriparatide group) and group 2 (control group). Group 1 was administered with a 20 mcg/8 IU subcutaneously dose of teriparatide injections daily for a minimum of 1-year duration.
Results: At end of 6 months, patients in group 1 showed a 100% fusion rate (Bridwell grade 1) while group 2 showed 88% fusion at end of 6 months. None of the groups showed screw loosening, cage subsidence, and proximal junctional kyphosis.
Conclusions: The teriparatide treated postmenopausal osteoporotic patients show superior results in terms of the rate of bone union, the average duration of bone union is earlier compared with the control group in patients operated with monosegmental MIS TLIF.

190

Improvements in Clinical, Radiological and Scoliosis Research Society-22 Outcomes in Congenital Scoliosis: A Case Series of 46 Patients

Raj Sakhrekar

Schoen Klinik, München, Germany

Objectives: The essence of congenital kyphoscoliotic deformity is a congenital structural defect including a vertebral or intervertebral disc with triplanar deformity. The purpose of this study is to assess the safety, functional outcome, and correction after surgery in patients with congenital kyphoscoliosis.
Methods: In total, 46 patients underwent surgery with a mean age of 6.2 years (range, 3 to 12 years). All patients underwent radiographic scanogram, computed tomography (CT) scanogram, three-dimensional reconstruction CT scans, and magnetic resonance imaging. Congenital deformities involved wedge vertebrae, Hemi vertebrae, unsegmented bony bar, and mixed anomalies. The patient underwent various types of deformity correction from an anterior, posterior approach, or a combination of both, and follow-up was done for 5 years.
Results: All patients underwent posterior deformity

correction except one who underwent anterior release and posterior deformity correction with fixation with fusion. The average fusion segments were 5.2 (range, 3–10). The mean major curve was corrected from an average of 65° to 20° with a correction rate of 65°. None of the patients had neurological complications postoperative. There was no kyphoscoliotic aggravation at the latest follow-up of 2 years. Scoliosis Research Society-22 scoring showed statistically significant improvement in domains of self-image, satisfaction with management and functional scores, and total scores. While there was no statistically significant improvement in mental health and pain.

Conclusions: The key to successful management is to do surgery at an early stage to balance the growth of the spine, anticipate the type and site of vertebral anomaly, and prevent the progression of the deformity in the early stage of life. Posterior-only surgery is the choice in deformity correction considering sagittal balance achieved, percentage correction, and patient satisfaction.

102

A New Strategy for Rapid Diagnosis of the Source of Low Back Pain in Patients Scheduled to Undergo Treatment with Cooled Radiofrequency Ablation

Pin-Yi Tu, Shih-Hsiang Chou

Department of Orthopedics, Kaohsiung Medical University Hospital, Kaohsiung Medical University, Kaohsiung, Taiwan

Objectives: The objective of this study was to develop a new strategy for rapid diagnosis of the source of low back pain (LBP) for treatment with cooled radiofrequency ablation (RFA).

Methods: Patients suffering from facet joint (FJ) or sacroiliac joint (SIJ) pain for more than 3 months were included. Two methods, Technetium Tc99m methylene diphosphonate single photon emission tomography/computed tomography (99mTc-MDP SPECT/CT) and a modified Fortin finger test were used to identify the source of LBP for treatment with cooled RFA. The Visual Analog Scale (VAS) and Oswestry Disability Index (ODI) were used to assess the patients' pain levels and disabilities, respectively. These two parameters were recorded at baseline and 1-week, 1-month, 3-month, and 6-month follow-up visits.

Results: A total of 40 patients with LBP were included in this study. Our results demonstrated that the patients with LBP identified by our new strategy had significant improvements in VAS or ODI scores at 1-week to 6-month follow-up visits ($p<0.001$) after receiving cooled RFA. Similar results were also found in patients with FJ pain and those with FJ and SIJ pain respectively. Among all the patients, over 70% had greater than or equal to 50% reduction in VAS and ODI scores. No serious adverse events were observed after treatment.

Conclusions: This new strategy could be successfully adopted for rapid diagnosis of the source of comprehensive LBP.

66

Examination of Factors Affecting Postoperative Walking Status of Spinal Cord Hemangioblastoma

Kenta Kurosu, Tomohiko Hasegawa, Yu Yamato, Go Yoshida, Tomohiro Banno, Yukihiro Matsuyama

Department of Orthopedic Surgery, Hamamatsu University School of Medicine, Hamamatsu, Japan

Objectives: To investigate the factors related to postoperative walking status for spinal cord hemangioblastoma treated in a single facility.

Methods: Of the 260 cases of spinal cord tumor surgery performed at our hospital from April 2010 to October 2020, 20 cases diagnosed with spinal cord hemangioblastoma by postoperative pathological specimens were included (average age, 44.6 years). Examination items are age, sex, neurological findings (lower limb paralysis, McCormick scale), imaging findings (tumor size, preoperative/posterior syringomyelia range), spinal cord tumor surgery history, spinal cord level, surgery-related factors (operation

time, bleeding volume, presence/absence of spinal drainage, spinal cord incision method), history of perioperative steroid use, and comparative study of related factors regarding walkability (walkable: McCormick scale 1–3, non-walkable McCormick scale 4–5) at the final observation.

Results: The average observation period was 3.5 years (range, 1 month–10 years). The tumors were high in eight cases of the cervical spine, four cases of the cervical thoracic spine, six cases of the thoracic spine, and two cases of the lumbar spine. The scale was I (n=13 cases), II (n=4 cases), IV (n=1 case), and V (n=2 cases). Preoperative lower limb palsy in seven cases, spinal cord drainage in seven cases, and perioperative steroid use in 11 cases. The non-walkable cases had a significantly poor preoperative McCormick scale (walkable: I, n=11 cases; II, n=4 cases; non-walkable: I, n=2 cases; IV, n=1 case; V, n=2 cases; p=0.012), but it was not related to the imaging findings (tumor size: p=0.366, preoperative syringomyelia range: p=0.822, posterior syringomyelia range: p=0.068).

Conclusions: The preoperative McCormick scale was associated with postoperative walking status. It was not associated with surgery-related factors or imaging findings. Therefore, it is important to perform surgical treatment before the symptoms of spinal cord hemangioblastoma become severe.