2023 APSS Medtronic Fellowship Report

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Host:

1. **Prof. Yasuhisa Tanaka**
   Department of Orthopedic Surgery
   Tohoku Central Hospital, Yamagata, Japan

2. **Prof. Kuniyoshi Abumi**
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   Sapporo Orthopedic Hospital, Sapporo, Japan

Fellowship period: July, 2023 – September, 2023

Introduction

I am extremely grateful to APSS for this opportunity to receive a three-month Medtronic Fellowship training at Tohoku Central Hospital in Yamagata, Japan under the instruction of Prof. Tanaka. During the training period, Prof. Tanaka also arranged several visits to Tohoku University Hospital in Sendai for me to learn complex spinal surgery. In the second month of the training period, I was fortunate to encounter Prof. Abumi who came to Tohoku Central Hospital performing an upper cervical spine surgery. I was granted approval by Prof. Abumi and Prof. Tanaka to spend the last two weeks of September learning at Sapporo Orthopedic Hospital and other hospitals in Hokkaido. This enabled me to have the most enriching and diverse learning experience in this APSS Medtronic Fellowship.

Weekly Schedule

Starting from July, I have been receiving guidance from the Director of Tohoku Central Hospital, Prof. Yasuhisa Tanaka, focusing on spinal surgery. The following is my daily schedule:

Monday	Tuesday	Wednesday	Thursday	Friday
	Case Conference 7:30-9:00	Ward Round 8:00-9:00		
Surgery	Surgery	Surgery	Surgery	Surgery

I assist in 1-3 surgeries daily, with a cumulative amount of around 60 surgeries in Tohoku Central Hospital. For a detailed list of surgeries, please refer to the case log at the end of the report. My primary role is as the first assistant, allowing me ample interaction and learning opportunities with the Japanese surgeons.

In addition to surgeries, every Tuesday morning from 7:30 to 9:00 is the Orthopedic Case Conference. Prof. Tanaka hosts the meeting, where we discuss postoperative images from the previous week's surgeries and preoperative images for the following week's procedures. On Wednesday mornings from 8:00 to 9:00, there is a Ward Round where Prof. Tanaka leads all the doctors for orthopedic patient rounds of the entire hospital.

Surgical Learning Experiences

The following section details the surgeries I assisted in and my personal insights:

1. Cervical Spine Surgery

Prof. Yasuhisa Tanaka was an apprentice of Prof. Shoichi Kokubun of Tohoku University, specializing in cervical myelopathy and cervical radiculopathy. They have published numerous papers on these topics. In particular, the data collected from the spinal surgery database in the Tohoku region of Japan contributed greatly to the precise diagnosis of cervical radiculopathy, especially in terms of the identification of corresponding shoulder and back pain regions for the C5-C8 root.

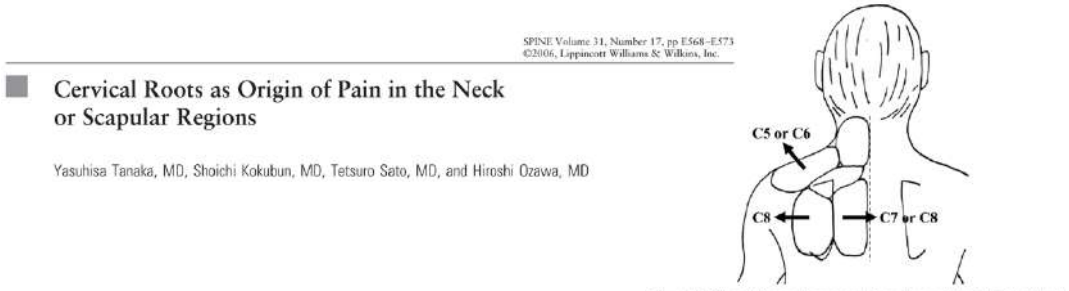


Figure 5. Site of the neck or scapular pain and the indicated level of the involved nerve root.

Prof. Tanaka primarily adopts posterior surgery for cervical lesions. For cervical radiculopathy, he uses posterior foraminotomy to relieve foraminal compression from potential pathological structures such as the ligamentum flavum, facet joint osteophyte, posterolateral and foraminal herniated disc, and Luschka (uncovertebral) joint osteophyte. He emphasizes that the decompression should reach the pedicles above and below the index segment to fully decompress the cervical root, while preserving at least 5 mm of the cervical facet joint to maintain stability. In Prof. Tanaka and his surgical team's years of experience, there have been no subsequent instability or deformity resulting from cervical posterior foraminotomy.

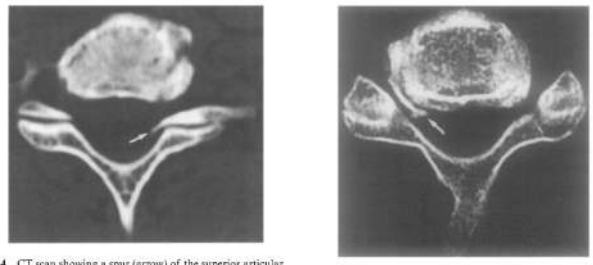


Fig. 4 CT scan showing a spur (arrow) of the superior articular process.

Fig. 3 CT scan showing a spur (arrow) of the Luschka joint.

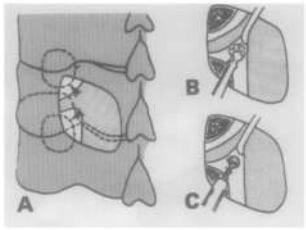


Fig. 6 Posterior foraminotomy. A: the pedicles above and below the nerve root are removed partially (arrowheads). Through an ample space the herniated mass (B) or spurs (C) are excised.

For cervical myelopathy, they mainly use Kurokawa double-door laminoplasty. This method does not require plates or screws and instead uses bone grafts to support the opened lamina, which is then secured with stitch wiring. This method is generally less expensive than Hirabayashi laminoplasty using plates and screws, and Prof. Tanaka believes that it may provide better function due to the symmetrical treatment of the cervical muscles on both sides.

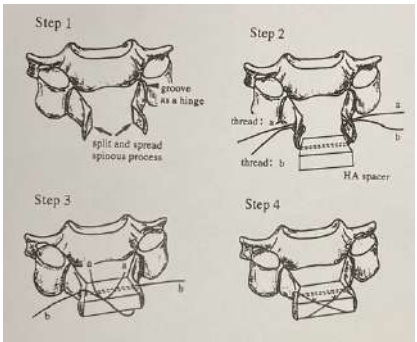
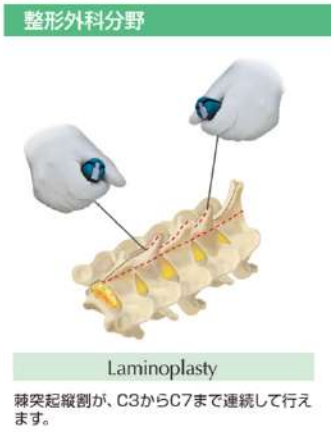
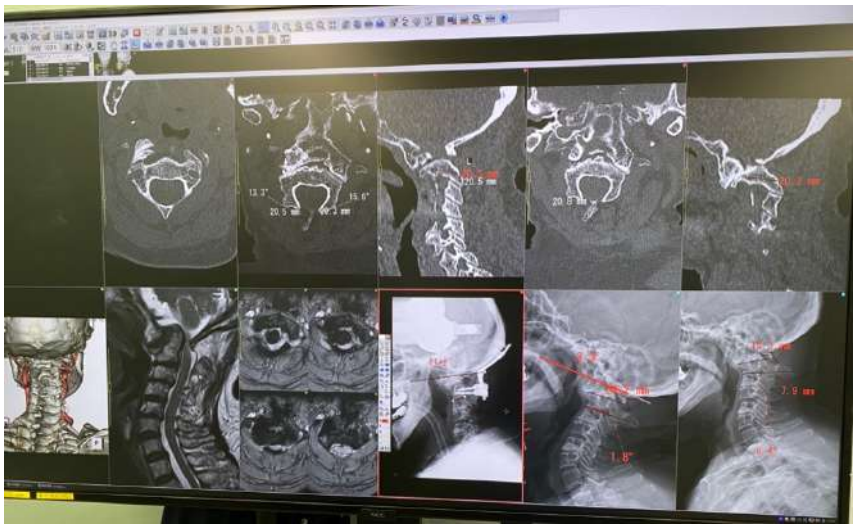


Fig. 11 Operative technique of Kurokawa's spinous process-splitting laminoplasty using hydroxyapatite (HA) spacers. Step 1: A longitudinal groove is made bilaterally. Each spinous process is split and its halves are spread. Step 2: A trapezoidal-shaped spacer is placed between the two halves of each split spinous process. Steps 3 and 4: The spacer is fixed by diagonally tying two silk threads which were passed through the holes.[13]

The doctors at Tohoku Central Hospital are extremely skillful in using the burr during cervical decompression, reducing the long-term occupational injuries to the hand caused by manual tools like the Kerrison punch. Another thing of particular note was the use of Tomita saw in Kurokawa laminoplasty to complete the midline lamina osteotomy fast and safe without causing spinal cord injury.



While at Tohoku Central Hospital, I encountered a case of C1 occipitalization, atlantoaxial dislocation, basilar invagination, and high cervical myelopathy. As the surgery involves high cervical levels, it carries higher risks and complexities. Therefore, Prof. Tanaka specifically invited Prof. Kuniyoshi Abumi, the inventor of the cervical pedicle screw technique, and former president of the Asia Pacific Spine Society (APSS) and the Cervical Spine Research Society – Asia Pacific (CSRS-AP), to perform the surgery.



For this patient, the primary goal was neural decompression. Although the kyphotic O-C2 angle caused compensatory hyperlordosis in subaxial cervical segments, for a patient nearing 80 years old, decompression for high cervical myelopathy is the most important goal. The O-C2 angle was restored by O-C2 fixation using the plate system developed by Prof. Abumi. The dens was reduced to below the foramen magnum, substantially alleviating the neural compression. The preoperative plan took into consideration the impact of rotational deformity and the trajectory of the C2 pedicle screw to avoid vertebral artery injuries. The C1 posterior arch and Foramen magnum decompression were performed with a burr and Penfield dissector. The extent of spinal cord decompression was checked with intraoperative ultrasound, and the surgery was then supplemented with a large amount of PSIS autograft implantation. Prof. Abumi, true to his mastery, performed this complex high-risk spine procedure with ease and smoothness, with the patient's postoperative neural function also being favorable. After the surgery, I discussed with Prof. Abumi and received his approval to visit Hokkaido in late September.

2. Thoracic Spine Surgery

With the recommendation of Prof. Tanaka and Dr. Kohei Takahashi at Tohoku Central Hospital (who also works at Tohoku University Hospital), I had the privilege of observing a Modified Ohtsuka method thoracic OPLL surgery at Tohoku University Hospital in Sendai. This method was invented by Prof. Toshimi Aizawa and his team. OPLL is a disease with a higher prevalence in East Asia than worldwide. The characteristics of this disease, such as spinal cord compression and easy adhesion to the dura mater, significantly increase the risk of surgical complications. Cervical OPLL can be effectively treated with posterior decompression like laminoplasty due to cervical lordotic alignment. However, thoracic OPLL doesn't have a similar posterior drifting effect after posterior decompression due to thoracic kyphosis. Therefore, Prof. Aizawa's team invented and standardized the Modified Ohtsuka method. The principle of this method is to cut the PLL at the segment without ossification after partial corpectomy, allowing anterior drifting of the entire OPLL. This posterior-based method achieves simultaneous anterior and posterior decompression without the need to deal with the adhesion between OPLL and dura, thus avoiding related surgical complications. It is a new surgical method published in the JNS Spine journal in 2021.

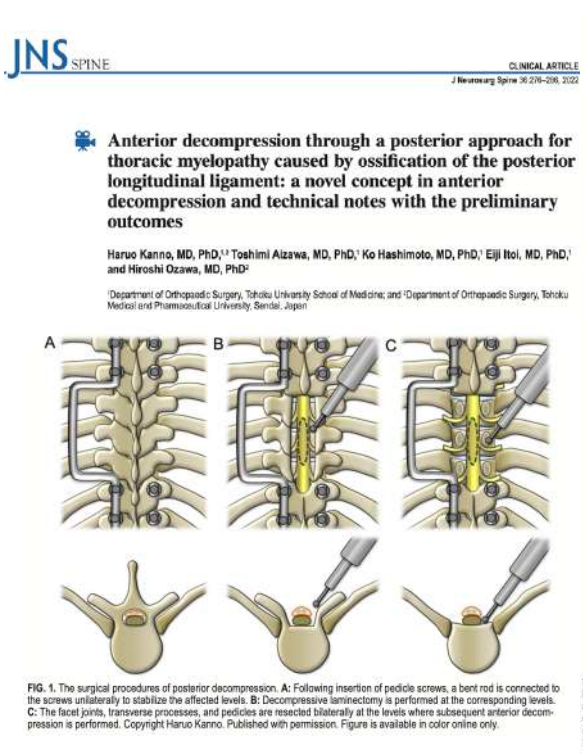


FIG. 1. The surgical procedures of posterior decompression. **A:** Following insertion of pedicle screws, a bent rod is connected to the screws unilaterally to stabilize the affected levels. **B:** Decompressive laminectomy is performed at the corresponding levels. **C:** The facet joints, transverse processes, and pedicles are resected bilaterally at the levels where subsequent anterior decompression is performed. Copyright Haruo Kanno. Published with permission. Figure is available in color online only.

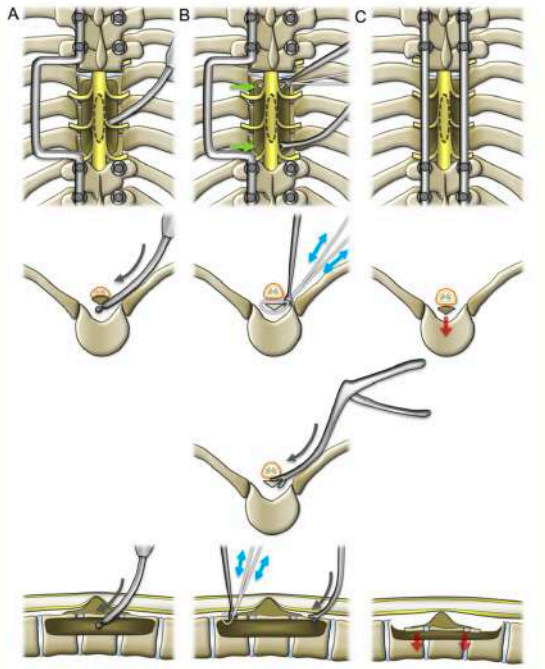
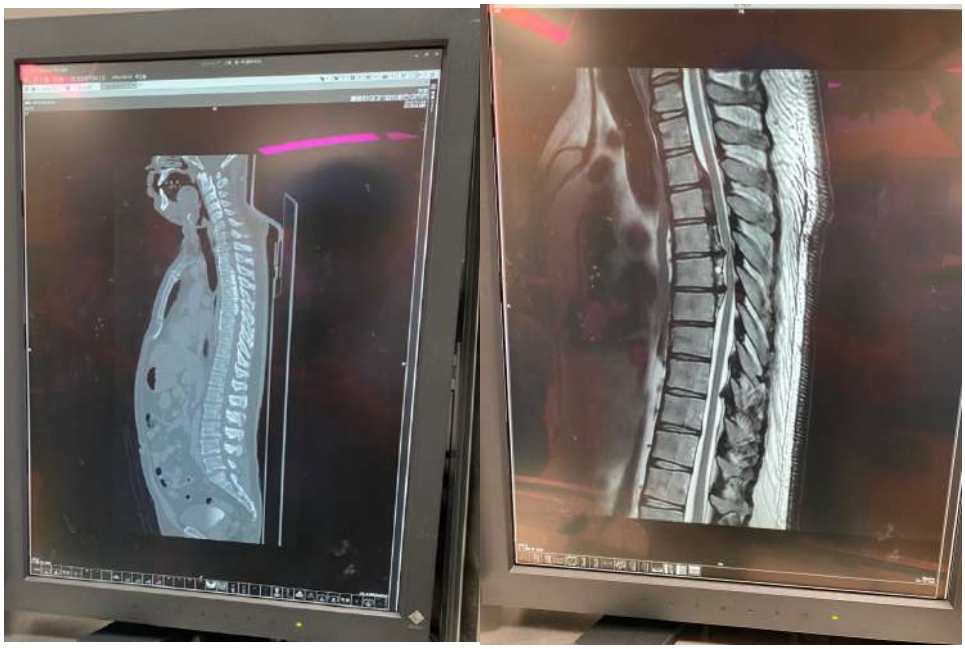


FIG. 2. The surgical procedures of anterior decompression through a posterior approach. **A:** Using a high-speed drill with a curved burr (*gray arrow*), the OPLL and posterior portion of the vertebral bodies are partially resected on both sides. **B:** The intact PLL and posterior portion of the vertebral bodies at cranial and caudal sides to the corresponding levels (*green arrows*) are resected using a threadwire saw (*blue arrows*) and/or a curved rongeur (*gray arrows*). **C:** Following anterior decompression, the anterior shift of the OPLL (*red arrows*) results in sufficient spinal cord decompression. Copyright Haruo Kanno. Published with permission. Figure is available in color online only.

The patient I observed this time had a six-segment T3-T8 OPLL. First, they stabilized the spine with a pre-bent Ω-shaped rod after fixing three levels above and below with pedicle screws (C7-T2 & T9-T11). After posterior decompression, a burr with a long-curved sheath was used for pediculectomy

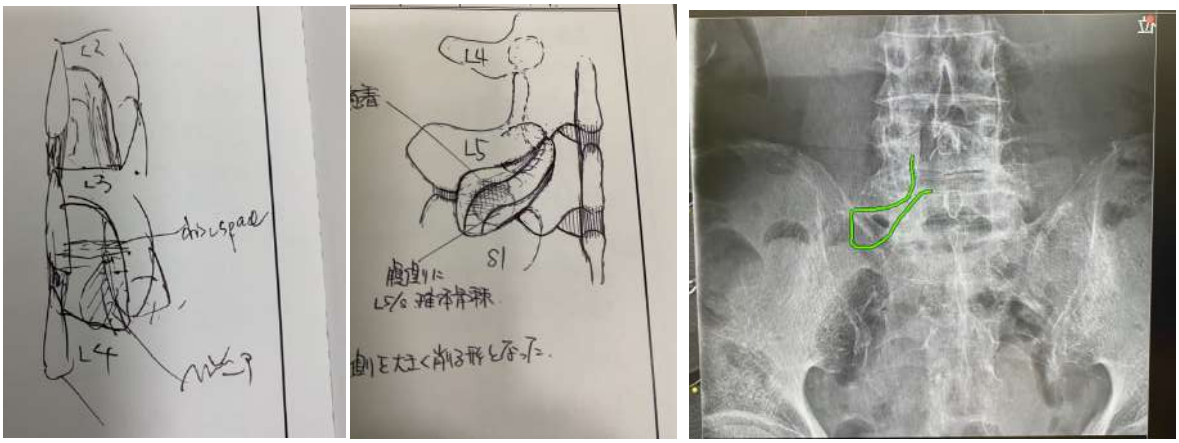
and partial corpectomy. Due to the angle of the curved burr, it is not necessary to perform costotransversectomy or sacrifice thoracic roots while doing partial corpectomy. This minimizes the impact on the blood flow of the thoracic spinal cord, postoperative chest wall numbness, and intercostal muscle weakness. After connecting the partial corpectomies of multiple segments, the Tomita saw is used to safely cut the non-ossified PLL at T3 and T8 under minimal manipulation of the spinal cord. Intraoperative ultrasound showed that the entire OPLL anterior drifts and the ventral cord compression anterior to the dura improved with more CSF flow space. Prof. Aizawa's team has treated more than 30 thoracic OPLL patients with this Modified Ohtsuka method.



In addition, I also participated in a T12 burst fracture surgery at Tohoku University Hospital. The patient had multiple trauma combined with spinal cord injury, ASIA B, and had undergone emergent posterior decompression and fixation for T10-L2 during the acute phase. Considering the comminuted fracture pattern and a McCormack score of more than 7 points, a second-stage lateral retropleural T12 corpectomy, and T11-L1 reconstruction surgery was performed. There was no need to take down the diaphragm or insert a thoracic drainage tube postoperatively due to retropleural approach. An expandable cage with large endplates was used during the surgery. The large contact area can disperse the pressure and prevent the subsequent cage subsidence and nonunion. During the surgery, I also shared our hospital's experience of lateral surgery with the doctors at Tohoku University and received great responses.

3. Lumbar Surgery

Lumbar fenestration surgery is the primarily decompressive surgery at Tohoku Central Hospital. Under the premise of preserving the posterior complex and retaining more than 50% of the facet joint, they mainly use burr to decompress bony structures and remove the entire ligamentum flavum for nerve decompression. Prof. Tanaka emphasizes the decompression to reach the upper and lower edge of the ligamentum flavum insertion and laterally to the medial border of the pedicle for complete decompression. Additionally, if it is L5 extraforaminal nerve root compression, the Wiltse approach can be used combined with the central approach for thorough decompression, which is called unroofing or radical L5 decompression in Tohoku Central Hospital.



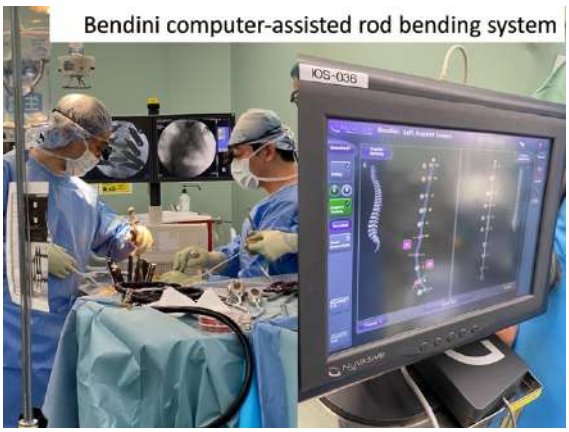
The medical record of neurologic assessment is very detailed in Tohoku Central Hospital. This is supplemented with CT myelograms and 3D MRIs for every patient. The reconstructions of 3D MRI can accurately locate coronal sections for extraforaminal pathology causing nerve root compression. The decompressive fenestration surgery is particularly suitable for aging patients, many of whom are over 80 or even close to 90, due to the agricultural nature of Yamagata Prefecture and the older age of residents. The cost of surgery without implants is also relatively low compared to instrumentation surgery.

The emphasis on preserving the posterior complex and paraspinal muscles is even reflected in surgeries for intradural extramedullary tumors in Tohoku Central Hospital. The Wiltse approach is used and a hemilaminectomy window is used for durotomy and tumor excision.

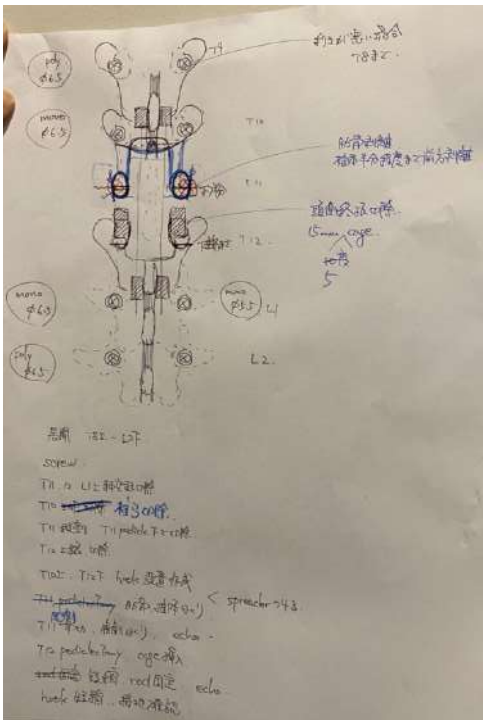
For adult spinal deformity, Tohoku Central Hospital and Tohoku University Hospital mostly opt for a staged operation. The first stage uses XLIFs to restore lordosis from L2 to L5, and then a week later, the second stage posterior spinopelvic fixation and L5-S1 PLIF are performed. Right-sided retroperitoneal transpsoas approach was mainly used in the XLIF procedure. Full-time nerve monitoring with free-run EMG is used during the entire procedure, and trigger EMG is used when placing the dilator. Preoperative MRI and CT myelogram, along with 3D reconstruction of bony and vascular structures in CT were assessed. This helps to carefully assess the risk of great vessel injuries during lateral surgery.

The second stage of posterior surgery emphasizes the reconstruction of L4-S1 lordosis to about 35-40 degrees. The alignment target of the overall lumbar lordosis is determined by the individual's spinopelvic parameters. In Tohoku University Hospital, an intraoperative thigh elevation device is used to create excessive hip extension, thereby increasing lumbar lordosis. The postural reduction maneuver avoids excessive stress on the pedicle screws and rods, thereby reducing the risks of subsequent screw loosening or rod fracture.

Another useful tool was the Nuvasive Bendini computer-assisted rod bending system used for long-segment deformity correction surgery. After the pedicle screws are placed, each screw head position is registered using computer navigation. The computer then automatically generates the shape of the rod based on the position of each screw head. The shape of the rod can be modified according to the desired alignment correction angle. The computer produces a series of suggestions on where and how much to bend the rod. Surgeons only need to follow the suggestions step by step to bend the rod. Although this may not be of much help to senior experienced deformity surgeons, it may benefit junior doctors in rod placement by reducing surgical time, preventing rod fracture resulting from repetitive rod bending, and reducing stress on pedicle screws.



For compression fracture nonunion or malunion causing kyphotic deformity, Prof. Tanaka and his team use the spinal shortening osteotomy invented by Prof. Kokubun. Monoaxial pedicle screws and Kokubun laminar hooks are used 1-level above and below, similar to the 4-rod construct to reduce the fusion level. Spinal shortening osteotomy is similar to a Schwab type 4 osteotomy. The main concept is to excise the wedged part and restore the rectangular shape of the vertebra. Along with the adjacent discectomy, the deformed wedged vertebra and disc space are shortened. The approach is smaller compared with the conventional pedicle subtraction osteotomy we usually perform at our hospital.

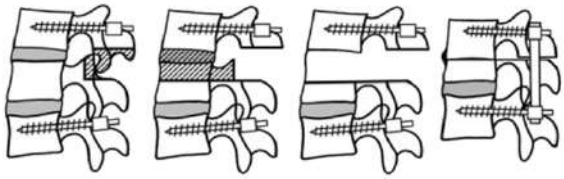


J Neurosurg Spine 15:21–27, 2011

Spine-shortening osteotomy for patients with tethered cord syndrome caused by lipomyelomeningocele

Clinical article

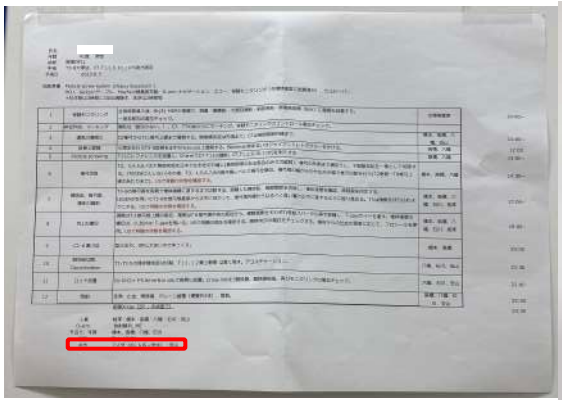
Shoichi Kokubun, M.D., Ph.D.,[1] Hiroshi Ozawa, M.D., Ph.D.,[1] Toshimi Aizawa, M.D., Ph.D.,[1] Ngo Minh Ly, M.D., Ph.D.,[1] and Yasuhisa Tanaka, M.D., Ph.D.[2]



Other thoughts

1. Intraoperative navigation has become a standard configuration for complex spinal surgeries, which has a great effect on reducing radiation, increasing the safety of complex surgeries, and training junior doctors. At Tohoku University Hospital, every complex spine surgery uses navigation for assistance.
2. The imaging system in the operating room of Tohoku University Hospital is very advanced. The surgical camera can be connected to the entire operating room, even to the operation room cafeteria to broadcast live surgery progress. This is very helpful for teaching and the surgical team members to grasp the progress.

3. Doctors at Tohoku University Hospital pay great attention to the team approach for complex spine surgery. They will list all the steps, required time, equipment preparation, and which members of the team should perform each stage of the operation in a table in advance. This is announced to all medical team members including the anesthesiologists, operating room nurses, radiologists, and medical students, and posted in the operating room to remind all members. The meticulousness even includes how many lunch boxes should be ordered at noon and who should order the lunch boxes.



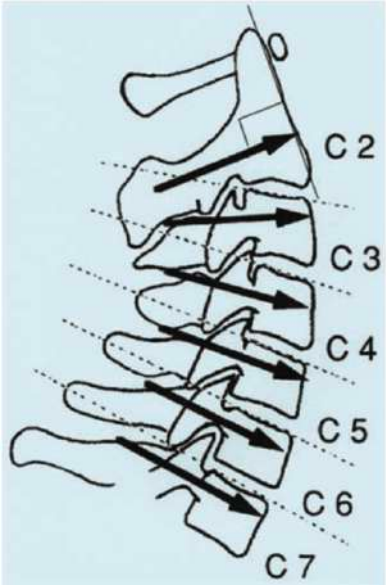
Prof. Aizawa and his team in Tohoku University Hospital

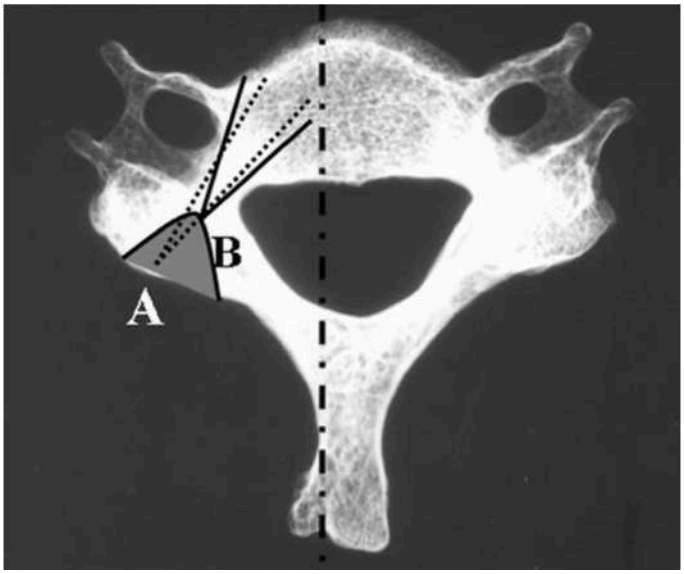
4. Observing the operating room rotation and nursing manpower control at Tohoku Central Hospital, I feel that it is very important to establish a nursing team. The nurses are not just responsible for a single operating room but move around to support each operating room under the direction of the head nurse. The team spirit prevents situations where some nurses are overwhelmed while others are idle. In addition, communication between the doctors and the surgical nursing team is key. A week before the surgery schedule, discussions will be held to prepare instruments for special surgeries and discuss possible surgical procedures in advance to prevent confusion.
5. In the operating room, there are many notes and reminders for standardized surgical procedures on the walls. Even newcomers like me can clearly understand the standard preparation process for different positions at a glance. Timeout, intraoperative positioning, and antibiotics will be noted on the whiteboard by the circulating nurse to remind all team members at all times. When the surgery is finished and the wound is being prepared for closure, the anesthesiologist will be notified so that the patient can wake up as soon as possible to increase operating room efficiency. I greatly admire these details, which is why Tohoku Central Hospital as a regional hospital can become the highest surgical volume hospital in the Tohoku region.

Learning Experience in Hokkaido

With the approval of Prof. Abumi and Prof. Tanaka, I spent the last two weeks of September in Sapporo, Hokkaido. Prof. Abumi serves as the director of the Sapporo Orthopedic Hospital and actively performs complex spine surgeries, including high cervical spine surgeries and deformity surgeries for cervical, thoracic, and lumbar spine. Apart from Sapporo Orthopedic Hospital, Prof. Abumi also arranged visits to different hospitals around Sapporo, like the endoscopic surgeries at the Sapporo Spine Endoscopic Clinic and scoliosis surgery at the Eniwa Hospital. However, due to my short stay in Hokkaido, I participated in fewer surgeries, but it was still a very enriching learning experience.

I had the privilege of learning Prof. Abumi's freehand subaxial cervical pedicle screw technique at the Sapporo Orthopedic Hospital. Prof. Abumi evaluates the preoperative brain CTA to see the Circle of Willis and the dominant side of the vertebral artery prior to the surgery. In surgery, Prof. Abumi stands on the head side of the patient, confirming the true lateral view under an intraoperative fluoroscope before inserting bilateral pedicle screws. He emphasizes that it's not necessary to pursue the anatomic pedicle axis, and enlarging the lateral mass insertion pilot hole can provide a more flexible safety trajectory for the pedicle screw. According to Prof. Abumi, a slightly medial breach of the pedicle wall is usually asymptomatic.





Apart from this, Prof. Abumi arranged for me to learn spine endoscopic surgery from Dr. Nagahama at the Sapporo Spine Endoscopic Clinic. Dr. Nagahama's simultaneous double C-arm approach and preoperative use of 3D CT and MRI for AI fusion imaging to precisely measure the endoscopic trajectory angle and distance left a deep impression on me. Moreover, Dr. Nagahama's development of the percutaneous endoscopic transforaminal lumbar interbody fusion (PETLIF) is an excellent minimally invasive fusion option.

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https://doi.org/10.1007/s00586-021-06916-y

ORIGINAL ARTICLE

Morphological analysis of Kambin's triangle using 3D CT/MRI fusion imaging of lumbar nerve root created automatically with artificial intelligence

Katsuhisa Yamada[1] · Ken Nagahama[2,3] · Yuichiro Abe[4] · Yoshinori Hyugaji[2,3] · Masahiko Takahata[1] · Norimasa Iwasaki[1]

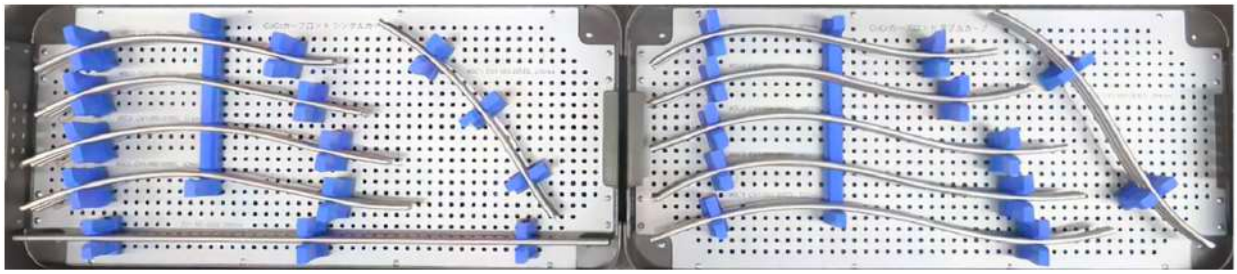
Prof. Abumi also arranged scoliosis surgery observation at Eniwa Hospital. Dr. Yuichiro Abe, Dr. Terufumi Kokabu and Dr. Yoko Ishikawa in Eniwa Hospital performed the scoliosis surgery. They first do multiple Ponte osteotomies to increase curve flexibility and then use the double rod derotation technique, applying two of the 11 AI-determined prebent CoCr rods to restore physiological alignment for adolescent idiopathic scoliosis patients. Direct vertebral rotation (DVR) is also performed to achieve excellent correction results. This correction technique has been published in JBJS Essential Surgical Technique for the guidance of spine deformity surgeons worldwide and has reproducible correction results.

JB&JS
ESSENTIAL SURGICAL TECHNIQUES

SUBSPECIALTY PROCEDURES

Four-Dimensional Anatomical Spinal Reconstruction in Thoracic Adolescent Idiopathic Scoliosis

Hideki Sudo, MD, PhD



Reflection and Gratitude

Prof. Tanaka and Prof. Abumi are true masters of spine surgery, humble, knowledgeable, and willing to guide surgeons of the next generation. I gained and learned a lot during my three months in Japan. I am also grateful to APSS for providing such a good exchange platform, allowing me, a young spine surgeon, to have the honor of learning at overseas APSS spine centers and meeting many passionate scholars from abroad, deepening my understanding of spinal disease treatment.

Case logbook

Date	Age	Sex	Diagnosis	OP methods	Role	Hospital
7/3	85	F	Deg. Lumbar scoliosis; Lumbar spinal stenosis	L2-5 XLIF + posterior percutaneous pedicle screw (PPS)	A1/A2	Tohoku Central Hospital
7/4	57	M	HIVD	L4-5 left laminotomy + discectomy	A1	Tohoku Central Hospital
7/4	77	M	L4 compression fracture; Lumbar spinal stenosis	L3-4, L4-5 bilateral laminotomy	A1	Tohoku Central Hospital
7/5	85	F	Lumbar spinal stenosis	L3-4, L4-5 left laminotomy	A1	Tohoku Central Hospital
7/5	80	F	cervical OPLL	C3-6 laminoplasty (Kurokawa method)	A2	Tohoku Central Hospital
7/6	83	F	Lumbar spinal stenosis	L3-4, L4-5 bilateral laminotomy	A1	Tohoku Central Hospital
7/7	71	M	Lumbar spinal stenosis	L3-4, L4-5, L5-S1 right laminotomy	A1	Tohoku Central Hospital
7/10	46	F	HIVD	L5-S1 left laminotomy + discectomy	A1	Tohoku Central Hospital
7/11	46	M	HIVD	L5-S1 MED left laminotomy + discectomy	A1	Tohoku Central Hospital
7/11	75	F	Lumbar spinal stenosis	L2-3 left laminotomy + L3-4 PLIF	A1	Tohoku Central Hospital
7/12	74	M	Lumbar spinal stenosis	L3-4, L4-5 bilateral laminotomy	A1	Tohoku Central Hospital

7/14	41	M	cervical radiculopathy	C6-7 right foraminotomy	A1	Tohoku Central Hospital
7/14	62	F	Lumbar spinal stenosis	L4-5 bilateral laminotomy	A1	Tohoku Central Hospital
7/18	72	F	HIVD	L2-3 left laminotomy + discectomy	A1	Tohoku Central Hospital
7/18	71	M	HIVD	L2-3 right laminotomy + discectomy	A1	Tohoku Central Hospital
7/18	56	M	cervical radiculopathy	C4-5, C5-6, C6-7 left foraminotomy	A1	Tohoku Central Hospital
7/19	81	M	cervical radiculopathy	C7-T1 right foraminotomy	A1	Tohoku Central Hospital
7/19	69	F	Lumbar spinal stenosis; HIVD	L2-3 right laminotomy + discectomy, L3-4 right laminotomy, L4-5 bilateral laminotomy	A1	Tohoku Central Hospital
7/21	74	M	Lumbar spinal stenosis	L4-5 bilateral laminotomy	A1	Tohoku Central Hospital
7/24	67	M	Lumbar spinal stenosis	L3-4, L4-5 bilateral laminotomy	A1	Tohoku Central Hospital
7/25	63	F	cervical radiculopathy	C6-7 right foraminotomy	A1	Tohoku Central Hospital
7/25	76	M	cervical myelopathy	C3-7 laminoplasty (Kurokawa method)	A1	Tohoku Central Hospital
7/26	61	F	cervical radiculopathy	C5-6, C6-7 foraminotomy	A1	Tohoku Central Hospital

7/26	56	M	Lumbar spinal stenosis; HIVD	L3-4 bilateral laminotomy, L4-5, L5-S1 right laminotomy, L4-5 discectomy	A2	Tohoku Central Hospital
7/27	69	M	Lumbar spinal stenosis; HIVD	L3-4 PLIF + L4-5 TLIF	A2	Tohoku Central Hospital
7/28	71	M	cervical myelopathy	C3-4 laminoplasty (Kurokawa method)	A1	Tohoku Central Hospital
7/31	64	M	Lumbar spinal stenosis	L3-4 TLIF + L3-S1 TPS	A2	Tohoku Central Hospital
8/1	57	F	C4-5 pyogenic spondylodiskitis	C3-6 pedicle screws + lateral mass screw, C4-5 right foraminotomy	A1	Tohoku Central Hospital
8/2	72	M	L2 cauda equnia intradural tumor	L1-3 right hemilaminectomy + tumor excision	A2	Tohoku Central Hospital
8/3	41	M	cervical OPLL + thoracic OPLL	C2-6 laminoplasty (Kurokawa method) + T3-8 OPLL anterior shifting (modified Ohtsuka method) + C7-T11 TPS	A3	Tohoku University Hospital
8/4	49	M	cervical radiculopathy	C6-7 right foraminotomy	A1	Tohoku Central Hospital
8/4	67	M	cervical OPLL	C3-5 laminoplasty (Kurokawa method)	A1	Tohoku Central Hospital
8/7	18	M	HIVD	L5-S1 left laminotomy + discectomy	A1	Tohoku Central Hospital
8/8	61	F	HIVD	L4-5 left laminotomy + discectomy	A1	Tohoku Central Hospital

8/8	84	F	cervical myelopathy	C3-4 Anteriror decompression and fusion	A2	Tohoku Central Hospital
8/9	69	F	Lumbar spinal stenosis	L5-S1 left laminotomy	A1	Tohoku Central Hospital
8/9	43	M	cervical myelopathy	C3-5 laminoplasty (Kurokawa method)	A1	Tohoku Central Hospital
8/10	59	M	Lumbar spinal stenosis	L4-5 TLIF	A1	Tohoku Central Hospital
8/14	81	M	Deg. Lumbar scoliosis	L3-4, L4-5 OLIF + L5-S1 PLIF + L3-S2AI percutaneous pedicle screw	A2	Tohoku Central Hospital
8/15	73	F	Deg. Lumbar kyphosis	2nd stage OP: L5-S1 PLIF + T10-S2AI TPS	Observer	Tohoku Central Hospital
8/15	66	F	Lumbar spinal stenosis	L3-4, L4-5 bilateral laminotomy	A1	Tohoku Central Hospital
8/16	72	F	L3 compression fracture with kyphosis	L3 vertebral body shortening osteotomy + L2-4 TPS & Kokubun hook	A2	Tohoku Central Hospital
8/17	76	F	Deg. Lumbar spondylolisthesis + Lumbar spinal stenosis	L3-4 PLIF	A1	Tohoku Central Hospital
8/18	80	F	Lumbar spinal stenosis	L3-4, L4-5, L5-S1 right laminotomy + L5-S1 discectomy	A1	Tohoku Central Hospital
8/21	89	M	Lumbar spinal stenosis	L4-5 bilateral laminotomy + right facet cyst excision	A1	Tohoku Central Hospital

8/21	74	M	L2 compression fracture with kyphosis + Lumbar spinal stenosis	L2 vertebral body shortening osteotomy + L1-3 TPS + Kokubun hook + L3-4 bilateral laminotomy	Observer	Tohoku Central Hospital
8/22	77	F	Lumbar spinal stenosis	L4-5 PLIF	Observer	Tohoku Central Hospital
8/23	66	M	Lumbar spinal stenosis	L2-3 bilateral laminotomy + L3-4, L4-5 PLIF	A2	Tohoku Central Hospital
8/25	79	F	C1-2 subluxation + basilar invagination	O-C2 fusion + C1 laminectomy + Foramen magnum decompression	A2	Tohoku Central Hospital
8/28	68	M	Lumbar spinal stenosis; adjacent segment dissease	L1-2 TLIF + L3-4 PLIF + T10-S1 TPS	A2	Tohoku Central Hospital
8/29	82	F	Lumbar spinal stenosis; L2, L3 compression fracture	L3-4 PLIF	A1	Tohoku Central Hospital
8/30	53	M	Lumbar spinal stenosis	L4-5 TLIF	A1	Tohoku Central Hospital
8/31			T12 burst fracture post T10-L2 TPS	T12 retropleural corpectomy and ALIF with expandable cage	A2	Tohoku University Hospital
9/1	82	M	Recurrent HIVD	L4-5 revision laminotomy + discectomy + right L5 root radical decompression	A1	Tohoku Central Hospital
9/4	72	F	Thoracic kyphosis	T11 shortening osteotomy + T11-12 PLIF + T9-L2 TPS	A3	Tohoku Central Hospital

9/5	75	M	Lumbar spinal stenosis	1st stage OP: L2-3, L3-4, L4-5 XLIF	A2	Tohoku Central Hospital
9/6	70	M	Lumbar spinal stenosis	L1-2 revision TLIF	A2	Tohoku Central Hospital
9/8	68	F	Deg. Lumbar kyphoscoliosis	1st stage OP: L2-3, L3-4 XLIF	A2	Tohoku University Hospital
9/8			Lumbar spinal stenosis	L4-5 revision TLIF	A2	Tohoku University Hospital
9/11	75	M	Lumbar spinal stenosis	2nd stage OP: L5-S1 PLIF + L2-S2AI TPS	A3	Tohoku Central Hospital
9/14	68	F	Deg. Lumbar kyphoscoliosis	2nd stage OP: L4-5, L5-S1 TLIF + T10-S2AI TPS + T9 tape augmentation	A3	Tohoku University Hospital
9/21	56	F	Cervical myelopathy; HIVD	C5-7 ACCF	Observer	Sapporo Orthopaedic Hospital
9/21	77	M	Lumbar spinal stenosis	L3-5 laminectomy	A1	Sapporo Orthopaedic Hospital
9/22	85	M	Lumbar spinal stenosis	L2-5 laminectomy	A1	Sapporo Orthopaedic Hospital
9/22	69	M	Cervical radiculopathy post ADR	C5-6 left radical foraminotomy + TPS	A1	Sapporo Orthopaedic Hospital
9/25	79	M	Lumbar spinal stenosis	L3-5 laminectomy	A1	Sapporo Orthopaedic Hospital
9/25	80	M	cervical myelopathy	C2-4 laminectomy	A1	Sapporo Orthopaedic Hospital

9/26	59	F	Cervical HIVD	C5-6, C6-7 ADR	A1	Sapporo Orthopaedic Hospital
9/27			Deg. Lumbar spondylolisthesis + Lumbar spinal stenosis	L3-4 laminectomy + L4-5 PETLIF	Observer	Sapporo Spine Endoscopic Clinics
9/27			HIVD	PETD	Observer	Sapporo Spine Endoscopic Clinics
9/27			HIVD	PETD	Observer	Sapporo Spine Endoscopic Clinics
9/27			Lumbar spinal stenosis	L3-5 laminectomy	Observer	Sapporo Spine Endoscopic Clinics
9/28	13	F	Adolescent idiopathic scoliosis	T8-L4 TPS + double rod correction	A3	Eniwa Hospital