REVIEW ARTICLE

Advances in neurosurgery: The Fujita Health University experience

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ABSTRACT

In a world with rapidly changing technologies in the field of neurosurgery, Japan leads the world in many subspecialities like vascular neurosurgery. Apart from this, neuro-oncology and spinal surgeries are also among the premium quality operations performed in the region. I would like to share my experience of spending 3 months at the Fujita Health University, Nagoya, Japan, and the rich expertise and technologies encountered during the period, which made me understand Neurosurgery in a better way.

Key words: Anastomosis, aneurysms, angiography, tumors

Neurosurgeons share a great professional gift; our lives have yielded an opportunity to help people in a unique and exciting way. I would like to reflect on the joy and excitement of being allowed to participate in the miracle that we call "Neurosurgery"

-Albert Rhoton

These are very famous lines from a person who is considered a legend in neurosurgical field as far as concepts of intriguing areas of brain anatomy is concerned. When we say "miracle," we mean it by every stretch of imagination as it has given so many patients those few years of disease-free lives, which was a rarity earlier. The field of neurosurgery has expanded its wings in last few years where virtually no part of brain has remained inaccessible. Recently, as India has emerged as a center for medical tourism, a lot of newer techniques and new technology has helped Indian neurosurgery to emerge at the forefront on the world map. The neurosurgery department at Bombay Hospital Institute of Medical Sciences has flourished over the years due to presence of a dynamic faculty which has helped many young neurosurgeons achieve glory. Owing to the sheer volume of cases coupled with the cutting edge technology and techniques in Japan, there could be no better place than Japan, to further add on the assets gained from my residency at the Bombay Hospital.

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As soon as I came here, the magnificent campus of Fujita Health University (FHU) hospital welcomed me along with the expert faculty of neurosurgeons which included Prof. Yoko Kato, who has earned the respect of many across the world as a dexterous vascular neurosurgeon from Japan. She constantly encouraged us to contribute to the department in every possible way. Other members of the vascular team included Dr. Watabe who has expertise in endoscopic evacuation of thalamic hematoma, Dr. Imizu who has expertise in microvascular anastomosis, Dr. Oda, and Dr. Oguri.

The other stalwarts in the department were Dr. Motoi Shoda who is an expert in spine surgeries and has an experience of more than 400 cases of lumbar spondylolisthesis surgeries. Along with him, the spine team included Dr. Kuno and Dr. Inoue. Dr. Shoda was instrumental in teaching all the fellows, the fine tips of spine surgery including instrumentation of lumbar and cervical spine. He made sure that the fellows attended spine conferences and CMEs and discussed the neurosurgical cases at length. Similarly, the oncology team had Dr. Hirose, Dr. Hasegawa, Dr. Yoshida, and Dr. Nagahisa who tirelessly carried out tumor surgeries throughout the day and operated on many complex skull-base tumors.

The department of neurosurgery at FHU has an extensive schedule for the international fellows including morning clinical meetings, neurosurgical care unit rounds, and participating in the daily surgeries. I had a keen interest in vascular neurosurgery and as Dr. Yasargil had stated once "only few people can dissect sylvian fissure", I surely wanted to be one.

I will be sharing my training experience at the FHU under following three divisions:

Vascular Neurosurgery

FHU is recognized as a center of excellence in microvascular neurosurgery worldwide. Many international fellows work here for gaining expertise in the surgical management of aneurysms, arteriovascular malformations (AVMs), and vascular bypass procedures for the much common Moya-moya disease. The vascular team consists of Prof Kato, Dr. Watabe, Dr. Imizu, Dr. Oda, and Dr. Oguri. The enlightening guidance of Dr. Sano is always present in technically challenging cases and he constantly shares his experiences in aneurysmal clipping surgeries with the fellows.

Instruments and technology

One small but vital tool here is the *"Jet irrigation bipolar forceps"* [Figure 1]. It is developed by Dr. Sano *et al*.[1] and serves as an indispensable gadget for jet irrigation while applying bipolar coagulation.

Its rate of irrigation as well as the number of drops can be changed as per the need and the irrigation is controlled by the surgeon with a foot switch. Apart from this, a wide variety of fine micro instruments including suctions, forceps, and clip applicators help in achieving excellent results. They also use 0 and 30 degree rigid endoscopes to visualize the deeper inaccessible parts of the aneurysm including the neck and perforators. The clip is applied and its position is confirmed under the endoscopic guidance which helps to prevent the inadvertent inclusion of perforators in the jaws of the clip and helps to identify any residual neck [Figure 2]. It definitely can help in achieving better clipping outcomes with lesser morbidity or smaller vessel infarcts.

Indocyanine green video angiography

Indocyanine green (ICG) is a dye used for intraoperative visualization of the vessels, veins, aneurysms, AVMs, and the Superficial temporal artery-Middle cerebral artery (STA-MCA) anastomosis. The dye is injected after the procedure at surgeon's discretion and it emits fluorescence after the application of infrared light and complete vascular anatomy including the arterial, capillary, and the venous phases can be visualized with the microscope. Thus, obliteration of the aneurysm and filling of nearby arteries/perforators [Figure 3], identification of arterial feeders and draining veins in an AVM, and the adequacy of the STA-MCA anastomosis, all can be seen easily with ICG angiography.

A recent addition to its armamentarium, FLOW 800 software, can analyze the temporal relation of the dye flow in the arteries and veins and interpret it as a graphic color-coded diagram [Figure 4]. FLOW 800 can thus be useful in both aneurysms and AVM surgeries, improving one's surgical outcome and results.

Three-dimensional computed tomography angiography

Three-dimensional computed tomography angiography (3D-CTA) is done for preoperative planning of ruptured and un-ruptured aneurysms and all the findings of the CTA are found concordant during the surgery. Thus, the conventional angiography has been replaced nearly completely as far as aneurysms are concerned.[2] Multiple views are taken along with the skull base and complex aneurysms involving the anterior communicating artery, posterior communicating artery, and internal carotid artery are seen with good resolution and their relationship to any vessel which is adhered to the dome can be studied. This may be particularly true in cases of MCA aneurysms. Aneurysms from anterior choroidal artery may also be detected, although smaller vessels may not be seen always (<1.2 mm). Operative simulation is done before the surgery. This is done after subtracting the proposed craniotomy bone from the image and rotating it as for example, a pterional craniotomy [Figure 5]. This helps the surgeon to orient himself regarding the position of the neck and dome of the aneurysm.

In cases of large ophthalmic aneurysms, even the extent of anterior clinoid drilling can be pre-assessed by bony subtraction of the ACP. Large cavernous segment ICA aneurysms can be easily visualized without any bone artifact. A large MCA aneurysm with small perforators stuck on its wall could be correlated well during the surgery [Figure 6].

Currently, the indications for digital subtraction angiography (DSA) here have been restricted to cerebral AVMs and in case of failure of 3D-CTA to demonstrate the aneurysm.

Technical details

The 3D-CTA at FHU hospital is performed using 320 row area detector CT Aquilion one (Toshiba Medical Co., Ltd) with the following parameters:

- 120 kV/270 mA
- Slice thickness: 0.5 mm
- Scan speed: 1.0 sec/cycle
- Scan range: 8.0 mm from foramen magnum
- Scan triggering: Sure start function
- Reconstruction pitch: 0.5 mm
- Target reconstruction: FOV = 24 cm (Side: M2-M3; Front: A2-A3; Post: VA-pica)
- 3D workstation: Toshiba extension (San Spark 20)
- Algorithm: Volume rendering
- 3D image: standard 11 projections + additional projection

Surgical techniques

Most of the aneurysms are unruptured here and thus excellent brain relaxation allows the surgeon to perform the surgery with minimal use of brain retractors. The sylvian fissure is dissected sharply and utmost care is taken to preserve each

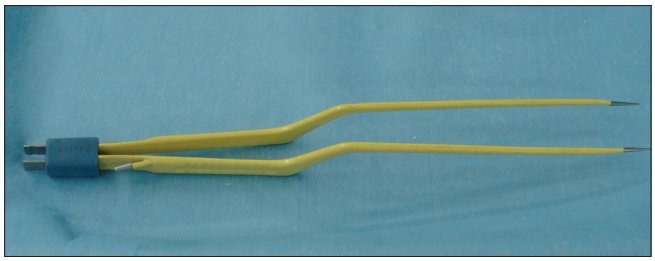

Figure 1: Jet irrigation bipolar forceps

Figure 2: Endoscopic visualization of the blades of the clip across the neck of an aneurysm

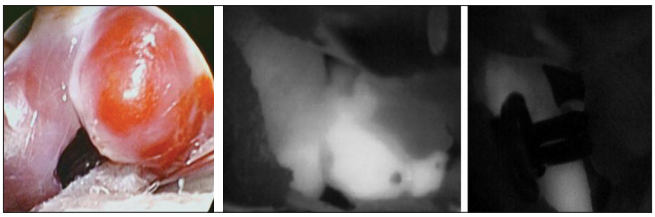

Figure 3: P-com aneurysm with complete exclusion from the circulation as witnessed by the nonvisualization of the dome on ICG angiography

vessel and especially veins and whenever in doubt, ICG angiography is performed to confirm their integrity. Various kinds of clips are available and appropriate size is chosen according to the neck size and aneurysm morphology. A special mention regarding ophthalmic segment ICA aneurysms is well deserved here as they are operated very frequently here. The anterior clinoid process is drilled extradurally with the help of bone CUSA and optic nerve is exposed. Then, the dura (falciform ligament) is cut on the optic nerve to expose the canalicular portion completely. Then, it is mobilized to visualize the neck which is clipped subsequently. Retrograde suction decompression is used for clipping large aneurysms. For STA-MCA anastomosis for Moya-moya disease, at least 8 cm of STA is identified and harvested with the help of a Doppler and the frontal and/or parietal branches are anastomosed

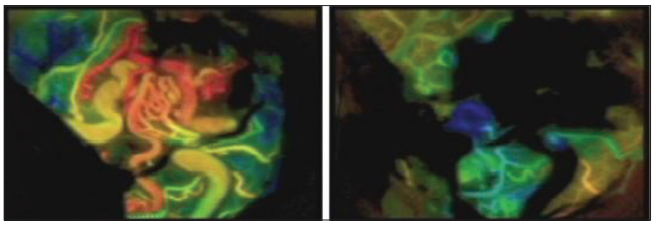

Figure 4: An AVM after color coding done by FLOW 800 (red: arteries; blue: veins, orange: arterialized veins)

Figure 5: Simulation of pterional craniotomy for approaching a P-com aneurysm

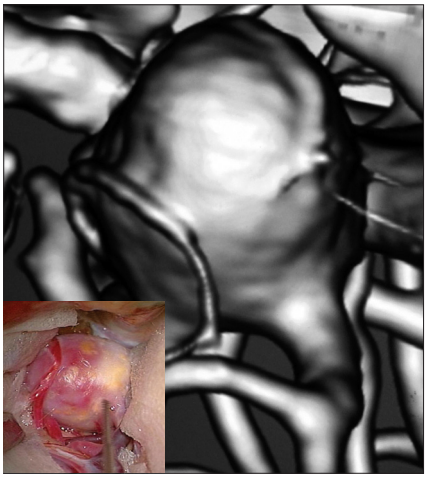

Figure 6: Intraoperative correlation of a large MCA aneurysm with perforators stuck to the wall

with the cortical MCA branches (M4). As mentioned, all the procedures are validated by an ICG angiography.

I would like to mention about Dr. Watabe's expertise in endoscopic removal of thalamic hematoma with intraventricular extension. He uses the contralateral frontal horn to enter in the lateral ventricle. Then, he performs a septostomy and enters into the lateral ventricle with the hemorrhage. After copious irrigation to maintain vision, he clears off the intraventricular component which guides him then to the site of rupture in the

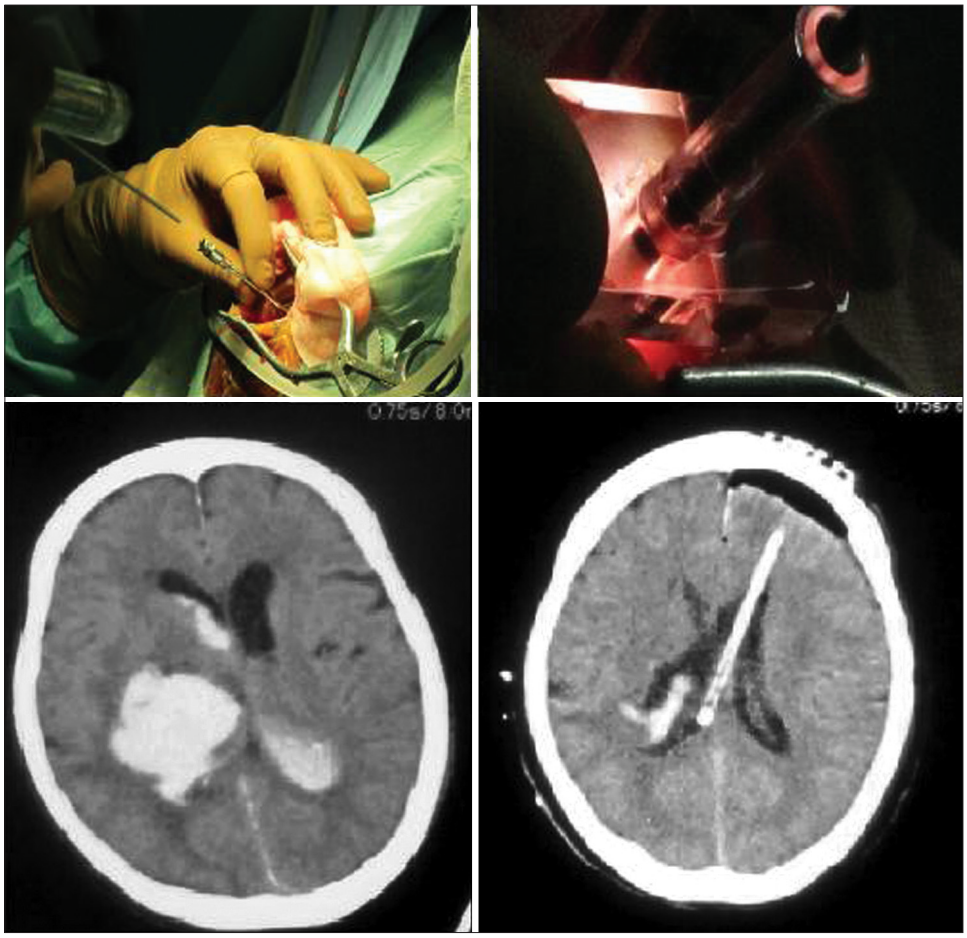

Figure 7: Endoscopic evacuation of right thalamic hematoma by contralateral approach

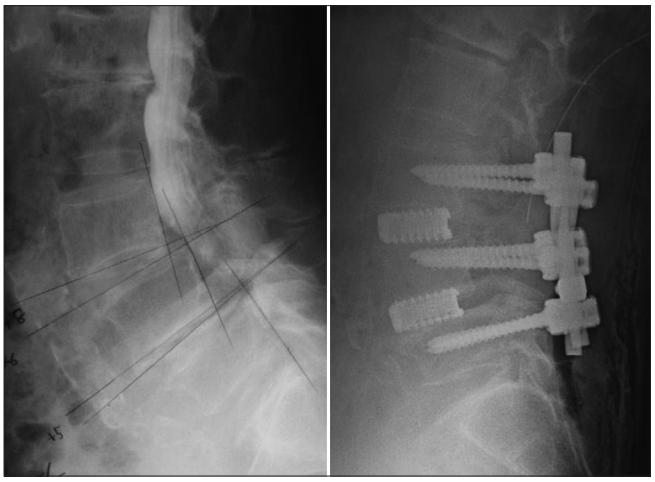

Figure 8: Pre- and post-operative X-rays of two-level isthmic spondylolisthesis

ependymal wall which subsequently leads to the hematoma cavity. The hematoma is sucked out and a drain is kept [Figure 7]. This less morbid approach helps in faster recovery of the patients. Hematoma removal of more than 38 mm size has been life saving for patients, while lesser volumes were removed to improve their functional status.

Spine Surgery

The spine surgical team consists of dynamic Dr. Motoi Shoda, Dr. Kuno, and Dr. Inoue. Dr. Shoda has a vast experience with lumbar spondylolisthesis and is a renowned spine surgeon internationally.[3] He has a great aptitude of teaching the fellows, communicating with them and to discuss the pathology of the disease in detail. He has been instrumental in the field of spine surgery since 1989. The wide range of cases include those of intra/extramedullary tumors, lumbar spondylolisthesis, cervical and lumbar disc herniations, cervical spondylotic myelopathy, and Chiari malformations.

Surgical techniques

I observed numerous procedures here and one such procedure was posterior lumbar interbody fusion (PLIF). This was a rather rare case of two-level isthmic spondylolisthesis. She was a 70-year-old patient who presented with features of back pain and intermittent claudication. The imaging protocol for every patient here includes plain X-rays, flexion-extension rays, X-ray myelogram, CT myelogram, and MRI. CT myelogram remains a mainstay investigation where facet anatomy becomes evident and dysplasia can be picked up with ease. The imaging had

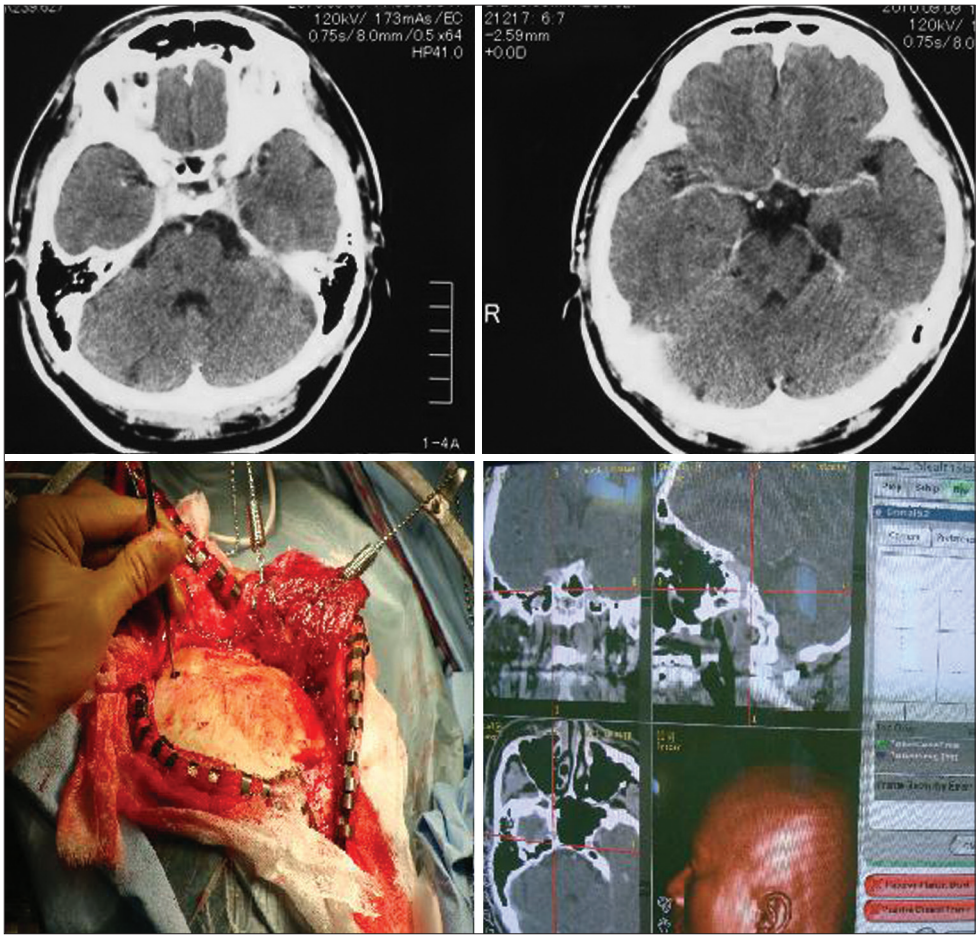

Figure 9: Preoperative CT scan showing an epidermoid in the left CP angle and exposure during anterior petrosectomy for the same using neuronavigation

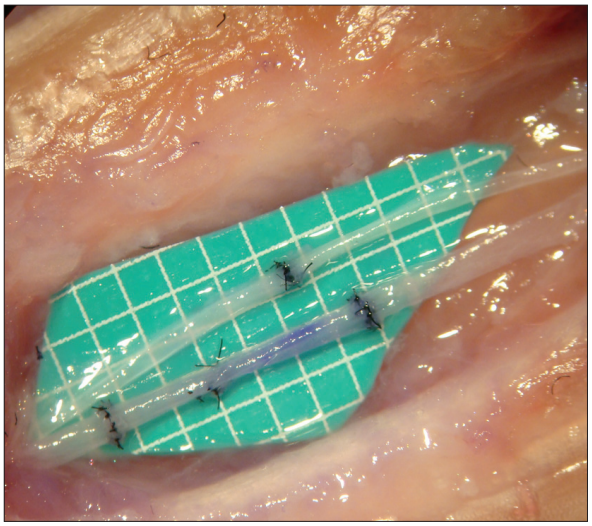

Figure 10: Microvascular and neural anastomosis on chicken wings

shown lumbar canal stenosis with Grade I listhesis at L3-4 and Grade II listhesis at L4-5 levels. Intra-operatively, titanium spacers of 12 mm with 50% hydroxyapatite were inserted in the disc space. In addition, the hydroxyapatite tubes were used to pack the remaining disc space. This helps in accelerating the bony fusion between the two endplates. The pedicular screws were inserted at L3, L4, L5 levels (5×45 mm). After the interbody spacers were in place, the root decompression became much easier. Postoperative result was excellent with immediate mobilization of the patient [Figure 8].

Oncology

The bulk of the neuro-oncology division is handled by the team of Dr. Hirose, Dr. Hasegawa, Dr. Matsuyama, Dr. Yoshida, and Dr. Nagahisa. Pituitary tumors, skull base meningiomas including anterior clinoid and tuberculum sellae meningiomas, vestibular schwannomas, and epidermoids constitute the bulk here.

Technology and digital subtraction angiography

Here, the STEALTH navigation is used for all the eloquent area surgeries. Another important difference is the frequent use of the DSA preoperatively to assess the tumor vascularity and embolization if needed.

Surgical techniques

Skull base surgeries are frequently done and we witnessed a petroclival meningioma, which was operated from the anterior

petrosectomy approach[4] (Kawase's approach). The patient was placed in the lateral position and temporal craniotomy done after lumbar drain was inserted. Neuronavigation was used for this patient. The other patient who was operated from the same approach was having recurrent trigeminal neuralgia due to a cerebello-pontine angle epidermoid. This patient who was operated twice through the retro-mastoid route was relieved of his pain after the surgery from the anterior petrosectomy approach [Figure 9].

Subtemporal extradural identification of the middle meningeal artery, the arcuate eminence, the greater superficial petrosal nerve, and gasserian ganglion was done and Kawase's triangle was drilled off. The posterior fossa dura was exposed and then, middle fossa dura was opened. The tentorium was cut after ligating the superior petrosal sinus and then the posterior fossa dura was opened too, forming a single cavity. The trigeminal nerve was freed and the epidermoid was excised piecemeal.

Neurosurgery Conferences and Updates

We also attended numerous vascular, oncology, and spine conferences (including a lecture from Prof. Park from Korea on cervical arthroplasty) during our stay which helped us in updating ourselves. I was especially impressed by the 69th Annual meeting of Japan Neurosurgical Society at Fukuoka, where a scientific feast was on offer and I could listen to the likes of Dr. Ossama Al-Mefty, Dr. J Z Zhao from China, and Dr. James Drake from Canada. I witnessed an interesting presentation by Dr. Sasaki, the president of the Japan Neurosurgical Society, who emphasized on the outstanding role of Japanese neurosurgeons in contributing scientific articles to top neurosurgical journals across the globe. We Indians were also among key contributors, especially in the *pediatric* and *spine* sections, although a lot more needs to be done to reach in the top 6 countries. We, the young neurosurgeons of India, should take more responsibility to bring out the best from us and contribute more scientific papers from our side.

Microvascular Anastomosis Skills Development

Also, I could perform anastomosis on the brachial artery of chicken wings with 10-0 nylon during my stay there. It helped to refine the dexterity under microscope and improve my anastomosis skills. Hands-on practice is always of use and it helped me to successfully do anastomosis of nerves and vessels [Figure 10].

Articles Written at Fujita Health University

1. An overview of the role of three dimensional computed tomography angiography in cases of intracerebral aneurysms: Recent updates and changing trends.
2. Recent advances in diagnostic approaches for subarachnoid hemorrhage
3. Surgical nuances of clipping after coiling: Looking beyond international subarachnoid aneurysm trial
4. Advances in neurosurgery: The Fujita Health University experience

Summary

The overall experience at the FHU was excellent as far as a young neurosurgeon like me is concerned. Apart from writing scientific papers, I saw more than 50 clipping surgeries and could participate in many. Aneurysm (ruptured and unruptured) surgeries, STA-MCA anastomosis, endoscopic thalamic hematoma evacuation, PLIF, Kawase's approach for a petroclival meningioma, and an epidermoid were much commonly performed over these three months, apart from other routine surgeries. The most important point was to experience a different work culture and it *certainly made the difference.*

Acknowledgments

I would like to acknowledge Bombay Hospital Institute of Medical Sciences for the financial assistance given to me for this fellowship. I would also like to thank Prof Hirose for giving me an opportunity to learn the Japanese perspective of neurosurgery. I thank Dr. Sano, Dr. Kato, Dr. Shoda, and Dr. Watabe especially for the constant encouragement and affection shown towards fellows. I would like to mention about my co-fellow from China's first affiliated hospital of Xiamen university, Dr. Sifang Chen, who helped me settle in from day one and discussed the cases at length which helped me clarify my doubts. Also, I would like to acknowledge Yuko Imai's (fifth-year medical student) constant help during my stay at the FHU which helped me to understand Japan in a much better way.

In the end, I would like to thank my teacher and guide Dr. C. E. Deopujari who has always helped and encouraged every resident like me to constantly improve and master the art. I will be always indebted for the guidance given to me, which helped me to understand the basics of neurosurgery during my residency at the Bombay Hospital. As I begin my endeavors in neurosurgery, I would like to conclude with these few lines from Robert Frost:

Whose woods these are I think I know.
His house is in the village, though;
He will not see me stopping here
To watch his woods fill up with snow.
My little horse must think it queer
To stop without a farmhouse near
Between the woods and frozen lake
The darkest evening of the year.
He gives his harness bells a shake
To ask if there's some mistake.
The only other sound's the sweep
Of easy wind and downy flake.

The woods are lovely, dark and deep,
But I have promises to keep,
And miles to go before I sleep,
And miles to go before I sleep....

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