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Letter to Editor

Simulation Training for Neurosurgical Residents: Need versus Reality in Indian Scenario

Sir,

Neurosurgical training is provided at 156 training centers across India[1,2] and most of the neurosurgical training programs are based on the traditional apprenticeship model. Changing health-care scenarios, for example, high patient satisfaction demands, cost constraints, ethical issues of practicing on patients, and intolerant and hostile attitude of our society toward surgical mis-happenings in the past two decades have reduced learning opportunities of neurosurgical residents.[3,4] Some centers have started to follow outcome-based reimbursements and reporting surgeon specific outcome data. In many instances, these factors practically lead to qualified faculty members performing the larger part of procedures themselves and thus reducing the required hands-on experience for resident trainees. To add to this list, there has been a disproportionate increase in the number of neurosurgical seats, without regard to actual training opportunities.[5] As most of the neurosurgery training programs in India follow the traditional apprenticeship model only, an unplanned increase in the number of residents is decreasing their surgical exposure. Thus, the need of better training is obvious for producing competent neurosurgeons. Laboratory training/simulation is an avenue that can augment the training prospects of neurosurgical trainees and has the capability to shorten the arduous learning curve of neurosurgery. It can provide uniformity in neurosurgical education and is a good tool of assessment also.[6-8] We made telephonic inquiries to faculty members/alumni of major neurosurgical training centers across various Indian states about the availability of simulation facilities and whether they are being utilized for resident training or not. Institute websites were also searched for these details. We have discussed the present status of simulation facilities for neurosurgical postgraduate students in India and shared our views on the challenges as well as possible solutions for the inclusion of laboratory training into the training curriculum. We have also mentioned our experience of starting simulation training in the form of cadaver dissection.

Current Situation in India

In India, there are two types of programs for a medicine graduate who aspires to be a neurosurgeon, namely Magister Chirurgiae/Master of Chirurgiae (Mch) and Diplomate of National Board (DNB). The course duration is 3 years for a candidate who joins the program after completing general surgery residency and 6 years for those who join directly after finishing graduation (MBBS). Currently, there are about 156 centers in India where there is a neurosurgical residency program (88 providing Mch training + 68 providing DNB training).[1,2] Mch training centers are largely in government-funded medical colleges, while most of the DNB programs are run by private hospitals. As compared to a large number of training centers, only a few utilize simulation regularly for their neurosurgical trainees. [Table 1] mentions a list of neurosurgical training centers with availability of simulation facilities in India.

The Neurosurgery Education and Training School (NETS) at All India Institute of Medical Sciences (AIIMS), New Delhi, is a nonprofit-based education and skills training platform established with Indo-German and medico-technological collaboration with the Indian Institute of Technology, Delhi, India. This is probably the only one of a kind facility dedicated to neurosurgery in India, which offers well-structured modules for both trainee as well as practicing neurosurgeons through its multiple cadaveric as well as computer and noncomputer based simulation programs.[9]

Neta Ji Subhash Chander Bose (NSCB) Medical College, Jabalpur, utilizes an anatomy dissection hall for their neuroendoscopy-training program organized twice a year and they have a small departmental laboratory also. Himalayan Institute, Dehradun, Ramaiah Institute, Bengaluru, and DY Patil Institute, Kolhapur, have good simulation (cadaveric dissection) labs. Although these laboratories use well-structured dissection programs as a part of training workshops, most of the participants are practicing neurosurgeons and information about regular use of dedicated resident training modules for their own postgraduates of neurosurgery is lacking.

Table 2 provides a list of simulation workshops organized on a regular basis. Although these meetings are open to residents and offer discounted course fees for them, the majority of participants are qualified neurosurgeons in their early career.

The 1st day of annual conferences of two professional neurosurgical societies of India, namely neurological Society of India (NSI) in collaboration with Congress of Neurological Surgeons, USA, and Neurological Surgeons Society of India (NSSI), is dedicated to various simulation workshops for residents as a fixed event. However, these two events are usually held only once a year and the number of residents that can take part is limited. CEMAST, Mumbai, is a nonprofit organization run by surgeons with grants from Karl Stroz, Germany, which caters to minimal access surgical training of 17 specialties including neurosurgery and skull base surgery. It also runs multiple workshops over year.[10]

Hence, it is obvious that simulation facilities that are dedicated for residents during their training period and available round

Table 1: Neurosurgical training centers with the availability of simulation facilities in India

Neurosurgical training center	Type of organization	Facilities	Remarks
All India Institute of Medical Sciences, New Delhi*	Government	Cadaver/synthetic physical models/ virtual simulation/animal *ex vivo* and *in vivo*	Organizes multiple workshops as a part of NETS, including an annual microneurosurgery workshop
PGIMER Chandigarh*	Government	Cadaveric simulation	
King Edward Memorial Mumbai	Government	Cadaver simulation/3-D stereoscopic anatomy modules	
Sawai Man Singh Medical College, Jaipur	Government	*Ex vivo* animal model training, 3-D printed models, Micro suturing	
Neta Ji Subhash Chander Bose Medical College, Jabalpur	Government	Cadaver simulation/indigenous physical models/neuro endoscopy	Biannual workshop for residents and practicing neurosurgeons
Himalayan Hospital Dehradun	Trust hospital	Cadaver simulation lab	
Ramaiah Institute Bengaluru	Public sector	Cadaver simulation lab	
DY Patil Institute, Kolhapur	Public sector	Cadaver simulation	Predominantly spinal endoscopy training
King George Medical College Lucknow	Government	Dry Micro suturing facilities	
Sanjay Gandhi postgraduate Institute of Medical Sciences Lucknow	Government	Dry microsuturing facilities	
National Institute of Mental Health and Neuroscience	Government		Lab yet to be commissioned, annual microneurosrgery workshop‡
Tata Memorial Hospital, Mumbai	Trust hospital	-	Lab yet to be commissioned
DY Patil Mumbai	Public sector		Neurosurgical simulation yet to be commissioned

*Only two departments, AIIMS, New Delhi, and PGIMER, Chandigarh, have their dedicated cadaveric laboratories, which are actively used for neurosurgical resident/fellow training. The rest of the centers do not use simulation as a routine part of resident training; ‡Though their neurosurgical skill lab is yet to be commissioned, NIMHANS organizes an annual microsurgical workshop for residents [Table 1]; §Some neurosurgical centers, for example, JJ group of hospitals Mumbai, Christian Medical College Vellore, Armed Forces Medical College Pune, DY Patil Pune use anatomy dissection facilities occasionally and not as a regular part of neurosurgery training. AIIMS – All India Institute of Medical Sciences, PGIMER: Postgraduate Institute of Medical Education and Research; NETS – Neurosurgery Education and Training School

Table 2: List of regular simulation workshops related to neurosurgery in India

Name of workshop	Frequency	Skills practiced	Participants
NSI conference	Annual	multiple	Predominantly residents
NSSI conference	Annual	multiple	Predominantly residents
NIMHANS microsurgery workshop	Annual	microsurgery	Predominantly residents
CEMAST[a]/Bombay hospital	Bi annual	Endoscopy/minimal access surgery	Practicing neurosurgeons/residents
Spinal endoscopy workshops/Dr SM Rohidass/Dr S Gore	Bi annual	Spinal endoscopy	Practicing neurosurgeons/spine surgeons
Prof Ramesh Teegla/Vijaywara, Andhra Pardesh	Annual	Cranial and spinal endoscopy	Practicing neurosurgeons/residents

[a]CEMAST organizes workshops for multiple surgical subspecialities; [b]AIIMS micro neurosurgery workshop and NSCB workshops are included in Table 1. AIIMS – All India Institute of Medical Sciences; NSI – Neurological society of India; NSSI – Neurological Surgeons Society of India; CEMAST – Center of Excellence for Minimal Access Surgery Training

the year at their disposal are very few as compared to large number of neurosurgical trainees trained every year.

Discussion

Simulation techniques are effective as they put trainees into a central procedural role and may allow trainees to view multiple scenarios in condensed periods of time.[11] Laboratory training helps to learn a procedure in an environment, which is free from the stress of operating room (OR), allows for margin of error, and is supervised by mentors. After simulation training, residents can perform procedures not only rapidly but also safely and with minimal

complications. Use of structured laboratory resources can provide uniformity in training and it also serves as an assessment tool.[12,13] Although there is an increasing evidence base which favors use of simulation training in neurosurgery,[14-18] still, simulation is used sparingly in India. Despite attempts of introducing structured training modules in neurosurgical training through the inception of NETS at AIIMS Delhi as early as in 2008, the utilization of simulation for residents is still low.[19] Proponents of traditional method believe that simulation may not be of much use in the Indian scenario, as the caseload in our country is much higher than that observed in the western world; high population and less number of neurosurgeons in India give ample opportunities to residents to learn under supervision in OR itself. Due to the heavy workload at some of the centers, residents and faculty may not be able to devote time to simulation. We believe that these statements cannot be generalized because of the following reasons:

First – not all domains of neurosurgery training are the same and the various subspecialties of neurosurgery have different training requirements, for example, shifting paradigms in post International Subarachnoid Aneurysm Trial era have skewed the neurovascular surgery scenario.[17,20] There is decreasing case load of simple vascular cases even in India and more complex cases are presenting for surgical management necessitating advance trainings (eg., requirement of anastomosis at a depth of a field, in limited vascular mobility and limited time). Such microvascular experience is difficult to acquire, just by observing few cases of more experienced vascular surgeons.[18,21,22] These challenges mandate laboratory training for prospective learners. Similarly, pediatric neurosurgery deals with delicate tissues and narrow operative corridors; spinal surgery has an inherent risk profile with a high chance of litigations and thus has a natural emphasis on minimizing harm to patients during transit from novice to expert.[16,23]

Second – not all centers across the country have the same load of neurosurgical cases, both in number and type. An increase in the number of seats without actually increasing the training base has led to decreased caseload per resident and hence reduced surgical exposure.[5] Thus to bring uniformity in training across the country, laboratory simulation may be used.

Third – due to changing ethical and social scenarios, and in most of the private centers, residents do not get required hands-on exposure.[4]

Fourth – not all individuals learn at the same rate, and hence, it is difficult to subjectively define the number of procedures performed as a measure of competency for different trainees. In other words, there is no objectivity to competence by traditional method.[8] Further, many centers actually have abandoned the practice of testing of surgical abilities to protect patients from the risk of being operated by a stressed surgeon. A simulation-based module can provide for testing competency without risk to real patients.[24]

The challenges and possible solutions for us

India is a vast country and various neurosurgical training centers are spread across the breadth of it, situated in different geographical, social, and resource settings. These factors may lead to a difference in training setups among various institutes.[5] As discussed, very few centers in India have dedicated in-house facilities that are used for regular laboratory training of their neurosurgical residents. Even if one thinks of rotation postings, these small number of centers alone cannot provide required simulation exposure to majority of trainees during their formative years. Nevertheless, a large number of centers where neurosurgical training is provided are in teaching hospitals where anatomy and forensic departments are already functional. They can very well start cadaveric dissection as the first step by a collaborative effort. Dry models/*ex-vivo* animal tissues (chicken wings) for vascular suturing are easy to start and can be practiced with loupes or microscope.[25] Three-dimensional (3D) printing is already being utilized effectively for complex pathologies at some of the institutes as a low-cost physical model.[26] There are few successful examples of indigenously developed dynamic physical models by individual neurosurgeons which are being used regularly in endoscopy training workshops.[27,28] Similarly, NSCB Jabalpur and NTES at AIIMS have also developed very low-cost models for practicing various neurosurgical techniques which can be replicated very easily.[4,19] We have started in a similar way at our institute. Being a teaching hospital, we have a functional clinical anatomy as well as forensic medicine departments. With the help of the anatomy department, we have attempted training of neurosurgical residents on cadavers, and our observations as well as resident feedback are encouraging. A few of representative pictures are provided [Figures 1 and 2]. We have virtual dissection facilities within the same hall and students can use both cadaver dissection and simulation facility [Figure 3]. We try to follow guidelines for achieving efficient workflow in skill laboratories published elsewhere,[3,7,29] and training sessions are being organized in coordination with different other surgical subspecialities, for example, head-and-neck surgery, traumatology, surgical oncology, and urology for maximum utilization of resources (cadavers). We agree that advancements in virtual simulators are challenging the "Gold standard status" of cadaver training,[20,30-32] and there is a general sentiment that these are ultimately destined to replace the art of cadaveric dissection. Still, a high-quality virtual simulator, which has realistic deformation of tissues and a good haptic feedback, requires a heavy investment in terms of initial cost, and as of now, they are yet not freely available outside few institutes in the west. Middle-income and low-income countries will have to wait for some time until their wider availability and cost reductions. Cadaver training will continue to help

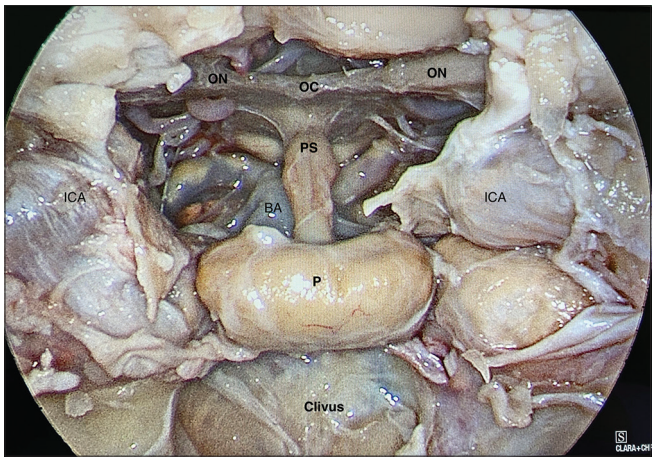

Figure 1: Demonstration of extended endonasal approach in a fresh cadaver. Sphenoid sinus and planum have been drilled and bilateral internal carotid arteries have been unroofed. P: Pituitary body, PS: Pituitary stalk, ON: Optic nerve, OC: Optic chiasm, ICA: Internal carotid artery, BA: Basilar artery

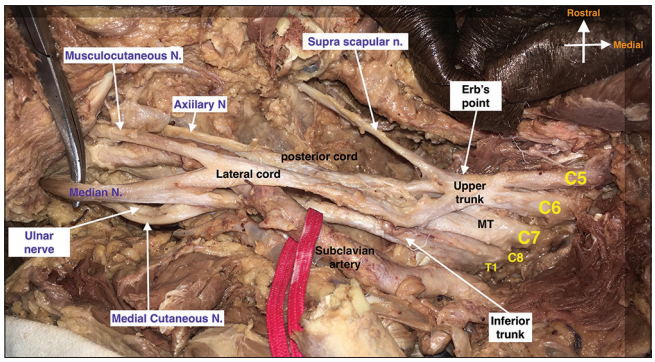

Figure 2: An exposure of right brachial plexus in a formalin-fixed cadaver. The clavicle has been removed to have an unobstructed view. The subclavian artery has been retracted inferiorly by a red sling. Brachial plexus surgery is one such domain of neurosurgery for which resident exposure is usually limited. Here, cadaveric dissection can be an important adjunct for resident training

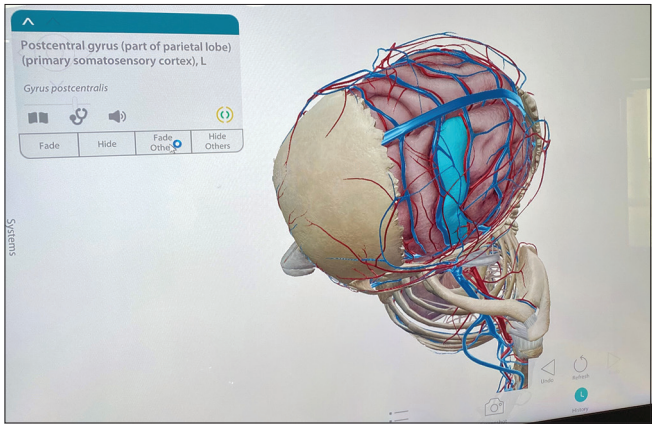

Figure 3: A virtual dissection model at our center

in a big way in these resource-limited countries as these dissections are already being used for undergraduates within most of their institutes. Hence, we should not consider cadaver dissection obsolete at present and instead look at the exemplary works of Professor Rhoton. Various cadaveric modules developed by him are very good and valid educational tools. Further, there are innovative concepts like "live cadavers" which are perfused and can have pathologies.[33,34] We are also inspired by cost-effective technologies like use of placenta models for vascular training,[13,21] interactive stereoscopic virtual reality (VR) for recreation of neurosurgical approaches,[35] and some of low-cost physical models, for example, Barrow Biomimetic Spine.[31] The latter is a 3D-printed realistic and relatively inexpensive spine model developed by residents at Barrow Neurological Institute and has many of the biomechanical and fluoroscopic qualities of the cadaveric spine. It can be adapted and modified to replicate a range of normal and pathologic anatomy. These may prove to be very useful training adjuncts in low- and middle-income countries, as they can provide a solution for limitation of cadavers. Use of shared cadaveric dissection facilities combined with other physical models and low cost VR models (for example, for endoscopy and endovascular surgery) seem to be currently the best available options for Indian scenario. Later on, depending on the availability of space and funds, separate laboratories dedicated to neurosciences like NETS at AIIMS New Delhi or even more futuristic setups like Barrow Innovation Center[31] may be envisaged at least in some centers. These laboratories should have well-equipped cadaveric as well as virtual simulation facilities that can mimic a real OR experience.[4] Multimodal training, balanced with the need for both high-cost and low-cost options, would be ideal.[15,19,30] However, the path is not easy, as practical difficulties in availability of cadavers, space, and cost constraints, are some of the issues that hinder development and widespread use of organized laboratory programs.[36] Further, finding faculty members, who are motivated and interested in teaching by mentoring simulations, is also difficult because the designing, application, and evaluation of a well-structured laboratory dissection/simulation program demand a significant input in terms of workforce (faculty) and time.[6] These programs also require regular improvements/updates depending on resident feedback and overall performance.

Conclusion

We wish neurosurgical training to move forward in a methodical, scientific, and objective manner in our country. This may be possible by inclusion of mandatory laboratory training into the neurosurgery training curriculum. Neurosurgical training centers can tap the already existing base of cadaveric dissection facilities in medical colleges. Various kinds of low-cost physical simulators along with endovascular VR trainers can be used as complimentary techniques to cadaveric dissection. The use of structured laboratory modules not only improves technical skills and competency but also provides an avenue for creating uniformity in training.

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Dr Chandershker E. Deopujari is co- chairman WFNS neuroendoscopy committee, memeber educational committee, Neurological Society of India and is associated with CEMAST.

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Conflicts of interest

There are no conflicts of interest.

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