

Indigenous Inexpensive Practice Models for Skill Development in Neuroendoscopy

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ABSTRACT

Introduction: Neurosurgery is a branch having a tough learning curve. Residents generally get very less hands-on exposure for advanced procedures like neuroendoscopy. With the limited number of cadavers available and ethical issues associated with animal models, practice models, and simulators are becoming the able alternative. Most of these simulators are very costly. We tried to build indigenous inexpensive practice models that can help in developing most of the skills of neuroendoscopy. **Materials and Methods:** Models were built for learning hand-eye coordination, dexterity, instrument manipulation, cutting, fine dissection, keyhole concept, drilling, and simulation of laminectomy and ligamentum flavum resection. These were shown in the neuroendoscopic fellowship program conducted in authors' institute, and trainees' responses were recorded. **Results:** Both novice and experienced neuroendoscopic surgeons validated the models. There was no significant difference between their responses ($P = 0.791$). **Conclusion:** Indigenous innovative models can be used to learn and teach neuroendoscopic skills. The presented models were reliable, valid, eco-friendly, highly cost-effective, portable, easily made and can be kept in one's chamber for practicing.

KEYWORDS: Clinical skills, educational models, neuroendoscopy, neurological model, simulation training

INTRODUCTION

Neuroendoscopy has become an important tool and is progressively increasingly used in cranial,^[1,2] spinal,^[3-5] and skull base^[6,7] pathologies. One can use neuroendoscopy either as a solo modality in neurosurgery, such as endoscopic third ventriculostomy,^[8] cerebrospinal fluid rhinorrhea,^[9] pituitary surgeries,^[7] craniopharyngioma,^[10] colloid cyst,^[2] hematoma evacuations, odontoid resection,^[4] trigeminal neuralgia,^[11] and surgery with the help of tubular retractor.^[12] Neuroendoscopic techniques are associated with a tough learning curve. Young neurosurgeons and residents generally get very less hands-on exposure for neuroendoscopy. Cadavers remain the gold standard for learning, but there is a limit for these gifts to the medical science. Animal models have the ethical debate associated with them.^[13] With this scenario, practice models and simulators prove to be an indispensable tool for learning and to prevent patient harm.^[14] Learning neuroendoscopy involves an understanding of depth perception, dissection, cutting, suturing, drilling, avoiding blind spot, avoiding collision of instruments, and achieving hemostasis under two-dimensional (2D) vision.^[15] At present, practice models in neuroendoscopy are quite costly^[16] and out of reach for most of the young neurosurgeons. A fully-fledged laboratory may also be out of reach for some of the institutions. To circumvent this problem, we tried to build certain inexpensive models, which can cover most aspects

of technicalities of neuroendoscopy and can be made or purchased by anyone.

MATERIALS AND METHODS

We chose custom-made clay utensils of inner diameter 9 cm, and a height of 9 cm, having a single hole of 3 cm on top of it, as shown in Figure 1. One had to pass a 4 mm × 18 cm size telescope (Karlstorz Inc., Tuttlingen, Germany) and instruments, and perform exercises of hand-eye coordination, dexterity, instrument manipulation, and simulation of laminectomy and ligamentum flavum removal on the foam-based floor. One exercise of drilling and an exercise of using tubular retractor for dissection and keyhole concept was also kept.

The authors used these models in the neuroendoscopy fellowship program performed at their institute in April and September 2016. Totally, 66 post MCh/DNB neurosurgeons performed different exercises on these models under the guidance of expert faculty. In the end, these trainees were asked to rate their learning and simulations on a Likert scale of 1–5, in which 1 meant very poor, and 5 meaning excellent. We considered ratings 4 and

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above as a favorable response. After getting the responses, we divided the trainees according to their years of neuroendoscopic experience into two categories Group A (up to 3 years of experience) and Group B (more than 3 years of experience) and analyzed data between them. SPSS 19.0 software (SPSS Inc. An IBM Company, Armonk, New York, USA) was used, and Chi-square test was used to derive the *P* value with the statistical significance considered when it was <0.05 .

Exercise 1: “The hand-eye coordination, dexterity, and instrument manipulation model:” We placed a sheet in which nine squares each of 2 cm × 2 cm size were drawn and numbered, and planted pins at their intersections, as shown in Figure 2. Surgeons were asked to pass the scope and endoscopic forceps through the top hole and to shift a piece of the object between the squares without touching the pins. The second exercise in the same model was to pass a rubber band ring between the different pins.

Exercise 2: “The laminectomy model:” We placed an ice-cream wooden spoon on the foam floor, marked it with a sketch pen to improve precision, and stuck it with plaster. Trainees were asked to use a Kerrison punch, and punch between the lines, as shown in Figure 3.

Exercise 3: “The ligamentum flavum removal model:” A Foley’s catheter, representing dural sac, was passed through the foam representing ligamentum flavum in this model. They were asked to separate the foam from the underlying tube by putting a patty between them and then pull the foam with a punch without injuring the tube, as shown in Figure 4.

Exercise 4: “The drilling model:” We placed a raw egg between two pieces of foam and stuck it with plaster. A hole of about 1 cm on top of the foam was made, and Destandau system was inserted, as shown in Figure 5. The trainees were asked to pass the scope, the suction, and a drill through their respective channels and then drill the egg, and write his/her name on the egg by slow paint brush technique.

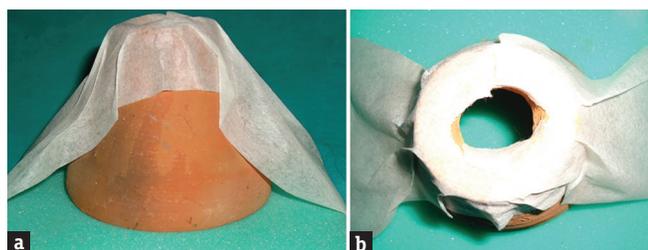


Figure 1: (a) Side view and (b) top view of clay made utensil

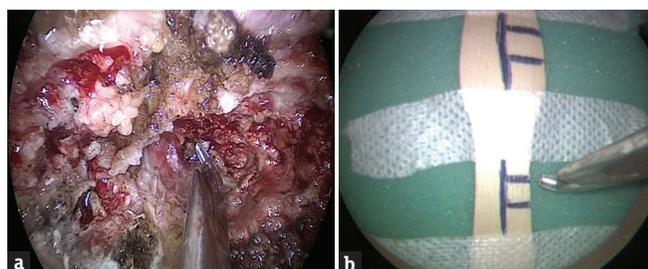


Figure 3: The laminectomy model. (a) Shows the actual surgery, and (b) shows the model

Exercise 5: “Dissection using tubular retractor model:” We placed a thick piece of foam over a prior cut papaya having boundaries marked inside it with pins. From the top of the foam a tubular retractor, described by Yadav *et al.*^[12] was passed. The telescope was fixed in the holder, and instruments were used to perform dissection and cutting. Initially, the tubular retractor was kept vertical, and exercise was done, and later it was tilted to work in a wide area to simulate minimally invasive surgery. Figure 6 shows this model.

Exercise 6: “The cutting model:” A piece of glove was pinned to the foam, and a square was marked over it. Fellows were asked to make the initial incision with a knife and then cut that glove with the endoscopic scissor without injuring the underlying foam, as shown in Figure 7.

Fellows were taught the disadvantages of keeping instrument, scope and the surgical target in straight line and the importance of triangularization in avoiding blind spot, avoiding tissue to pull toward scope, technique of hand support, precision grip, etc.

RESULTS

Sixty-six trainees gave their ranking for these models. Totally, 50 (75.8%) responses gave four and above ratings as shown in Figure 8.

Experience wise: Group A was neurosurgeons up to 3 years of experience ($n = 31$, i.e., 47%), and Group B was more than 3 years ($n = 35$, i.e., 53%). Group wise also the trainees gave

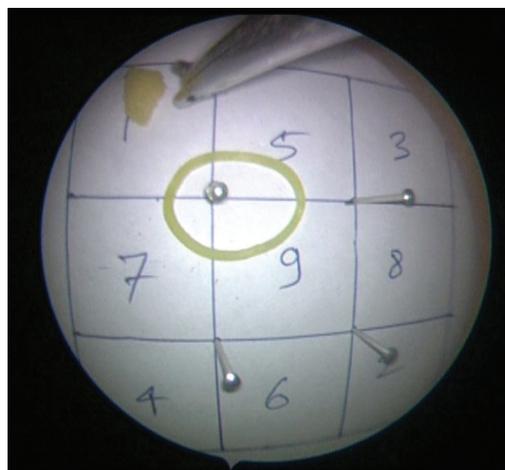


Figure 2: The hand-eye coordination, dexterity, and instrument manipulation model

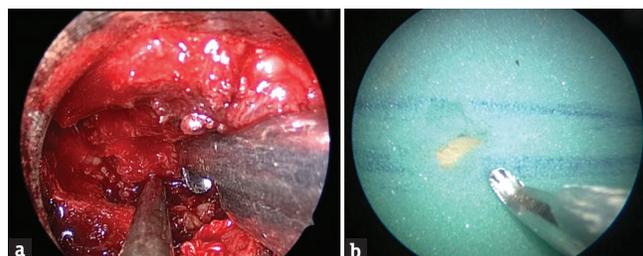


Figure 4: The ligamentum flavum removal model. (a) Shows the actual surgery, and (b) shows the model

a favorable response as shown in Table 1. Statistically, there was no significant difference between the responses with the $P = 0.791$.

DISCUSSION

At present, with increasing lawsuits and high expectations from patients, the residents are getting less and less hands-on

exposure in neurosurgery. The scenario is even worse for neuroendoscopy. With less number of cadavers available and ethical and validity debate associated with animal models, simulators, and hands on models provide an able alternative. The existing good simulators and practice models around the world are either too costly^[14] such as S.I.M.O.N.T. neurotrainer (Prodelphus, Germany), Phacon sinus system (Phacon, Leipzig, Germany), and Kezlex endoscopic models (Ono and Co., Tokyo, Japan), or provide only the basic training of hand-eye coordination.^[17] The presented models provided good training of hand-eye coordination, instrument manipulation, dexterity, fine dissection, cutting, drilling, and simulation of laminectomies and removal of ligamentum flavum. These models were also used to teach the basic concepts of neuroendoscopy. These models were reliable, inexpensive (built up cost of <50 rupees each), easy to build, have low maintenance, nontoxic, and can be placed in one's chamber for practicing.

The results showed that there was an equal benefit to both novice and experienced neuroendoscopic surgeons, wanting to learn, and improve skills. For a neurosurgeon, who knows the anatomy, learning neuroendoscopy needs the skills of hand-eye coordination, dissection, cutting, suturing, drilling, and hemostasis under 2D vision. Our models provided good training for the said skills, barring hemostasis. One can use a wired camera instead of the conventional endoscope for practice, which can further

Table 1: Rating according to the groups

	Rating					Total
	1	2	3	4	5	
Experience grading						
Up to 3 years						
Count	1	1	7	11	11	31
Percentage within experience grading	3.2	3.2	22.6	35.5	35.5	100.0
>3 years						
Count	1	2	4	13	15	35
Percentage within experience grading	2.9	5.7	11.4	37.1	42.9	100.0
Total						
Count	2	3	11	24	26	66
Percentage within experience grading	3.0	4.5	16.7	36.4	39.4	100.0

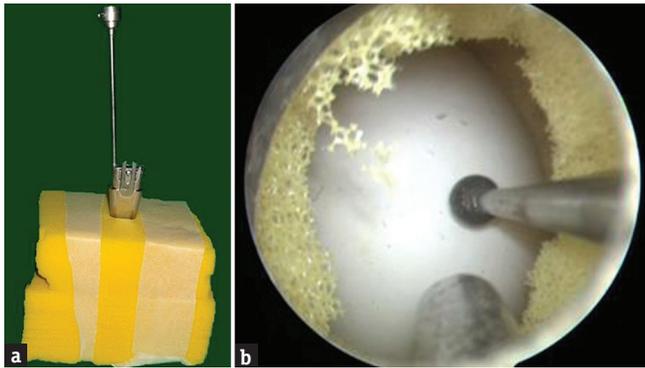


Figure 5: The drilling model. (a) Shows the outside, and (b) shows the endoscopic view of the model

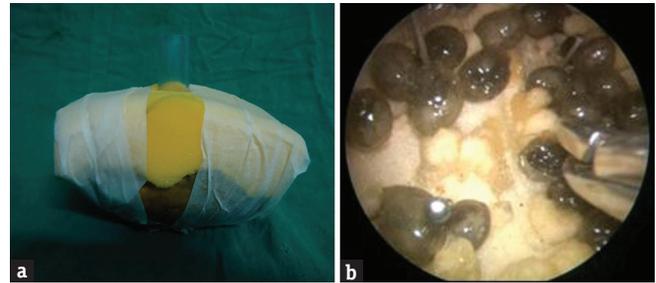


Figure 6: Dissection using tubular retractor model – (a) shows the outside, and (b) shows the endoscopic view of the model

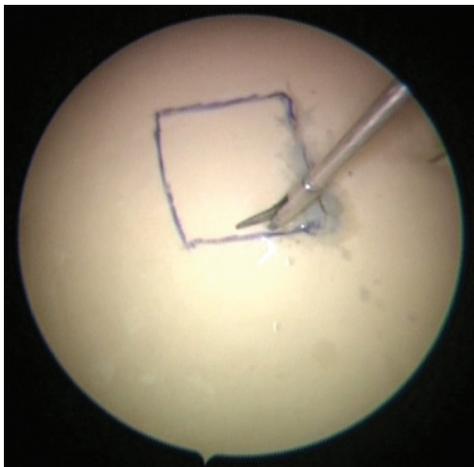


Figure 7: Cutting model - it shows the line drawn on the glove, which is pinned on the foam

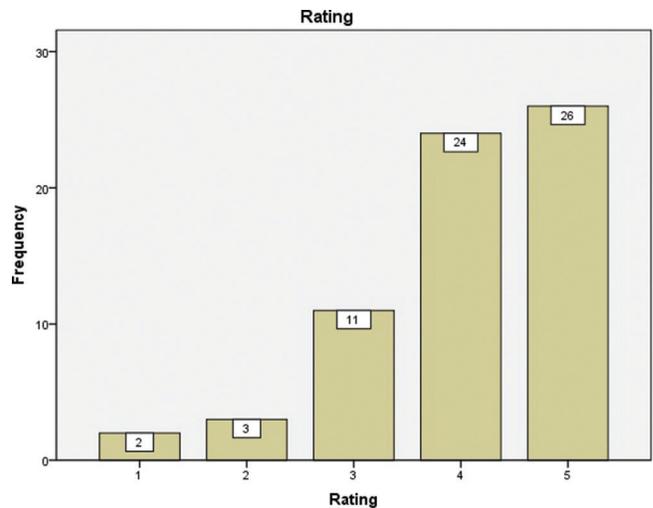


Figure 8: Trainees' responses

reduce the costs. A webcam can also be put to obviate the need of camera source, as is used by Espinoza *et al.*,^[18] but that will take away the liberty of zooming and recentering of the target from the surgeon. One can use his laptop or a simple television in place of monitor to practice. Led light source can be used for illumination.

However, the presented models had certain limitations also. First, they lacked the exercise for hemostasis, and second, the simulations for nasal and ventricular anatomy were not made as in company made ones.^[19] We could have kept separate ratings for individual exercises to better assess each model. Finally, the good ratings given by trainee fellows may be because of goodwill effect as they had come for the fellowship program. Therefore, we also need more validation of these models by other practitioners of neuroendoscopy.

CONCLUSION

Indigenous innovative models can be used to learn and teach neuroendoscopic skills. The presented models were reliable, valid, eco-friendly, inexpensive, portable, easily made, and can be kept in one's chamber for practicing.

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Conflicts of interest

There are no conflicts of interest.

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