Application of Three Dimensional Wooden Neuroanatomy Models in Medical education and Objective Structured Practical Examination

Muhammed Asif, Venkatesh Gokuldas Kamath, Shivarama Bhat, Ramakrishna Avadhani

Medical education witnesses changing trends in the pattern of evaluation of the students. The previously employed laborious theory examinations and one time evaluation is being replaced by periodic evaluation methods and testing of application skills of the student. Here the objective is to introduce a novel technique called objective structured practical examination (O.S.P.E) for assessing the students using building block Neuroanatomy models. After a thorough Neuroanatomical study, seven (three dimensional) Neuroanatomy models of sections of brainstem at seven levels were prepared using teakwood. The various nuclei and tracts were represented using wooden stubs. These are unique as they are building block models and can be assembled and disassembled. The machine carved three dimensional Neuroanatomy models can be assembled and applied at an O.S.P.E. station and the students can be asked to rebuild it by positioning the nuclei and tracts at appropriate places followed by discussion of individual tracts.

Keywords: O.S.P.E, Neuroanatomy, Three dimensional wooden Models
INTRODUCTION
Models have been used to describe intricate anatomical structures for centuries. In the year 1711 Bologna museum is recorded to have collections of models of clay, wood and wax made by the famous painter Ercolle Lelli (1702-1776) representing statues of skinned bodies showing surface muscles called “notomies”\(^1\). The famous anatomical wax models of La Specola, Florence by the Dutch anatomist, Bernard Siegfried Albinus (1697-1770) and Jan Wanderlaer (1690-1759), his artist and engraver also depict the importance of models in studying anatomy\(^2\). The nuclei and tracts in the brain stem are so minute that their anatomy cannot be appreciated in formalin fixed sections of the brain stem. Hence models are the best way to understand and describe anatomy. Models can be prepared using various materials like wax, wood, plaster of Paris, resins, glass, acrylic etc. Here an attempt was made to prepare wooden three dimensional building block models as wood can be easily carved, preserved and handled with bare hands unlike formalin specimens.

CONSTRUCTION OF 3 DIMENSIONAL WOODEN NEUROANATOMY MODELS
Materials used
The materials used are Teak wood, Sand paper, Wood primer, Acrylic paint, Chisel, File, Cutting machine, a machine to make the surface smooth and Carving machine.

Procedure
Blocks of wood of particular size is made using cutting machine. Then the surface is smoothed. The carving machine is then used to shape the blocks. The edges of the shaped wooden blocks are smoothened using a file. The wooden stubs are made using chisel and carving machine. Chisel is used to make depressions on the carved wood to fit the stubs. Then the carved wood and stubs are smoothened with sand paper. Once the wood is completely smooth 2-3 coats of wood primer is applied. It’s allowed to dry for

![Figure 1 Sections of Midbrain, Pons and Medulla using Wood](image-url)
2-3 days. Finally colouring is done using acrylic paint. The paint is then allowed to dry.

After a detailed study and review of brain stem, the exact positioning of all the nuclei and tracts were noted and these models were prepared by the authors to simplify the understanding of Neuroanatomy to medical students. The nuclei and the tracts were represented using wooden stubs. At some places artistic sketches were used to depict nerves and decussations like superior Cerebellar peduncle and Vagus nerve as shown in the figures below.

The result of all the effort was seven wooden sections at various levels of brainstem. These sections include medulla at the level of pyramidal decussation, lemniscal decussation & the olive, pons at the level of facial colliculus & trigeminal nuclei and the midbrain at the level of superior and inferior colliculus. All these sections are unique as they can be dissembled and re-built. All the seven sections are shown in Figure 1. Figure 2, 3 and 4 shows the sections of medulla and midbrain where the wooden blocks representing various nuclei and tracts are dissembled on the right side and assembled on the left side. Moreover all the nuclei, the tracts, decussations, lemnisci and the nerves are labelled as shown below the figure. The entire model can be dissembled and kept at an O.S.P.E. station and the students’ ability to rebuild it can be tested. The entire exercise is very novel, innovative and interactive and involves active thinking on the part of the medical student.

**DISCUSSION**

Models and sketches by artists were the only means of anatomical illustration prior to the invention of formalin as preservative. Early studies in anatomy reveal profound contribution by august artists like Leonardo da Vinci (1452-1519) and Michelangelo (1475-1564). Early museums mainly consisted of wax, clay, ivory and wooden carved models called “Anatomical manikins” as working on cadavers was considered illegal and unethical.

The earliest recorded Neuroanatomical studies date back to 14th century in the works of Italian physician Guido da Vigevano. In his textbook “Anathomia” are displayed six plates showing for the first time Neuroanatomical structures and techniques which include trephination, depiction of meninges, cerebrum, spinal cord and the ventricles.

Sixteenth to eighteenth century again witnessed a large number of paintings and models by artists like Fabricius who prepared
the ‘Tabulae Pictae’ an anatomical atlas and Clemente Susini who prepared over 2000 models. During these ages ethical and legal issues prevailed in the society regarding dissection of dead bodies.

The Turin’s Anatomy Museum of University of Turin, Italy established in 1739 is known for its collection of Neuroanatomy specimens and houses over 950 specimens that include models and dry specimens of brain.

Ballestriero recounts the first coloured wax models prepared in the late seventeenth century by the wax modeller Gaetano Giulio Zumbo and French surgeon Guillaume Desnoues. The quality of models prepared from wax surpassed those prepared from wood, marble or clay.

The models are advantageous over formalin specimens as they do not have any health hazards, can be preserved for long easily and can be used to depict intricate details like embryology and development of organ systems and fine structures like Neuroanatomical sections that cannot be seen by naked eye.

The present technique of preparing models is unique as they can be disassembled and assembled. This is therefore like a jigsaw puzzle and involves active thinking on the part of the student as he tries to keep the nuclei and tracts at their appropriate place. Moreover the individual nuclei and tracts can be removed,
Objective Structured Practical Examination Using Neuroanatomy Models

150 July 2013 International Journal of Health and Rehabilitation Sciences Volume 2 Issue 3

held in hand and discussed which makes the whole student evaluation process more interactive.

The modern student evaluation techniques involve assessment of practical skills of the students using novel methods called objective structured clinical/practical examinations (O.S.C.E/O.S.P.E.)[11]. In this method there are various stations and in each station the medical student is given a task to perform and a group of teachers assess the task based on a prior prepared written criteria. In one of these stations such a model can be applied.

**Example**

O.S.P.E. Station: Anatomy

Sections: Neuroanatomy

Criteria assessed:

1. Identification of the level of section.
2. Identification of nuclei and tracts.
3. Appropriate positioning of the nuclei and tracts.
4. Drawing a neat labelled diagram and labelling.
5. The student can be asked to verbally explain the entire section.

**Figure 4** Section through Medulla at the level of the Olive

A - Pyramidal tract, B - Inferior olivary nucleus, C - Medial lemniscus, D - Inferior cerebellar peduncle, E - Spinal nerve & Tract of 5th Nerve, F - Hypoglossal nerve, G - Hypoglossal nucleus, H - Nucleus ambiguous, I - Ventral and Dorsal Spinocerebellar Tract, J - Dorsal nucleus of Vagus, K - Nucleus of Tractus solitarius, L - Vestibular nucleus, M - Tectospinal tract, N - Medial longitudinal Fasciculus, O - Dorsal Accessory Olivary Nucleus, P Medial Accessory Olivary Nucleus, Q - Lateral spinothalamic tract, V - Vagus nerve, FLR - Floor of 4th ventricle
CONCLUSION

Models are the best means to illustrate fine and intricate anatomical details that cannot be seen by naked eye as fine structures can be magnified to any extent. Moreover, once prepared they can be preserved for long durations without any health hazards to the students and teaching staff. These three dimensional wooden models create interest among the students to learn Neuroanatomy as building a model resembles solving a jigsaw puzzle. The use of these models at O.S.P.E. stations is again a novel method of student evaluation.

CONFLICTS OF INTEREST

None declared

REFERENCES