Room-Temperature Resin Casting Technique a Low Cost Effective Teaching Tool in Human Anatomy

EAST Edirisinghe#, DEH Kotalawala, HDG De Fonseka and SG Yasewardene
Department of Anatomy, Faculty of Medical Sciences, University of Sri Jayewardenepura, Nugegoda, Sri Lanka
#surangiy@hotmail.com

Abstract *- Traditionally gross anatomy is taught at medical schools with cadaver dissections. Due to the cost involved in maintenance the medical faculties are considering novel teaching/learning tools in Anatomy. As a solution the Department of Anatomy, Faculty of Medical Sciences (FMS), University of Sri Jayewardenepura (USJP) has invented a method of mounting considerably anhydrous human tissues in a solid resin casts to study detailed anatomy. To develop a durable low cost technique to preserve human tissues in a manner that details the anatomy while retaining relevant properties. The tissues were initially fixed using formalin to stop the decaying and decomposition. The water content was significantly removed using series of 99.9% acetone while maintaining the original tissue architecture. Dehydrated tissue parts were exposed to sub-atmospheric pressure in a resin bath to replace all acetone molecules by resin. Final specimens were embedded in clear resin after mixing with the catalyst, which will polymerized into a solid resin cast. The human specimens were taken from the cadavers that have been donated to the Department of Anatomy, FMS, USJP with written consent obtained prior to death to use the cadaver for medical teaching and research. This is an appropriate method for preserving human body cross-sections at specific vertebral levels. In this method, dehydrated human tissues were embedded in a clear synthetic resin cast, while preserving the original shape and volume. These casts have zero exposure to formalin during handling. The specimens are more durable than other routine specimen preservation methods used in Sri Lanka. Finally the tissue waste is low and thereby the preservation and maintenance cost of cadavers could be reduced drastically. Currently these resin casts are in use for teaching/learning anatomy at FMS, USJP. Undoubtedly the detailed anatomy is best learned by cadaver dissections. Resin casted specimens are a cost effective and successful supplementary method of teaching/learning gross and cross sectional Anatomy with no exposure to formalin.*

Keywords— *Resin-Casting, Anatomy, Teaching*

I. INTRODUCTION

Learning anatomy is essential when studying medicine. Traditionally gross anatomy has been taught in medical schools with cadaver dissections. Due to the immense difficulty in obtaining cadavers to the Medical schools, to reduce the cost involved in cadaver preservation, maintenance and to minimize recognized health hazards of exposure to the formalin (the usual preservative of cadavers), the medical faculties are considering novel teaching/learning tools for anatomy.

Computer assisted teaching methods, Plastinated specimens, plastic mannequins and formalin mounted specimens are some such teaching/learning tools. Also with the frequent usage of imaging techniques in diagnoses such as CT scans and MRI, it is essential that the medical students and heath care professionals need to have a clear knowledge and understanding of cross sectional anatomy.

As a solution we at Department of Anatomy, Faculty of Medical Sciences(FMS), University of Sri Jayewardenepura(USJP) have invented a method of mounting anhydrous human tissues in a solid resin casts, to study detailed Anatomy including cross sectional Anatomy.

This method is highly suitable teaching tool in medical education in 3rd world countries, because this method could be used as a low cost procedure with high quality and durability.

The cadavers that have been donated to the Department of Anatomy, FMS, USJP with written consent to use for medical teaching and research purposes were used to obtain specimens.

II. MATERIALS AND METHODS

In this method, dehydrated human tissues/organs, while retaining most properties of the original sample were embedded in a uniformly distributed clear synthetic resin cast.

A. Specimen selection

The specimens were pre fixed using 10% formalin and phenol in order to stop the decaying process of these highly putrifiable tissues and to reduce the fungal growth respectively. Thin sections were obtained from specimens with high muscle bulk (Eg- Cross section of the thigh) as it play an important role in the outcome .The thicker specimens will take more time for dehydration process.
Partial dehydration will develop a layer of water vapour between the specimen and the solidified resin with time, which will make the resin cast useless. Thinner the specimen, better the outcome will be.

B Obtaining a proper specimen/cross section

Specimens were dissected carefully by an Anatomist in order to highlight the important structures and areas. The facial coverings were removed as they can trap air and alter the final outcome. The Anatomist pre plan the incisions and open up the organs to visualize the interior. The blood clots and other remnants were washed and removed thoroughly. Different methods were used to obtain the cross sections depending on the type of the organ. Brain cross sections were taken by using a sharp brain knife and the anatomist being confident enough to take the proper section by a single cut without wasting the preserved organ. This method is also applicable for obtaining sections from small solid organs such as heart, kidney & lung.

It's easier to perform above method under minimum facilities, but the disadvantage is the thickness of the slice is high , it takes more time for dehydration and the final specimen would be heavier and more resin is needed.

Same section with better quality could be achieved from freezing the organ to -25^{0}C before slicing.
To obtain the abdominal cross-section, the specimens were frozen in -25^{0}C for 48hours. The freezing will prevent decaying the specimen and help in controlling the thickness of the section. Then place the specimen in the wooden mould with interior lining of polythene(FIG - 1).

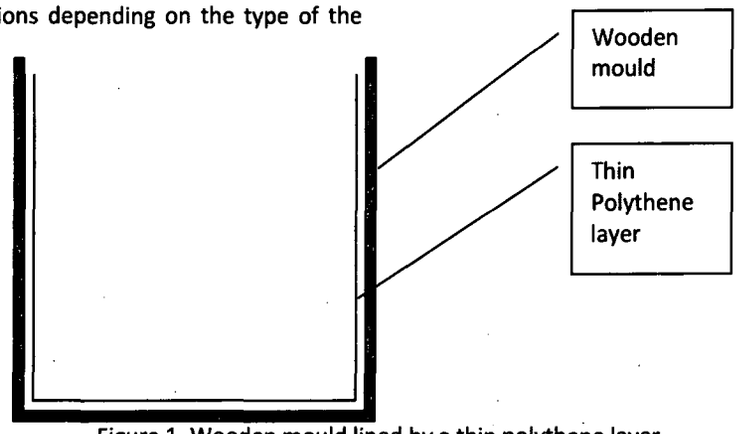


Figure 1. Wooden mould lined by a thin polythene layer

The specimen should be positioned using polyurethane blocks in the anatomical position

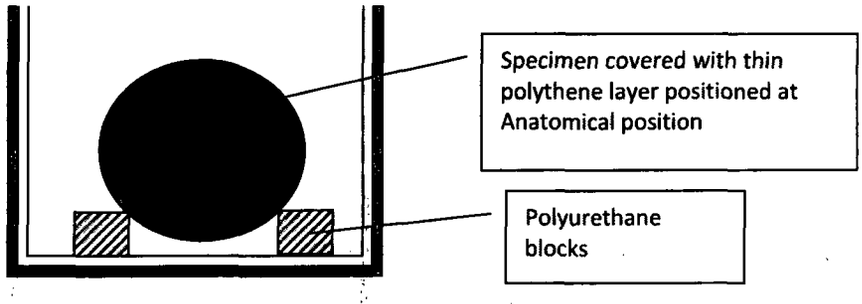


Figure 2. Specimen set at anatomical position in the mould box

Add the polyurethane in to the mould(FIG – 3 & 4)

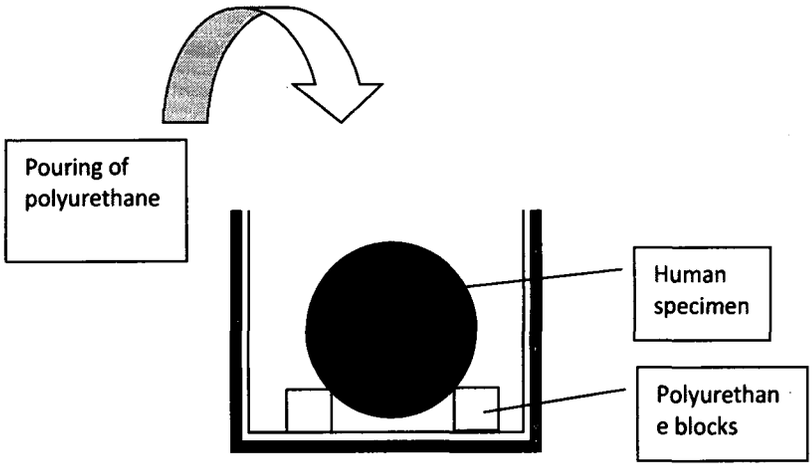


Figure 3. Pouring of the polyurethane in to the mould

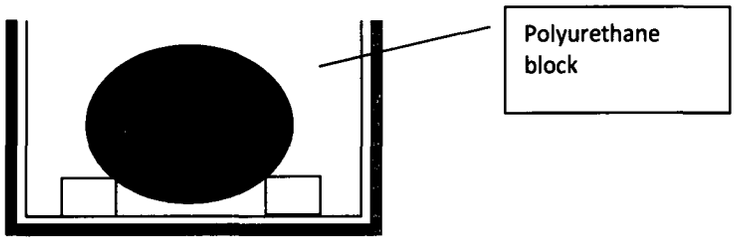


Figure 4. Finally allow to set the specimen in the polyurethane mould

Polyurethane form will cure in 10-15 minutes. Once it is cured polyurethane block was removed. The block was sent for sectioning using a high speed band saw. By this method the specimen could be fixed in anatomical position and prevent displacement during cutting.

The thickness was adjusted by changing the gap between the blade and the plate which placed in parallel to the blade. Once the slices were prepared, slowly polythene and polyurethane covers were removed to separate the specimen.

Left over polyurethane parts were reused to fix the next specimen in the anatomical position.

If polyurethane is not available in the laboratory, freezing the specimen in -25^{0}C for 48hours and obtaining sections immediately will give a similar outcome.

C. Dehydration

99.9% Acetone was used for the dehydration. The specimens were dipped without folds in an acetone baths and kept at room temperature(27^{0}C). The acetone baths were changed weekly. Acetone density was assessed using acetonometer weekly and process was repeated until acetone density reached near 95 -98%. Room temperature dehydration shrink the specimen by 20%. To minimize this volume reduction, the same dehydration process was carried out at -25^{0}C, where the tissue volume reduction was around 10%.

Depending on the size and the thickness of the specimen the duration of the dehydration may vary.

Abdominal cross section with 5mm thickness minimally took 2 months to dehydrate completely.

Graded Alcohol series method was also used for the dehydration. But the final outcome was not up to the level as Acetone being used.

D. *Resin casting*

Final casting was done using a lead / heat resistant plastic moulds. The total volume of the mould was measured initially. The estimated dehydrated specimen volume was subtracted from the total volume. Final volume was divided in to 3 parts. Commercially available mould release was applied on the inner surfaces of the mould for easy removal of the final product. Degassed clear resin (volume of 1/3 of the final calculated volume) with the hardener was mixed in 100:1 ratio respectively which will lead to an exothermic polymerizing chain reaction. Meanwhile the dehydrated specimen was taken out and dipped in a resin bath

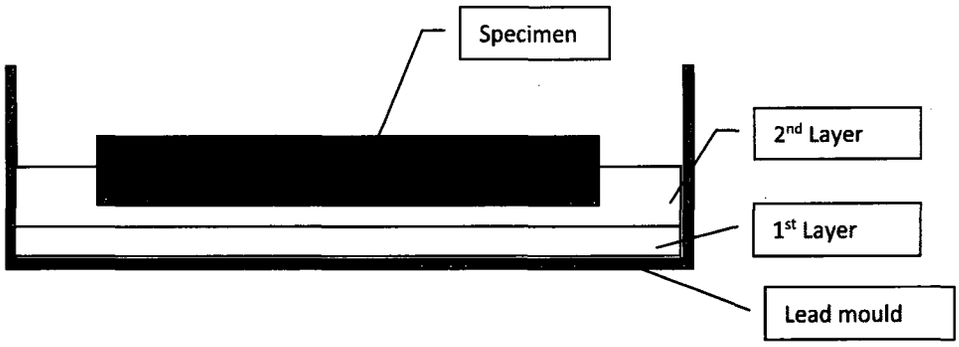


Figure 5. After 2nd layer of resin poured

In 15 -20 minutes time the resin would convert to a semi solid state. Once the mixture became semi solid state the 2nd 1/3 of degassed resin was mixed with the hardener and applied with the specimen. Once the 2nd layer became semisolid level the 3rd layer was poured on top of it and kept 24 hour for proper curing at room temrature.

Solidified cast was removed after 24h and the surfaces were polished using series of water sand papers and brazo for a better outcome.

III. RESULTS AND DISCUSSION

The new technique allows to embed highly dehydrated human tissues/organs in a uniformly distributed synthetic resin.

This method is highly useful especially for cross sectional anatomy demonstration.

Also from this method can be applied for more delicate tissues (brain) cross sections demonstration.

Additionally this method helps to demonstrate body cavities which are difficult and time consuming to dissect and demonstrate practically.

The resin cast specimens are more durable than other specimen preservation methods used in Sri Lanka. The specimens are dry and odorless and these casts are best used at initial stages of learning anatomy.

These resin casts are at present used for teaching/learning anatomy at FMS, USJP.

This new method has zero exposure to formalin when students are handling the specimens. It can retain the structural details even in continuous and repeated usage. As the specimens casts are highly durable, the tissue wastage is minimal. Thereby the cost of preservation and maintenance of cadavers was reduced drastically.

The outcome of tissues with high bone and fat is better because of low water content and easy to dehydrate.

The Ideal and more practical dehydration technique is use of 99.9% acetones at 27^{0}C. Even though graded alcohol series is routinely practiced in histology slide preparation it was not helpful in resin casting. Because the specimen is larger (compared to histology slide) and having high water content.

The acetone dehydration process could be done also in -25^{0}C in order to minimize the tissue shrinkage and gives the maximum efficacy of dehydration by acetone

Final output of dehydration at 27^{0}C is equal to performing it at -25^{0}C except for the difference in tissue shrinkage and duration for dehydration.

IV. CONCLUSIONS AND RECOMMENDATION

Undoubtedly detailed anatomy is best learned by cadaver dissections and use of cadaveric specimens. Resin casting is a highly successful supplementary method of

teaching/learning gross and cross sectional Anatomy with no exposure to formalin and other health hazards.

This method greatly reduces the cost of human tissue preservation, maintenance and disposal. In this method the specimen were embedded in a clear resin solid mould and it is easy to handle, specimen architecture is preserved as the original specimen with high durability. This method will also reduce the fear/apprehension of the students to handle real human tissues in learning anatomy. Specimen based learning of cross sectional anatomy is best thought by this method.

REFERENCES

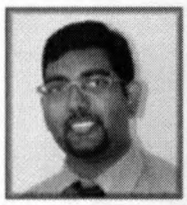
Von Hagens G 1979a: Impregnation of soft biological specimens with thermosetting resin and elastometers. Anat Rec 194(2):247-255

Glover RA, Henry RW, ward Rs 1998: Polymer preservation technology : Poly cur. A next generation process for biological specimen preservation. J Int Soc Plastination 13(2): 39

Latorre R, VaquezJM, Gil F, Ramirez G, Lopez – Albors O, Orenes M, Martinez- Gomariz F, Arencibia A, 2001 : teaching anatomy of distal equine thoracic limbs with plastinised slices. J Int Soc Plastination 16:20-30

Raoof A, Liu L, Zhao H, Falk K, Bodnar T, Ducke E, 2006: Plastinated specimens as an adjunct to dissections: Are they realy helpful? J Int Soc Plastination 21:35

BIOGRAPHY OD AUTHOR



Dr E.A.S.T Edirisinghe is a Lecturer at Department of Anatomy, Faculty of Medical Sciences, University of Sri Jayewardenepura. He also conducts lecturers for Sport Science students of Faculty of Applied Science, University of Sri Jayewardenepura and M.Sc in Medical-Physics students of Faculty of Medicine, University of Colombo. He has produced several research publications in Anatomy teaching, cadaver dissections, cadaveric studies and anatomical variations