Room Temperature Resin Casting Technique, A Low Cost and Effective Teaching Tool in Human Anatomy

S.Edirisinghe[1], H.Kotalawala[1], D. De Fonseka[1], H. Dissanayake[1], S. Yasewardene[1]

ABSTRACT

Objectives: To develop a cost effective optimal technique to preserve human tissues in a manner that detailed anatomy and almost all relevant properties are retained.

Methods: The study was done in the department of Anatomy, Faculty of Medical Sciences, University of Sri Jayewardenepura. The tissues are initially preserved using formalin to stop the decaying since soft tissues are subjected to rapid decomposition. The water content is significantly removed using series of 99.9% pure acetone baths while maintaining the original tissue architecture. Dehydrated tissue part is embedded in a degassed clear liquid resin after mixing with the catalyst, which will polymerized into a solid resin cast.

Results: In this invention, dehydrated human tissues, while preserving the original shape and volume are embedded in a clear synthetic resin cast. Follow up has been done over 3 years to date. No significance change has occurred in preserved specimens were observed. This is an appropriate method for preserving human body cross-sections at specific vertebral levels. The specimens are more durable than other specimen preservation methods used in Sri Lanka, tissue waste is minimum and there by the cost of preservation and maintenance of cadavers are reduced drastically. Currently these resin casts are used for teaching/learning activities in department of Aanatomy, FMS, USJP.

Conclusions: Undoubtedly the detailed anatomy is best learned by cadaver dissections. But resin casting is a highly successful, cost effective supplementary method of teaching/learning gross and cross sectional Anatomy with no exposure to formalin.

Key words: tissue preservation, resin cast

INTRODUCTION

Anatomy is a key subject in medical undergraduate and postgraduate curriculum. Traditionally gross anatomy has been taught in medical schools with cadaver dissections. Dissection of cadavers provides student with the unique perception of details of human

[1]Department of Anatomy, University of Sri Jayawardanapura, Sri Lanka

anatomy that is thought to facilitate understanding of complex anatomy of human body (1). Due to the immense difficulty in obtaining cadavers to the Medical schools, to reduce the cost involved in cadaver preservation and maintenance and also due to the recognized health hazards of exposure to the formalin (the usual preservative of cadavers), the medical faculties are considering novel teaching/learning tools of anatomy (2). Advance imaging facilities as 3D CT reconstructions and high resolution cadaveric CT scans are some newest modalities in teaching anatomy (3). Computer assisted teaching methods (4), plastinized specimens (5), plastic mannequins and formalin mounted specimens and prosected specimens (6) are some such teaching/learning tools used in Sri Lanka. Also with the frequent usage of imaging techniques in diagnoses it is essential that the medical students need to have a clear knowledge of cross sectional anatomy. Traditionally anatomy has been taught on a regional basis. However cross-sectional anatomy is routinely encountered by clinicians. With the advent of modern medical imaging, more and more cross-sectional images of human anatomy are available as teaching material for modern day students.

Can we improve spatial understanding of anatomy and imaging by exposing students to cadaveric cross-sectional specimens? We attempted to answer this question in a carefully designed case control study.

As a solution we at 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 including cross sectional Anatomy. This method is highly suitable teaching tool in Anatomy, because the product was invented 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.

MATERIALS AND METHODS

Tissue plastination was first discover by von Hagens in 1985 (7).This method of resin casting, the technique is somewhat different from tissue plastination and can easily be performed by anyone with a

low cost. The dehydrated human tissues/organs, while retaining most properties of the original sample and volume are embedded in a uniformly distributed clear synthetic resin cast.

Specimen selection: The specimens were pre fixed using 10% formalin and phenol in order to stop the decaying process of these highly peutrifiable tissues and to reduce the fungal growth respectively. The specimens with high muscle bulk (Eg. Cross section of the thigh) the thin sections were used as it play an important role to the outcome because it will take more time for dehydration process and if not properly dehydrated it will form a layer of water between the specimen and the solidified resin which will make the resin cast useless. Thinner the specimen, better the outcome.

Obtaining a proper specimen/cross section: Specimens were dissected carefully by an Anatomist in order to highlight the relevant structures and areas. The coverings and fascias 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. Depending on the type of the organ the method used to take cross-sections will differs. 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 using sharp dissecting knives.

The advantage of this method of taking sections is, it's easier to perform under minimum facilities, but the disadvantage is the thickness of the slice is high and takes more time for dehydration and the final specimen would be heavier and more resin are needed. Same section with better quality could be achieved from freezing the organ to -25^{0}C and do the slicing.

To obtain the abdominal cross-section, freeze the specimen in -25^{0}C for 48hours. The freezing will prevent decaying the specimen and can control the thickness of the cut. Then place the specimen in the wooden mould with interior lining of polythene (Figure 1). The specimen should be positioned using polyurethane blocks in the anatomical position (Figure 2). Then mix the two components of the polyurethane and pour in to the mould (Figure 3 & 4). Polyurethane form will fix cure in 10-15 minutes. Once it is cured remove the polyurethane block contain human tissue

(Figure 5). Then remove the block and send it for sectioning using a high speed band saw. By this method it will help to fix the specimen in anatomical position and prevent moving during cutting. The thickness can be adjusted by changing the gap between the blade and the plate which placed in parallel with the blade. Once the slices are prepared, slowly remove the polythene cover and take the specimen. Left over polyurethane parts can be reused to fix the next specimen in the anatomical position before putting the liquid polyurethane.

If these chemicals are not available in the lab one can easily freeze the specimen in -25^{0}C for 48hours and cut it by using a hand saw in order to get the slices. But the thinness of the specimen is higher, the uniformity of the specimen is lost and the quality of the cut is not as fine and clear as by the electric band saw.

Dehydration: 99.9% Acetone was used for the dehydration. The specimens were dipped without folds in an acetone bath and kept at room temperature (27^{0}C), changing the acetone weekly. Acetone density was assessed using acetonometer weekly and processed repeated until acetone density approaches 95 -98% at 27^{0}C. During this room temperature dehydration specimen will reduce its volume evenly by 20%. To minimize this volume reduction, the same dehydration process could be carried out -25^{0}C, where the tissue volume reduction is around 10%. Depending on the size and the thickness of the specimen the duration of the dehydration may vary. 5mm thick cross section of abdomen minimally will take 1-2 months to get completely dehydrated. Graded Alcohol series were also used for the dehydration. But the final outcome was not up to the level as Acetone being used.

Resin casting: Final casting was done using a lead / head resistant plastic moulds. The total volume of the lead or plastic mould was measured initially. Then 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 mixed in 100:1 ratio respectively. This will lead to an exothermic polymerizing chain reaction. Meanwhile the dehydrated specimen was taken out and dipped in a resin bath.

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 is becoming semisolid level the 3rd layer was poured on top of it and left 24 hour for proper curing

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

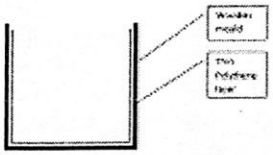

Figure 1. Wooden mould lined by a thin polythene layer

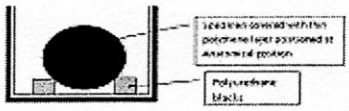

Figure 2. Specimen set at anatomical position in the mould box

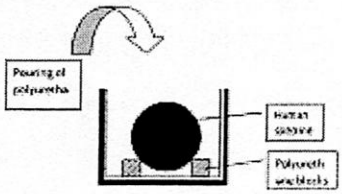

Figure 3. Pouring of the polyurethane in to the mould

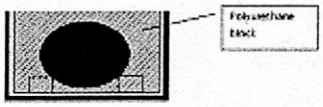

Figure 4. Finally allow to set the specimen in the polyurethane mould

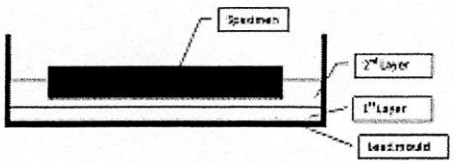

Figure 5. After 2nd layer of resin poured

RESULTS AND DISCUSSION

In this invention, highly dehydrated human tissues/organs are embedded in a uniformly distributed synthetic resin. In another aspect, the invention provides a method of preparing the human tissues/organs/sections which the water

content is completely removed from water-bearing human tissue while the original shape and volume of the tissue is significantly maintained. This method is highly validated for cross sectional anatomy demonstration. Also from this method can be applied for more delicate tissues like brain cross sections demonstration and to demonstrate areas and of body cavities which are very difficult and time taking to dissect and demonstrate in normal anatomy dissection hall for student teaching.

Thinner the specimen slice the outcome is better. The resin cast mounted 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 so that the elements of fear/apprehension of the students towards handling of cadavers are removed. These resin casts are at present used for teaching/learning anatomy at FMS, USJP. This new invention will have zero exposure to formalin when students are handling the specimens, retaining the structural details. As the specimens casts are highly durable, so that the tissue wastage is minimal. Thereby the cost of preservation and maintenance of cadavers were reduced drastically. The outcome of tissues with lot of bone and fat tissue is very much high because of containing less water and easy to dehydrate.

The Ideal dehydration technique used is with 99.9% acetones at 27^0C. 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 -25^0C in order to minimize the tissue shrinkage and gives the maximum efficacy of dehydration by acetone. Final output of dehydration at 27^0C is equal to performing it at -25^0C except for the difference in tissue shrinkage and duration for dehydration.

CONCLUSION/ RECOMMENDATION

Undoubtedly the 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. Also this method drastically 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. Also method will reduce the fear/apprehension of the students to handle real human tissues in learning anatomy. Reduction to the exposure of formalin is another advantage. Specimens based learning of cross sectional anatomy is much easily studied from this method.

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CORRESPONDANCE:

Dr. S. Edirisinghe
Department of Anatomy,
University of Sri Jayewardenepura

E mail-edirisinghe@sap.ac.lk
@sjp.ac.lk

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