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RESEARCH ARTICLE

WET MUSEUM ENHANCES THE TEACHING AND LEARNING ABILITY OF GROSS & CLINICAL ANATOMY

Amarjyoti Chaturvedi, Kanchan Bisht, Pooja Bhadoria and Mathew Joseph

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Abstract

Introduction: The acquisition of knowledge of medical science initiates by acquiring basic information of human structure which is provided by a branch of science that is Anatomy. For learning and teaching Anatomy, we need to preserve human cadavers and organs for long term utility, following suitable methods and conduct medical exhibition and surgical skill training program from time to time.

Materials&Method: The present studywas conducted on 40 wet specimens obtained from routine formalin embalmed dissected cadavers at dissection hall of the Institute. After fine dissection, specimens were mounted in Perspex jar filled with Kaiserling solution. Specimens were then observedunder three categories; one with paint and varnish, second with varnish only and third without paint and varnish. Observation were recorded in every 3 months for whole one year.

Results: Specimens with paint and varnish were appearing like artificial specimens while those with varnish only gave natural appearance with shiny surface. However, in some specimens, a white fatty layer was formed making the solution inside the jar hazy. Specimens without paint and varnish appeared 100% natural making it easier for students to correlate with their theoretical knowledge.

Conclusion: Paint and varnish was not found to be applicable for all specimens. By applying other methods, we can preserve specimens for long time without wasting chemical and specimen. These mounted specimens can be utilised for exams, exhibitions, study purpose as well as for surgical skill training programs.

Introduction:-

Dissection of cadavers and the specimens prepared through their fine dissection have long been the source of learning and teaching human Anatomy, a subject which forms the cornerstone of Medical education **[1].**Museum is the place where these dissected specimens are preserved for education purpose of all the medical disciplines **[18].**The beginning of such medical museums can be traced back as early as 16th century **[20,21].**Learning through the aid of museum is based on the belief that a better way to remember something is to see it rather than going through its verbal or written description**[7].**

The quality of specimen chiefly depends on the fineness of its dissection**[4].**Ideally grossing of larger specimens should be done in fresh state while for smaller specimens, fixation should be done first **[29].**It is recommended to

Corresponding Author:- Dr. Pooja Bhadoria

immerse the specimen in fixative just after it is obtained with volume of fixative being at least twenty times the volume of specimen **[28,29].** The required rate of fixation is 1 hour per mm of tissue thickness **[30].**Ideally specimens should not be washed with tap water as it can result into hemodialysis. It is hence recommended to wash and keep the specimens in saline water, not for more than two hours, to avoid the same **[16].**

Forty percent formalin has been used for a long time as a primary fixative and preservative with satisfactory results. Similarly preservation with ten percent neutral buffered formalin also yields comparable results, however it should be changed timely to prevent deposition of paraformaldehyde residues which can damage the specimens **[18].**

The most commonly used method for preparing specimen still continues to be Kaiserling's technique, which includes fixation, colour restoration, preservation, mounting in acrylic or Perspex jars with Kaiserling solution in it**[4,5]**.However improper fixation, washing the specimen with tap water, surplus amount of hydrosulphite and not using fresh formalin are some of the factors which can lead to unwanted result with even Kaiserling's technique. While mounting the specimen, care should be taken to permit clearance ½ inch at sides and 1 inch at top and bottom of the jar **[16].**Glass jars come with the advantages of cheaper cost, better transparency and resistance to fluids used but their heavy weight and fragile nature restrict their use**.**Acrylic jars are also frequently used these days owing to its transparency, long lasting nature and easy manufacturability. As a universal practice, Perspex jars are now increasingly being used with its biggest advantage being its adaptability to the requirement of the specimen, on heating **[12,18].**

The main objective of a museum is not only to teach the viewers but also to attract them making the learning process much easier **[9].** To increase the aesthetic appeal of museum specimens, they can be coloured following proper colour coding, which can not only make the specimens more alluring but also teaching and learning process would be much easier.

In 1977, a German scientist, Dr. Von Hagens invented a new technique for preserving specimens, called as plastination, which comprises fixation, dehydration impregnation followed by hardening **[14].**Its major advantages include lack of unpleasant odour of formaldehyde and negligible risk of infection **[15].**Virtual museum or digital museum is an emerging concept, promoting studies in different disciplines without the limitation of geographical location**[18].** Pictorial archives are being used in some advanced museums for education purpose **[13].** With digitalisation being the need of the hour, museums are also undergoing digitalization, i.e. developing various software related to the field of Anatomy so as to keep the medical students updated with the new advances in the field of Medical education. However, the conventional methods of teaching Anatomy like cadaveric dissection and museum teaching through models and specimens will undoubtedly still remain irreplaceable **[33].**

Materials And Method:-

Ideal place to prepare wet museum was Anatomy dissection hall where our essential and non-essential required material could be found easily. Our work station was restricted to a small carpet area inside dissection hall with water sink facility as well as electrical sockets.

We categorized our required materials into two groups, essential and non-essential.

A) Essential materials:

1. **Organs from dissected cadaver**

Organs were obtained from fresh cadavers and kept inside formalin filled buckets. Instead of a fresh cadaver, we usedalready formalin preserved specimen for preparation of wet museum. Badly deteriorated specimenswere discarded and excluded from this study.

2. Perspex jar

We used total 40 rectangular Perspex jars with rounded corners, with same dimensions and transparency, as shown in **Fig.1.** Dimension of Jar: Height- 25mm, Width: 25mm, Thickness: 1mm.

3. Chemicals

10% formalin

Kaiserling solution (for 1 jar)

- 40% formalin: 800 ml
- Glycerin: 1500 ml

- Potassium acetate: 180 gm
- Water: 4500 ml

Kaiserling modified solution for fetus

- Glycerin: 4000 ml
- Water: 2000 ml
- 40% formalin: 50 ml

B) Non-essential materials

Surgical instruments, silicone gum gel, stitching thread, fiber plate, fevi quick.

Method:-

We took out all the prosected organs from the formalin bucket and kept them under running water for approximately half an hour to get rid of the irritant formalin fumes. Each organ was washed separately and extra fatty tissue was taken off. For drainage of excess water, the organs were again kept for half an hour. Then we proceeded for fine dissection with the help of surgical instruments including scalpel, fine, blunt and toothed forceps and small scissors. Specimens were then kept for one whole day for drying. Next day the specimens were segregated into three categories: Specimens painted with varnish only, specimens painted with varnish and acrylic paint and specimens without varnish and paint.

Before mounting the specimens into the jar, their orientation was first decided according to their anatomical position in the body. For proper fixation inside the jar, handmade fiber stands were prepared using fiber plates and adhesive. The dimension of fiber plate was slightly more than that of jar, so as to lodge properly inside the jar without the help of adhesive and avoid floating after filling the jar with chemical.

After completing the above steps, specimens were fixed on the fiber plate stand by using thread. Perspex jars were cleaned with liquid soap and left for drying for half an hour. For filtration of chemical, we used non-woven cloth, as shown in **Fig. 2** which was same as normal handkerchief. Thereafter, the chemical was poured into the jar and temporarily covered by glass plate. Next day, all the jars were permanently covered by applying silicone around the glass plate.Observation were recorded in every 3 months for whole one year.

Observation and Results:-

Specimens painted with acrylic paint and varnish were observed to be appearing like artificial specimen, as shown in **Fig. 3.** Specimens painted with only varnish gave natural appearance with shiny surface, as shown in **Fig. 4** but in some specimens like stomach, it formed a fatty white layer, makingthe solution inside the jar look hazy. Specimens without paint and varnish with only fine dissection appeared 100% natural, as depicted in **Fig. 5** making it easier for students to correlate them with their theoretical knowledge. All these categories were however found to be inappropriate for preserving the fetus specimens probably owing to its high formalin concentration leading to shrinkage of fetuses.

Discussion:-

Formaldehyde has been used as a fixative for a very long period now, but it makes the tissues rigid, which renders tissue handling very difficult. Addition of 0.025M sodium pyrophosphate together with 0.001 M magnesium chloride has proven to minimise the rigidity produced by formalin, leaving the tissues softer and easy to handle **[23].** However, the health hazards of formalin cannot be ignored, including its carcinogenic property as it has been classified as a potential carcinogen, causing nasopharyngeal cancer, by International Agency for Research on Cancer (IARC) **[32].** Thiel's embalming technique is popular for its non- toxic nature and better colour preserving property, although slight changes can be observed on histological examination of such specimens, embalmed with this technique **[24,26,27].** Kaiserling solution was further modified by Pulvertaft and specimens which were fixed and mounted by this modified method were found to yield great outcome over a span of 35 years, with only slight discolouration**[28].**

Vijaykumar et al. prepared160 museum specimen, over a period of 3 months using Perspex jars, embalmed cadavers and Kaiserling solution. In their study penetration was enhanced by spot injection with a syringe and needle in some tissues. They tried to conserve the natural architecture of heart specimens by padding the chambers of heart as well as great vessels with cotton. They suggested that before mounting the specimens permanently and keeping in

museum, they can be first mounted temporarily for one or two weeks so as to remove any extra unwanted tissue or pigments from the specimens, improving the overall outcome **[35].**

Painting the museum specimens with different colours not only improves the visual appeal but also makes the learning and teaching process much easier. As shown in **Table 1,** different materials were used by different authors for painting the museum specimens and conclusions were drawn. Congdon E. D. used albuminous paints while Saunders used lacquer for painting wet specimens. Although it worked well for larger structures, smaller structures still could not be painted upto the mark giving blurry appearance. Studies conducted by Jain et al. and Prabhu et al. proved to have yielded satisfactory results over a span of more than five years without any significant disfigurement or discolouration**[7, 36-39].** Kaur et al. used different paints like acrylic, white enamel and transparent nail paints for colouring various structures in fifty wet specimens according to the colour coding followed in Anatomy. The specimens were then mounted in jars filled with formalin and observed for two years. The specimens were reported to maintain their appearance without any significant loss of colour**[42].**

A similar study was carried out byPotaliya et al. using acrylic colors for painting different structures of museum specimens. As in our present study, Kaiserling (I and II) solution and Perspex jars were used for preservation of the specimens. A very smooth experience, without any change in colour of wet specimens was reported in the entire two and half years **[10].**

In our study, the specimens which were preserved in Kaiserling solution and painted with acrylic paint and varnish, maintained their colour and structural integrity over a period of one year but appeared artificial. The specimens which were painted with only varnish appeared natural and shiny even after one year but the solution inside the jar became hazy due to accumulation of a fatty layer from the specimen. This method although was not found suitable for visceras like stomach etc, but can be used for painting structures like tendons and ligaments, giving shiny appearance. The specimens which were not at all painted and directly preserved in the solution following proper steps, yielded optimal result while maintaining the natural appearance in the one year study period.

Teaching Anatomy with the aid of museum specimens can help in reinforcing the knowledge already gained through the class lectures. This fact was supported by a few studies conducted by Tote et al. and Kramer et al. on medical students **[40,41].** Tote et al. in their cross-sectional study, split 70 first year medical students into two groups. Students from the first group were directly exposed to dissection after teaching theoretical part of a particular topic. On the other hand, the second group was given a prior orientation though museum specimens and then exposed to dissection. The knowledge grasped in both the groups was then tested in the form of questionnaires before and after the teaching. On evaluation, the mean score obtained by the second group was observed to be significantly better, clearly indicating the vital role of museum specimens in teaching Anatomy **[40]**.

With advancement in education tools, the traditional way of teaching is gradually being taken over by newer methods. Education system has started including augmented reality (AR) as a part of teaching to make the learning process exciting.

Sugiura et al., based on his observation, advocated that including AR technology for teaching Anatomy in museums could bring a whole new experience for medical students. He concluded that in spite of a few physical inconveniences, the students were prepared to embrace new AR based technology for learning in Anatomical museums, rather than sticking to conventional exhibition trend **[22].**

Conclusion:-

Anatomy, as a subject, has been the cornerstone of Medical curriculum with cadaveric dissection and museum teaching being an integral part of its teaching. The specimens displayed in the museums should be properly preserved so as to continue this tradition. Colouring or painting these specimens can further strengthen the visual appeal, making the learning process easier and relatable. Out of the three methods followed in our present study, painting the specimens like tendons and ligaments with only varnish can help in maintaining the natural appearance to some extent and make them look shiny. However for preservation of visceras, to maintain the natural appearance, it was sufficient to preserve them in Kaiserling solution after careful and fine dissection. With the addition of virtual museums and AR based technology, the learning experience can further be enhanced. However, the conventional methods of teaching Anatomy like cadaveric dissection and museum teaching through models and specimens will undoubtedly still remain irreplaceable.

Table 1:- Materials used by different studies for painting museum specimens.

S.No.	Author	Year	Material used
1.	Congdon et al.[36]	1932	Albuminous paint
2.	Saunders et al.[37]	1944	Lacquer
3.	Robert et al. [38]	1997	Silicon
4.	Jain et al.[39]	2014	Camlin oil paint & white enamel paint
5.	Prabhu et al.[7]	2015	Acrylic or poster paint, nail paint, amyl acetate
6.	Potaliyaet al.[10]	2016	Acrylic paints
7.	Kaur et al.[42]	2017	Acrylic, white enamel and transparent nail paints

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