ORIGINAL RESEARCH

Preservation of Museum Specimens with Epoxy Resin – A Dry Preservation Technique

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Abstract

Background: The deterioration of tissue is a natural process which is recognized as a major hindrance in educational institutions. The preservation of specimens is considered to have scientific values which are more appreciated in academic interest for educational purposes. But unfortunately the technique followed over decades for preservation of the specimens makes it more difficult for its easy usage.

Aim: The aim of the study is to preserve the museum specimens for a long period of time without any distortions with epoxy resin.

Materials & Methods: The study was conducted in the department of oral pathology & microbiology. 10 samples were selected of which 6 were hard tissue specimens and 4 were soft tissue specimens. The specimens were subjected to fixation with 10% formalin for 24 hours and washed later. The selected specimens were trimmed and embedded within epoxy resin. The resin is allowed to set completely for 7 days and finally trimmed and polished.

Results: The results showed better preservation of the specimens in terms of structural details, shrinkage, clarity and interface between the specimen and resin. The presence of minimal air bubbles seen at the time of fabrication and with slight yellowing of the epoxy models was appreciable over a period of 6 months but the clarity of the resin was not sacrificed. The preservation of museum specimens proved to show acceptable results overall.

Conclusion: The usage of epoxy resin to preserve museum specimens in this methodology can be definitely beneficial in educational institutions and can be recommended henceforth.

Keywords: Preservation, Museum specimens, Epoxy resin.

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Introduction:

The integral part of learning in Oral pathology is the study of gross specimens.[1] The specimens provide an illustrative and explanatory adjunct in understanding the disease. The main purpose of museums is to preserve and to restore specimen collections for educational institutions so that those specimens may remain safely in their collections for future generations to learn from. The Museum specimen believes that each individual scientific specimen has inherent educational value.[2] Beginning in the 17th century, the whole specimens have been preserved by submerging and storing them in chemical fluids.[3] It is called Wet preservation technique. The specimen is prepared first by 'Fixing' it using Formaldehyde. This prevents the further deterioration and decay process (Autolysis) of the specimen. Decay is a natural process but it is disadvantageous to morphological studies, teaching, and research. Therefore, it has always been a goal to find ideal preservation techniques.[1] The preservation is usually done with Alcohol, either Propanol or Isopropyl alcohol of 70% concentration in glass containers or bottles sealed with closure. Although, the fixative and fluid preservation process cause a chemical alteration of the specimen which leads to discoloration, shrinking, or swelling of the specimen and also accounts for periodic renewal of the fluid.

The primary criteria for long term specimen preservation with morphology & anatomy preserved in its best possible condition are still a challenge.[4] Any pathologist or technician would always desire for a dry, odorless, durable and non-toxic preserved specimen which can be handled without any protective equipment. For which, a process called 'Plastination' was invented by Dr. Gunther Von Hagens, University of Heidelberg in 1978.[1] Even though Plastination was the most acceptable method of specimen preservation, affordability becomes a question. It is

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expensive and needs more equipment than the conventional laboratory equipment.[1,5] Moreover, it has a limited application in oral pathology as this technique is much suitable for large specimens. Paraffinization and infiltration has also been tried out with high molecular weight polyethylene glycols but proved to give poor results.[1] Hence in an attempt to preserve the specimen for a longer period of time with affordable expenditure and minimum equipment in the laboratories numerous materials have been tried out and none qualify to meet all the requirements. The epoxy resin is a broad group of reactive compounds that are characterized by the presence of an oxirane or epoxy ring.[6] The industrial purpose of epoxies are majorly coatings, adhesives and matrices for their outstanding mechanical properties, high adhesive strength, high electrical and heat resistances.[7] Epoxy will continue to be the superior of all the resins because of its versatile properties.[8] In recent times the epoxies have been used innovatively for embedding delicate botanical species which are widely used as decorative pieces or ornaments. Also they have been used to preserve fossils and small insects that have been used for academic purposes as well as memorable decorative pieces. These multifunctional and adaptable natures of epoxies have been utilized in our study. Hence, this novel study was undertaken to assess the ability of Epoxy resin to preserve the museum specimens retaining its morphology and architecture.

Materials & Methods:

This study was conducted using selected excisional or resection biopsy specimens received in the Department of Oral Pathology & Microbiology at Saveetha Dental College & Hospitals, Chennai. This is a preliminary study done with 10 samples. The 10% Formalin fixed resection specimens were taken as samples. 10 different excisional/ resection specimens were chosen, out of which 5 are hard tissue specimens, 2 are soft tissue specimens and 3 are combinations of both hard and soft tissues. The resin casting of the specimens are done using epoxy resin. The specimens to be preserved in museums are selected, and trimmed. The hard specimens are immersed into hydrogen peroxide for about 45 minutes to remove excess debris post fixation which is not done for soft tissue specimens. Later, it is subjected to grades of alcohol for dehydration i.e. Isopropyl Alcohol at 70%, 90% & 99.9%, for 30 minutes in each concentration at 37^0 – 45^0C. The dehydrated specimens were then immersed in Epoxy resin. The resin was purchased from a commercial online market. (Alpha system Epoxy system -103, Alcos, India). The Epoxy resin is prepared in 2:1 ratio of base and hardener respectively, according to the manufacturer's instructions. The base solution (Part A) is taken first and then a harder solution (Part – B) is added to it with the help of measuring cup and mixed for about 15-20 minutes until it's completely miscible with each other. Then the specimen is placed & stabilized into a silicone mold within which the resin is poured and allowed to sit for 24-48 hours for initial set. The silicone molds can be chosen according to the size of the specimen. The specimen from the mold was retrieved after 7 days once the resin is completely cured. Finally, it can be trimmed and polished to get a smooth final model. The epoxy models with the specimens were analyzed over a period of 6 months to evaluate the clarity and yellowing property of the resin.

The epoxy resin embedded specimens were analyzed for 6 parameters. The specimen parameters are shrinkage, structural detail, interface between specimen and resin & clarity with a scoring criteria of 0 = unacceptable, 1 = satisfactory and 2 = acceptable. The parameters pertaining to Epoxy resin, yellowing & bubbling are analyzed with scoring criteria of + = mild, ++ = moderate and +++ = severe. All hard and soft tissue specimens

Table 1: Table showing the different characteristics of the specimen preserved with epoxy resin model

SL NO	SIZE	TYPE OF THE SPECIMEN
SPECIMEN 1	9X6cm	Hard tissue & soft tissue
SPECIMEN 2	4X3.5cm	Soft tissue
SPECIMEN 3	4X4cm	Hard tissue & soft tissue
SPECIMEN 4	4X2cm	Hard tissue
SPECIMEN 5	4X1.5cm	Hard tissue
SPECIMEN 6	4X1.2cm	Hard tissue & soft tissue
SPECIMEN 7	4X1.3cm	Hard tissue
SPECIMEN 8	4.5X0.7cm	Hard tissue
SPECIMEN 9	4X0.5cm	Hard tissue (Tooth)
SPECIMEN 10	4X1.5cm	Soft tissue

Table 2 showing the overall percentages of various parameters analyzed for the preserved hard and soft tissue specimens.

PARAMETERS	UNACCEP-TABLE	ACCEPT-ABLE	SATISFAC-TORY
Shrinkage	-	20%	80%
Structural details	20%	10%	70%
Interface between the specimen and resin	-	20%	80%
Clarity	10%	10%	80%

Table 3 showing the overall percentages of parameters analyzed for the epoxy resin embedded with hard and soft tissue specimens.

PARAMETERS	MILD	MODERATE	SEVERE
Yellowing effect	90%	10%	-
Air bubbles	40%	40%	20%

were evaluated for both, the specimen parameters as well as resin parameters. The evaluation of the specimen embedded epoxy models were examined by a pathologist using a magnifying lens in all dimensions. The percentages have been calculated according to the parameters and its scores to evaluate the ability of Epoxy resin in preservation of specimens.

Results:

The study was performed using 10 specimens, which were selected based on the difference in the size of the specimen. The sizes of the specimen preserved in epoxy resin are summarized in Table 1. The percentage analysis of the parameter for hard and soft tissue specimens with respect to specimen shrinkage demonstrated 80% acceptable and 20% satisfactory results. 70% of the specimens demonstrated structural details that are acceptable except for 20% which showed unacceptable results. The interface between the specimen and resin were not disturbed showing 80% acceptable and 20% satisfactory results. Superior results were obtained in terms of clarity with 80% acceptable results, 10% satisfactory results and 10% unacceptable results. The Overall percentages analyzed for parameters of preserved hard and soft tissue specimens are further summarized in table 2 (Figure 1). The parameters of the Epoxy resin used were analyzed after 6 months for yellowing which showed 90% mild yellow discoloration and 10% showed moderate discoloration. The presence of air bubbles in the epoxy model was not a favorable outcome and 40% of the specimens demonstrated mild air bubbles and 40% exhibited moderate air bubbles followed by 20% with severe air bubbles. The Overall percentage analyzed for various parameters of epoxy resin are summarized in Table 3 (Figure 2).

Discussion:

The museum specimen collections are incomparable storehouses of geological, biological, and genetic resources throughout the world.[9,10] The gold standard wet preservation

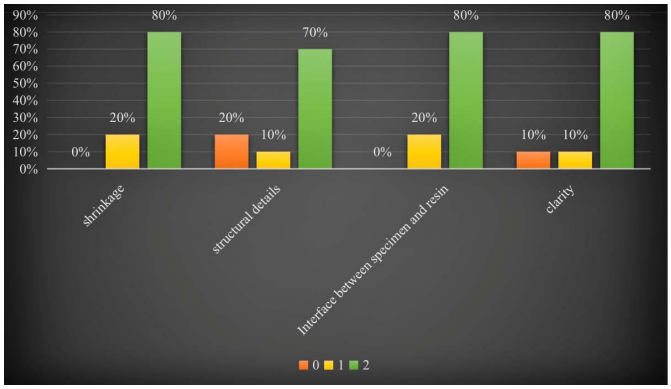

Figure 1: Bar chart depicting the percentage value of the epoxy preserved specimens with its scoring criteria. 0 represents unacceptable; 1 represents satisfactory; 2 represents acceptable. The percentages of all the parameters analyzed shows predominantly acceptable results.

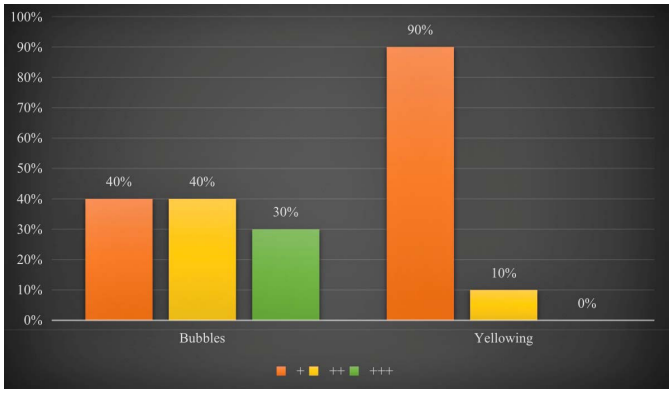

Figure 2: Bar chart depicting the percentages of epoxy resin parameters with its scoring criteria. + represents mild; ++ represents moderate; +++ represents severe. The percentages are almost evenly distributed in each category with respect to air bubbles whereas there is preponderance of mild yellowing.

Figure 3 showing the picture of an epoxy model with hard tissue attached with a soft tissue specimen.

Figure 4 showing the picture of an epoxy model with soft tissue specimen.

technique with alcohol has a major advantage and the specimen can be easily accessed when needed. Yet this technique has too many pitfalls. On considering the health issues, continuous exposure or contact with lower concentrations of these chemical fluids may cause eye and skin irritations, while higher concentrations can cause more serious symptoms like pneumonia and pulmonary edema to the Oral pathologists and technicians.[11] So opting for a safer alternative necessitated this study. No other studies have been done with this technique of preserving the museum specimen with epoxy resin.

In present study the specimens were immersed and mounted in Epoxy resin and were analyzed for various quality assessment parameters. The final outcome of this study proved to show better results in preserving the specimen with its morphology and anatomy being undisturbed. The clarity of the specimen through the resin bulk is more appreciable along with its minute structural details. The specimen as well as the resin did not undergo shrinkage in most of the tissues (figure 3). It is also observed that the specimen cannot be damaged by any external force since it's safely protected 360 degree with the Epoxy resin. Although, this technique does not seem to be very well appreciable for soft tissue specimens as they gave unacceptable results due to its poor clarity and visibility of structural details through the bulk of the resin. Also no retraction of soft tissue specimens, shrinkage or any sort of ill effects to the tissues was appreciated (figure 4). This might be because the epoxy resin offers High strength, Low Shrinkage, Excellent adhesion to various substrates, Effective electrical insulation, Chemical and solvent resistance, high flexural strength and low toxicity as its major properties. Epoxies also have tensile strength ranges from 90 to 120MPa and a tensile modulus ranging from 3100 to 3800MPa.[6] Also, the epoxy resins after curing are moisture resistant which was one of the primary reasons for choosing epoxy resin in this study.

The Dry preservation technique by epoxy resin has many advantages over the gold standard wet preservation technique. It is non-toxic, non-infectious, and does not exude fumes or fluids. The specimens require little storage and no maintenance.[1,12] Thus, the time saved can be usefully redirected to expanding the collection rather than just maintaining it. The specimens can be handled without any PPE and can be stored for longer periods anywhere along with appropriate documents. In comparison with the dry epoxy resin embedding method the gold standard wet technique suffers many other disadvantages other than health issues. The storage jars of wet technique should be monitored periodically for deterioration of chemical, tight closure and breakage that would lead to leakage of flammable chemical fumes into the storage area. Also, the necessity for renewal of the chemical fluids periodically makes it more expensive for maintaining the museum specimens. Long term preservation of the specimen in the same liquid causes discoloration, shrinking, or swelling of the specimen.

The study has its own limitations which include time consuming post curing works such as trimming, polishing and mounting to obtain a good display of specimen, hence a dedicated Pathologist and other technicians are needed. Learning anatomy on only museum specimens is a compromise because of its limitations in terms of tactile experience that is provided by wet cadavers.[1] The major disadvantage is that the specimen cannot be retrieved any further. Though the present study demonstrated satisfactory results, long term studies with more number of specimens with different size, shape and consistency would yield concrete conclusions to use this technique as a standard dry specimen preservation method.

There are precautions that need to be followed. The epoxy resin with UV resistance properties has to be procured for the non-yellowing longevity of the resin in which specimens are preserved. The resin has to be mixed patiently for 15-20 minutes until a uniform suspension is obtained to avoid craze lines due to non-uniform mixture and also the bubbling effect of resin. The specimen after retrieval has to be untouched for 7 days before final trimming and polishing.

Conclusion:

The specimen preserved epoxy models are non-toxic and non-infectious, more over its very handy for usage. We strongly believe that this technique is superior to those preserved in formalin or alcohol, both in terms of user acceptance and ease of maintenance. Hence, embedding specimens in epoxy resin in any pathology department for maintenance of a student museum or preservation of rare specimens can be accomplished.

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References:

1. Spoorthi Banavar Ravi VMB. Plastination: A novel, innovative teaching adjunct in oral pathology. J Oral Maxillofac Pathol. 2011;15(2):133.
2. Powers, Prather, Cook, Woolley, Sierwald P. Revolutionizing the use of natural history collections in education. 2014 Dec 1;13(1):24.
3. Piechota D, Rose CL, De Torres AR. Storage of Natural History Collections: Ideas and Practical Solutions. Vol. 34, Journal of the American Institute for Conservation. 1995. p. 89. http://dx.doi.org/10.2307/3179440
4. Standards in the Care of Wet Collections | Conservation and Collections Care. [cited 2020 Jul 2]. http://conservation.myspecies.info/node/33
5. Dawson TP, James RS, Williams GT. Silicone plastinated pathology specimens and their teaching potential. Vol. 162, The Journal of Pathology. 1990. p. 265–72. http://dx.doi.org/10.1002/path.1711620314
6. Epoxy Resin: Types, Uses, Properties & Chemical Structure. [cited 2020 Jul 2]. https://omnexus.specialchem.com/selection-guide/epoxy-resins-a-to-z-technical-review-of-thermosetting-polymer
7. Jin F-L, Li X, Park S-J. Synthesis and application of epoxy resins: A review. Vol. 29, Journal of Industrial and Engineering Chemistry. 2015. p. 1–11. http://dx.doi.org/10.1016/j.jiec.2015.03.026
8. Capricho JC, Fox B, Hameed N. Multifunctionality in Epoxy Resins. Vol. 60, Polymer Reviews. 2020. p. 1–41. http://dx.doi.org/10.1080/15583724.2019.1650063
9. Fisher RD, Ludwig CA. Catalog of Type Specimens of Recent Mammals: Rodentia (Myomorpha, Anomaluromorpha, and Hystricomorpha) in the National Museum of Natural History, Smithsonian Institution. Smithsonian Contributions to Zoology. 2014. p. 1–125. http://dx.doi.org/10.5479/si.19436696.642
10. Patil S, Ganavi BS. The Museum Maze in Oral Pathology Demystified—Part I. Vol. 14, The Journal of Contemporary Dental Practice. 2013. p. 770–6. http://dx.doi.org/10.5005/jp-journals-10024-1401
11. Slater D. HEALTH HAZARDS OF FORMALDEHYDE. Vol. 317, The Lancet. 1981. p. 1099. http://dx.doi.org/10.1016/s0140-6736(81)92261-3
12. Aufdemorte TB, Bickley HC, Krauskopf DR, Townsend FM. An epoxy resin and silicone impregnation technique for the preservation of oral pathology teaching specimens. Vol. 59, Oral Surgery, Oral Medicine, Oral Pathology. 1985. p. 74–6. http://dx.doi.org/10.1016/0030-4220(85)90119-7