REVIEW

Comparison of Various Dry Preservation Techniques of Museum Specimens in Laboratories - A Systematic Review.

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Abstract

Background: Tissue degeneration is a normal process that is acknowledged as a significant barrier in educational settings. The scientific usefulness of specimen preservation is well acknowledged and is particularly valued in academic pursuits for instructional objectives.

Aim: The aim of this study is to do a systematic review to identify the effectiveness of various dry preservation techniques of museum specimens in histopathological laboratories.

M&M: The articles for this review were searched from PubMed Central, Cochrane Database of Systematic Reviews, Google Scholar, EMBASE and direct web search using the search terms "preservation of museum specimens; pathology; alternative; dry preservation technique.

Results: The final of 5 articles were included in the review. Once the articles to be reviewed were finalized, data was collected from each article, tabulated, verified and interpreted which compared the efficacy of various dry preservation techniques of museum specimens in histopathological laboratories. Academic fields have found significant advantages in using dry preservation methods. Despite the challenges associated with plastination, the preservation process has been standardized based on extensive studies.

Conclusion: In the near future, plastination could serve as a portable learning tool. Although it may not be cost-effective, this technology is likely to be adopted in educational institutions after multiple trial & errors. However, when uncertainty arises, it is always advisable to rely on the gold standard of formalin preservation.

Keywords: Preservation, Dry technique, Museum specimen, Laboratories

Introduction

The museum specimens are the most valuable assets of a pathology department. These specimens are historically significant because they represent pioneering efforts that offered comprehensive information and understanding of normal and a pathology[1]. They serve as an aid in understanding the disease by serving as examples and illustrations as well. The primary goal of museums in educational institutions is to maintain and preserve specimen collections so that future generations can use them as teaching aids[2,3]. The value of museum specimens has increased over time, increasing the probability of genetic analysis in the future[4]. The primary challenge lies in preventing the deterioration of specimens and ensuring their long-term preservation while maintaining their morphology and anatomy in the best possible condition[5]. There are various techniques for preserving and maintaining these specimens which are broadly classified under 2 categories: Wet & Dry preservation, where both the techniques have their own pros & cons. Wet preservation procedures use chemical reagents to preserve the specimens, whereas dry preservation involves embedding the specimen internally and externally in various resins[6]. Various studies have been conducted in order to provide a consistent technique for preserving specimens in museums, but unfortunately, it's still in dilemma. Even Though, there are various attempts to devise newer techniques, the gold standard is the wet technique of immersing the specimen in 10% formalin and embedded in a glass jar where the solution is renewed every year. This current study is carried out to systematically review the literature that have attempted to maintain the specimens using various procedures and thus identify the best prospective technique to preserve the human specimens in the near future.

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Conflict of Interest: None

Materials & Methods

This review was done in accordance with guidelines given by PRISMA guidelines for Systematic Review[7].

Search strategy:

A systematic search was done with PubMed Central, Cochrane Database of Systematic Reviews, Google Scholar, EMBASE and direct web search using the search terms "preservation of museum specimens; pathology; alternative; dry preservation technique". To prevent the possibility of missing out on relevant titles, every possible term was included in the search. Following the removal of duplicates, titles were separately assessed by two researchers using predetermined inclusion and exclusion criteria. The remaining papers were reviewed in their entirety, and a decision was made based on the relevancy of the abstracts and complete texts. Disagreements between the two researchers were aired and settled through consensus.

Inclusion & Exclusion strategy:

Inclusion criteria:

- Original research.
- All research performed with human samples.
- All research performed with dry museum specimen preservation techniques till date.
- All studies published in English language only.

Exclusion criteria:

- Studies performed with other species.
- Studies performed with wet museum specimen preservation techniques.
- Studies published in other languages.

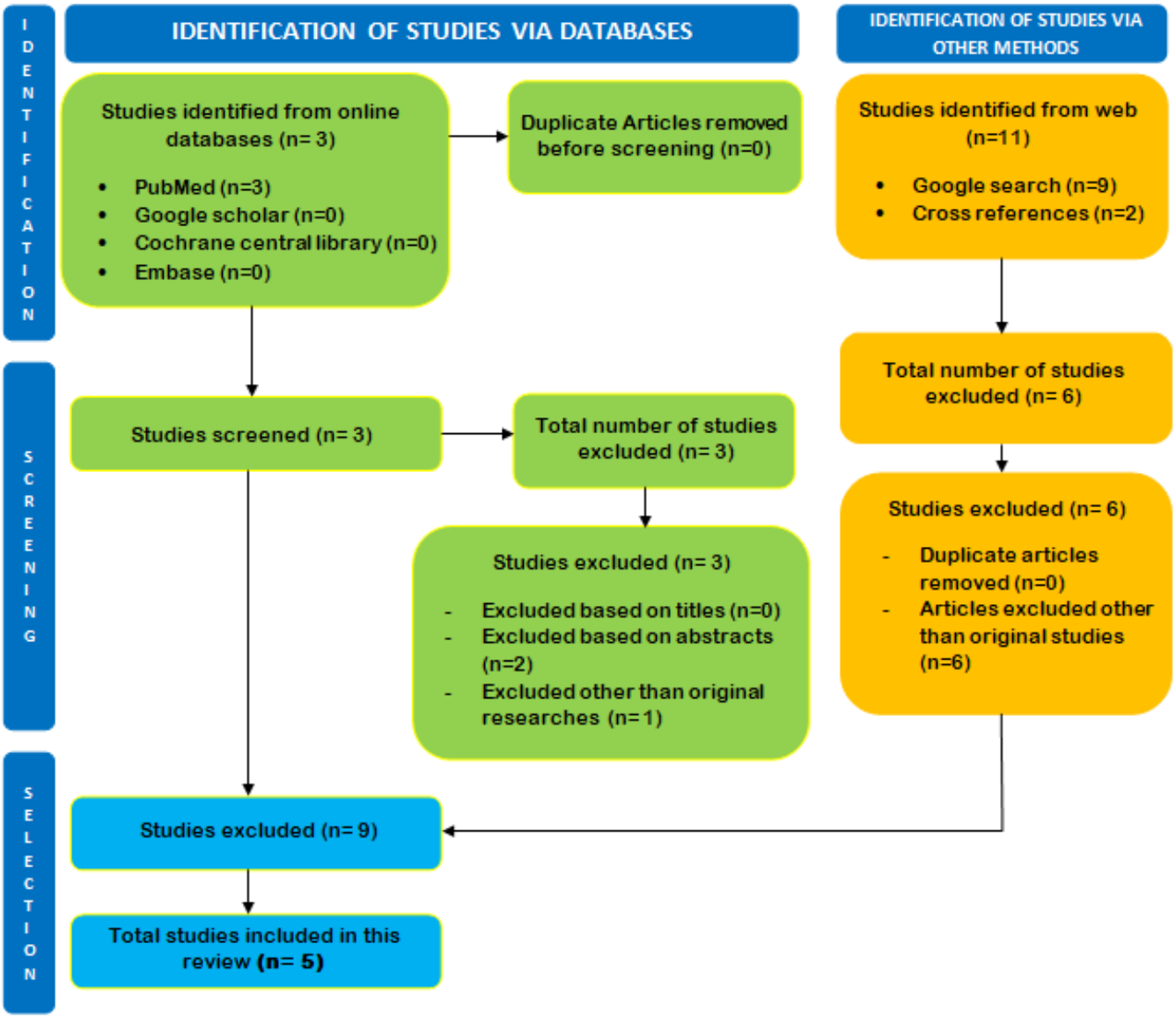

Fig. 1: The process of selection of articles in accordance with guidelines given by PRISMA guidelines (2020) for Systematic Review

Search strategy:

To identify the studies to be included for detailed evaluation in systematic review, following search strategy were developed for each database searched:

1. PubMed (All types of study design published till 2024)
2. The Cochrane Central Register of clinical Trials (All types of study design published till 2024)
3. Google Scholar (All types of study design published till 2024)
4. EMBASE (All types of study design published till 2024)
5. Web search (All types of study design published till 2024)

Data collection & analysis:

A comprehensive search was done using electronic databases which were scanned and evaluated independently by two authors to identify the relevant studies. The studies duplicated in the different databases were excluded. In case of any disagreement between the two authors, final decision was obtained by discussion between the two authors.

Table 1: The summary of the articles included in the systematic review

S. No	Author	Year	Sample	Technique	Material used	Advantages	Disadvantages
1.	Thamilselvan S. et al.	2021	Hard tissue - Bone, tooth Soft tissue - Oral tissues	Resin embedding	Epoxy resin	It is non-toxic, non-infectious, and emits no fumes or fluids. The specimens require little storage and minimal maintenance.	-Time-consuming - Post-curing tasks including trimming, polishing, and mounting are required to get a decent specimen display. -The specimen cannot be retrieved. - Air Bubbles in the resin were noticed to be more.
2.	Riederer MB	2014	Hands, legs, brain, pelvic floor	Dry technique - Plastination	S10 - Silicone, P40 - Polyester, Prussian blue impregnation	S10 - ideal for well dissected specimens and larger body slices. P40 - Excellent for fine slices because they become transparent.	S10 - Fine structures become more resistant to damage but also become more rigid P40 - Nervous structures are more difficult to identify. -Badly prepared specimens do not become better by plastination. - Plastination of brain tissues, shrinkage and rigidity are more prone.
3.	Mehra.S et al	2003	Hearts	Glue immersion & coating	Quickfix® (Wembley Laboratories) and amyl acetate	Specimens preserved by this method are much lighter than their wet counterparts. They are inexpensive, non-toxic and durable. Good contrast between structures were noticed.	Shrinkage of specimens noticed. Usage of higher concentration of glue caused inadequate penetration and rigidity because of its high viscosity.
4.	Dawson PT et al	1990	Uterine fibroid, ventricular aneurysm, pulmonary embolus, renal infarction, emphysematous lung, cirrhosis, bladder stones, myocardial infarction, lung tumor, aortic aneurysm	Dry technique	Silicone polymer	Outstanding colour retention; flexibility, allows a more deep investigation of intricate structures; and aesthetic superiority, odourless, and remarkably life-like. Plastinated specimens require little storage space and no maintenance	Limitations noticed yet not mentioned by the authors
5.	Auldemorte BT et al	1985	Ameloblastoma with segmental mandiblectomy	Dry technique	Epoxy resin & Silicone	Dry and odourless, and no special storage. They are nontoxic,noninfectious and realistic.	Limitations noticed yet not mentioned by the authors

Abstracts of the studies were evaluated to identify the final studies to be included based on the inclusion and exclusion criteria. Full text articles were evaluated when the abstracts did not provide adequate information regarding the groups compared. The following data were extracted from the studies and were analysed: Author, year, type of sample, technique of preservation, material used for preservation, advantages and disadvantages.

Results

Study selection:

The systematic search from the electronic databases of PubMed revealed 3 studies and web search revealed 11 articles. No studies were obtained from the database of google scholar, cochrane and EMBASE. Search via databases revealed 3 articles and after removal of duplicates and title & abstract scan, 0 studies were identified. Search via other methods yielded 11 (web search: 9; cross references: 2) articles. After scanning of titles & abstracts 6 articles were eliminated as they did not meet the inclusion and exclusion criteria. Full text articles for the other 5 studies were obtained for more detailed evaluation. A total of 5 studies met the inclusion and exclusion criteria of the intended research. Study selection process is depicted in the form of PRISMA flowchart (2020) in figure 1.

Study characteristics:

The study characteristics are summarised in table 1. A final of 5 studies were included in this review.

Type of samples - All 5 studies have used human tissues both soft & hard tissues. The samples were variable which included normal as well as pathological tissues. 2 studies[8,9] have utilised pathological samples such as Uterine fibroid, ventricular aneurysm, pulmonary embolism, renal infarction, emphysematous lung, cirrhosis, bladder stones, myocardial infarction, lung tumour, aortic aneurysm and ameloblastoma of jaw. 3 studies[10,11,3] have utilised normal tissue such as specimens obtained from oral cavity, abdomen & pelvis, upper limb, lower limb, thorax, head & neck, embryology, hands, legs, brain, pelvic floor and heart.

Preservation technique - 3 studies[8,9,11] have preserved their specimens using dry preservation technique via injecting the resins (epoxy, silicone, polyester & prussian blue impregnation followed by resin) into the tissues and 1[3] study have embedded the specimen within the resin without injecting. 1 study[10] utilized glue (Quickfix®) and a solvent (amyl acetate) as a preservation medium via immersion & coating technique.

Advantages - 1[11] study found that silicone was better for large specimens & polyester was better for fine or small specimens. However, the common advantages noticed for dry preservation techniques by 4 other studies[8–10,3] were non toxic, easy to carry, easy storage, odourless, non-infectious and dry.

Disadvantages - the most common disadvantages noticed by dry preservation techniques in 1 study[3] were time consuming, specimens cannot be retrieved, shrinkage, rigidity and air bubble formation. 1 study[11] found that fine structures became more rigid and were more prone for breakage. Also minute structures were difficult to identify. 2 studies[8,9] did not mention their study disadvantages. 1 study[10] found that there was mild shrinkage of the specimens seen.

Discussion

According to the preservation of specimens in the museum in pathological laboratories whether dry or wet technique, both are time consuming. These museum items ought to be preserved for future generations for educational purposes, therefore minor inconveniences can be disregarded. These research have revealed a variety of benefits and drawbacks.

Mehra S et al.[10] preserved cadaveric hearts with Quickfix® (Wembley Laboratories) & amyl acetate. The specimens were immersed in the solution of Quickfix® (an all purpose adhesive) & amyl acetate (solvent) for a period of 3 months. After which the specimens were dried and again coated with freshly prepared Quickfix® solution. They found that this technique was beneficial for them as a teaching tool. The hearts were dry, firm, and dark with a polished appearance. The atrioventricular valves were translucent, showing clear details and the structures had good contrast. The chordae tendineae remained flexible, and the valve cusps' rough and clear zones were distinctly visible in natural light with no fungal growth even after years of usage. Apparently, the procedure of the solution preparation in terms of liquid parts has not been clearly explained by the researchers. Since this is not an ideal material for preserving a specimen, the usage and technical difficulties are mandatory to be explained. Hence, multiple trials are required before opting this as a technique in laboratories.

Of all the dry preservation techniques, plastination was opted more. The most common polymers employed in plastination are silicone (S10), epoxy (E12) and polyester (P40)[8,9,11]. Plastination, a well-established method for preserving biological tissues, was developed by von Hagens in 1979[12]. This technique yields dry, odorless, durable and manipulable specimens. Several researchers have explored modifications to von Hagens' original methodology (Bickley et al., 1981[13]; Tiedeman et al., 1986[14]; von Hagens et al., 1987[15]. The principle of plastination involves removal of water and lipid from the tissues which are then replaced by a plastic (curable polymer). This technique allows safe, touchable, genuine, odour-free, nontoxic, biohazardous end products and long term preservation which was also noticed in the studies included in this review which is better from the gold standard wet preservation technique stored using formalin. Definitely, dry preservation technique avoids a messy environment thus enhancing the teaching-learning process in institutions.

Thamilselvan S, et al.[3] had experienced many pitfalls via resin embedding technique and they have also concluded that this technique was not found to be beneficial for soft tissues. Thus, injecting the resin into the tissues of the specimen is a much better approach rather than just embedding as it does not allow the specimen to be visualised closely and also the minute structures cannot be touched as well, especially for soft tissues. Also the major drawback of dry technique is that the specimen cannot be retrieved for progressive research[16]. But the genetic evaluation using the formalin preserved specimens allows DNA deterioration over a period of years where research is again questionable.

Dry preservation techniques for museum specimens were intensively investigated in laboratories during the late 70s, but interest and experimentation with these approaches waned over time. Though this procedure has advantages, the disadvantages like handling, technique sensitivity & expense outweigh the benefits, prompting a return to traditional formalin preservation. Furthermore, resin impregnation hardens and reduces the flexibility of specimens, limiting students' tactile experiences. These specimens have a high level of institutional integrity, thus trials with them were not appreciated. Apart from being nontoxic, noninfectious, and easy to maintain and transport, there is no evidence to support the use of dry preservation procedures for keeping museum exhibits in laboratories.

Conclusion

In comparison, dry preservation techniques were found to be beneficial in academic areas. The plastination technique even though it proposes various challenges, the procedure to be followed for preservation is standardized after multiple researches. This can be a pocket friendly learning tool in the near future. Though this plastination technique is not cost effective, it can definitely be followed in institutions. In case of doubtful situations, it is always better to follow gold standard formalin preservation.

References

1. Dr. K.Vijayakumar, Dr. Raju Bokan, Dr.Vaishaly Bharambe, Dr. Mandar Ambike, Dr.VK .Arun Prasad, "Preparation of Wet Specimens in Anatomy Museum: A Practical Approach to Overcome Difficulties", ijmsir- January - 2020, Vol – 5, Issue -1, P. No. 179 – 188.
2. Parasakthi, M. Scope and Features of Museum Setup Techniques in Oral Pathology. Journal of Biomedical and Pharmaceutical Research. 2020 - 9(5). 10.32553/jbpr.v9i5.808.
3. Thamilselvan S, Sherlin HJ, Jayaraj G, Don KR, Santhanam A. Preservation of Museum Specimens with Epoxy Resin – A Dry Preservation Technique. Oral Maxillofac Pathol J 2021;12(1): page no. 14-17. https://ompj.org/files/article%203-167707877ba4aaf769e8abfb726a230680293755.pdf
4. Nakahama N. Museum specimens: An overlooked and valuable material for conservation genetics. Ecological Research, (2020), 1440-1703.12181. 10.1111/1440-1703.12181
5. Miyan K, and Khan S. Plastic Embedding: A Noble Technique for Preserving Specimens in Museum. International Journal of Science and Research. 2021. Vol. 10, No.9, P.No. 923-925. https://www.ijsr.net/archive/v10i9/SR21918161737.pdf
6. Reid DG. An Introduction to Molluscs: Curation, Conservation and Uses. Oxford University Museum of Natural History. The Biology Curator. (2000) Issue 18-3, pages 11 - 17. http://www.natsca.org/article/408
7. Page M J, McKenzie J E, Bossuyt P M, Boutron I, Hoffmann T C, Mulrow C D et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews BMJ 2021; 372 :n7.1. 10.1136/bmj.n71
8. Dawson TP, James RS, Williams GT. Silicone plastinated pathology specimens and their teaching potential. J Pathol. 1990 Nov;162(3):265-72. 10.1002/path.1711620314. PMID: 2266465.
9. Aufdemorte TB, Bickley HC, Krauskopf DR, Townsend FM. An epoxy resin and silicone impregnation technique for the preservation of oral pathology teaching specimens. Oral Surg Oral Med Oral Pathol. 1985 Jan;59(1):74-6. 10.1016/0030-4220(85)90119-7. PMID: 3883284.
10. Mehra S, Choudary R, Tuli A. Dry Preservation of Cadaveric Hearts: An Innovative Trial - The Journal of Plastination. J. Int. Soc. Plast. (2003) 18: 34-36. https://doi.org/10.56507/HBYI4293
11. Riederer BM. Plastination and its importance in teaching anatomy. Critical points for long-term preservation of human tissue. J Anat. 2014 Mar;224(3):309–15. http://dx.doi.org/10.1111/joa.12056
12. Ravi SB, Bhat VM. Plastination: A novel, innovative teaching adjunct in oral pathology. J Oral Maxillofac Pathol. 2011 May;15(2):133–7. http://dx.doi.org/10.4103/0973-029X.84475
13. Bickley HC, von Hagens G, Townsend FM. An improved method for the preservation of teaching specimens. Arch Pathol Lab Med. 1981 Dec;105(12):674–6. https://www.ncbi.nlm.nih.gov/pubmed/6895457
14. Tiedemann K, Hagens GV. The technique of heart plastination. The Anatomical Record. 1982 Nov 1 [cited 2025 Jan 18];204(3):295–9.
15. von Hagens G, Tiedemann K, Kriz W. The current potential of plastination. Anat Embryol (Berl). 1987;175(4):411–21. http://dx.doi.org/10.1007/BF00309677
16. Hayat, Khizar & Qureshi, Anas & Rehan, Sarmad. Plastination-An innovative preservative technique. Trends in Anatomy and Physiology. (2018). 1. 10.24966/TAP-7752/100003.