Preservation of human tissue by plastination: An anatomical perspective

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ABSTRACT

The necessity of preserving human tissue has increased over the years because of various reasons. Preserved tissues play a crucial part in the teaching and research of anatomy. This review paper has compiled the basic techniques of human tissue plastination from the anatomical perspective and its advantages over typical methods. One of the most effective techniques we used to preserve human tissue is plastination. It was developed by German anatomist Dr. Gunther Von Hagens. After him, many improvements are made to get maximum results. Because of this technique’s advancement, we can see an accurate 3-D sample of human tissue, which is anatomically correct and looks almost real. There are essential procedures for all types of plastination like fixation, dehydration, defatting, force impregnation, positioning, and hardening. Silicone, epoxy, and polyester are primarily used as the polymer. Acetone is used for dehydration. Removal of fat is crucial for tissue preservation by plastination. Plastinated specimens are used in laboratories for teaching anatomy, in research institutes for morphological studies, and also in forensic to solve crimes. After analyzing several research articles, it was concluded that plastination has much more advantages than other human tissue preservation techniques for anatomical usages.

INTRODUCTION

Preserving human tissue and using it for the future has been an essential practice in different walks of science. Various processes that have been used in the past and using formalin and ethanol for preservation are still popular because of the simplicity and product availability (Shian et al., 2016). Phenol-based fixative has also been reported as an alternate to formalin (Rahman et al., 2021). Yet, plastination has changed the path of human tissue preservation, as, by this procedure, we can get real-like specimens (Hagens et al., 1987). Plastination is a technique that involves slowly replacing tissue fluids and a portion of tissue lipids with a polymer when under vacuum. 13th. Silicone (S10), epoxy (E12), and polyester (P40) are the most common polymers used in plastination (Sora et al., 2019). True biological specimens that are safe, touchable, genuine, odor-free, nontoxic, and biohazardous are the end products. They do not need to be treated with gloves, and they do not require any special storage or care. Plastination delays the deterioration of dissected specimens, allowing time to prepare new specimens for the anatomic archive (Kumar et al., 2018). Dr. Gunther Von Hagens, a German physician and anatomist, invented this tissue preservation technique while experimentation with kidney slices and plastic polymer stain types of plastination at the University of Heidelberg in 1977 (Horst et al.,
DISCUSSION

Benefits over formalin preservation
Medical professionals, mainly anatomists, have often focused on preserving corpses from natural processes of decomposition and putrefaction so that they can be used for further studies and research. Embalming is the most effective method of preventing cadaver decomposition/putrefaction (Coleman and Kogan, 1998). Wet organs preserved in formalin have drawbacks such as an obnoxious odor and bleached colorless sections that lack a naturalistic appearance. They are difficult to keep up with for an extended period of time. In addition, in a dissected specimen, the luminal architecture, proportions, and branching structures are difficult to view. By considering these facts, newer areas have been researched in order to minimize the disadvantages. Plastination is one such procedure that has the potential to solve most of the difficulties (Latorre et al., 2016; Riederer, 2014).

Types of plastination for human tissue preservation
Plastination can be done in four different ways, resulting in four different types of specimens.

1. Silicone-impregnated specimens: They are durable, versatile and are primarily used in educational settings.

2. Specimens with polymerizing emulsions: Specimens made with polymerizing emulsions are as opaque as silicone specimens, but they are rigid and prone to breakage to some degree. This method is used in dense body slices that show a greater contrast between the fat tissues, which shows up clean, and with intensely stained parenchyma.

3. Transparent body or organ slices: Epoxy resins are used to create a transparent body or organ slices. These slices enable researchers to study the topography of all internal organs in a non-collapsed and non-dislocated state. Furthermore, the samples are effective in advanced sectional topography education programs.

4. Opaque brain slices: Polyester resin is impregnated into opaque brain slices, allowing for a special distinction between fiber and nuclear areas.

Uses of plastination in academia
Plastinated organs improve the teaching-learning process at all levels of schooling, from secondary (biology, zoology) to university level (anatomy, pathological anatomy, and so on) (Latorre et al., 2007). In addition, plastination has started to transform the process of teaching and learning human and veterinary gross anatomy in recent years. Most medical curricula use human bodies to explain macroscopic anatomy, but cadaveric resources are not accessible in many countries around the world (McLachlan et al., 2004). Plastination will fill the void in those countries and act as a complement to anatomy education. Plastination of body parts is becoming more important in tissue storage and anatomical training over time (Hubbell et al., 2002).

Uses of plastination in research
The term "scientific plastination" refers to the creation of plastinated tissues, especially transparent tissue sections (sheet plastination using E12 or P40 techniques), which are extremely important for the research on both macroscopic and microscopic frameworks. Furthermore, plastination provides an excellent opportunity to investigate the structures that exist between the macro and microscopic levels, known as the "mesoscopic" region. Thus, plastination is positioned as the most appropriate method for investigating structures in the mesoscopic area (Sora et al., 2019).

MATERIALS AND METHODS

Method of plastination
Basic steps for plastination are pretty consistent for all types of tissues or the whole body.

The steps are given below,

Anatomical dissection and fixation
Fixation is the first stage in Plastination. To destroy all the bacteria and avoid tissue decomposition, formaldehyde or other preservation agents are injected through the arteries. This treatment takes about 3-4 hours. After that, the dissection process begins. To preserve the individual anatomical structures and components, the skin, connective tissue, and fatty tissue are extracted. Dissection can take quite a long time, depending on the complexity of the specimen.

Removal of body fat and water
When all of the requisite dissections have been performed, the Plastination process will begin. The water and soluble fats are removed from the body in an acetone bath in the first process. Under freezing conditions, acetone sucks all of the water out of the cells and absorbs them. It could take anywhere from 500 to 1,000 hours of work.

Forced Impregnation
The central phase or third stage of the plastination process is forced impregnation. A liquid polymer, such as synthetic rubber, polyester, or epoxy resin, is used to immerse the specimen. Acetone boiling at a low temperature when a vacuum is formed. **Curing**

The specimen is hardened in the final stage. This can be done with gas, light, or heat, depending on the polymer. Curing the plastinate prevents it from decomposing and decaying. Dissection and Plastination of an entire body take about 1,500 hours and takes about a year to complete.

**Ethical considerations and when to use plastination**

Plastination allows tissue to be preserved for a long time – often indefinitely. All donors must give written permission for their bodies to be donated and used for medical research. Although certain samples can be stored for a long time and the right to utilize plastination as a preservation method is included in a donation agreement form, it is not expressly mentioned in the form. So strict regulation is needed (Riederer et al., 2012).

**Limitations**

The process is technique-sensitive and time-consuming, and it also necessitates the use of skilled labor. It is pricey because a lot of the polymers have to be imported. To achieve a good display specimen, a lot of post-curing work is needed, such as trimming, polishing, coloring, and mounting. The plastinates do not have the same emotional and tactile experience as a wet cadaver.

**CONCLUSIONS**

Unlike other technologies that were initially met with harsh criticism, plastination was accepted from the outset. While it is a much superior preservation technique to conventional approaches, there is still room to improve. Despite the ethical concerns, the number of donors willing to go through this procedure demonstrates how this procedure has captured the public and how this admiration can be used to inform society for the better. After assessing the recent studies on plastination, it becomes evident that this is a noble technique to preserve human tissues for anatomical perspective.

**Conflict of Interest**

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