International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Impact Factor 2024: 7.101

The Necessity of Long-Term Hazardless Tissue Preservation is the Mother of Plastination

Dr. Sachin Sharma[1], Dr. Monika Sharma[2]

[1]Professor, Rachana Sharir Department, Institute for Ayurved Studies & Research Faculty of Ayurved, SKAU, Kurukshetra

[2]P. G Scholar, Rachana Sharir, Department, Institute for Ayurved Studies & Research Faculty of Ayurved, SKAU, Kurukshetra

Abstract: ***Anatomy is fundamental to the medical field and plays a critical role in clinical practice. As the world continues to evolve and curiosity about the human body grows, there has been a notable increase in the number of individuals pursuing this field, leading to a higher demand for cadavers. One of the most essential prerequisites for the use of human bodies in educational settings is the appropriate preservation of cadavers, which is achieved by treating them with special chemicals. The history of preservation dates back to the body of Raja Dashratha, who was treated in a tail droni and placed in running water, as described by Acharya Sushruta. This has progressed to the use of formalin and other preservatives, marking significant advancements in tissue preservation till Plastination. It is an art of anatomical embalming. Plastination, developed by Gunther von Hagens in 1977, is a technique for preserving tissue in its life - like state for long - term, hazard - free preservation of specimens for medical, educational, and scientific purposes. It is a process of anatomical specimen preservation by forced impregnation method with curable polymers like silicon, epoxy or polyester resins. In this process, water and lipids in biological tissues are replaced by curable polymers, which are hardened, thereby resulting in dry, odorless and durable specimens. These techniques are based on the type of polymer used for impregnation and consist of four steps: fixation, dehydration or defatting, forced impregnation and curing or hardening. This article explores the necessity of maintaining tissue integrity over extended periods without the use of hazardous chemicals. By examining the historical context, technological advancements, and the growing demand for safer alternatives, we state that the evolution of Plastination is a direct response to these needs.***

Keywords: Plastination, Tissue preservation, Anatomical specimens, medical education, Rachana Sharir

1. Introduction

Anatomy, often referred to as the backbone of medical science and a stepping stone to clinical practice, has long been recognized as a core discipline within the scientific field. The history of anatomical specimen preservation is intrinsically tied to the development of anatomy itself, and the evolution of anatomical study reflects changing attitudes toward dissection[1]. Dissection is often described as a challenging yet rewarding journey—one that, despite its difficulties, ultimately leads to greater understanding and insight. Learning anatomy through hands - on dissection enhances clinical knowledge in a meaningful way[2]. To achieve this, the study of gross anatomical specimens is essential. Therefore, to ensure that future generations can benefit from this vital learning, there is a critical need to preserve cadavers from the natural processes of decomposition and putrefaction.

1.1 History of Body Preservation

Body preservation techniques have evolved significantly across cultures:

1) Raja Dasharatha's (7323 BCE) body was immersed in an oil - filled boat and placed in flowing water[3].
2) Egyptian Mummification (2600 BCE): Used natron salt and resin - coated linen wrappings[4].
3) Sushruta Samhita (600 BCE): Mentioned underwater body preservation techniques[5].
4) Alexander the Great's (336 BCE) body was preserved in honey to prevent decay.
5) Medieval and Renaissance Eras: Alcohol, salt, and wax were used for preservation.
6) Modern Innovations: Formaldehyde - based embalming followed by plastination revolutionized preservation.

Over the centuries, preservation methods have evolved, from the ancient mummification of *Raja Dashrath's* body in *Tail Droni* to modern techniques like cryo - preservation. The exploration of Plastination emerged as an advancement in this ongoing process of preservation, building on lessons learned from previous methods and overcoming their limitations[6].

1.2 Plastination

In 1977, german physicist and anatomist professor Gunther Von Hagen invented named and refined the plastination technique. The greek verb ""Plassein"" which means "to shape or to mold" is where the word plastination itself comes from. These processes use curable polymers, mainly silicone, epoxy and polyester in place of the water and lipids present in biological tissues. These polymers eventually harden to create specimens that are dry, undisturbed, long lasting, and naturally seeming. Many applications of plastinated specimens have been prepared by the standard techniques of Plastination[7]. These specimens have been considered as an important tool for teaching and exposition purposes.

Purpose: Plastination, originally developed to preserve biological tissue for anatomical study, has evolved to play a key role in clinical research and education. Clinical Plastination enhances medical training by providing detailed, durable specimens for teaching ultrasound, radiographic anatomy, and surgical techniques. It enables clinicians to better understand anatomical structures and integrates with diagnostic and surgical procedures. The epoxy Plastination technique also offers new possibilities for both anatomical and clinical research. Overall, clinical Plastination significantly improves anatomy education and advances research in applied medicine.

Principle of Plastination:
Plastination is the process of forcing plastic resins into biological tissues. the idea is to remove the tissues water and lipids and replace them with a plastic (curable polymer) to create specimens that are touchable odorless, and retain the original sample's characteristics[8].

Curable polymers are used, such as epoxy, polyester or silicone, and each of these offers unique properties and benefits, such as -

- Epoxy – For Transparent sheet Plastination (E12 technique)
- Silicone rubber - For luminal cast Plastination (S10 technique)
- Polyester – For Brain tissue Plastination (P40 technique

The type of polymer utilized determines the impregnated specimens mechanical (firmness or flexibility) and optical (transparency or opacity) characteristics. Gross specimens, dissected specimens and cross - sectional slices can be preserved permanently into specimens that are clean, dry and practical to use. Hence, the irritating and harmful effects of older preservative liquids like formaldehyde are prevented by the Plastination process, allowing us to obtain clean, dry, resistant preparations of unlimited duration, which can be examined without gloves or any other type of protective equipment and do not require any special treatment or storage conditions.

General procedures of Plastination: The Plastination process begins with formaldehyde fixation, followed by rinsing under running water to remove the fixative. Soft tissues are cleaned either as hollow structures (for L. C. P.) or soft tissue sheets (for S. P.), while hard tissues like bones or teeth are bleached using 5 - 8% hydrogen peroxide for 24 hours. Soft tissue cleaning involves underwater dissection, followed by immersion in 98% acetone (ten times the tissue's weight) for water and fat removal, with the tissue stored at -25ºC for six days. The acetone is replaced 2 - 3 times over 18 days until the yellow color disappears or the acetone concentration reaches 98%. The tissue is then dried at room temperature and impregnated with resin through techniques like the sandwich method or force impregnation. After curing with a hardener, the specimen is durable, safe, and ready for display in a departmental museum.

Types of Plastination: Although all Plastination techniques have a similar basic protocol, depending on the type of polymer used and the type of anatomical preparation, the general classification is[9]:

1) **Luminal cast Plastination**
   It is done for hollow organs like lungs, stomach, intestine, ventricles of the brain, vascular pattern of the heart, and kidneys. Beautiful and precise bronchial patterns can be seen by this technique. Basically, it is a resin - casting method, not a tissue preservation method, for studying vascular patterns and internal structures of hollow organs.
2) **Sheet Plastination**
   It involves creating thin transparent or thick opaque sections of the body or organs, which display cross - sectional anatomy similar to CT or MRI scans. These sheets can be made in various planes, with thin sections (2 - 3 mm) closely resembling histology slides. Miniature bones, such as ear ossicles or teeth, can also be preserved. Polymers like epoxy, polyester, or polypropylene resins are used to create these plastinated sheets.
3) **Organ Plastination**
   In this process, the entire body or an organ is Plastinated.

2. Methodology

1) Luminal Cast Plastination

Hollow organs such as the stomach, duodenum, trachea, and blood vessels like the thoracic aorta, abdominal aorta, renal vessels, and brain ventricles are carefully prepared for Plastination. The cast material is thoroughly cleaned using running tap water or a syringe, and minor openings are sealed with thread or artery scissors. To preserve the structures, epoxy resin is mixed with a hardener in a 2: 1 ratio, or silicone is applied using a silicone gun and tube. The resin is then poured into the cast, and curing time is allowed—epoxy requires 2 to 3 days, while silicone takes about 24 hours shown in fig.1. After curing, the cast is removed, cleaned, and mounted on a glass or fiber sheet, with proper labeling to ensure accurate identification. This process results in well - preserved specimens ready for display or study shown in Fig.2.

Figure 1: Steps involving luminal cast Plastination

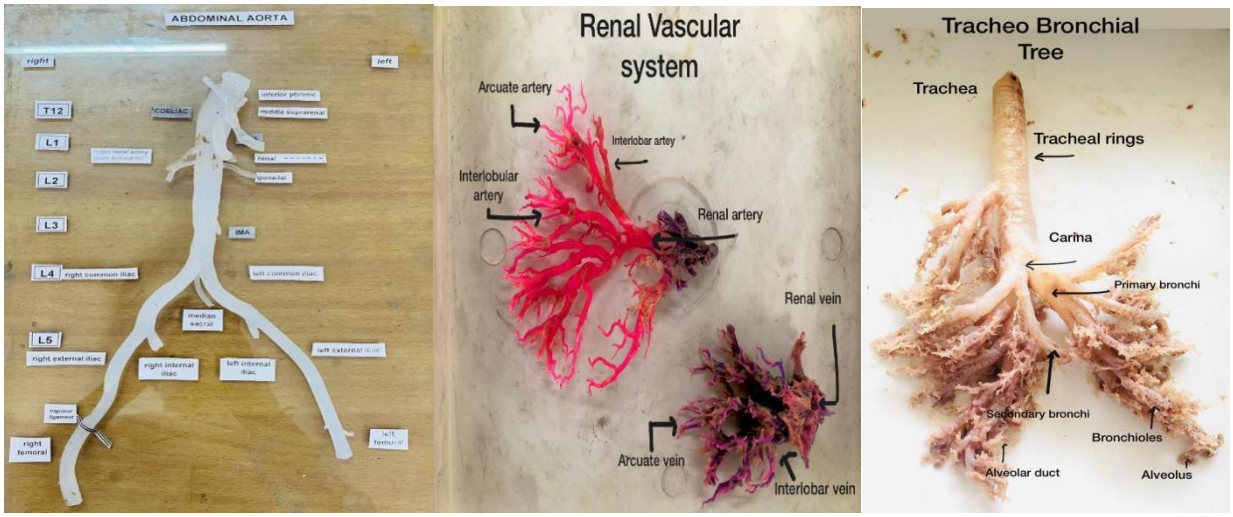

Figure2: Luminal cast Plastination of (a) abdominal aorta (b) Renal artery and vein (c) Tracheo Bronchial tree.

2) Sheet Plastination

The methodology for sheet Plastination begins with cleaning the specimen through underwater dissection and measuring its size and shape. Dehydration and defatting are crucial to prevent tissue shrinkage, with less than 10% shrinkage being acceptable. Thin or ultra - thin sections are cut using a shark blade (3 teeth per inch) or a diamond band saw. A cast is selected based on the thickness of the tissue slice, and the sandwich method is recommended for beginners in sheet Plastination. Finally, the specimen is impregnated with resin and cured to ensure durability and preservation shown in Fig.3.

Figure 3: Sheet plastinates of ear ossicles and T. S. of uterus.

3) Organ Plastination

Organ Plastination begins with fixation and thorough cleaning of the organ, followed by dehydration with acetone and defatting to remove water and fat. The organ is then impregnated with a polymer resin, typically epoxy or silicone, using a vacuum or force impregnation method. After impregnation, the organ is placed in a Chamber, and a coating of resin and hardener is applied and left to harden. The specimen is then carefully sectioned or left intact, depending on its intended use. Finally, it is mounted for display or educational purposes, ensuring accurate labeling for identification Fig.4

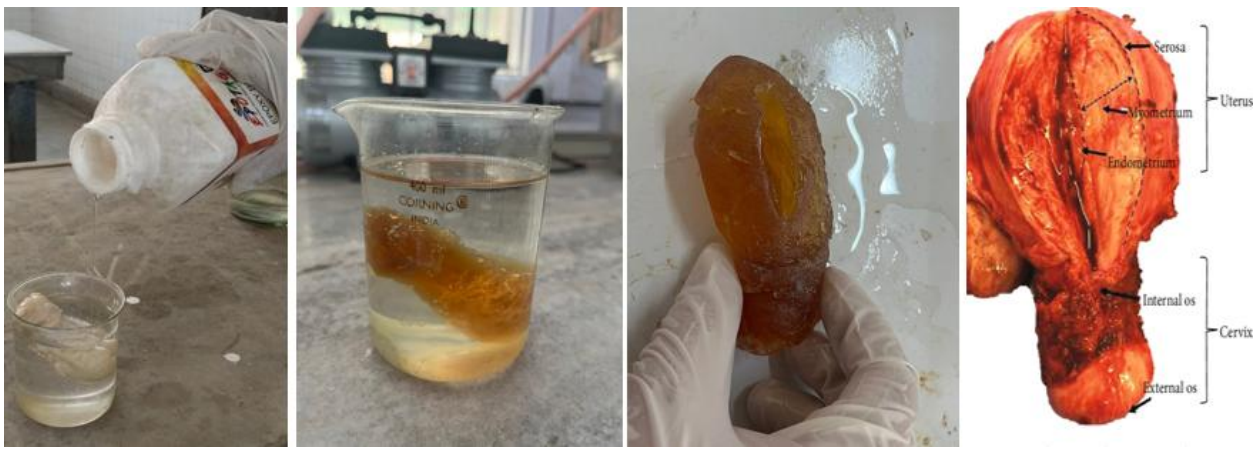

Figure 4: Organ Plastination of Uterus and Fetus.

3. Result and Discussion

Observing the external morphology of the plastinated specimens provides a comprehensive understanding of their structure and anatomical features. It allows us to appreciate the complex arrangement of tissues and identify key structures. Additionally, the plastination process caused a notable drop in saturation, which resulted in a slight change in the heart's general color. However, the hue remained largely unchanged, indicating that the Plastination process did not alter the basic color of the tissue. Hence, it does not significantly alter the overall appearance of the tissue. Modifications were made to the vacuum pressure settings and curing time. These adjustments maintained specimen integrity while reducing costs.

These plastinated specimens overcome the existing formalin preservation method, and it is pleasant to touch, handle, do not cause any respiratory irritation and topical allergic reactions. However, these specimens were prepared with indigenous epoxy resin with a specialized catalyst to improve cost - effectiveness and enhance polymer penetration. Adjustments were made to the vacuum impregnation and curing process to optimize specimen clarity. Also, these specimens / anatomical museum models will last many years and reduce the need for many internal organs for teaching in the routine classroom deliberations. The Plastinates can be stored openly without consuming space like a laboratory and museum. There is an additional concern over the carcinogenic potential of formaldehyde, and determining safe levels is making it advantageous to remove such fumes from the anatomical laboratory as much as possible. Recent research has demonstrated that the growth of plastination has created new opportunities for gross anatomy in the medical sciences as a whole.

Applications:

- Educational Use: Plastinated specimens are used in medical education to provide a realistic view of anatomical structures without the decay associated with traditional preservation methods.
- Research: The technique allows for detailed anatomical studies and can be used in various biological research fields[11].

4. Conclusion

Plastination has been considered so far as an ideal technique for long - term preservation of well - dissected specimens and body slices. It is not only beneficial for preservation, but also a valuable addition to anatomy teaching. We are all aware that plastic specimens can be easily handled without chaos and are more accepted by students to help them learn anatomy better[12]. This updated method even allows scholars all over the world to view and project anatomy. Plastination has the capacity to maintain fragile structures and their connections, making them traceable under a microscope[13]. The body can be viewed in a new way by even untrained individuals through a sacred ritual known as plastication. But it seems that a lot of anatomists are still unaware of how revolutionary plastination is for studding anatomy. Plastination has given anatomists more options by expanding the variety of specimens available for study and instruction.

References

[1] Pashaei S. (A brief review on the history, methods and applications of Plastination). Int J Morphol, Jan 1, 2010: 28 (4): 1075 - 79.
[2] Dibal NI, Garba SH, Jacks TW. Plastinates: (Possible tool for medical education in the near future, mini review). Res Dev Med Educ, 2018; 7 (1): 3 - 7. Doi: 10.15171/rdme.2018.002
[3] Parsh j, sh ram charit manas (ramayana), edited gorakhpur, gorakhpur printing press, ramayana 1/156, 2002. Pp.453.
[4] Ajmani, M. (2019). Embalming: Principles and Legal Aspects. Jaypee Brothers Medical Publishers Pvt. Limited.
[5] Sushruta samhita of maharsi - susruta, hindi commentary by kaviraja ambikadatta shastri, part1, chaukambha sanskrit sansthan varanasi, reprint edition, sharir sthana, 2014; 5/61 - 66
[6] Latorre R. Albors OL. (Guides and protocols for good practice. VI. Plastination). ACTA DE MADRID 2015., Oct 1, 2015; 19 (S1): 39 - 45.
[7] Von Horst C. von Hagens R. Sora C, Henry RW. (History and development of Plastination techniques). AnatHistolEmbryol., 2019; 48: 512 - 517. https: //doi. org/10.1111/ahe.12497

[8] Neha Saini. (Plastinated specimens as teaching AIDS). International Journal of Contemporary Medical Research, 2017; 4 (5): 1216 - 1218.
[9] Sora M - C, Latorre R, Baptista C, Lopez - Albors O. (Plastination - A scientific method for teaching and research). Anat Histol Embryol., 2019; 48: 526 - 531. https: //doi. org/10.1111/ahe.12493
[10] Menaka R (2010). Lead Paper: teaching and learning of Anatomy by Plastinates. XXVth Annual Convention of IAVA and National Symposium, Rajiv Gandhi College of Veterinary and Animal Sciences, Puducherry.
[11] Hayat K, Qureshi AS, Rehan S, Rehman T. (Plastination - an innovative preservative technique in Anatomy). Trends Anat Physio, 2018; 1: 003.
[12] Plastinated specimens have been widely acknowledged as valuable educational tools for **teaching and anatomical exposition** (Pashaei, 2010).
[13] Studies confirm that plastination enhances medical training, particularly for ultrasound, radio graphic anatomy, and surgical simulations (Sora et al., 2019; Hayat et al., 2018).