Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(6), 1392-1400 | ISSN:2251-6727

A Comparative Study of Plastinated Specimen and Formalin Fixed Speimen in Anatomy

Ms. Kavita C. Jorkar,[1] Dr. Mini Mol P.,[2] Mr. Harikrishan P.R.[3], Dr. Charushila D. Shinde[4].

1. PhD. Scholar, MGM Medical College, Kamothe, MGMIHS, Navi Mumbai, Maharashtra, India - 410 209
2. Associate Professor, MGM Medical College, Kamothe, MGMIHS, Navi Mumbai, Maharashtra, India - 410 209
3. PhD. Scholar, MGM Medical College, Kamothe, MGMIHS, Navi Mumbai, Maharashtra, India - 410 209
4. Professor, MGM Medical College, Kamothe, MGMIHS, Navi Mumbai, Maharashtra, India - 410 209

CORRESPONDING AUTHOR

Dr. Mini Mol, Associate Professor, MGM Medical College, MGMIHS, Kamothe, Navi Mumbai, Maharashtra, India - 410 209.

(Received: 27 September 2025 Revised: 05 October 2025 Accepted: 18 November 2025)

KEYWORDS
Cadaver, Plastination, Preservation, Polymers, Resin.

ABSTRACT:

Background and Objective: Plastination is a technique of cadaveric preservation developed by Dr. Gunther von Hagens in 1977. In this process, the curable polymers are forcefully impregnated to the biological tissue thereby resulting into an odourless, dry, long lasting, and natural looking specimen. There are two type of plastination whole organ plastination and sheet plastination. Most commonly used polymers include epoxy, silicon and polyesters. The conventional method of preserving cadavers involved formalin which is known for its irritant nature. This study is aimed in preparation of plastinated specimen and evaluating the efficacy of plastinated specimen by comparing with formalin fixed wet specimen by using the feedback questioner.

Method: Processing of plastinated specimen involves four crucial steps that are Fixation, Dehydration, Force impregnation and Curing. For whole organ plastination of duodenum we have used PLASTODUR-S-18 resin and for sheet plastination of section of arm and kidney we have used PLASTODUR E-45. The resulted specimen was evaluated from the Teaching faculty of Department of Anatomy, Pathology and Surgery MGM Medical College, MGMIHS, Kamothe, Navi Mumbai by using feedback questioner.

Result: The resulted whole organ plastinated specimen duodenum and sheet plastination specimen were dry, long lasting, easy to handle and useful for differentiating structures.

Conclusion: Plastinated specimens are not only restricted to anatomy department but also beneficial to other specialties such as pathology, radiology and surgery. It is also beneficial for museum preservation and in research.

INTRODUCTION

Every medical student begins their medical career by learning anatomy. Anatomy is a biological science which deals with the study of structure of human body.

Medical course depends on the cadavers for teaching and learning gross anatomy for which the preservation of cadavers and specimens for long time is of utmost important.

For this, cadaveric specimen is preserved by different preservative methods such as Thiel embalming, Hypodermic embalming, Surface embalming etc. and all these methods involves the use of formalin for preservation which is known for its irritantnature and its long-term use may lead to health issues of dermatitis, conjunctivitis etc.[1]

Plastination is a technique of cadaveric preservation developed by Dr. Gunther von Hagens in1977.[1] In this process, the curable polymers are forcefully impregnated to the biological tissue there by resulting into an odourless, dry, long lasting, and natural looking specimen.[2]

It involves four crucial steps that are Fixation, Dehydration, Force impregnation and Curing.

Depending on the polymer infused the optical quality of the specimens may vary. Mostcommonly used polymers

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(6), 1392-1400 | ISSN:2251-6727

include epoxy, silicon and polyesters.[3]

Since the use of plastinated specimens are not restricted to dissection hall teaching it can be used in lecture room and small group teaching as well. with long shelf life of these plastinatesit can be used for decades for teaching purpose with minimal exposure to formalin and low demand with respect to handling and storage.

Plastinated specimens are also better options for anatomy museums for self-directed studiesby students. These plastinated specimens are not only restricted to anatomy department but also beneficial to other specialties such as pathology, radiology and surgery.[4]

The plastination however cannot be an alternate for traditional hands on dissection but anadditional tool for teaching anatomy.

This study is aimed in preparation of plastinated specimen and evaluating the efficacy of plastinated specimen by comparing with formalin fixed wet specimen.

MATERIAL AND METHODOLOGY

The study was conducted at MGM Medical College, Kamothe, MGMIHS, Navi Mumbai. 30 teaching faculty were involved to take the feedback of the processed plastinated specimen.

MATERIALS:

Specimen: - One Duodenum, One Section of kidney and arm were used for processing the plastinated specimen.

Chemicals: - 5% formalin solution and Acetone

Resin: - Plastodur S-18 Part A & B and Plastodur E-45

PROCEDURE: The procedure consists of the following steps: -

➢ **Fixation:** The specimens were fixed with 5% formalin solution for 10 days to prevent autolysis.

➢ **Dehydration:**

- The specimens were then dehydrated in 3 changes of previously cooled acetone (90%,100%,100%) into the air tight container.
- For each change the container was kept at minus 20°C for 7-10 day.
- The volume of acetone was 10 times more than the volume of specimen.

➢ **Forced impregnation:**

- Dehydrated duodenum specimen immersed in Plastodur-S-18 Part A and Section of kidney and arm specimens were immersed in Plastodur E-45 further kept in plastination chamber.
- Allowed the vacuum slowly. This led to force the silicon to impregnated into the tissue by replacing the acetone.
- Avoided continues or rigors bubbling.
- Once the bubble stops, it indicated that the dehydration is completed.
- It required a week for completion of this step.

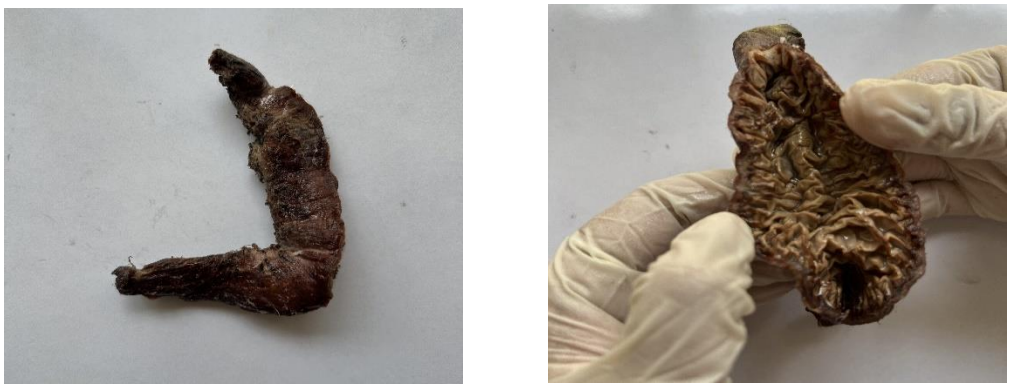
➢ **Curing:**

<u>Curing for whole organ plastination</u>

- With the help of brush the Plastodur-S-18 Part B (catalyst) applied on the all surface of organ.
- Kept it in hot air oven for a week at 60°C to cure.

Figure 1. Formalin Fixed Duodenum

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(6), 1392-1400 | ISSN:2251-6727



(A) **(B)**

Figure 2. Whole Organ Plastinated Specimen of Duodenum showing (A) External View and (B) Internal View

Curing for Sheet plastination

- Silicon tube placed between two glass slab and held together by binding clip.
- Specimen was then placed inside this flat chamber.
- Slowly, Plastodur E-45 was poured over the specimen.
- Curing was done by exposing the specimen to UV light
- It required around 30 min to cure.

Figure 3. Section of Arm

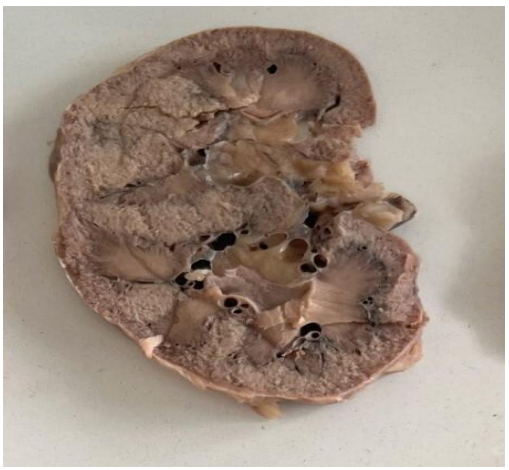


Figure 4. Section of Kidney

Figure 5. Sheet Plastination of Arm

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(6), 1392-1400 | ISSN:2251-6727

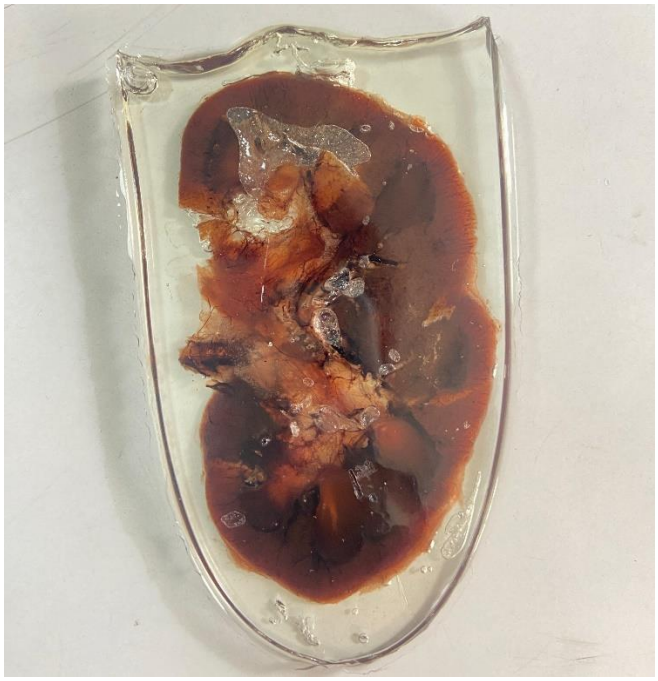


Figure 6. Sheet Plastination of Kidney

COMPARATIVE STUDY

- Comparative study held on the basis of the feedback taken from teaching faculty of Anatomy, Pathology and Surgery department of MGM Medical College, MGMIHS, Kamothe, Navi Mumbai by using feedback questioner.

RESULTS

Feedback for whole Organ Plastination, Sheet Plastination and Formalin Fixed Specimen was collected (n=30 for each) from MGM Medical College, MGMIHS, Kamothe, Navi Mumbai. The data was tested by **Wilcoxon rank-sum test,** to compare the **distribution of ordinal responses** between the two methods **for each characteristic**. The Wilcoxon rank-sum test was applied to asses paired responses and level of statistical significance set at $p < 0.05$. The comparative analysis was conducted to evaluate the perception of teaching faculty regarding various characteristics of Plastinated specimen vs formalin fixed wet specimens.

Table 1. Comparison of Whole Organ Plastination versus Formalin Fixed Specimen

Sr. No.	Characteristic	P-Value	W Statistic	Decision
1	Odourless	$p < 0.0001$	$W = 884.0$	Significant
2	Dry	$p < 0.0001$	$W = 882.0$	Significant
3	Easy to handle	$p < 0.0706$	$W = 565.5$	Not Significant
4	Long lasting	$p < 0.1226$	$W = 549.0$	Not Significant
5	Irritant nature	$p < 0.0001$	$W = 99.0$	Significant
6	Low cost	$p < 0.0001$	$W = 25.0$	Significant
7	Flexibility	$p < 0.0036$	$W = 263.5$	Significant
8	Useful in differentiating structure	$p < 0.2960$	$W = 386.0$	Not Significant
9	Suitability for practical examination	$p < 0.3005$	$W = 386.0$	Not Significant
10	Overall experience is good	$p < 0.9219$	$W = 443.5$	Not Significant

The results indicates that the whole organ plastinated specimens were significantly preferred over formalin fixed specimens in terms of being odourless ($p < 0.0001, W = 884.0$), Dry($P < 0.0001, W = 882.0$), Irritant nature($P < 0.0001, W = 99.0$), and it exhibited greater flexibility($p < 0.0036, \mathrm{W} = 263.5$). These differences were statistically significant, leading to rejection of null hypothesis.

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(6), 1392-1400 | ISSN:2251-6727

In case of Low cost ($P < 0.0001, W = 25.0$) there is a significant difference observed between whole organ plastinated specimens and formalin fixed specimens.

On other hand, no statistically significant differences were observed between two preservation of methods regarding Easy to handle ($p < 0.0706, \mathrm{W} = 565.5$), Long lasting($p < 0.1226, \mathrm{W} = 549.0$), Useful in differentiating structure($p < 0.2960, \mathrm{W} = 386.0$), Suitability for practical examination ($p < 0.3005, \mathrm{W} = 386.0$), Overall experience is good($p < 0.9219, \mathrm{W} = 443.5$)

Table 2. Comparison of Sheet Plastination versus Formalin Fixed Specimen

Sr. No.	Characteristic	P-Value	W Statistic	Decision
1	Odourless	$p < 0.0001$	$W = 884.0$	Significant
2	Dry	$p < 0.0001$	$W = 882.0$	Significant
3	Easy to handle	$p < 0.0706$	$W = 565.5$	Not Significant
4	Long lasting	$p < 0.1226$	$W = 549.0$	Not Significant
5	Irritant nature	$p < 0.0001$	$W = 99.0$	Significant
6	Low cost	$p < 0.0001$	$W = 25.0$	Significant
7	Flexibility	$p < 0.0036$	$W = 263.5$	Significant
8	Useful in differentiating structure	$p < 0.2960$	$W = 386.0$	Not Significant
9	Suitability for practical examination	$p < 0.3005$	$W = 386.0$	Not Significant
10	Overall experience is good	$p < 0.9219$	$W = 443.5$	Not Significant

In case of Sheet Plastination when compare with formalin fixed specimen, sheet plastinated specimens were substantially preferred over formalin-fixed specimens for Odourless ($p < 0.0001, W = 887.0$), Dry($P < 0.0001, W = 888.0$), Easy to handle($P < 0.0081, W = 617.5$), Irritant nature($P < 0.0001, W = 164.5$).

For Low cost ($P < 0.0001, W = 42.5$) and Flexibility ($P < 0.0001, W = 47.5$) significant difference was observed between sheet plastinated specimens and formalin-fixed specimens.

However, no statistically significant differences were observed between sheet plastination and formalin-fixed specimens in case Long lasting($p < 0.0555, W = 572.5$), Useful in differentiating structure($P < 0.3010, W = 386.0$), Suitability for practical examination($P < 0.3010, W = 386.0$), Overall experience is good($P < 0.883., W = 459.5$).

This finding suggests that the plastinated specimen has definitely an advantage in terms of odourless, long lasting and easy to handle as compared with the formalin fixed specimens for teaching and learning anatomy.

DISCUSSION

Plastination emerged as an alternative to traditional method of preserving biological specimens in the year 1977 by Dr. Gunther Won Hagens. During these procedures, the water and lipids in biological tissues are replaced by curable polymers, primarily polyester, epoxy, and silicone, which subsequently harden and ultimately produce specimens that are durable, odourless, and natural-looking[1].

It has been shown that this approach works better for preserving biological specimens. Furthermore, plastinates are an excellent teaching and learning aid as they can be used outside the dissection room, in a portable manner. They are also free of many toxic effects

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(6), 1392-1400 | ISSN:2251-6727

of chemicals like formalin, making them ideal museum specimens. They are also flexible and easy to handle.

Additionally, biological specimens deteriorate and fade with time when preserved in formalin. Its degradable odour further limits handling and close examination of specimens. eventually becoming in the way of anatomy instruction and learning.

Transparent cross-sectional specimens are useful in many research fields. An ever-growing understanding of topographical relationships is necessary for diagnostic imaging using CT and MRI. Topographical details are revealed almost all the way down to the histological level.[2]

In the present study we have prepared whole organ specimen, sheet plastinated specimen and by using a feedback from the department of Anatomy, Pathology and Surgery we evaluated the benefits of plastinated specimen over formalin fixed wet specimen.

WHOLE ORGAN PLASTINATION

Knowledge of the anatomy and morphology of the anatomical organ is crucial for medical and paramedical courses. Three traditional plastination techniques—S10, P40, and E12—were introduced by Gunther von Hagens on the basis of materials used.[5]

In present study, we used Plastodur- S-18 resin for whole Organ Plastination. Some other resin was used by different authors. A Comparative study between characteristic features of plastinated specimen with different resins are mentioned in **Table 3.**

Table 3. Comparative study between characteristic features of plastinated specimen with different resins[5,6,7]

Sr. No.	Characteristics features	R. Menaka (2015) Resin used- chloroform and natural wood finish solution	Pandit S (2015) Resin used- Epoxy, Polypropylene, Orthocryl and silicone	Rafiemanzelat F (2021) Resin used- P96	Present study Resin used- Plastodur-S-18
1.	Dry	Yes	-	Yes	Yes
2.	Odourless	Yes	Yes	Yes	Yes
3.	Easy to handle	Yes	-	Yes	Yes
4.	Irritant Nature	No	-	-	No
5.	Long lasting	Yes	-	Yes	Yes
6.	Shrinkage	Minimal	Yes	Minimal	No
7.	Colour retention	No	Yes	Yes	Yes
8.	Low cost	Yes	-	Yes	No
9.	Flexible	-	No	Yes	Yes
10	Retention of gross anatomy	-	Yes	Yes	Yes

Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(6), 1392-1400 | ISSN:2251-6727

SHEET PLASTINATION

Plastination of biological tissue with different resin such as epoxy, polyester, UV resin allows section of 2-3mm to be preserved for anatomical studies.

In this study a new resin Plastodur E-45 was used for sheet plastination which being low viscosity as compare to other used resin. as it allowing the free flow of the molecules thus making the procedure easy to carry out resulting into a detailed and fine specimen.

➢ SECTION PREPARATION

Most challenging part in sheet plastination was the execution of the method in preparing the section of specimens. Whether the specimen needs to be first plastinated with the resin and then slices need to be taken or directly sections are taken and then plastinated.[8]

The available data (Eckel et al., 1993) stated that for section less than 1.5mm the whole specimen is plastinated into a block and then sections are taken from that block. For 2-3mm thickness first the sections from the specimen were taken and then plastinated.[9]

In our study we employed a method of freezing the arm, to be sectioned in deep freezer at -20°C for 24hrs prior to the sectioning. We did not get the desired sections of 2mm when kept it for 2hrs hence increased the freezing time.

➢ SAW PREAPARATION

The fine slices of the specimen depend mainly on the kind of saw blade used for slicing the sections.[12] In order to achieve thin slices of 2-3mm we have used the hacksaw blade which is easily available from local hardware shop. Prior to the saw used it was cooled at -20°C for 24hrs.

In contrast to our study, (Alston et al.1997) used shark band blade which was less toothed[10].

In order to achieve thin slices of 2-3 mm, (Fasel et al.,1988) modified the saw by added liquid nitrogen to cool the sawblade and the block rests on while being cut. This process was carried out for about two hours prior to cutting.[11]

Sheet plastination can be used as a vital tool for understanding and clarification of in situ structure in detailed. The anatomical structures can easily be understood which previously would have been difficult to appreciate.

PLASTINATION TECHNIQUE IN ANATOMY TEACHING AND LEARNING.

In all medical and paramedical courses, anatomy is a fundamental subject.

India has a total of 612 government and 291 private medical colleges.[12] The demand for cadavers used in medical education and research is rising along with the corresponding rise in medical colleges in India over the past few decades.[13] Due to lack of knowledge about the body donation, in medical institutes there is scarcity of cadavers. As plastinated specimens can used for long term, the number of requirements of new cadavers will be reduced.

Many alternative techniques to dissection have been developed in the recent years such as synthetic cadavers, virtual cadavers but unlike Plastinated specimens they lack the real-life touch.

In present study, we created odourless, long lasting, dry and easy to handle plastinated specimen which include whole organ plastination, sheet plastination Plastodur-S-18, Plastodur E-45 respectively.

To study the effectiveness of the plastinated specimen in teaching and learning anatomy a survey was conducted through feedback questioner from the faculty of anatomy, pathology and surgery for whole organ plastination, sheet plastination with formalin fixed wet specimen. In case of formalin fixed wet specimen, the feedback was satisfactory for the differentiating anatomical structures but there was an exception which include odour, irritant nature, handling of specimen.

In contrast to our study, a data was stated by (Latorre R. et al. 2016) 97.7% of students said that the plastinated specimen improved their knowledge of and comprehension of anatomy.[14]

To evaluate the benefits of plastinated specimen some faculty conducted a demonstration classes by using the prepared plastinated specimen to note the responses of students of medical, paramedical and allied health sciences. Amongst the feedback from anatomy teachers, stated that Plastinated specimen was more effective in teaching and learning anatomy as compared to the 3D models.

Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(6), 1392-1400 | ISSN:2251-6727

Overall, while receiving feedbacks few amongst the teaching faculty has shown interest in exploring the plastinated specimen for future use while some have proclivity for traditionally used formalin fixed wet specimens.

FUTURE PROSPECT AND CHALLENGES IN PLASTINATION

Plastination open a new window for teaching and learning anatomy. At present plastination is not only being used as teaching and learning tool but also gaining popular in research.

But still the procurement of the chemicals and materials used for plastination is not easily available with only handful of companies making it available with high cost.

Another challenge being that the standardized protocol not yet available for the processing of specimens for plastination.

To add the Anatomy act does not allow for sharing of plastinated specimen to different colleges and institutes. Hence, stopping the percolations of the specimen to interdisciplinary sectors.

CONCLUSION

The process of cadaveric preservation known as "plastination" includes both sheet and whole organ plastination. It involves Fixation, dehydration, forced impregnation, and curing are its four essential phases. When it comes to cadaveric preservation, the plastination technique lessens the need for irritating chemicals like formalin.

The current study came to the conclusion that, plastination can be utilized as an additional teaching and learning tool in the anatomy, pathology, and surgery departments, but cannot be a replacement for the traditional dissection hall teaching. We can create long-lasting, dry, odourless, easy to handle specimens with the plastination technique. Plastinated specimens can also be used for museum preservation and in research.

ACKNOWLEDGMENTS

We would like to extend Sincere gratitude to everyone who donated their body for anatomical studies. Also, we would like to acknowledge the participants of this study for their willingness to share their experiences and insights.

DISCLOSURE STATEMENT

No conflict of interest.

FUNDING

There is no funding associated with the work featured in this article.

ETHICAL APPROVAL

The study has been approved by the IEC at, MGM Medical College, MGMIHS, Kamothe, Navi Mumbai on 29.12.22(Approval number: DHR-EC/2022/SC/12/142).

REFERENCES

1. Pashaei S. A brief review on the history, methods and applications of plastination. International Journal of Morphology. 2010;28(4):1075-9.
2. Hagens G, Tiedemann K, Kriz W. The current potential of plastination. Anatomy and Embryology. 1987;175(4):411-21.
3. Sora M, Latorre R, Baptista C, López-Albors O. Plastination—a scientific method for teaching and research. Anatomia, Histologia, Embryologia. 2019;48(6):526-31.
4. Singh O, Mishra BK, Pandit S Maheshwari T P, Hasan S. Plastination: A Promising Method for Preserving Biological Specimens: A Review Article. International journal of scientific and Research Publications. June 2013:3(6).
5. Rafiemanzelat F, Sheikhi M, Rabiei AA, Setayeshmehr M. P96 Technique for Tissue Plastination in Preparing Long Lasting Anatomical Specimens. Anatomical Sciences. 2021; 18(1):31-44.
6. R. Menaka S. Chaurasia. Plastination of Internal Organs as Teaching/AnatomicalMuseum Model. Livestock Research International. January-March 2015;3(1):25-27
7. Pandit S, Kumar S, Mishra BK. Comparative study of anatomical specimens using plastination by Araldite HY103, polypropylene resin, 6170h19 orthocryl and silicone – a qualitative study. Medical Journal Armed Forces India. 2015;71(3):246-53.
8. Ottone NE, Baptista CA, Latorre R, Bianchi HF, Del Sol M, Fuentes R. E12 sheet plastination:

Techniques and applications. Clinical Anatomy. 2017;31(5):742-56.

9. Eckel HE, Sittel C, Walger M, Sprinzl G, Koebke J. Plastination: a new approach to morphological research and instruction with excised larynges. Ann Otol Rhinol Laryngol. 1993 Sep;102(9):660-5.

10. Alston M, Janick L, Wade RS, Weber W, Henry RW. A shark band saw blade enhances the quality of cut in preparation of specimens for plastination. J Int Soc Plastination. 1997; 12:23–26.

11. Fasel J, Mohler R, Lehmann B. A technical note for improvement of the E12 technique. J Int Soc Plastination. 1988; 2:4–7.

12. Himel Mondal, Sachin Soni, Ankita Juyal, Joshil K. Behera, Shaikat Mondal. Current distribution of medical colleges in India and its potential predictors: A public domain data audit. J Family Med Prim Care.2023;12(6):1072-1077.

13. Rokade SA, Gaikawad AP. Body donation in India: social awareness, willingness, and associated factors. Anat Sci Educ.Mar-Apr2012;5(2):83-9.

14. Latorre R, Bainbridge D, Tavernor A, López Albors O. Plastination in Anatomy Learning: An Experience at Cambridge University. J Vet Med Educ. 2016 Fall;43(3):226-34.