



IMPLICATIONS AND PERCEPTION OF PLASTINATION AMONG MEDICAL UNDERGRADUATES: A BRIEF REVIEW.

Anatomy

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ABSTRACT

The medical students of the newer generation are more enthusiastic and explorers when it comes to acquiring knowledge, especially through the world wide web (www) & multi-media. In an attempt to increase their motivation and enhance anatomy learning various methodologies have been introduced in recent years like problem-based learning, virtual reality surgical simulators, and computer-based learning methods. One such innovative technique is Plastination. Plastinates have become one of the revolutionary innovations in anatomical education and has become an ideal tutoring tool in other fields also like pathology, obstetrics, radiology and surgery. The plastinates are very powerful learning tools as they are very durable and help in gaining anatomical knowledge and strengthen individual capacities for medical scholars exercising a wider variety of learning strategies. This review is intended to survey the utility of these plastinates among the medical undergraduates and to identify their efficacy compared to the dissected wet specimens for gaining anatomy knowledge. The results of this review reveal that the plastinates can only act as adjuncts for learning anatomy and that the medical undergraduates still prefer the traditional method of learning with gross dissected and prosected specimens to gain anatomy knowledge in most of the medical schools.

KEYWORDS

plastination; anatomy; dissection; education.

INTRODUCTION

This critical review is intended to survey the utility and efficacy of Plastinate models by medical undergraduates around the globe. A newer innovation in permanent preservation of the body was made by removing the body fluids and replacing it with a polymer – a process called as plastination¹. Plastination is a method wherein the tissues are preserved in a "life-like" state; the specimens are permanently preserved by replacing body fluids like fat & water. The term Plastination was derived from "plast" meaning in Greek ("plassein" = to shape, to form), and was first described by Dr. Gunther Von Hagen, a German-born Physician & anatomist who preserved bodies by plastination techniques in 1977 at German University of Heidelberg². He preserved anatomical structures in a manner in which people could view the body architecture and plastinates could be used as a form of recycling for educational purposes³. The plastination technique produces "plastic" bodies/viscera which remain life-like, non-toxic, odorless, dry, durable & easy to handle for learning purposes. The standard procedure involves four basic steps:

a) Fixation:

The organ is kept in 10% Formaldehyde to stop the process of decomposition. Minimum fixation with a low percentage of formalin and short time duration (1-2days) will yield a more flexible and natural-looking specimen.

b) Dehydration:

Fine dissection is done and all unwanted structures like connective tissue are removed. It is kept in an Acetone bath, under the freezing condition the water gets replaced by acetone inside the cells.

c) Forced impregnation:

The specimen is kept in a bath of liquid polymers like silicone, polyester, or epoxy resin. By creating a vacuum, the acetone is made to boil, and as it vaporizes & leaves the cells, it draws in the polymer within the cells so that all the cells get filled up with the plastic material.

d) Hardening and curing:

Plastic is then cured, using gas, heat, or Ultraviolet light to harden the specimen. The organs are then termed as "Plastins" or "Platinates". The plastinates can be classified as the whole organ plastinate; sheet plastinate and luminal plastinate.

Implications of plastinates in Anatomy education:

Plastinates can be well preserved for a long duration of time; they give the appearance of fresh specimens, they are dry, durable, odorless, lightweight, non-toxic, and non-infectious. Plastinates can be exhibited for a long time, they are easy to handle and can be transported with ease⁴.

Plastinates can also be used for light microscopy as well as for ultra-structural studies after deplastination with sodium methoxide⁵.

Surgically removed specimens and pathological specimens can be preserved for a very long time by plastination for teaching and research. The Plastinated animal gastro-intestinal tract, kidneys, and the trachea-bronchial tree can be utilized for teaching endoscopic techniques in veterinary colleges⁶.

The rare species of animals or birds or archeological materials can be plastinated for exhibiting in a museum. The tissues found in the crime scenes can be Plastinated and preserved in a Forensic laboratory for Medico-legal evidence⁷.

In a research conducted in plastination of biological specimens reported that medical students who visited their museum displaying both dissected specimens and plastinates. The majority of the participants in their feedback preferred the plastinates to the traditional anatomy models, the reason being that the plastinates gave a clearer image, and was easy to identify the anatomical structures with a 3D visualization. The Plastinates were easy to handle for studying purposes compared to the dissected specimens. Hence, Plastinates were considered as excellent training tools and for future research⁸.

The advantage of transparent sheet plastinates is that the anatomical arrangement and architecture of the specimens are well maintained in an undisturbed way⁹. The sheet plastinates can be used for comparative studies with MRI and CT images, giving students a better understanding of anatomical relations for clinical diagnosis^{10, 11}. Plastinates give a very high resolution compared to a freezed tissue hence, suitable for 3D reconstruction¹⁰. Plastinates can be utilized for drawing and later digitally photographed or scanned, this can be stored permanently for learning purposes^{12, 13}. The present anatomical databases show a low resolution for small anatomical structures, the plastinates can generate large features for anatomical animations,

hence, provide a useful anatomical database¹⁴.

Disadvantages of plastinates in Anatomy education:

Plastination requires a lot of skill; it is time-consuming and requires few trials and errors for beginners. Special equipment is required. Most of the polymers required are patented and very expensive, they need to be imported. Acetone used as an intermediary solvent is very expensive and is highly inflammable. Plastinates lack the feel and texture of a real organ⁷.

The use of plastinates in various exhibitions and trading of plastinate models has been in controversy for a very long time and has been constantly criticized; several ethical issues have been raised by various organizations¹⁵.

Perceptions of medical scholars on Plastination models and dissected wet specimens as teaching-learning tools for Anatomical studies:

In a study conducted with 340 medical students on the perception of students on anatomy education supported by plastinated cadavers in Turkey, 47.4% were not aware of plastination and 60.2% believed that plastination had a positive effect on their anatomical knowledge and 39.4% agreed that anatomy education provided with plastinated cadavers affected their theoretical anatomy exam success positively. 60.8% agreed that plastinates give a 3D effect for anatomy structures¹⁶.

The most common curable polymers used in anatomy are silicon, epoxy, and polyester resins. Polyester resins are used for making opaque brain slices and epoxy resins are used for transparent body or organ slices. P45 polyester sheets plastinated specimens were utilized for assessment by 120 medical students in a study conducted at Karbala University, Iraq. The sheets were very transparent, dry, odorless, durable, easy to handle and no health hazards were related to their usage. In the students' feedback, their degree of satisfaction was high (94%) and they (87.5%) choose to work with plastinates rather than a formalin preserved specimen in their practical class¹⁷.

In a study conducted with 100 newly admitted medical students on perception towards cadaveric dissection, their attitudes towards dissection were reported as 93% showed fear, 91% showed excitement, 89% having interest, and 35% showing depression. The following were the symptoms experienced by the students while entering the dissection hall: nausea; vomiting; formalin smell; eye-watering/redness; skin irritation.

Most of them agreed that dissection in spite of all the symptoms experienced can still be helpful in their curriculum¹⁸. It was noted that the plastinated bodies are very difficult to dissect compared to the wet bodies, two-thirds of the participants opted for cadaveric dissection but agreed that plastinates can be combined with wet specimens for a better understanding of the subject¹⁹.

It was opined that teaching human anatomy with the help of audio-visual aids has become routine and that teacher-centric (didactic) lectures are slowly becoming replaced by innovative newer techniques with the incorporation of newer advanced technology²⁰. Kirkpatrick in his book entitled "Evaluation of training" proposed a scale to estimate the impact of a new educational intervention. This can be an important scale to ascertain the significance of plastination in anatomical studies. According to Kirkpatrick's hierarchy, the following criteria mentioned in the table below are utilized to determine the various levels²¹. (Refer to Table 1 below).

Table 1: Criteria for Kirkpatrick's hierarchy.

LEVELS	PERCEPTIONS	EVALUATION
1.	Reaction	Relates to participants opinion on learning experience.
2.a.	Change of attitude-perception	Relates to changes in the attitude towards the educational intervention.
2.b.	Change of knowledge-skills	Relates to acquisition of knowledge and skills with the educational intervention.
3	Behavioral change	Relates to change of behavior in the workplace due to intervention.

4.a.	Change in organization clinical practice	Changes in the clinical delivery care due to educational program.
4.b.	Benefits to the patients.	Improvements in the health due to educational program.

It has been reported that 75% of medical scholars agreed that plastinates would be useful and only 33.3% agreed that plastinates cannot replace the wet specimens, however, 80% of them agreed that they could be used in combination with the wet specimens for gaining accurate anatomical knowledge²². The usefulness of plastination in dental anatomy teaching was studied, wherein it enhanced the student's learning experience. About 91.4% of students showed better results in the examination after implementing plastination in their clinical dentistry curriculum compared to the 80% results with students exposed to cadaveric dissection only²³. Refer Table 2 below.

Table 2: General characteristics of previous studies done on perception towards Plastination reviewed using Kirkpatrick's hierarchy.

Authors	Participants	Type of comparative study (plastinates or dissected specimens)	Level	Evaluation of statistical significance.
Azu et al; 2012 22	280	Non-comparative	1	No
Baker et al; 2013 23	77	Comparative	2b	No
Emdadul Haque et al; 2017 24	143	Comparative	1	Yes
Bhandari et al ; 2016 19	350	Non-comparative	1	No

It was noticed that two-thirds of the students considered that plastination is helpful for the 3-dimensional visualization and special orientation of anatomical structures²⁴. It has been reported that the plastinated bodies are very difficult to dissect compared to the wet bodies, two-thirds of the participants opted for cadaveric dissection but agreed that plastinates can be combined with wet specimens for a better understanding of the subject¹⁹ (Refer Table 2).

Recently, it was observed that understanding the student's characteristics is very important before the amendment in the curriculum and selection of a teaching-learning method²⁵.

In a study conducted with 100 first year medical students of SKIMS Medical College in Jammu & Kashmir, 70% of them agreed that videos & models act as complements to cadaveric dissection although 41% of them reported allergic symptoms to formalin²⁶. In a survey conducted at Cyberjaya University of medical sciences, Malaysia, 183 medical students participated and 72.2% of them preferred cadaveric dissection and 63.6% preferred the plastinated specimens and 8% preferred self-directed learning. One of their suggestions was to allocate more time duration for practical classes and cadaveric dissection instead of learning with the plastinates²⁷.

In a survey conducted in Nigeria in 2011 involving 80 teaching faculty of various ranks to assess which teaching tool they prefer for anatomy education & their awareness regarding plastination. It was observed that 93.75% were aware of what plastination was about and only 27.5% had seen the plastinates before. Among the teaching tools, 40% of plastic models, 36.25% cadavers, 15% pathology pots and 8.5% plastinates were used for teaching anatomy at various universities in Nigeria. The respondents opined that plastinates were a great source, realistic & excellent tool for teaching and felt that such supporting tools can help in teaching – learning and for examination purpose²⁸. In the department of Anatomy at Ekiti University in Nigeria in 2018, a study was conducted involving 114 medical students, 55.3% of them strongly agreed that participating in cadaveric dissection as a small group helps to develop professional skills. Most of the students 46.5% disagreed that plastinates, computer based training, mobile phones are substitutes to cadaveric dissection in future, 42.1% agreed that dissection is one of the best learning methods to understand the human anatomy²⁹. Ultramodern technology should be enforced in medical education, thereby avoiding a negative impact on the scholars. Studies involving 3 – dimensional technology in medical education is needed to develop a pedagogical technology to enhance the scholar's

anatomical skills. To improve the quality of medical education imparted and competency of the physicians produced we need to acquire long-term and comprehensive research studies on medical students, medical educators, and medical school administrators to get a deeper insight.

CONCLUSION

We can conclude from this review that Plastination models can only be utilized as adjunct teaching-learning tools for anatomical studies by medical undergraduates and teaching faculty. Gross anatomy dissection is the cornerstone procedure adapted by the medical students for learning the relations, structure, and functions of the organs despite its complexity and associated discomfort due to formalin used for preservation of the cadaver. Hence, dissection and prosection cannot be undermined due to the development of newer innovations like plastination models and advancements like 3D digital anatomy modules.

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