

Plastination: A Promising Method for Preserving Biological Specimens: A Review Article

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Abstract- Plastination is a process of tissue preservation by embedding tissues with synthetic materials, as silicone polymers and epoxy resins to produce dry, durable, handy and natural looking specimens useful as a unique tool for teaching of anatomy, pathology, radiology and surgery. Since 1980s, (when it was invented by Professor Gunther Von Hagens experimentally), plastination technique, quality and cost effectiveness is developing. Plastinated specimens are popular among students and teachers, both, as they are easy to handle, odorless, nonhazardous and stable. Plastinated specimens are long lasting so require less number of cadavers. This is a promising method for producing ideal specimens for teaching and learning processes.

Index Terms- Plastination, plastinated specimens, museum technique

I. INTRODUCTION

Plastination is a process of long term preservation of biological tissues in a dry, odorless, easily handlable and storable manner. It is a cost effective, durable & stable method. Although it is difficult to prepare a well plastinated specimen, but it is most promising method to preserve the specimens as an alternative to formalin preservation [1].

II. HISTORY

Even though a major German encyclopedia (the 19th edition of the Brockhaus Encyclopedia, 1992) indicates that the word "Plastination" is derived from the Greek (from *plassein* = to shape, to form), the term is, in fact, a creation of Gunther von Hagens. *Professor Gunther von Hagen* is a German born Physician & Anatomist who has preserved human bodies through 'plastination' [2]. He discovered this process in 1977 in a laboratory at the German University of Heidelberg. He was experimenting with kidney slices and plastic polymers when he came across the technique, whereby blood, fat, water and other fluids are replaced by plastic, enabling corpse tissue to be preserved for centuries. After receiving patents from US government for his work on preserving biological tissues with polymers. There has been an ongoing battle of education vs. art vs. ethics. The Institute of Plastination, along with Dr. von Hagens made their first showing of plastinated bodies in Japan in 1995, which drew over three million people. Depending on how

the body is to be used, materials such as silicone rubber, epoxy resin or polyester render the bodies firm or flexible, transparent or opaque. Once preserved the bodies are highly durable, but still retain the natural surface structure and, according to von Hagens, they '*are in the identical condition they were in prior to preservation, all the way down to microscopic level...Thus, even microscopic examination can still be carried out*' [3].

Von Hagen has displayed his plastinates in a manner in which all internal organs, nerves, blood vessels and bones - can be viewed by the public, thereby giving an insight into the human body. The plastinates are being used as a form of recycling for educational purposes [3].

Leonardo da Vinci and Andreas Vesalius, the two outstanding anatomical artists of the Renaissance, used anatomical drawings to better understand the workings of the human body. Von Hagens is fascinated by their work, but wrote '*Neither illustrations nor models can convey the individual beauty of these structures to us, for the source of truth is in the originals*' and so has taken their work a stage further [3].

Churches and religious groups vehemently object to von Hagens, believing that his creations are against the laws of nature and that people should be respected in death as well as life. Much as they did for the millions who died in the concentration camps, churches have been holding services to pray for those people whose bodies have already been 'plastinated' and are in the exhibition. However this has not prevented two and a half million people in Japan, eight hundred thousand in Mannheim, five hundred and fifty thousand in Vienna and six hundred thousand in Switzerland coming to view the exhibit. In addition, over three thousand have signed up to be preserved by Dr von Hagens and his team in the future [3].

The scientific value of using plastinated bodies and organs in a teaching environment like anatomical courses at medical schools is hard to dispute. The specimens, whether bodies or organs, produced by this method may be handled by students for easier examination. Unlike their counterparts 'swimming' in a mixture of fixative and preserving solution that can only be viewed from the outside, these specimens may be handled and examined from all angles, and comparisons made. For example organs in their normal and pathological states may be examined side by side to illustrate disease processes, such as placing lungs from a healthy individual, a lung cancer patient and a patient suffering from asbestosis side by side for comparison [4].

III. ETHICAL ISSUES

I.C. Sturdgess has illustrated a debate on plastination: science or art [4]. He wrote that The German exhibition both fascinated and horrified, although long queues were reported outside of the museum, which eventually decided to remain open around the clock to cope with the masses. Some 800,00 visitors were counted in total in Mannheim, and similar figures viewed the exhibition when it travelled to Japan, Vienna and Cologne ('Körperwelten'). The show included some 200 plastinated bodies or body parts, and it was possible for visitors to follow the form of the human body by looking at a series of thin longitudinal or cross sections. Several bodies were opened up or taken apart in layers, showing the relative positions of bones and organs. In one preparation, all the nerves were coloured yellow, to make it easier to follow them through the body in three dimensions. One other display is a plastinated man carrying his own skin over his arm like a coat, to expose his skeleton and muscles and other exhibits, also stripped of their skin, are posed as a runner, a fencer and a chess player, all revealing their muscles in action. These bodies appear to convey an impression of being 'alive', which is one reason why they remain controversial' [4]

Sturdgess has alleged that Indeed the German show comes close to crossing the border between science, education and exhibitionism, with dead humans becoming mere objects 're-created' by an artistic anatomist. Those who support the exhibition have suggested that showing plastinated corpses should be considered as no more a desecration of the dead than placing mummies in museums. Others pointed out that corpses have long been used to educate medical students and plastinated corpses are a safe, sanitary and highly effective method of teaching anatomy. It has been reported that some onlookers would be honoured to have their own bodies made plastic after death for the sake of educational displays. Several spectators, however, had mixed feelings, and while admitting that plastination had tremendous educational value, they had a worry that this benefit might be undermined in exhibits designed more to satisfy curiosity. A number on visiting the exhibition, however, found it morally reprehensible, suggesting that it was dehumanizing, and that the deceased, plastinated or otherwise, had no business being used as an 'attraction'. Suggestions such as the use of the bodies for sensational purposes, as in sideshows would be improper, and comments along the lines of 'when you die, you should be allowed to die, not carted around the world as a laminated corpse' and 'rest in peace and not in pieces' were also made [4].

Although Von Hagens says he follows strict consent procedures for whole-body specimens, he maintains that "*consent is not important for body parts.*" Von Hagen's body donations are now being managed by the Institute for Plastination (IFP) established in 1993 [5].

Sturdgess has written whatever people think about the display of plastinated bodies, it does appear that they are an educational medium, and perhaps as such they belong in academic institutions, and not displayed to members of the public as an art. Many visitors to the exhibition in Cologne ('Körperwelten'), however, stated that they knew more about the human body after they had seen the exhibition than before, and that it even encouraged them to pay more attention to their health and their life-style in order to prevent diseases. Perhaps,

therefore such exhibitions do serve to educate the general public, and hence should not be confined to academics [4].

IV. THE PRINCIPLE

Plastination is an unusual method of permanently preserving tissue in a 'life-like' state, in which biological specimens are preserved by replacing the fluids of the body (i.e. fat and water) with synthetic materials. This method produces '*plastic*' bodies or organs, which remain very life-like, non-toxic, odorless, dry, and durable and may be handled easily for examination, as referred to the article in Biomedical Scientist (June 2000 page 520) [5]. Standard process of plastination includes -*Fixation*, that is embalmed body is kept usually in a formaldehyde solution, in order to halt decomposition. *Dehydration*- after any necessary dissections take place, the specimen is then placed in a bath of acetone. Under freezing conditions, the acetone draws out all the water and replaces it inside the cells. *Forced impregnation*- the specimen can then be placed in a bath of liquid polymer, such as silicone rubber, polyester or epoxy resin. By creating a vacuum, the acetone is made to boil. As the acetone vaporizes and leaves the cells, it draws the liquid polymer in behind it, leaving a cell filled with liquid plastic. *Hardening and curing* -The plastic must then be cured, either with gas, heat, or UV light, in order to harden it. A specimen can be anything from a full human body to a small piece of an animal organ, and they are known as either "plastins" or "plastinates". Other Plastination methods include -Core- tech room temp procedure, Epoxy E12 procedure, Polyester P35 (P40) - procedure [5].

Maria Miklošova and Vojtech Mikloš alleged that the silicone S 10 technique is the standard technique and most frequently used method in plastination and there are many causes of failure [10]. Most common failures are shrinkage and change of colour [6]. The other types of failures are visible defects, which includes deformation, crained surface, damaged arteries and nerves or roughen surface of specimen.[7,8] The spots on organ surface are also common defects [9]. Based on their analyses, they have shown the causes of this defects are: inappropriate temperature of reaction mixture, usage of old formalin specimens with colour changes, usage of bad fixed specimens or the specimens with dry spots on surface testifying untimely drying of material [10].

V. BENEFITS OVER OTHER PRESERVATION METHODS

The traditional method of preserving specimens is by saturation with a formalin based solution as open, wet preparations or by enclosure in glass or Perspex pots. Open specimens are unpleasant to work with due to formalin vapour emitted and require lots of maintenance as rapidly deteriorate and dry out.

Students are also reluctant to examine or handle such material these factors. These factors, in addition to the health hazards associated with formalin, limit the use fullness of this type of preparation. Glass or Perspex potted specimens overcome some of these problems but they tend to be bulky, fragile, and need regular maintenance if the preserving fluid is not to become

cloudy and obscure the details. colour preservation is poor and the *parallax error* caused by the spatial separation from the pot surface leads to difficulties in pointing out features. Good quality transparencies and recent advances in radiological imaging, led to decline in the use of pots. [1].

Other methods have been in place for thousands of years to help with the decomposition of the body. Mummification used by the Egyptians is a widely known method which involves the removal of body fluid and wrapping the body in linens. Prior to mummification, Egyptians would lay the body in a shallow pit in the desert and allow the sun to dehydrate the body. Formalin, an important solution to body preservation, was introduced in 1896 to help with body preservation. Soon to follow formalin, color preserving embalming solutions were developed to preserve lifelike color and flexibility to aid in the study of the body. Paraffin impregnation was introduced in 1925 and the embedding of organs in plastic was developed in the 60s'. Body preservation methods current to the twenty-first century are cryopreservation which involves the cooling of the body to very low temperatures to preserve the body tissues, plastination and embalming. Plastination is used in hundreds of laboratories worldwide to help with the teaching and study of the body [5] Plastination is useful in anatomy as well as serving as models and teaching tools. Students who are enrolled in introductory animal science courses at many universities are finding the value in experimental learning in animal science through collection of multispecies large-animal management and production practicums [5]. With the use of plastination as a teaching method of animal science means less animals will have to be killed in the name of science, due to the fact that plastination process allows specimens to last a long time [5].

The plastinated specimens retain their dilated conformation by a positive pressure air flow, which allows them to be used to teach both endoscopic technique and gastrointestinal anatomy. The College of Veterinary Medicine in Raliegh, North Carolina used both PC (plastic coating) and PN (plastination) to investigate and compared the difference in the two methods. The PC method was simple and inexpensive, and the plastinated specimens were more flexible, durable, and lifelike than those preserved by the PC method. The use of plastination allowed the use of many body parts such as muscle, nerves, bones, ligaments, and central nervous system to be preserved [5].

Whole specimen paraffinisation and infiltration with high molecular weight polyethylene glycols have been tried in the past, though they have proved unsatisfactory in one way or another. The most promising method, however, is the process of specimen plastination by impregnation of tissues with silicone polymers or epoxy resins. It leads to production of ideal specimen [1].

Regarding costs Von Hagens et al. estimate the cost of establishing a plastination lab. As \$ 50000 with chemicals costing \$ 40 per kg tissue [11]. Bickey et al. estimate a lower figure of \$ 15000 for hardware and \$ 150 per kg tissue for chemicals [12]. T.P.Dawson et al estimated their expenditure considerably less \$ 296 for hardware and \$ 53 for chemicals. He further says a plastinated heart heart weighing about 350 gm would cost approximately \$ 19 in materials and be maintenance free [1].

VI. CONCLUSION

With the review regarding this process, we can say that plastinated specimens are definitely ideal way of preserving biological tissues. It produces a long lasting, easily handlable, non hazardous and almost natural looking specimen which helps in teaching in various fields of medicine. It also reduces the need of bodies to prepare new specimens, as they get damaged with repeated handling. Plastinated specimens are also better options to be used in Anatomy museums for self directed studies by students. Not only in Anatomy, these specimens also proved beneficial in other specialties as pathology, radiology and surgery.

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