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Research Article

POLYESTER PLASTINATION OF WHOLE BODY AT ROOM TEMPERATURE

Ezhilarasan S[1], Jeyanthi M[2]

Department of Anatomy, Government Theni Medical College, Theni, Tamilnadu, India. Pin No-625531

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Corresponding Author:
Dr. Ezhilarasan. S
Department of Anatomy,
Government Theni Medical
College, Theni, Tamilnadu
India Pin No-625512
sathuruvelarasan@gmail.com

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ABSTRACT

Plastination technique was first developed by Gunther Von Hagens in 1979. By this technique dry, odourless specimens can be prepared. The plastinated specimens can be kept for years together without any change in the external appearance. According to the standard plastination procedures, formalin fixed specimens must be dehydrated by acetone at -25°C and the forced impregnation of specimens with silicone polymers or polyester resins must be done by applying vacuum. In our present study we have done plastination with a new type of commercially available polyester resin and also during the procedure both dehydration and forced impregnation by applying vacuum were done at room temperature to avoid the purchase of costly explosion proof deep freezers. Using this technique we have plastinated a whole dissected body which is very useful for demonstrating the various structures of the body to the students without the irritating effects of formalin.

I. INTRODUCTION

Plastination is a technique in which, water and lipids in biological tissues are replaced by a curable or reactive polymer. The polymer is subsequently hardened, resulting in dry, odourless and durable specimens. Water and lipids cannot be replaced directly by a polymer. So initially the water and lipid contents in a tissue are replaced by acetone, which is later replaced by the polymer (the acetone acts as an intermediary solvent).This technique was developed by Dr. Gunther von Hagens in the year 1979, at the Heidelberg University, Germany [1]. During this process a specimen dehydrated by acetone is immersed in a bath containing polymer and the polymer with the specimen is subsequently placed inside a vacuum chamber and vacuum is applied. When the pressure inside the vacuum chamber is reduced, the acetone boils and vaporizes. The acetone is sucked out of the tissue at the moment it vaporizes, and the resulting vacuum in the specimen causes the polymer solution to permeate the tissue. This exchange process is allowed to continue until all of the tissue has been completely saturated [2]. Plastination with silicone rubber (S10) and Sheet plastination of brain slices with polyester resin were the two techniques originally developed by Von Hagens. Latter the Chinese siliconeplastination technique with a silicone polymer called Su Yi Chinesesilicone [3] and the North Carolinasilicone plastination technique [4] were developed. In India general purpose orthophthalic polyester resin was widely used in many institutions of anatomy to plastinate human organs and also to preserve many veterinary specimens [5], [6]. Plastination with general purpose orthophthalic polyester resin will produce a dark black colour specimen, due to the yellowish colour of this resin.So in our present technique we have used a commercially available Isopthalic polyester resin for plastinating a whole dissected body. The main purpose of this study is to prepare a long durable and cost effective dissected plastinated body, mainly for demonstration of the various structures to the medical students, without the toxic effects of formalin.

II. HEADINGS

1. Aim of the study

To plastinate the whole dissected human body with polyester resin. Till now dissected, whole bodies are plastinated using silicone polymers. The S10 is the original silicone polymer used by Von Hagens for plastinating the whole dissected body.

Only a few studies regarding whole body plastination are reported in the literaturefixation was not needed. But for plastination usually 10% formalin is used to fix the body.This is mainly because of the cost of the silicone polymers. The silicone polymers used for this technique are not commercially available, because the exact composition was not revealed in any of the previous studies. In our present study we used a high quality commercially available polyester polymer for plastinating the whole dissected body. The dissected plastinated body

can be kept as a dry specimen for demonstrating the various structures to the Medical students. This will reduce the need for new cadavers, [7], [8].

2. Materials and Methods

Plastination of human body with the use of polyester resin done in our institution was a modification of the original technique of plastinating dissected human bodies with silicone rubber. According to Von Hagens, dissected whole bodies must be plastinated with silicone polymers. (He described this technique as standard S10 plastination). An unclaimed body allotted to the I MBBS students for dissection was used for this study. We have not used donated bodies for the study in order to prevent ethical issues.The embalmed body was dissected (except the face) to show the various muscles, nerves and blood vessels. The body cavities were not opened during dissection. A commercially available Isopthalic polyester resin and a hardener (Methyleythyl ketone peroxide) were used for this present technique. Dehydration by acetone at -25℃ is the standard procedure for dehydrating all plastinated specimens. Dehydration at -25℃ prevent shrinkage of specimens. But in our present study the whole body was dehydrated in room temperature (due to non-availability of a large deep freezer) and was then immersed in polyester resin mixed with cross linker or hardener). Vacuum is applied at room temperature and when impregnation is achieved, the body was kept under sunlight to initiate curing.

Chemicals used Equipments used during the process of polyester plastination of whole body include:

- Acetone (98-99% pure)
- Polyester resin-Isopthalic polyester resin and
- A hardener-Methyleythyl ketone peroxide
- A large Stainless steel container for storing the whole body
- Steel vacuum chamber with measuring gauge
- Vacuum pump
- Acetenometer

The procedure for plastination includes, fixation, dehydration by acetone, forced impregnation in vacuum and curing.

2.1 Fixation:

Fixation with 10% formalin was done during embalming.

2.2Washing

The whole dissected body was washed in running water for a period of 24 hours to remove the excess formalin content.

2.3 Dehydration

After washing the dissected body in running water for a period of 24 hours, the body was dehydrated in a graded series of acetone at room temperature. Initially the body was placed in 70% acetone for a period of 1 month, and then transferred to 90% acetone for a period of another 1 month. Finally the body was placed in pure (100%) acetone for a period of a month. The total dehydration time was about 3months (one month for each change). Dehydration in graded series of acetone will prevent shrinkage of tissues. The volume between the body weight and the acetone solution was maintained at the ratio of1:10. An acetonometer"figure-1", was used to monitor the acetone concentration every day. Dehydration was considered to be complete when the concentration of acetone measured with an acetonometer was stable at 98% during the last one week.

2.4 Forced Impregnation

According to the original protocol for plastination forcedimpregnation by vacuum must also be done at low temperatures inside a deep freezer (to prevent rapid hardening of the polymer and hardener mixture). In our study, since the polyester polymer mixed with hardener will not cure at room temperature, forced impregnation by vacuum was done at room temperature. After dehydration, the dehydrated dissected body was immersed into the polyester resin mixed with hardener in the ratio of 10:1 at room temperature in a large stainless steel container for a period 24 hours. This allowed excess acetone to escape and the body to equilibrate with the polyester resin naturally without any force. Then the body was transferred to a vacuum chamber "figure-2"designed and built in the Department of Anatomy, Government Theni Medical College. The chamber was constructed with steel. A meter was mounted at the top of the chamber to measure the vacuum. The chamber was connected to a vacuum pump for creating vacuum. Vacuum was applied intermittently at room temperature daily for a week. The vacuum pump was turned on in the morning and the pressure was slowly increased until a vacuum of -20mmHg has reached and the pump was turned off in the evening (the pump was used for a period of 6 hours in a day). This procedure was repeated daily for a period of one week. At the end of the week the body was removed from the resin bath.

2.5 Curing

Excess resin is wiped off from the body with a cloth soaked in xylene and the dissected body was allowed to harden at room temperature by exposing to sunlight for a period of 1 week.

3. Result

The total period for dehydration by acetone at room temperature was three months and the period for impregnation was about one week. The body was well impregnated after a week and after curing for another week it was ready to be handled"figure-4".

4. Discussion

The preparation of dry anatomical specimens that can retain much of their natural features, like colour and texture has been a long-standing goal of many anatomists and pathologists [9].The optical (transparent or opaque) and mechanical (flexible or firm) properties of the plastinated specimens are determined by the type of polymer used. Silicone is used for whole body plastination to obtain a natural look. Polyester polymer is mainly used for plastinating thin brain and body slices [10], [11], [12]. In this study we have chosen a high quality polyester resin, mainly because of its cost and easy availability. After plastination with polyester resin, the original structure and colour of various muscles, blood vessels and nerves were well maintained in the body. There was no odor or toxicity. During our study we measured the length and breadth of the whole body before and after plastination to evaluate the shrinkage. In our study shrinkage of the whole body was less than 5%. According to the original protocol for whole body plastination dehydration by acetone must be done at -25°C to prevent shrinkage [13] and vacuum must also be applied inside an explosion proof deep freezer.In our study dehydration was done in graded series of acetone to prevent shrinkage [14]. The polyester resin used in this procedure will not cure at room temperature even after mixing with a hardener unless being exposed to sunlight, so forced impregnation by vacuum was also carried out at room temperature. Dehydration and forced

impregnation by vacuum at room temperature avoids buying of an explosion proof deep freezer [15].

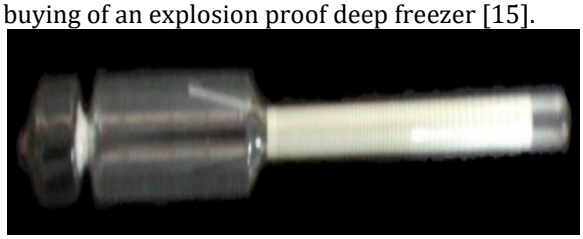

Figure-1: Acetonometer

Figure-2: Steel vacuum chamber

Figure-3: Showing the process of dehydration

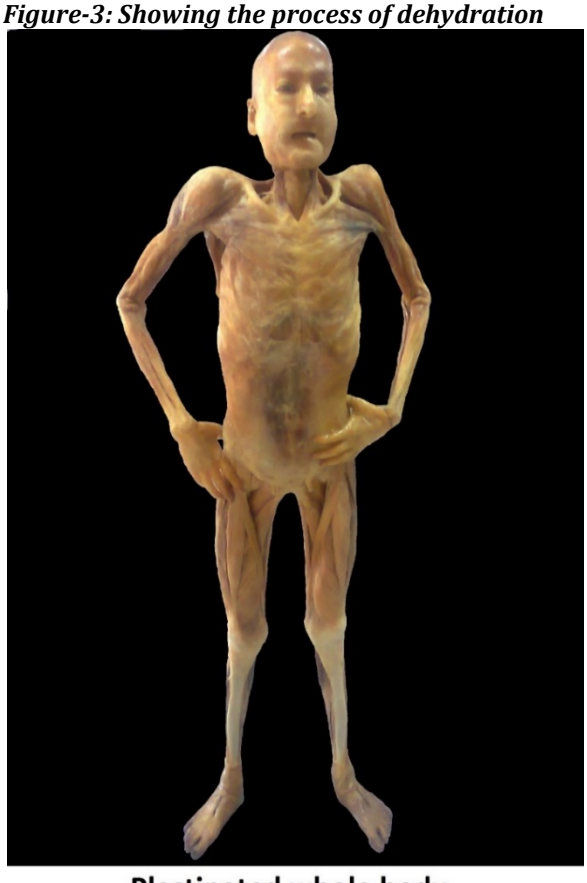

Figure-4: Dissected and plastinated whole body

Table 1: protocol for whole body Polyester plastination method

Day 1	Washing in running water
First week	Immerse in first acetone bath (70%) acetone. for a period of one month.
Second month	Immerse in second acetone bath (90%) for a period of one month.
Third month	Immerse in third acetone bath (100%) for a period of another one month (Check purity of acetone bath with acetonometer consequently for the last one week.
End of third month	Immerse in polyester resin without vacuum for a period of 24 hours
End of third month	Forced impregnation done by applying vacuum for one week intermittently.
Last one week	Curing of body at room temperature by exposing to sunlight for a week.

III. CONCLUSION

We have also used the same technique for plastinating individual organs, with successful results, but the duration for dehydration and the total time for forced impregnation were entirely different. The success of whole body plastination depends mainly in calculating the total period for dehydration and applying vacuum for forced impregnation. The pressure of the vacuum pump must be slowly increased, so that a slow and steady vacuum can be achieved. If the vacuum is achieved quickly, it causes rabid evaporation of acetone resulting in incomplete penetration of tissues with the polymers resulting in a compressed specimen [16]. The body was plastinated in the department on January 2011 "figure-4"according to this protocol. After plastination with polyester resin, the original shape and colors of the muscles, nerves and blood vessels are well preserved. The body was odourlessand free of formalin toxicity. No gross changes in the external appearance were observed in the body following the impregnation and curing. In our study shrinkage of the body was less than 5%. Dehydration was done at room temperature and a special type of vacuum chamber purely designed and constructed locally was used. Further a commercially available polyester resin and a hardener (both of which even after mixing will not cure at room temperature unless being exposed to heat or sunlight) were used. All these factors helped in reducing the cost of this technique. This dissected plastinated body can be kept for any number of years without formalin and can readily be used as a dry specimen for demonstrating the various structures to the students.

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