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Polyester plastination of human cadaveric specimens

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Abstract

Plastination is a technique for preparing dry specimens, which can be used for demonstration as well as for mounting in museum Plastination technique was first developed by Gunther von Hagens in 1977. Till then Plastination has become the gold standard for preservation of biological specimens. Recently plastination of human organs with general purpose resin has been done in many Institutions of Anatomy in India. But general purpose resin has the property. To darken the colour of the specimens. So in the department of Anatomy, Government Theni Medical College we used a new type of commercially available Isopthalic polyester resin for plastination. In the past three years more than 30 specimens have been plastinated in our department by this technique. According to the standard plastination procedures, complete dehydration of formalin fixed specimens by acetone can normally be achieved at -25°C and the forced impregnation of specimens with silicone polymers or polyester resins can be done by applying vacuum.

Keywords: Plastination; Polyester Resin; Methyl Ethyl Ketone Peroxide; Acetone; Dehydration; Forced Impregnation.

Introduction

Plastination was developed by Dr. Gunther von Hagens in the year 1979, at the Heidelberg University, Germany. In this process, curable polymers replace water and lipids in biological tissues. The polymer is subsequently hardened, resulting in dry, odourless and durable specimens. During this process, a specimen dehydrated by acetone is immersed in a polymer and kept in a vacuum chamber and the pressure is reduced to the point where the solvent (acetone) boils and vaporizes. As soon as the acetone vaporizes and goes out of the tissue, an empty space or vacuum is created inside the tissue. 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-while a matter of only a few days for thin slices, this step can take weeks for whole bodies (Von Hagens, 1987).

Literature Survey

Plastination with polyester resins (P40) for thin brain slices and silicone polymers (S10) for organs and whole body introduced by von Hagens were the original plastination techniques (Von Hagens, 1987). Latter several other silicone polymers and additives were introduced for plastination, like the Chinese silicone plastination with a silicone polymer called Su Yi Chinese silicone (Zheng et al., 2000) and the North Carolina silicone plastination technique (Henry et al., 2004). In India mostly general purpose resins were used for plastination (Ramakrishna et al., 2002).

Aim of the study

To discuss our experience and results of plastination with a new type of commercially available Isopthalic polyester resin, which is normally used in fibre glass industries. This study was a modification of the original plastination technique developed by Dr. Gunther von Hagens and the main aim was to make the procedure easier and cheaper.

Materials and Methods

The general purpose resin used for plastinating organs in many institutions in India has the property to darken the colour of the specimens. So in our present study, we used commercially available Isopthalic polyester resin and a catalyst for plastinating the specimens. Human specimens collected from cadavers, during routine dissection in the Department of Anatomy, Government Theni Medical College, Theni were used for this plastination.

Chemicals and equipment's used for Specimen preparation:

Acetone (98-99% pure).
Polyester resin-Isopthalic polyester resin.
A hardener-Methyl ethyl ketone peroxide ($C_8H_{18}O_6$).
Stainless steel containers for storing the specimens.
Vacuum chamber with measuring gauge.
Vacuum pump.
Dehydration equipment-Acetenometer.

Plastination procedure consists of the following steps – fixation, dehydration, forced impregnation in vacuum and hardening of resin.

Fixation: In our present work, since the organs were collected from the cadavers, which are already embalmed and stored in formalin, fixation was not needed.

Dehydration: Freeze substitution in -25°C acetone is the standard procedure for dehydration of all plastinated specimens (Von Hagens, 1986; Tiedemann and Ivic-Matijas, 1988; Brown et al, 2002). Dehydration at -25°C prevent shrinkage of specimens. In our present study

also the specimens were dehydrated at -25°C degrees in a deep freezer. The specimens were dehydrated in a graded series of acetone at -25c. At least three changes of acetone are needed, initially in 90% and then in 100% acetone.

Initially the Specimens were placed in 90% acetone at -25°C for a period of 6 days, and then transferred to two consecutive pure (100%) acetone baths (at -25°C). The total dehydration time was about eighteen days for all specimens (6days for each change). The volume of acetone solution used for dehydration was about 10 times the volume of the Specimen (specimen/acetone ratio was 1:10). A direct.

Reading acetonometer 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 two days.

Forced Impregnation in vacuum: After dehydration, the dehydrated specimens were immersed into the polyester resin mixed with hardener in the ratio of 10:1, at room temperature in stainless steel containers (some plastic containers may be eroded by the polyester resin) for a period 24 hours. This allowed excess acetone to escape and the specimens to equilibrate with the polyester resin naturally without any force. Then the specimens were 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 for about 12hours intermittently from morning to evening (until a vacuum of -20 mmHg was reached) and on the next day the specimens were removed from the resin bath.

Curing: Excess resin is wiped off with a cloth soaked in xylene and the specimen is allowed to harden by exposing to sunlight for more than a day.

Results and Discussion

The total period for dehydration was 18 days and the period for impregnation was about 24 hours. Specimens were well impregnated and after curing they were ready to be handled. According to the original technique dehydration by acetone must be done at -25°C to prevent excessive shrinkage of specimens and vacuum must also be applied inside an explosion proof deep freezer (the polymers after being mixed with a hardener, will cure quickly at room temperature). In our study the polyester resin even after mixing with a hardener will not cure at room temperature unless being exposed to sunlight. Hence vacuum was applied at room temperature. This avoids buying of an explosion proof deep freezer (Gubbins, 1990).

Conclusion

More than 30 high quality gross anatomical specimens (Fig. 3-12) have been plastinated in our department according to this protocol. After plastination with polyester resin, the specimens (limbs, heart, liver, spleen, brain and kidney), retain their original shape and colors. They have no odor or toxicity. No gross morphological changes were observed in the specimens following the impregnation and curing. During our study we measured the sizes and diameters of the specimens before and after plastination to evaluate the shrinkage. In our study shrinkage of specimens was less than 10%. The vacuum chamber used for this procedure was purely designed in our department and further commercially available polyester resin was used, both of which helped in reducing the total cost for this technique.

Future scope: Plastination is carried out in many institutions worldwide and has obtained great acceptance particularly because of the durability. Plastinated specimens can be repeatedly handled by students without causing any body reactions of chemicals and can be stored for years together. Plastination with different types of resins can be tried in future to reduce the cost of this technique.

Fig. 1: Acetonometer

Fig. 2: Steel Vacuum chamber designed in Govt. Theni Medical College

Table 1: Protocol for Polyester plastination method

Day 1	Immerse in first cold (-25c) acetone bath (90%) acetone. 1:10 specimen: acetone ratio (for a period of 6 days).
Day 6	Immerse in second cold 100% acetone bath (for a period of 6 days).
Day 12	Immerse in third cold 100% acetone bath for a period of another 6 days (Check purity of acetone bath with acetonometer for last 2 days.
Day 18	Immerse in polyester resin without vacuum.
Day 19a	Forced impregnation done by applying vacuum for 12 hours.
Day 19b	Specimen immersed in resin bath & kept outside vacuum chamber for the next 12 hours.
Day 20	Curing of specimen by exposing to sunlight.

Fig. 3: Plastinated specimen of trachea

Fig. 4: Plastinated specimen of arm

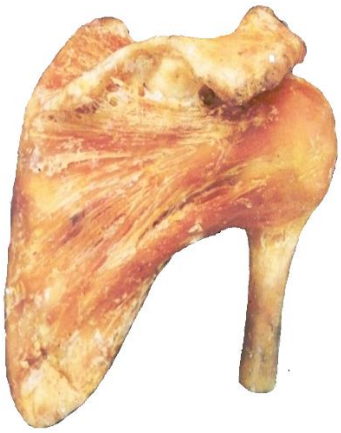

Fig. 5: Plastinated specimen of scapular region

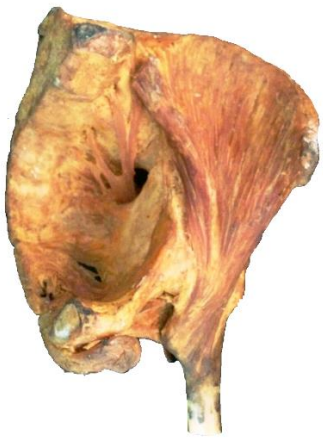

Fig. 6: Plastinated specimen pelvis

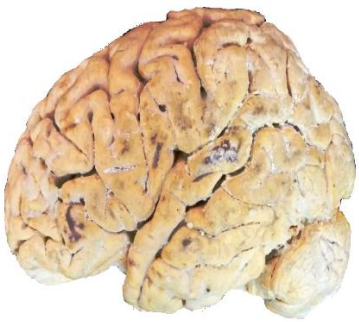

Fig. 7: Plastinated specimen of brain

Fig. 8: Plastinated specimen of spleen

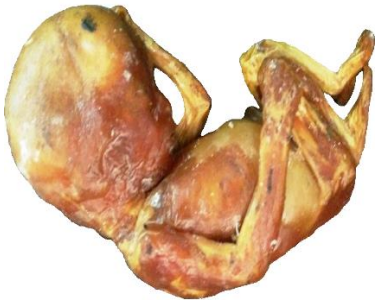

Fig. 9: Plastinated specimen of foetus

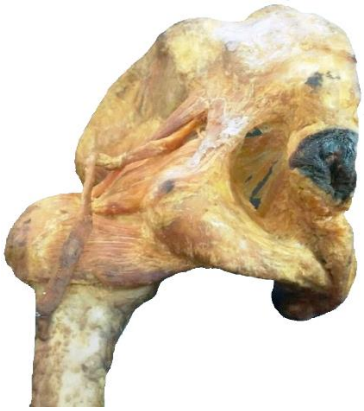

Fig. 10: Plastinated specimen of ischiorectal fossae

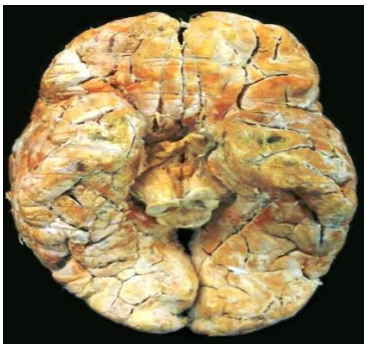

Fig. 11: Plastinated specimen of base of brain

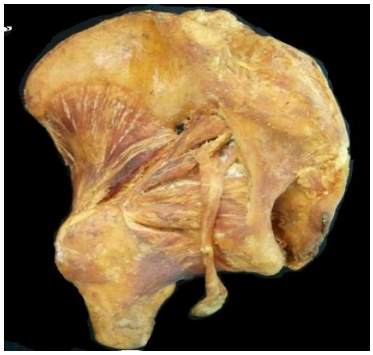

Fig. 12: Plastinated specimen of gluteal region

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