PLASTINATION USING STANDARD S10 TECHNIQUE-OUR EXPERIENCE IN CHRISTIAN MEDICAL COLLEGE, VELLORE

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ABSTRACT

Plastination is a unique method of preserving tissue in a dry and odourless state, invented by Dr. Gunther von Hagens. In recent years, plastination has been introduced in many Anatomy Departments, where plastinated specimens also known as plastinates are used as an adjunct in the teaching of gross anatomy. Currently in the Department of Anatomy, Christian Medical College, Vellore, Silicone S-10 standard plastination technique is used to preserve body parts. In the past 2 years more than 150 specimens have been plastinated for demonstration as well as museum displays. The formalin fixed tissues are dehydrated in acetone. Forced impregnation is done using a vacuum chamber and finally the specimens are hardened in a gas chamber. Adapting plastination technique has yielded dry, odourless and durable plastinates which are useful as an adjunct for demonstration of prosected specimens and as excellent museum specimens.

Key words: plastination, teaching, preservation of body parts, freeze substitution, vacuum impregnation.

INTRODUCTION

Plastination is the process of preservation of anatomical specimens by impregnation with curable polymers like silicone, epoxy or polyester resins which keep the anatomical specimens in a dry and odourless state[1]. It was developed by Dr. Gunther von Hagens in the year 1979, at the Heidelberg University, Germany[2]. In recent years plastination has revolutionized the way in which gross anatomy can be presented to students[3]. As the plastinates are easy to handle, flexible and devoid of noxious effects of formalin, they serve as excellent teaching tools and as museum specimens. Plastination is an outstanding tool to study cross-sectional anatomy[4,5]. Utilization of sectional imaging modalities in medicine has heightened the need to understand sectional anatomy[6]. Plastinates help the students to study cross-sectional anatomy like a puzzle, disassembled and put back together again. This enables the students to trace the course of nerves and blood vessels through the head, neck, trunk and extremities[7].

In plastination, water and lipids in the biological tissue are replaced by curable polymers which are subsequently hardened[8]. Gross specimens, dissected specimens, and cross-sectional slices can thus be preserved permanently into specimens, which are clean and dry[9]. The plastinates are resistant to the mechanical damage that inevitably will result from passing through many hands[7]. Plastinates are easy to handle and require minimal after care. They can be stored in cup-boards, which reduces the cost as well as the irritation and potentially harmful effects of preservatives such as formaldehyde which are used for storing the specimens [10].

Production of each plastinate is said to be both expensive and time consuming when compared to other teaching aids like wet specimens, paper mache, glass and wood models[11]. Recently, in Christian Medical College, Vellore, plastination is being used as a method of preserving prosected specimens and anatomical organs. The aim of this paper is to discuss our experience in using plastination technique, its advantages and pitfalls.

MATERIALS AND METHOD

In Christian Medical College, Vellore, Standard Silicone-10 (S10) technique has been adapted for preserving prosected specimens and organs since 2009. Plastination procedure consists of the following steps - fixation, dehydration,

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Fig. 1a

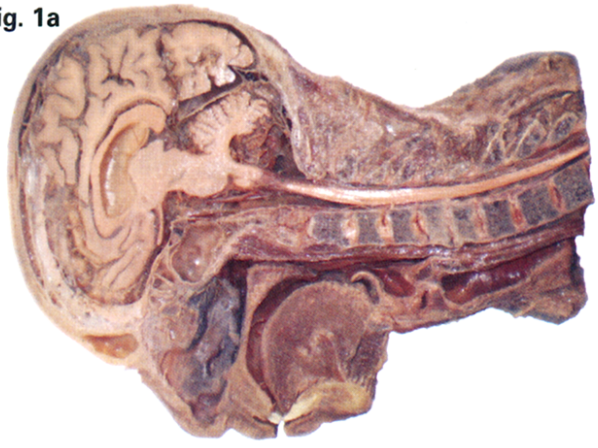

Fig. 1b

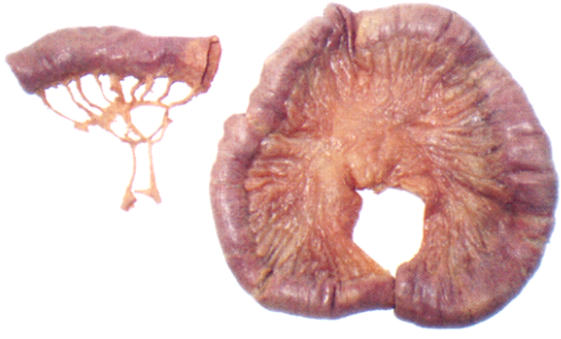

Fig. 1c

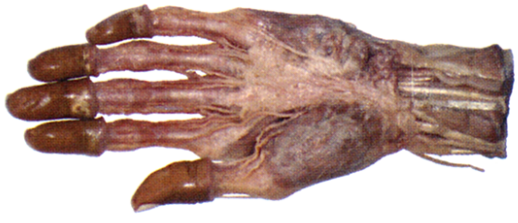

Fig. 1d

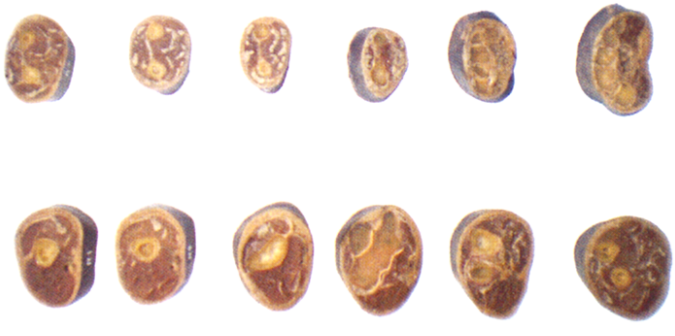

Fig. 1e

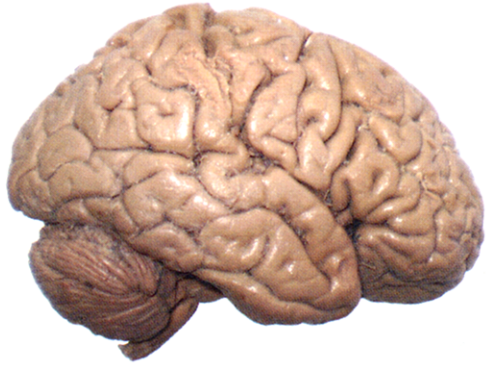

Figure 1. Plastinates of
a. sagittal section of head and neck
b. small intestine
c. prosected specimen of hand
d. cross-section specimens of upper limb
e. full brain

forced impregnation in vacuum and hardening. The specimens are fixed in formalin, washed and pre-cooled at 4°C, following which the specimens are shock-frozen at -85°C for few hours in a mixture of 85% acetone. The specimens are then dehydrated by freeze substitution in acetone at -25°C. At least three changes of acetone are needed, initially in 85% acetone and then in 100% acetone. The volume of acetone used for dehydration is about 5-10 times the volume of the specimen. The level of dehydration is measured using acetonometer. Once the specimens are dehydrated, the fatty specimens are kept in 100% acetone overnight or for one or two days at room temperature for degreasing. Since the cost of acetone is an important factor in the cost of plastination, an acetone distillation plant has been installed. Recycled acetone has been used during the initial stages of dehydration while new 100% acetone is used at the final stage. Next, forced impregnation is done in a bath of silicone resin which contains 100 parts of S-10 with one part of Silicone 3 (S-3), which acts as a catalyst in a vacuum chamber. In this step, the intermediary solvent acetone is replaced by silicone. Vacuum is applied slowly, as determined by the rate at which the mixture bubbles. Impregnation is

determined to be complete when acetone bubbles are no longer released from the specimen. Once the bubbling ceases, the specimens are taken out of the vacuum chamber. The excess resin is drained off and the specimens are placed in a gas chamber. Silicone -6 (S-6) is used as the hardener in the curing chamber. Once the specimens are hardened, they are ready to use. Polymers S-10, S-6, S-3 were obtained from Biodur, Germany.

RESULT

Dry, robust, odourless specimens are obtained (Figure 1a-e).

DISCUSSION

The preservation of anatomical specimens that retain much of their natural features has been a long-standing goal of anatomists, pathologists and other medical educators[9].

The stages of plastination are precooling, dehydration, vacuum impregnation and curing. After fixation, the specimens are washed in running water and then precooled at 4°C. Precooling is done to prevent ice crystals[12]. Dehydration is done either in serial exposure to solutions of gradually increasing ethanol concentration or by acetone. Dehydration in ethanol results in excessive shrinkage. Acetone is also capable of causing tissue shrinkage of varying degrees. Cold acetone causes the least amount of shrinkage[13]. If ethanol is used as the dehydrating agent, then an additional step is needed in which the ethanol is replaced with a suitable intermediary solvent like acetone or methyl chloride[12]. But acetone can be used both as a dehydrating agent as well as an intermediary solvent. It can also be recycled. Therefore dehydration by freeze substitution with acetone has been used in our department. In the vacuum impregnation step, the intermediary solvent acetone in the specimen boils out of the specimen, creating a pressure gradient between the interior of the specimen and the surrounding resin, thus the silicone is drawn into the specimen Vacuum pressure should be determined by the rate at which the mixture bubbles and can be regulated by adjustment of a shutoff valve. Rapid impregnation should not be done as it will result in compressed specimen, due to the sudden fall in pressure within the specimen. This will also result in incomplete impregnation[12]. Curing can be done either by gas, heat or light. For standard S10 plastination, gas curing with S6 has been used.

In Christian Medical College, Vellore, plastinates of prosected limb specimens, sagittal sections of head and neck, lungs, heart, anterior thoracic wall, stomach, liver, kidney, spleen, intestines with and without mesentery, cross-section specimens, diaphragm, spinal cord, full and dissected brain specimens are used for demonstration and as museum specimens. Considering the difficulties in obtaining human cadaver for teaching anatomy, plastination serves as an excellent way of obtaining more durable specimens. The pitfalls we experienced were shrinkage of few kidney and spleen specimens and cracking of a few organs which could have been due to rapid vacuum impregnation[12].

The feedback from students regarding plastinated specimens being used as teaching materials revealed that most of them like to handle plastinated specimens more as they are devoid of formalin smell and are easy to handle. It also enables them to understand the exact relation of structures which would get damaged or disturbed in formalin fixed specimens. Others have felt that, plastinates are less flexible and caused difficulty in visualizing deeper structures like bulla ethmoidalis and hiatus semilunaris. This view has been found to be similar to the experiences of a school in Malaysia with plastinates[14].

The general belief that production of plastinates is expensive needs revision as in our experience, other than the initial cost of obtaining the equipment, further financial input is minimal. Cost of acetone used can be drastically reduced by installing acetone distillation plant which enables reuse of used chemical. The silicone

resins used are expensive but the volume of resins used per specimen is minimal, can be stored at 250 and reused. The plastinate developed is also more durable and true to human anatomy compared to other man made models and also help to reduce the dependence on newly obtained cadaver[11,15]. This is more so in case of neuroanatomy teaching as the brain and spinal cord specimens are difficult to obtain and even more difficult to use as a teaching aid due to its propensity to degenerate with each demonstration. The procedure thus optimizes the usage of a cadaver.

CONCLUSION:

In our experience, plastinates are permanent, clean, non-toxic and durable. They serve as an excellent museum specimens. Easy handling and examination of specimens without any noxious effects makes plastination an excellent adjunct to the teaching of anatomy. However disadvantages of plastination include shrinkage and inability to manipulate superficial structures to study deep structures.

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