



## Using of plastinated sheet specimens in medical courses-An review article

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### ABSTRACT

This review was written based on different reviews that discuss Plastination technique as well as students opinion aboutsatisfaction of use of P45 sheet plastinated slices in teaching of medical courses like Anatomy, Pathology, and Radiology. All the samples were prepared based on the Hoffen polyester P45 procedure that includes (fixation, dehydration, forced impregnation, and curing) was the technique that depends on this study. The produces plastinated samples were assessed by 120 students from Kerbala University in Iraq. The resulted samples showed that the P45 sheet plastinated specimens were clear, dry, odorless, durable, easy to handle and there was no health hazard associated with their uses. 113 of 120 student's rated high satisfaction of using P45 sheet plastinated specimens. The high benefits come from using of P45 plastinated sheet specimens in Anatomy comparing with Pathology and Radiology courses. Among of many studies that discuss using of polymers P35, P40, and P45 in plastinated sheet models. The P45 plastination technique has advantages (safety, costly, requires less space in casting chamber, and short time-consuming) in compression with P40 and P35. There is no report that mentions any negative impression from using P45 plastinated sheet samples.

In conclusion, P45 Sheet plastination prepared by the Dalian Hoffen technique is a wonderful resource for study of gross anatomy, cross-sectional anatomy, pathology, and radiology.



## 1. INTRODUCTION

“Plastination is a technique of tissue preservation developed by Dr. Gunther von Hagensin Heidelberg, Germany in 1978”. In this technique, tissue fluid and fat are removed from biological tissues and replaces it with a curable polymer. The polymer hardens in time resulting in a dry, odorless and durable specimen. Three basic polymers are routinely used for slice production, depending on the desired product. Silicone for 1 cm slices, polyester for semitransparent brain slices (3-4 mm) and epoxy for transparent body slices (2-3 mm) (H. J. Sui & Henry, 2007), (Weiglein, 1996).

The procedure of this technique included four major steps which are fixation, dehydration, forced impregnation and hardening. The most common curable polymers used in this process are silicone, epoxy and polyester resin. Among these polymers, polyester resin has been used for the production of opaque brain slices, while epoxy resins are used for transparent body or organ slices (Ogaili, 2016), (Shirbadgi, S. A., Gouda, S., Mahesh, G. M., Raju, H. G., & Begum, 2014). In 1995, Dr. Von Hagens made his first showing of plastinated bodies in Japan, which attracted over three million people that depending on how the body use materials such as silicone rubber, epoxy resin or polyester render the bodies firm or flexible, opaque or transparent (Shirbadgi, S. A., Gouda, S., Mahesh, G. M., Raju, H. G., & Begum, 2014)

Previous research showed that all the plastinated resources available were heavily used and deemed useful by students. Although the properties of plastinated specimens accommodate student needs at various levels, traditional material should be used in conjunction with plastinated resources (Latorre et al., 2007).

The rapid development of software that used in teaching gross anatomy, cross section anatomy & radiology have required depth study of sectional anatomy so, sheet plastination gives a real anatomical feature and its regards as an important way that support this development (Gao, Liu, Yu, & Sui, 2006).

### **Protocol**

The general protocol of Hoffen polyester P45 technique that shown in table 1 includes:-

### **Slicing**

After samples preparation through cutting the residual tissue, cleaning, and washing by tap water. The first step of freezing the horse legs is frozen at (-15) for one day by using deep freezer. Specimens were wrapped with plastic film then embedded in polyurethane by using multifunction embedding box then sample is frozen at -70 as a second step of freezing for one week. Specimen were slices into desired specimen thickness (3mm) by using Band saw Blade 1/2" x 80", 3 TPI

### **Fixation and bleaching**

“The time between getting specimens and starting plastination procedure

and the quality of samples it must be fresh and free from any defect or any deformation of tissue because that influence the quality of produced slices so , it is necessary to fix the slices and sometimes bleach them depending on the desired color of the specimens. Slices are kept in 10% formalin for (14) days. When fixation was completed the fixative washes out in running tap water for 12 hours. In bleaching, the slices were immersed in 5% H<sub>2</sub>O<sub>2</sub> (bleacher) overnight and rinse with running water for one hour”.

### **Dehydration and Degreasing**

Before dehydration and degreasing, the slices are pre-cooled at 5°C before placed in cold acetone in order to avoid the formation of ice crystals and shrinkage. The slices are placed in first cold acetone bath 90% at (-25°C). Next, after stabilization the acetone concentration the stack of slices is transferred into the next fresh acetone bath 95% at -15°C.

The last change is in 100% acetone at room temperature for one week for degreasing. The purity of acetone was measured by using appropriate acetometers to ensure that dehydration was completed.

### **Preparing the Hoffen polyester P45**

Forced impregnation is replacement of solvent acetone with polymer P45. The Hoffen polyester P45 impregnation bath was made by mixing of: one liter of polyester P45 resin with 10mg of P45A, 30ml P45B (hardener) and 5g of P45C (plasticizers). Heat and stir well the mixture for polymerization. Boiling at 100°C then the mixture was placed in a cold water bath for cooling to 30°C. The Mixture is stored in refrigerator

### **Casting chamber preparation**

The slices were put between two pieces of glass after washed with pure acetone 99.9%. Casting chamber was made from two plates of glass, the thickness of each plate was 4mm and space between two glass plates was 5mm. An appropriate length of plastic flexible tube was put between the pieces of glass on three sides which are: bottom, left and on the right side of the chamber (U like shape). To obtain closed chamber, clamps were used on three mentioned sides.

### **Forced impregnation**

The casting chamber was slowly filled with Hoffen polyester P45 mixture by using a funnel. The filled chamber is sealed and placed in the room-temperature vacuum chambers for impregnation. The pressure is decreased gradually to - 20 mm Hg until the acetone gas bubbles ceases completely that takes 4-6 hours. After impregnation, it is an important to check and correct the location of slices inside casting chamber with steel wire to get a good sample position in casting chamber.

### **Curing**

The Hoffen P45 technique cured with heat in a water bath. The impregnated slices were cured in a water bath 40°C for 72 hours then slices were

removed from casting chamber. Sample was cover with plastic film to avoid scratches during cutting along the edge of the slice (H.-J. Sui & Henry, 2015)

Steps	Material
Slicing	Using of Band saw to cut the specimen for slices then rinse, clean and cool slices.
Fixation and bleaching	10% formalin for (14) days to fix the slices. 5% H2O2 for bleaching.
Dehydration	Immerse the slices in the1st acetone bath 99% and 2nd acetone bath 95% at -15°C.
Forced impregnation	All tissue samples were impregnated with polyester P45 resin in the vacuum chamber
Curing	40°C water bath was used for curing

Table1: General protocol of Hoffen polyester P45 technique.

**Assessment of Samples**

P45 plastinated preserved specimens were assessed by 120 students from 2<sup>nd</sup>,3<sup>rd</sup> and 4<sup>th</sup> year in Kerbala University, Karbala city, Iraq, who have attended Anatomy, Pathology and Radiology courses.

Before starting assessment of samples, one hour lecture included video, and PPT presentation file was given to students to show them Introduction, history, Procedure and types of plastination technique. One plastinated sample was available for each group that includes five students.

All samples were observed by students and many questions were answered. The questionnaire included written questions for two hours time that included:

What do you think about the importance of plastinated samples in teaching?

Little		Average		Important		Very Important	
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In which course (Anatomy, Pathology, and Radiology) that depending of plastinated samples are more useful?

Anatomy	
Pathology	
Radiology	

If you could choose to work with a plastinated or formalin-preserved specimen in your Practical class, which would you prefer?

Formalin-preserved	
Plastinated	
Both(Formalin-preserved+ Plastinated)	

Express your degree of satisfaction with the plastinated specimen

Non satisfied	satisfied								
Non satisfied		Very little		Little		Average		high	

**Student feedback**

The results of survey has briefly summarized below  
 What do you think about the importance of plastinated samples in teaching?

Little	0	Average	16	Very Important	104
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Express your degree of satisfaction with the plastinated specimen

Little	0	Average	7	high	113
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In which course (Anatomy, Pathology, and Radiology) that depending of plastinated samples are more useful?

Anatomy	110 of 120
Pathology	70 of 120
Radiology	80 of 120

If you could choose to work with a plastinated or formalin-preserved specimen in your Practical class, which would you prefer?

Formalin-preserved	5
Plastinated	105
Both(Formalin-preserved+ Plastinated)	10

The results of this study show that 63% of the students agree that using of plastinated are high importance and 90% of them appear highly satisfaction in depending on plastinated models in teaching medical classes.

This questionnaire has revealed that 86 %, 20%, 53% of the students who showed their opinions that sheet plastinated samples could be depended in teaching Anatomy, Pathology and Radiology courses respectively.

In practical classes, 60% of the students prefer to treat with plastinated models while 20% prefer to formalin-preserved specimens and 40% they are

looking for using both samples (plastinated plus formalin preserved specimens) in the practical sessions.



Figure 1 sheet plastinated of horse leg

### **The Progress of Plastination**

Using of plastinated model specimens in teaching medical classes are very important and their use regard as an improvement for the education system. Nowadays in some universities, using of plastination samples become very familiar with Anatomy, Pathology and Radiology courses, especially in the practical sessions.

In Iraq, using of plastinated models has been depended as a reference for anatomy classes in Kufa University and Basra University (Sawad, 2014). In Kerbala University, teaching system of medical classes completely depend on using of formalin preserved specimens, formalin preserved jars, X-Rays films in Anatomy, Pathology and Radiology courses respectively. This study characterized as a first trial that discussed using of plastinated specimens in Kerbala University. The traditional P35 & P40 resin have been improved as a polyester resin that can be

used in sheet plastination technique (Gao et al., 2006)(Sora, Brugger, & Traxler, 1999)(Weiglein, 1996).

The resulted samples of this study that show in figure 1 represent in highly important and useful because they were dry, clear, odorless, durable and they gives the details of anatomical structure.

Some people are very sensitive to formaldehyde and may experience adverse effects (the formalin health hazard) such as watery eyes, burning sensations in the eyes, nose, and throat, nausea, wheezing, coughing and irritation of the skin (Singh, Mishra, Pandit, Maheshwari, & Hasan, 2013). For this reasons most of the students prefer plastinated sample in their teaching and regard it's a good model could be used in teaching anatomy.

Among of many studies that discuss using of plastinated sheet models. There is no report that mentions any negative impression from using P45 plastinated sheet samples. The previous researchers show that P45 plastinated samples can be used in teaching anatomy (Chun, Yu, Qin, & Sui, 2015).

The P45 plastination technique has advantages in comparison with P40 and P35 which are:-

1. The P35&P40 slices are cured with UV-light instead of water bath that used in P45 that make this process safety and costly.
2. The vertical position of P45 plastinated sheet specimens requires less space in casting chamber.
3. The time that used for preparation P35 or P40 sheet plastinated specimens is more than to prepare same slices with P45 (H. J. Sui & Henry, 2007).

Finally, these results are consistent in agreement with workers who use P45 polymer in preparation of plastinated sheet samples (Gao et al., 2006).

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