COMPARATIVE CHARACTERIZATION OF PLASTINATION METHODS

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ABSTRACT

Anatomy is the foundation of medicine. Practical anatomy education at Medical Universities is usually performed on cadaveric material. The proper conservation of biological material is important not only for the quality of medical education but also for the health of both students and lectors. Von Hagens offers plastination – a modern conserving method for long-time preservation of anatomical structures.

The three basic techniques used in plastination are: S10, P40, and E12. In the present work we offer a comparison between them as well as tips from our practice, which can be useful for beginner plastinators.

Keywords: *plastination, S10, P35, P40, E12, anatomy*

INTRODUCTION

Practical anatomy education at Medical Universities worldwide is usually performed on cadaveric material. This material is not permanently stable, because following death tissues deteriorate and decompose. The influence of microorganisms from the external and internal environment, and the action of enzymes in tissues are the reasons for the disintegration of the biological material.

10% aqueous solution of formaldehyde, used in the last 150 years, preserves the biological matter, but it is highly toxic – it causes inflammation of the mucous membranes and triggers allergic reactions that can be fatal. The toxic effect of this conservation mixture is considerable, regarding both students and teachers.

The alteration of the tissue color is yet another problem for the anatomy education. Formaldehyde-preserved anatomical objects don't have the real morphological appearance of the educational material.

Due to those reasons, over the last centuries anatomists have looked for a new harmless conservation method to preserve the biological material in stable condition and at the same time be safe for human health.

Many of these problems were solved when Gunther von Hagens started applying the plastination method in his practice (*von Hagens et al.*, 1987). This method caused a revolution in the preservation of anatomical preparations for medical training. Initially, experiments for impregnation of soft biological specimens with thermosetting resins and elastomers were made (*von Hagens*, 1979). They subsequently led to the modern plastination method.

Gunther von Hagens offers three classic forms of plastination technology (*von Hagens*, 1985/86). They were developed over the decades following their introduction. Many researchers (Henry, 1996; Latorre et al., 2007; Sivrev, 2007; Jimenez, 2014;

Juvenato, 2015) describe some modifications of these three plastination forms.

The three classic plastination techniques are named in connection with the using materials: S10, P40 and E12.

MATERIAL AND METHODS

For plastination, we use biological material, prepared during dissection exercises. It is fixed with 10% aqueous solution of formaldehyde. Acetone is used to dehydrate and to replace the fixative in the tissues. Apllying the forced impregnation method, acetone is replaced with Biodur S10, P40 or E12. After hardening, the preparations are ready for using in an education process.

RESULTS

S10 plastination technique

In this method, the tissue fluid is replaced with Biodur S10. The resulting anatomical preparations were kind of close to life-like. They are elastic, resistant to medium mechanical load and harmless to human health. This method is best suited for plastination of internal organs and making joint preparations.

We use the S10 technique mostly for gross neuroanatomical plastination. We have previously described the plastinated brains, but the preparation of spinal cord is demonstrated for the first time (fig 1).

At the Department of Anatomy of the Medical Faculty in Stara Zagora we attempt to develop brain slices by applying S10 plastination equipment. The obtained plates are of high quality but they are not sufficiently resistant to mechanical stress. We demonstrated these S10 plastinated brain slices at previous scientific forums.

In the Plastination Laboratory of the Department we currently develop a protocol to plastinate a whole human brain using the S10 technique. It is of crucial importance to observe the duration of all phases during the plastination process.

P40 plastination technique

This method is mostly used for making plates of brain with thickness 0.3-20 mm. The initially proposed in the 1990's P35 plastinatsion technique has been replaced with the more sophisticated P40 plastinatsion technology. The latter does not require a pre-staining of brain tissue, as polyester copolymers, which are impregnation material in this techniques, cause a strong contrast between gray and white matter of Cerebrum.

In our practice, we use a modification of P40 plastination technique for brain slices. We demonstrated results using this method at previous scientific forums. The contrast between gray and white matter of Cerebrum is good (fig 2).

E12 plastination technique

E12 plastinatsion technique is well suited for making topographoanatomical slices with thickness 0.7-1.2 mm of the limbs and trunk. Impregnating material is epoxy resin. Resulting plates are translucent, hard and resistant to mechanical stress (fig 3).

Combination of plastination techniques

At the Department of Anatomy in the Faculty of Medicine we have developed a unique method of combined plastination of human eye. The vitreous body is replaced with Biodur S10, the soft tissues are impregnated with polyethylene glycol using the "impregnation substitution" of *Steinmann's* method. Plastinated preparations are life-like, soft and elastic, but are not resistant to mechanical stress. Another disadvantage is that the polyethylene glycol does not harden and preparations should be touched with rubber gloves. We have previously described this method in detail in Journal of International Society for Plastination (*Sivrev et al.*, 1997).

The whole head of a woman has been preserved using a combination of two plastination techniques. Blood vessels are filled with colored silicone, while the whole head is plastinated using *Seinmann's* substitution method (fig 4).

DISCUSSION

Our results in S10 plastination technique are a viable addition to the experience of other researchers (*Henry*, 1991; *Henry*, 1993; *Mccreary*, 2014). Our method of combined plastination for preparation of improved ophthalmologic teaching models is unique and has not been applied elsewhere. Our results using P40 and E12 techniques are similar to the achievements of other teams (*Weiglein, 1993; von Hagens*, 1994; *Sora*, 2014). The most important quality of plastinated anatomical preparations is that they are absolutely safe for human health.

CONCLUSIONS

Plastination is a modern method for making of anatomical preparations. S10 technique is suitable for plastination of soft body parts but it is aslo suitable to prepare S10 brain slices.

P40 plastination method is usually used for preparation of brain slices. However, we consider its usage for making of transparent plates of all organs to be completely possible too.

Plastinated specimens are safe to handle and completely non-hazardous for human health.

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LEGEND

Fig 1. Demonstration of S10 plastination technique: preparation of Spinal cord *(Anatomical Museum of Anatomy Department, Medical Faculty – Stara Zagora).*

Fig 2. Demonstration of P40 plastination technique: Brain slices *(Anatomical Museum of Anatomy Department, Medical Faculty – Stara Zagora).*

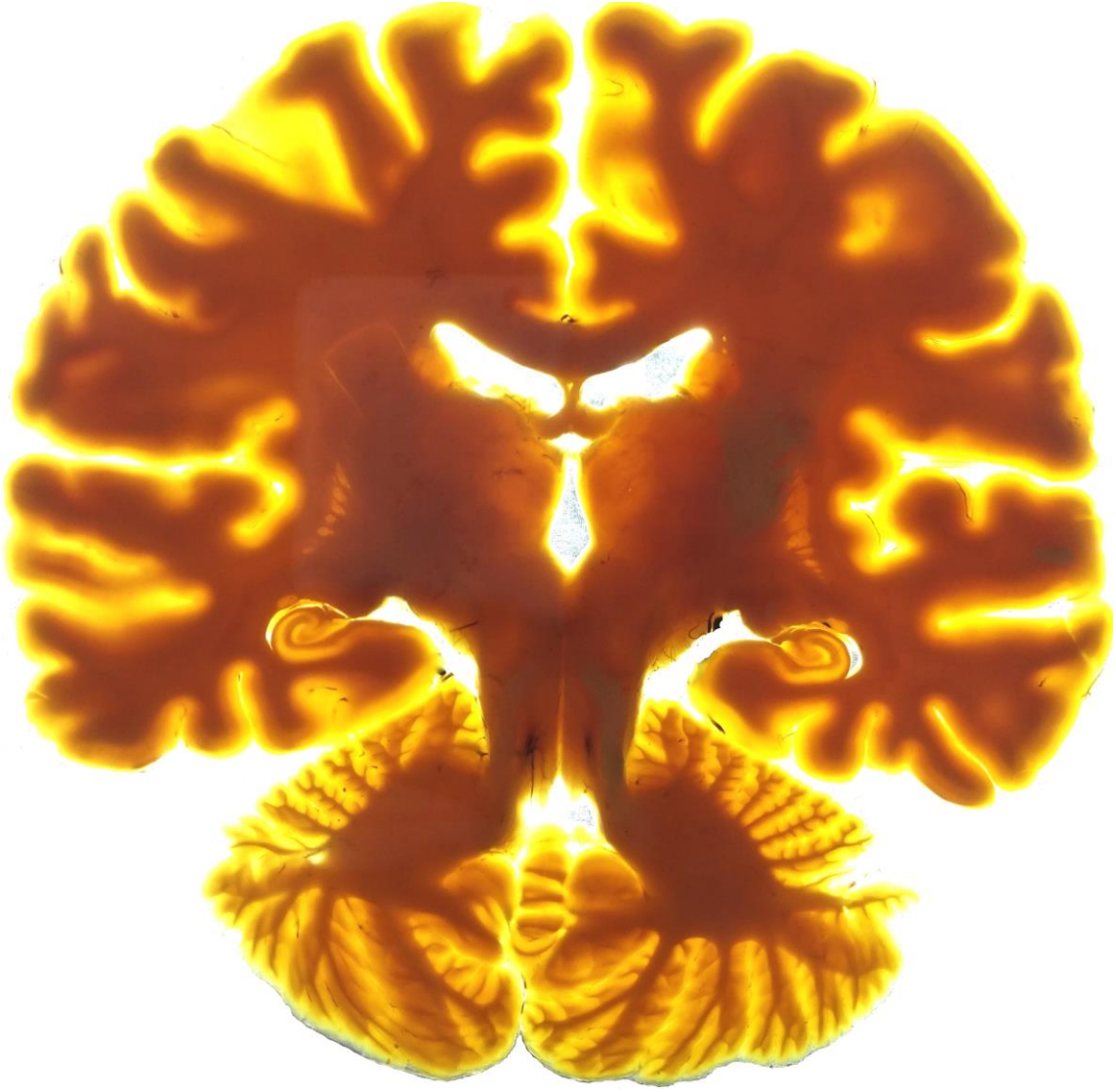

Fig 3. Demonstration of E12 plastination technique: Transversal section of thoracic region *(Anatomical Museum of Anatomy Department, Medical Faculty – Stara Zagora).*

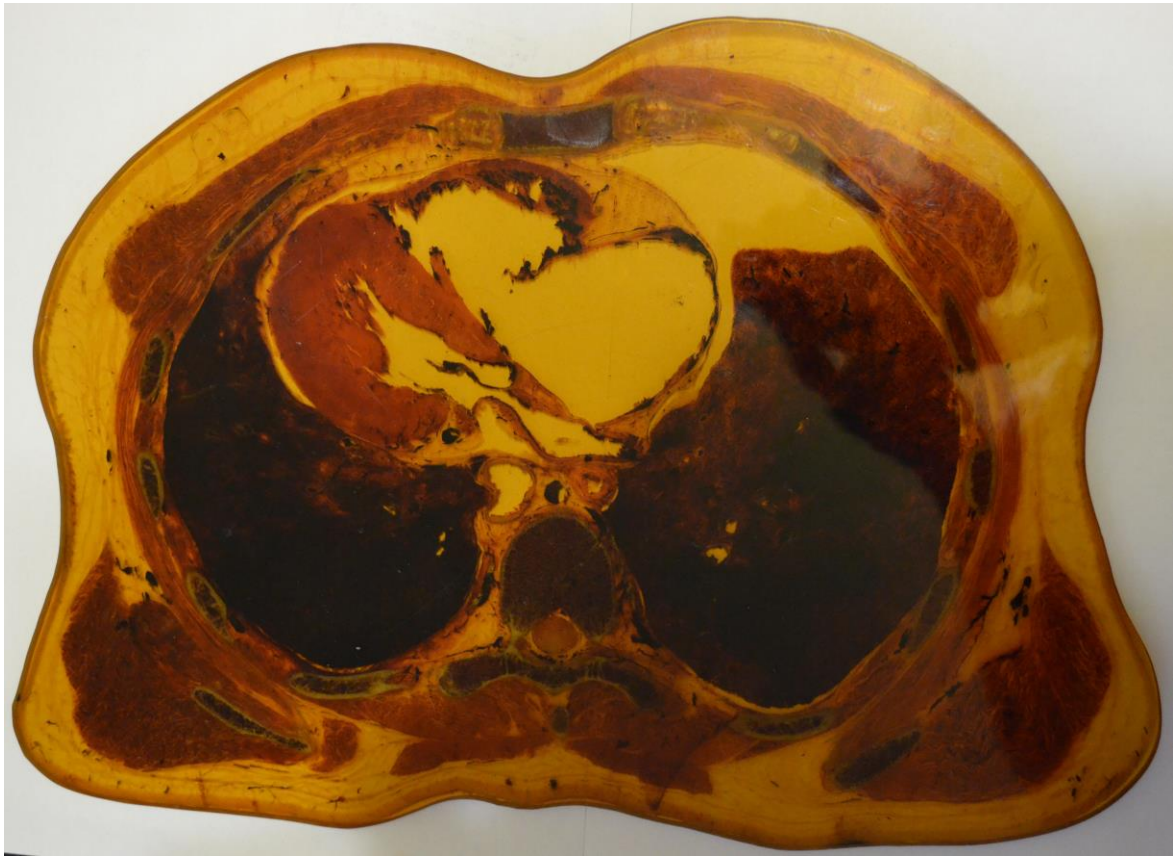

Fig 4. Demonstration of combination of two plastination techniques: A female head *(Anatomical Museum of Anatomy Department, Medical Faculty – Stara Zagora).*