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PRODUCTION OF ANATOMICAL SPECIMENS FOR TEACHING PRACTICE IN VETERINARY ANATOMY BY MEANS OF POLYETHYLENE GLYCOL (PEG) IMPREGNATION. A COMPARISON WITH THE METHOD OF PLASTINATION

Nota científica

PRODUCCIÓN DE PIEZAS ANATÓMICAS PARA LA ENSEÑANZA EN LA ANATOMÍA VETERINARIA USANDO LA IMPREGNACIÓN CON POLIETILENGLICOL (PEG). COMPARACIÓN CON EL METODO DE PLASTINACIÓN

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RESUMEN

Buscando un método alternativo a la plastinación, en el presente estudio se usó la impregnación con polietilenglicol (PEG) para producir piezas anatómicas durables, para usar en la enseñanza en medicina veterinaria. Las piezas se fijaron en una solución de formalina 2% y se impregnaron con presión de vacío baja de 15 milibar. Usando esa técnica se produjeron piezas anatómicas didácticas, como articulaciones móviles, órganos huecos, piezas inyectadas con color, y órganos seccionados. Las piezas anatómicas impregnadas con PEG tienen muchas ventajas en comparación con las piezas plastinadas, e.g., se pueden conservar en bolsas o cajas de plástico, son resistentes a la infección con hongos y bacterias, no son irritantes para la piel, y se pueden usar exitosamente en la enseñanza de la medicina veterinaria.

Palabras clave: polietilenglicol (PEG), piezas durables, enseñanza, anatomía veterinaria.

ABSTRACT

To explore an alternative for plastination, in this study impregnation with polyethylenglykol (PEG) was used for production of durable anatomical specimens for teaching in veterinary medicine. The specimens were fixed in 2% formaldehyde and impregnated in a vacuum with a low-pressure of 15 millibar. By using this technique moveable joint specimen, hollow organs, colour injected specimens, and parts of organs were produced for didactic purposes. The PEG-impregnated specimen has several advantages, e.g., can be stored in plastic bags or boxes, are resistant against fungi and bacteria, and produce no-skin irritation, and has been successfully used in veterinary anatomy teaching.

Key words: polyethylenglykol (PEG), durable specimens, teaching, veterinary anatomy.

INTRODUCTION

Since the invention of formaldehyde, anatomical specimens can be stored almost timeless without major difficulties. Specimens are stored in large tanks, which have to be tightly closed to avoid vaporisation of formaldehyde. For demonstration purposes the specimens have to be watered for 24 hours.

The toxicity and cancerogenic effect of formaldehyde lead us to investigate other substances without any side effects. One of the substances is the polyethylene glycol (PEG). Therefore, producing PEG-impregnated specimens becomes an interesting alternative.

Nowadays for the production of durable anatomical teaching specimens the method of plastination is used predominantly (DeJong and Henry, 2007; Sora and Cook, 2007; Sora, 2007; Weber et al., 2007; Henry and Latorre, 2007; Sui and Henry, 2007). However, many anatomical teaching institutions have been searching for less expensive and practicable methods than the plastination for the production of durable anatomical educational material.

Polyethylene glycol (PEG) has been used since the seventies for conservation of anatomical specimens (Racek, 1974; Geymayer and Gütebier, 1979; Steinmann, 1982). This method is still in use, in spite of the triumphal procession of the plastination, because it is easier and cheaper (Uhlmann, 1991). PEG-impregnation in comparison to plastination offers financial advantages and greater flexibility of specimens than that of plastination.

This study reports our experience in production of anatomical specimens with polyethylene glycol (PEG) for teaching practise in veterinary anatomy.

MATERIALS AND METHODS

Various preparations were performed before PEG impregnation. Hollow organs were emptied and washed. For the specimen of a joint, the blood vessels and synovial cavity were filled with colour resin, latex or methylmetacrylat (Tensolvet™). Nerves, blood vessels and lymph nodes were carefully dissected and exposed. Specimens were washed and bleached with 20% hydrogen peroxide.

The method of PEG impregnation was described previously (Steinmann, 1982). In brief, the prepared specimen was placed in a solution of 2-5% formaldehyde for several days or weeks, depending on the size of the specimen. A suggestion that the fixation solution infiltrates the tissue about 1 cm per day was used to estimate dura-

tion of the fixation. To achieve a better fixation, multiple injections of a formaldehyde solution in a large specimen were tried. After fixation the specimen was moved into a stainless steel wire basket, which was hooked inside a vacuum tank and submerged in the PEG solution (Polyethylen-glycol 400, Merck Company, Germany). When hollow organs were processed, all the fixation fluid and air inside the cavities were removed before placing into the PEG solution. The tank remained in a low-pressure of 15 millibar and a temperature of 50°C until the impregnation solution is completely dehumidified, which was indicated when no more water flow marks exhausted. The PEG solution was changed several times during impregnation.

After completely saturating, the specimen was taken out of the tank and dabbed off carefully with pulp to remove excessive PEG solution. After complete impregnation, the specimens were removed from the vacuum chamber and dried for several days by placing them on filter paper in a room protected from direct sun light. After drying, the specimens were soft, life-like and suitable to be used in the educational process. The appearance of the so-impregnated specimens is similar to their natural condition.

RESULTS

By using the PEG impregnation method, some high quality specimens (Fig. 1-4) were produced, such as: the stomach of a horse (inner view), pharynx of a pig (opened), and the bovine carpal region with injected synovial structures.

PEG impregnated specimens offers some advantages compared to plastinated ones. First, flexibility is higher; joint specimens show nice white ligaments and movements are possible without damaging them. Once processed, PEG specimens can be stored for a long time and used for teaching, with no need for additional service. A big advantage of this method is the short processing time, so a specimen can be processed in two weeks, a period which is impossible for plastination. However, PEG specimens are hygroscopic so that they are never completely dry.

Experience in PEG-impregnated specimens storage

Storage of specimens is most suitable in larger plastic boxes packed in plastic bags. If the specimens are stored in an open manner for a long period they will dry-up and perish. Thus, after demonstration of specimens in the dissection hall, they should be repacked as soon as possible.

If the PEG-impregnated specimens are handled properly, a long term use can be achieved



Fig. 1. Pharynx of a pig, dorsal view.
Fig. 1. Faringe de un cerdo, vista dorsal.

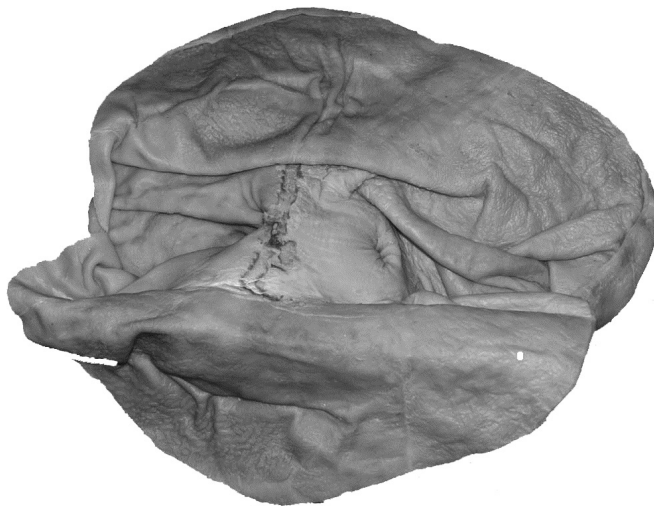


Fig. 2. Stomach of a horse, internal view (mucous membrane).
Fig. 2. Estómago de un caballo, vista interior (membrana mucosa).



Fig. 3. Bovine carpal region with injected synovial structures, medial view.

Fig. 3. Articulación del carpo de un bovino con estructuras sinoviales inyectadas, vista medial.



Fig. 4. Bovine carpal region with injected synovial structures, lateral view.

Fig. 4. Articulación del carpo de un bovino con estructuras sinoviales inyectadas, vista lateral.

because they are resistant to fungi and bacteria. Voluminous hollow organs can be stored after the air in the organ is pressed out. For demonstration purposes these organs can be refilled with compressed air. A PEG-impregnated specimen with methylmetakrilat injection is inflexible and suitable for demonstration in showcases.

In spite of a light darkening of structures, these specimens proved to be excellent models for the educational process. When the specimen is not used anymore it was inserted in a plastic bag and kept in a dark and cold place.

DISCUSSION

The PEG technology appears much cheaper than that of plastination. One barrel PEG with a content of 220 liters costs about 500 €. Fluid PEG can be recycled. In order to recycle PEG, the PEG mixture needs to be heated up to 90°C in order to exhaust water vapor (Steinmann, 1982). To save the PEG solution, hollow organs can be compressed to a minimum in volume and fit into a vacuum tank for impregnation. After the impregnation, hollow organs can be connected to a compressed-air pump and refilled with air so that their natural form and size can be re-stalled. The PEG-impregnated hollow organs can also be filled with foam (Polyurethane foam Fa: KauPo, Plankenhorn, Max Plank Str. 9/3, D-78549 Spaichingen, Germany) and stored in their natural size.

Other advantages of PEG impregnation is that PEG-impregnated organs can be varnished with nitrocellulose. For didactic purposes and a better differentiation of adjacent structures, watercolours and/or oil paints can be used (Geymayer and Gütebier, 1979). The PEG-impregnation can be used for large hollow organs, like the rumen in ruminants or the large intestine in horses. PEG-impregnated hollow organs can be opened so you can look at the inside components, which is particularly useful for the demonstration of various appearances of mucous membranes in the stomach of dogs, cats, pigs or horses. In addition, as PEG-impregnated specimens are sliceable these can be investigated histologically. PEG-impregnated joints are moveable.

In addition, various pre-treatments can be applied on specimens before impregnation in order to meet various purposes. For example, blood and lymph vessels can be filled with colored resins so topography of vessels and nerves can be demonstrated. On the extremities of the domestic animals different cavities can be filled with coloured methylmetakrylat (Tensolvét™) for a better orientation in topography.

In summary, PEG impregnation is a very useful alternative to plastination. Both PEG and plas-

tinuation methods have their own pros and cons. In comparison to plastination, PEG-impregnation offers financial advantages and greater flexibility of specimens. The PEG-impregnated specimens are not toxic, have high skin kindness and can be used over several years.

Which method should be used will be largely determined by the specific purpose the specimen is created for.

PEG impregnation and plastination are two distinct methods for preservation, which should complement each other. The difference between these two techniques is determined by the resin. Alcohol (polyethylene glycol) is used for PEG, while a silicone rubber is used for plastination. The alcohol does not polymerise in the PEG impregnation process and therefore specimens are soft, whereas the silicone rubber will polymerize and get hard during plastination. Depending on the needs we could use PEG impregnation for joint specimens, which will be flexible and permit movement.

In general, the use of PEG is desired when a higher flexibility is required, or when producing hollow organs which could be expanded; but any anatomical specimen could be preserved through this method. PEG impregnation is much cheaper than plastination and requires less technical equipment. PEG impregnated specimens are equivalent in aspect and shape to plastinated specimens. When using the plastination method we can display diverse presentation of dissected specimens. Muscles are hard in plastinated specimens and therefore they can replace bones in plastinates. This is a major advantage, but it also has the disadvantage of losing joint mobility.

LITERATURE CITED

- DeJong K., and Henry R.W. 2007. Silicone plastination of biological tissue: Cold-temperature technique – Biodur™ S10/S15 Technique and Products. *J. Int. Soc. Plastination* 22:2-14.
- Geymayer P, and T. Gütebier. 1979. Polyethylenglykole, ihre chemie und anwendung in der präparationstechnik. *Präparator* 25:65-70.
- Henry R.W., and R. Latorre. 2007. Polyester plastination of biological tissue: P40 Technique for brain slices. *J. Int. Soc. Plastination* 22:59-68.
- Racek M. 1974. Weitere vereinfachung der paraffinierungsmethode durch verwendung von polyäthylenglykol. *Präparator* 20:48-49.
- Sora M-C, and P. Cook. 2007. Epoxy plastination of biological tissue: E12 Technique. *J. Int. Soc. Plastination* 22:31-39
- Sora M-C. 2007. Epoxy plastination of biological tissue: E12 Ultra-thin technique. *J. Int. Soc. Plastination* 22:40-54.

- Steinmann, W.F. 1982. Makroskopische präparationsmethoden in der medizin. p. 213-216. Thieme, Stuttgart, Germany.
- Sui H.J., and R.W. Henry. 2007. Polyester plastination of biological tissue: Hoffen P45 Technique. *J. Int. Soc. Plastination* 22:78-81.
- Thiel, W. 1992. Die Konservierung ganzer Leichen in natürlichen Farben. *Ann. Anat.* 174:185-195.
- Uhlmann K. 1991. Die Konservierung anatomischer Studienpräparate mit Polyethylenglykol 400. Langzeiterfahrungen und Vorstellung eines neuen, vereinfachten Verfahrens zur forcierten PEG-Imprägnation durch Luftentfeuchtung bei Normaldruck. *Präparator* 37:19-22.
- Weber, W., A. Weiglein, R. Latorre, and R.W. Henry. 2007. Polyester plastination of biological tissue: P35 Technique. *J. Int. Soc. Plastination* 22:50-58.