PLASTINATION OF WHOLE-BODY SLICES WITH POLYMERIZING EMULSION

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INTRODUCTION

The availability of plastination has permitted us to introduce sectional anatomy at the Institute of Anatomy of the University of Vienna. Sectional anatomy is a valuable approach to the acquisition of an understanding of body structure. Before our use of plastinated slices, it had been neglected for many years.

Sectional anatomy provides a three-dimensional concept of the relationship among body structures. Up until now, this has been achieved mostly through the use of handbooks and atlases. Also, sectioned specimens can be studied like a puzzle, disassembled and put back together again. This enables the students to trace the course of nerves and bloodvessels through the head, neck, trunk and extremities.

Our experience would also suggest that sectional anatomy is a valuable adjunct to recent advances in diagnostic imaging techniques such as computerized axial tomography, nuclear magnetic resonance and ultrasound. It is very valuable, for example, to have a CAT scan of a plastinated specimen and the specimen itself available for comparison.

SPECIFICATIONS OF AN EFFECTIVE TEACHING SECTION

The full benefit of sectional anatomy can be realized only if the sections conform to certain specifications. We recommend that the following criteria be observed:

1. The specimen should be resistant to the mechanical damage that inevitably will result from passing through many hands.
2. The surface should be dry.
3. Health risk should be minimal.
4. Maintenance and storage should be easy.
5. The specimen should be natural in appearance with vivid surface detail.
6. The specimen should be odorless. ;
7. Production should not be too complicated.
8. The production process should be affordable.

Although methods are available to display cross-sectional specimens in flat chambers, they seldom match all of the requirements listed above. Conventionally preserved specimens are not completely acceptable because they are wet, smell rather bad, emit formaldehyde vapor and require elaborate air circulation and ventilation. We have found plastination with PEM 27 (an epoxy-based emulsion) or S 10 (silicone rubber) to be an elegant and satisfactory means of meeting the desired criteria.

SELECTION OF A BODY FOR SECTIONING

The process of plastination of whole-body slices actually starts with the proper choice of corpses. Our criteria are as follows:

1. The shortest possible postmortem interval is desirable. Normally, a corpse will arrive at our institute 2 to 10 days after death. Because of the autolytic degeneration of delicate tissues, we usually select only those bodies arriving between two and five days postmortem.

2. Although the general state of the circulatory system is more important than age, the deceased should not be too old. Considering the superannuated population we deal with, an age of 50-60 years is looked upon as desirable.

3. The body should be of average stature and weight. This may sound trivial but a trend to obesity can be seen in our population and we must take care to assure that the specimen will fit our equipment.

4. The body should be free of any deformity that would affect the morphology of the sections.

We have found that only 1 to 2 percent (2-5 corpses) per year are suitable for sectioning. Interestingly, among those selected, there prove to be more men than women. This is inconsistent with the composition of the donor population itself which consists of more women than men. In addition to whole bodies selected as above, we also plastinate the skulls of autopsied cadavers with the brain left in situ.

PREPARATION OF THE BODY FOR SECTIONING

Selected bodies or body parts are now embalmed. Generally, whole corpses are injected with 15-20 liters of Kaiserling-I solution, using an irrigator system with approximately 160 cm water column. Kaiserling-I solution consists of 200 ml formalin, 15 gm potassium nitrate, 30 gm potassium acetate and 1000 ml deionized water.

According to our experience, this solution enhances color retention while still providing adequate fixation. After injection, corpses are turned on the ventral surface for overnight storage. Body parts are infused only via their main artery (Lischka et al, 1981)

Embalmed cadavers are now transferred to a tank for long-term storage. In contrast to those stored for dissection, bodies to be sectioned are kept floating in Kaiserling-I solution. Storage time, at present, is usually a minimum of three months. Since we are producing sections 1 to 4 cm thick, prolonged storage does not seem to have an adverse effect. By remaining afloat throughout the entire period of storage, the shape of the corpse does not suffer from deformation. Furthermore, the embalming fluid is not pressed out of the weight-bearing parts, as would happen if they were stored on trays. Corpses are processed in order of their sequence of acquisition.

FREEZING AND SLICING

Before a cadaver is frozen, sectioning lines are drawn. Sections of the head (cross, coronal or saggital) are marked at 1 to 2 cm. Cross-sections of the trunk and limbs are marked at 4 cm. The body is then transferred to a deep-freezer where it remains at-25C for several days.

Sections are cut with an ordinary carpentry band saw, using a blade with 6 teeth per cm. Since we are cutting thick sections, lateral deviation of the blade is minimal. Notches that do occur are ground smooth after curing. Cutting of the skull is complicated by the enormous hardness of the petrous bone and teeth (particularly if dental restorations are present).

As sections are produced, they are immediately submerged (at room temperature) in plastic containers filled with 80% ethanol. Distance is maintained between sections as they thaw by the interspersing of plastic grating sheets. Since ethanol is comparatively cheap, it is changed at least once.

Once thawed, sections are carefully cleaned of any defilement and sawdust. Loose .pieces of intestine are sutured and pinned in place. Using compressed air, vessels and other cavities are cleaned of all detritus.

DEHYDRATION AND DECREASING

The sections are now dehydrated by freeze substitution using acetone of a grade between 96 and 100% purity. This is carried out by precooling the ethanol-saturated sections to 5°C and immersing them in three changes of 10X their volume of acetone at -25"C. Specimens remain in each bath for two weeks. Freeze substitution offers several advantages when compared to other methods of dehydration:

1. The time required is shorter.

2. Specimen shrinkage is reduced.

3. Amount of dehydrating solutions used and discarded is less than that with a graded series of ethanol.

The first and second bath can be reused as long as water concentration does not exceed 5%. Acetone used for the final bath must be 99-100% pure. Because of the differing densities of water, grease and acetone a gradient develops in the dehydrating baths. Water and grease are found at the bottom, in that order, while the top layer consists of fairly pure acetone. Therefore:

1. Specimens should not be placed directly on the bottom.

2. It is important to stir the solution daily.

3. Sections should not be in contact with one another. Adequate interspace should be maintained with plastic grating sheets.

4. Before measuring the water concentration, it is always necessary to stir the bath.

There should always be enough acetone in the dehydrating vessels so that the section closest to the surface does not become dry. Transfer of sections from one bath to the next should be done quickly and gloves should always be worn to prevent skin injury. It is also advisable to wear a gas mask. Dehydration is complete when the water concentration stabilizes at 1% or less.

Since the degreasing capacity of -25°C acetone is not very high, all specimens with osseous structures or considerable fatty tissue are subjected to a separate degreasing procedure. Thorough degreasing enhances the optical quality of finished sections, particularly when plastinated with silicone rubber. Also, storage in the degreasing medium is permissible for a much longer time than in acetone, time that can provide flexibility for one's impregnation schedule.

To accomplish degreasing, we immerse the sections in methylene chloride at room temperature. After two weeks the bath is changed. Sections can remain in this medium for months but must not be left in acetone for this length of time. Long exposure to acetone causes hardening of the surface and interferes with polymer impregnation resulting in poor specimen quality (reduced flexibility).

FORCED IMPREGNATION AND CURING

Both Biodur S 10 and Biodur PEM 27 are used for plastination of body sections. Our procedure for S 10 is described in another paper published in this journal. In this article we will describe only the procedure for PEM 27 (epoxy-based polymerizing emulsion) . We use S 10 (silicone rubber) on specimens of the following types:

1. brain tissue, isolated or in situ
2. specimens to be used by students for self-instruction.

PEM 27 is our choice for all specimens requiring good visual appearance with clear surface detail. PEM 27 specimens should not be used in circumstances where they would be handled by a number of people since they are far more fragile than those impregnated with silicone rubber.

Forced impregnation is carried out according to recommendations in the Heidelberg Plastination Folder - 1985, a publication obtained from Dr Gunther von Hagens of the Institute of Anatomy, University of Heidelberg. A reaction mixture of PEM 27 and E 6 (hardener) is used. Impregnation is started on Monday. Vacuum is applied gradually, maintaining a slow boiling rate. It is then maintained until Thursday when the sections are removed and new sections started.

Impregnated specimens are wiped free of excess resin and placed in an oven at 40C where they remain for 4-5 weeks. Curing is complete when the specimens are thoroughly dry.

GRINDING AND LABELING

Cured specimens are stored until a large enough number has accumulated for grinding. Sections are polished on a wet grinder until cut surfaces are smooth. By grinding the surfaces in this manner it is possible to demonstrate specific structures such as the median atlanto-axial joint, showing the transverse atlantic ligament. Grinding is not *a* popular step because it is accompanied by an impressive amount of noise and dirt. Polymerized resin on the lateral and inner surfaces is removed with the help of drilling devices. So far, six totally sectioned bodies have been prepared in this way.

A permanent, etching type of drawing ink is used for labeling the specimens. Solvent in the ink etches the surface of the plastic and the ink adheres to the etched surface. The area to be marked is prepared with clean ethanol or acetone and wiped dry.

Proper storage and access to specimens is dependent on a complete inventory system. We record the following information on index cards in a file:

1. the index number
2. an anatomical classification
3. the date of forced impregnation
4. the resin used
5. the praeparator
6. location of the storage site and/or the user's name

Specific anatomic structures demonstrable on the specimen should be noted. Sections are usually stacked in cardboard boxes, prominently marked with the index numbers of the specimens it contains.

In the future we hope to acquire a full-time technician and increase the efficiency of our laboratory. When this is accomplished we intend to introduce sheet plastination and plastination of brain tissue with P 35.

REFERENCES

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