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A new simple method for conservation and demonstration of body sections for teaching clinically oriented courses in gross anatomy

In the last 10–15 y, imaging techniques such as ultrasound, computed tomography (CT) and nuclear magnetic resonance imaging (MRI) have become indispensable in clinical diagnosis. The traditional courses in gross anatomy, however, usually guide the students through human anatomy only by conventional dissection of bodies. Although this concept gives a comprehensive insight into topography, it fails to prepare students for the interpretation of sectional images as used in computed tomography. We therefore decided to supplement our teaching of gross anatomy by offering a special course of cross-sectional anatomy. A major problem was that unprotected sections do not withstand handling by students long enough, and that display cases for anatomical preparations are usually made of glass. Previously described means for the conservation and demonstration of body sections are rather complicated, fragile and nonpractical. Plastinated body sections present other disadvantages (see below). For these reasons we have developed a new simple method for the presentation of body sections.

Human bodies were fixed in the traditional way using 4% formol solution without additives and were frozen at −25 °C. Sections were cut at a thickness of 10–20 mm using a band-saw (model MS41R, Hobart GmbH, Offenburg, Germany) with a universal saw blade and the speed set at 740 rpm.

For construction of the cuvettes (Fig. 1) we used acrylic glass of 10 mm thickness (Plexiglas GS 233; Röhm GmbH Chemische Fabrik, Darmstadt, Germany), high-grade steel bolts (6 × 60 mm), nuts, and collars (6 mm inner diameter). Each section was placed on an acrylic glass plate and was surrounded tightly by a gasket made from a soft rubber string. Two different types of rubber strings were used depending on the thickness of the body section to be stored: 15 × 20 mm or 15 × 25 mm in cross-section (Meteor, Shore A, hardness 20°, obtained from Gummi-Schulden GmbH, Essen, Germany). After the rubber strings had been cut into appropriate lengths to surround the body section tightly, both ends were carefully connected with glue (Pattex, Henkel, Düsseldorf, Germany). The design of the cuvettes is shown in Figure 2. A pair of rectangular acrylic glass plates was cut so as to be larger than the respective body section by ~ 7 cm. These plates were fixed plane to plane by adhesive tape, the outline of the body section was drawn on the plates, and a second outline was drawn around this at a distance of about 15 mm, considering the width of the rubber gasket. After that, 10–12 boreholes were drilled into the pair of planes along the outer outline. The body section was then placed on one of the acrylic glass plates, the rubber gasket was placed around it, and the second plane was mounted. The space between plates and section was minimised by tightening the nuts. Finally, the cuvettes were filled with formol using a syringe with a 21 G cannula fitted with silicon tubing, and a second cannula served as an outlet for the air. For classroom use, photographs of the sections were appropriately marked to define questions and were presented to the students together with the original sections (see Fig. 3).

Body sections mounted in these cuvettes have proved to be stable for 4 y since preparation (Figs 2, 3) so that it was possible to repeat an established teaching programme based on defined sections. The cuvettes are mechanically robust enough to withstand even rough handling by the students. Colours of tissues in the sections correspond to those seen in the dissecting room next door and do not fade even after several years (Fig. 3). The preparations are free of shrinkage artifacts since no dehydration is used. Since the sections are about 15 mm thick, they retain a certain degree of 3-dimensional structure (Fig. 3).

During the classes the cuvettes were displayed together with the respective photographs and were compared with CT and MRI scans. Concomitant with dissection in the dissecting course the students had to identify the same structures as discussed there focusing in particular on aspects of topography that are of clinical relevance. The students highly appreciated the preparations as an interesting and useful supplement to their training in anatomy.

A traditional method for the long-term presentation of anatomical preparations has been to place them in display cases made of glass or acrylic glass. Although glass cases are inexpensive and can be obtained in standard sizes, they have disadvantages in particular with respect to handling. Glass cases are fragile and they pose a problem in the immobilisation of specimens. When moved around often, such specimens are subject to mechanical wear and tear and gradual destruction. Such display cases are therefore mainly suitable for anatomical museums and not in not for the occasional rough handling by students.

Albrecht (1988) developed a type of modified display case made of an acrylic glass cover and an opaque plastic back. These cases are, like ours, tailored to the size of the preparations. However, the sections are kept in place by pins inserted in the plastic back of the case and not by mechanical pressure as in our cuvettes. Albrecht's cuvettes offer some advantages when compared with traditional display cases. They permit the study of body sections with little optical distortion as the top plate is closely parallel to the surface of the object. The preservative fluid can easily be renewed and the lack of air bubbles prevents oxidation. On the other hand, the manufacture of these showcases is complicated as highly exact mitre joints have to be cut. In addition, as the sections are kept in place only by the pins pierced into their rear, moving such cases during classroom work will gradually damage the specimens. Finally, since the back plate is made of opaque plastic, the sections can be viewed only from one side.

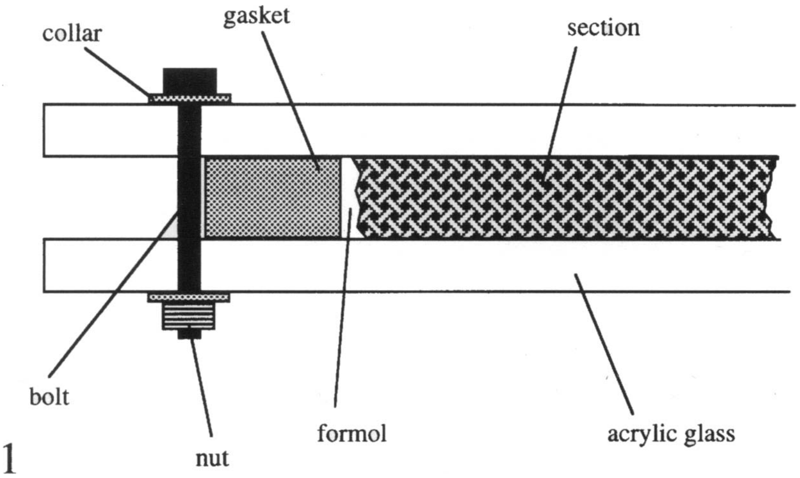

Fig. 1. Construction scheme for a cuvette (cross-section). The section is held in place by pressure exerted through the plates after tightening the nuts. At the same time the soft rubber gasket is deformed, sealing the cuvette efficiently.

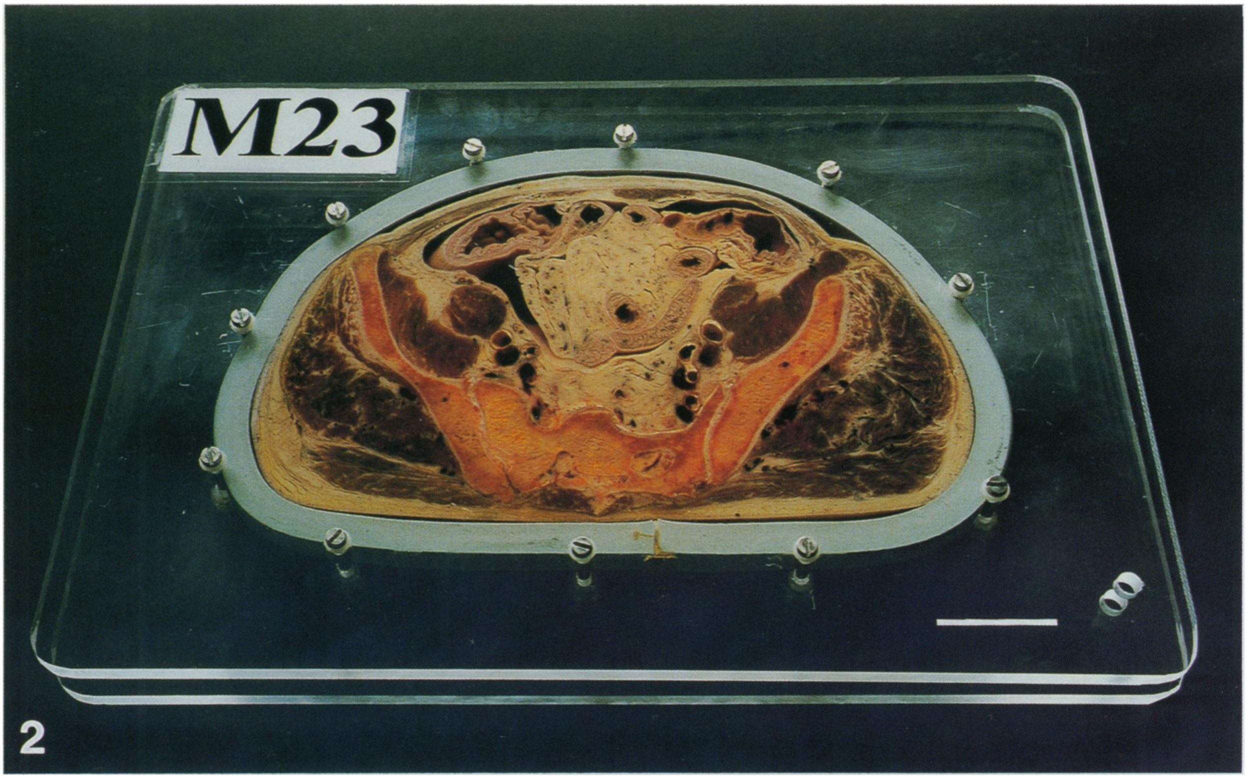

Fig. 2. A complete cuvette showing a cross-section of a male pelvis in the plane of the hips. This preparation has now been in use during classes for 4 y. Bar, 5 cm.

In contrast, the manufacture of our cuvettes does not require precision instruments or advanced skills. The cuvettes allow efficient immobilisation of the sections (1) by using tightly fitting gaskets and (2) by simply adjusting the positions of the bolts and nuts by tightening them properly. At the same time, pressing the acrylic glass plates against the section from both sides minimises optical distortion and impedes any detritus or oil droplets etc. from accumulating on the surface of the section. Due to the mechanical elasticity of the soft rubber strings, our cuvettes are very stable and withstand handling very well. Only small volumes of preservative fluid (i.e. 10–20 ml) are usually needed to fill the cases. Moreover, our cuvettes can be viewed from the back as well as from the top.

A widely recognised technique for preserving body sections is plastination (von Hagens et al. 1987, 1991). In that case, sections of, for example, 2.5–4 mm in thickness are first dehydrated in cold acetone and then impregnated by a special epoxy resin in a vacuum chamber. After hardening, such plastinated sections are brilliant, colourful and can be stored permanently. In spite of their great aesthetic appeal plastinated sections have their disadvantages. The colours of the tissues as well as their whole appearance are changed due to dehydration and impreg-

Fig. 3. Higher magnification from the upper left area of the section shown in Figure 2. Note the 3-dimensional appearance of several structures such as the colon (arrows), the small intestine (arrowhead), and the external iliac artery (asterisk). Examples for questioning and answer: (1) which structures are marked A, B, and C? (2) Identify the blood vessels marked D–G. Bar, 2 cm.

nation with transparent resin, and shrinkage artifacts cannot be prevented completely. The 3-dimensional aspect of structure is lost because the sections are usually thin and become more or less translucent, and free spaces in and around organs are filled with the resin. Moreover, plastination requires experience, is time consuming, and special equipment such as a low temperature freezer and large vacuum chambers are required. Finally, the resins are expensive. As a result, plastination is still not used in all anatomical institutions.

Recently, digitised images of human body sections have been made available by the Visible Human Project (VHP) for visualisation on computers (Ackerman, 1992). Major advantages of these images are (1) colours are quite natural, (2) a complete series of thin (0.3 mm) slices is available, and (3) corresponding CTs are available for most planes. This material is most useful, but may have the following disadvantages for classroom uses. (1) While real sections (such as our cuvettes) can be moved around to various rooms and even to the dissecting room, the use of the VHP images depends on availability of an appropriate computer. (2) The VHP pictures have been taken from the cross-sectional surfaces of a deep-frozen body while thin layers were milled off one by one. Since in the VHP images the spaces in and around organs are filled with body fluid ice these images lack the third dimension that proved to be helpful to our students.

In conclusion, the cuvettes described here provide a new, inexpensive technique of preserving and demonstrating body sections. These sections correspond perfectly to illustrations found in appropriate atlases (e.g. Ellis et al. 1991) and have been successfully integrated into teaching gross anatomy in our institute.

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