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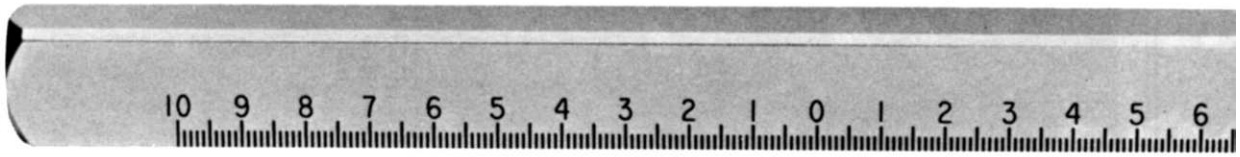

PLASTINATION OF NEUROANATOMICAL AND ANATOMICAL SPECIMENS

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With the advent of plastination some 11 or 12 years ago, it became possible to build a "library" of teaching and research tissue specimens without shelf upon shelf of alcohol and formalin filled jars. The specimens are dry, last indefinitely, are virtually odor-free, durable, and depending on the tissue, are somewhat flexible and retain adequate color differentiation. The plastination process may be used for almost any animal or human tissue of almost any size. The plas-tinated specimens are remarkably well preserved and can serve in many teaching, demonstration and research roles. The use of plastinated tissues in the neurosciences would greatly facilitate such tasks as teaching neuroanatomy, lab procedures (without repetitive use of live animals) and other tasks requiring the visualization of the central and peripheral nervous system either in situ or removed from the body. The process of plastination outlined here has variants which can produce remarkably lifelike specimens which are almost indestructible.

METHODS

While there are four distinct types of plastination, the most common method and the one which will be discussed here is the silicone impregnation method or as it is more familiarly known, the "S10" method. In this and other plastination techniques, tissue water and lipids are replaced by cured polymers. The process is comprised of 4 main steps: 1. fixation; 2. dehydration; 3. forced impregnation and 4. curing. An additional step of degreasing may be necessary for some lipid rich specimens (see von Hag-ens, Tiedemann & Kriz, 1987 for a recent review).

Fixation can be accomplished by most of the standard methods and fixatives. As our plastination lab is an adjacent to the gross anatomy area, we process mainly tissue that has been fixed by arterial injection. Some additional tissue is provided from autopsies and is fixed by immersion. After several days in the fixative, the immersion fixed specimens are rinsed in clear water to remove excess fixative. They or arterially fixed tissue are then placed in 60%-70% ethanol to start the dehydration process. The specimens are passed through increasingly pure changes of ethanol until water content of the alcohol is less than 1%. This can usually be accomplished in 1 to 5 weeks. In addition to water, glycerols and other embalming fluid ingredients are extracted concurrently. Finally, the ethanol is exchanged for either acetone or methylene chloride which acts as the volatile intermediary with the silicone base and also as a degreasing agent for lipid-rich specimens. As with dehydration, is done by immersion in increasingly pure baths. Fresh tissue fixed by immersion in a 5% to 20% formalin solution, can be dehydrated directly in an acetone bath at -25 degrees C. until the 1% water content is attained.

Forced impregnation is the step in which the silicone/hardener (S/H) replaces the acetone or methylene chloride in the dehydrated tissue. This step can be accomplished at room temperature, but is better accomplished at-20 to -30 degrees C. The S/H mixture remains somewhat non-reactive at the cold temperatures and can then be used for

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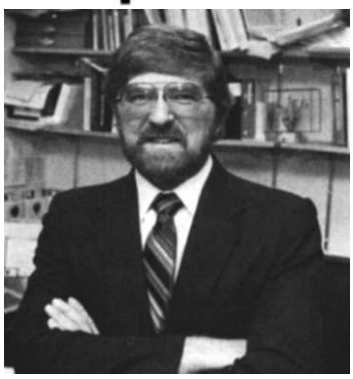

Editor's Column

Summer is here. I just finished talking with the people at the Kopf Company in Tujunga, and it is to get to H4°F out there today . Pheonix, Arizona had 122°F yesterday and that was hot enough to close the airport for a time, since the planes are not allowed to take off if the temperature is above 121°F. I think that either of those temperatures is hot enough! Ohio has had its share of bad weather this spring, with both floods and tornadoes causing a lot of damage and loss of life. I guess we can still talk about the weather, but can do nothing about it.

I was talking with a friend in Bristol, United Kingdom yesterday, and he mentioned that they are now having to take personal safety precautions. A few days ago, a bomb demolished the car of a researcher as he was getting into it. Fortunately, he was not hurt badly, but that, linked with a second bomb at another research facility has made the situation there very tense. The animal rights movement has claimed responsibility for both bombings aimed at animal researchers. This is probably a portent of things to come here. We must be careful and at the same time be sure we do all we can to educate the public about the benefits and humaneness of our research. Thank your congressmen when they vote for bills supporting research. They need cudos too.

The article in this issue of the Carrier is very interesting. It describes a method of preserving tissue in a very useful and relatively inexpensive way. The specimens are very tough and pliable, yet maintain very good features and detail. Plas-tination can be used for any tissue and almost any size specimen. In one of the journals of the Plastination Society, there is a picture of a fully plastinated horse brain and spinal cord-almost 8 feet long! A useful process. Hope you have a good summer.

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subsequent impregnation operations. The S/H mixture is placed in a vacuum chamber with a tempered glass lid and the specimens are submerged in it. A vacuum pump is attached to the chamber via a port in the side of the freezer and a gradually increasing vacuum is initiated. A final vacuum reading of 2 to 15 mm Hg is necessary. Monitoring of the impregnation rate is by viewing the gas bubbles rising to the surface of the liquid silicon. A moderate rate of gas release is desirable. After about 3 weeks, the specimens are removed from the vacuum chamber, drained, and exposed to a curing vapor in a closed container for several days. The specimens are now ready to use. For the first several months they must be kept in a closed plastic bag when not directly being used for demonstration so that the curing medium can continue to penetrate.

OBSERVATIONS AND EXPERIENCES

Figure 1 illustrates some of the desirable qualities of these plastinated specimens. The human spinal cord displays flexibility yet is rigid enough to maintain an arc. The cauda equina was splayed prior to curing to readily differentiate the many nerves. Although not visible in this photo, many of the small blood vessels still contain blood (now plastinated) not removed in the embalming procedure. If the specimen becomes soiled, it can be cleaned with a water and detergent solution. It

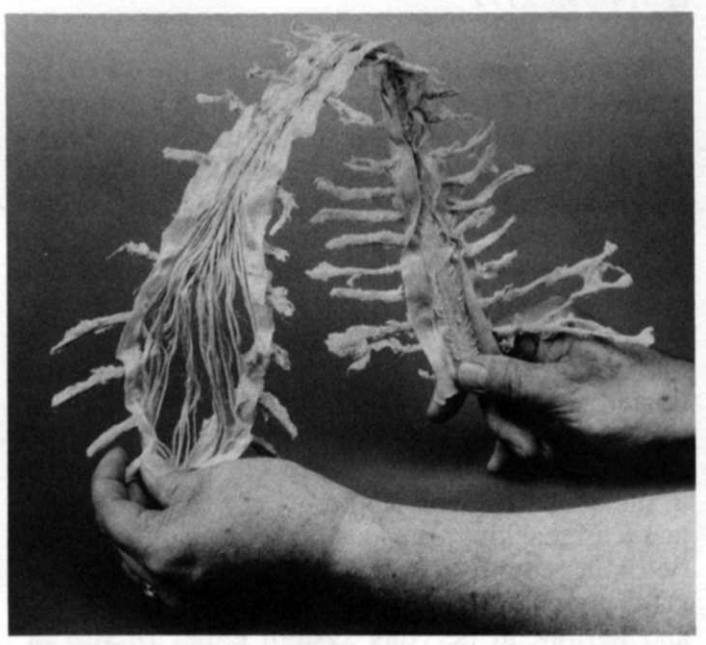

Figure 1. Plastinated human spinal cord showing the flexibility and detail of the fixed neural and connective tissue.

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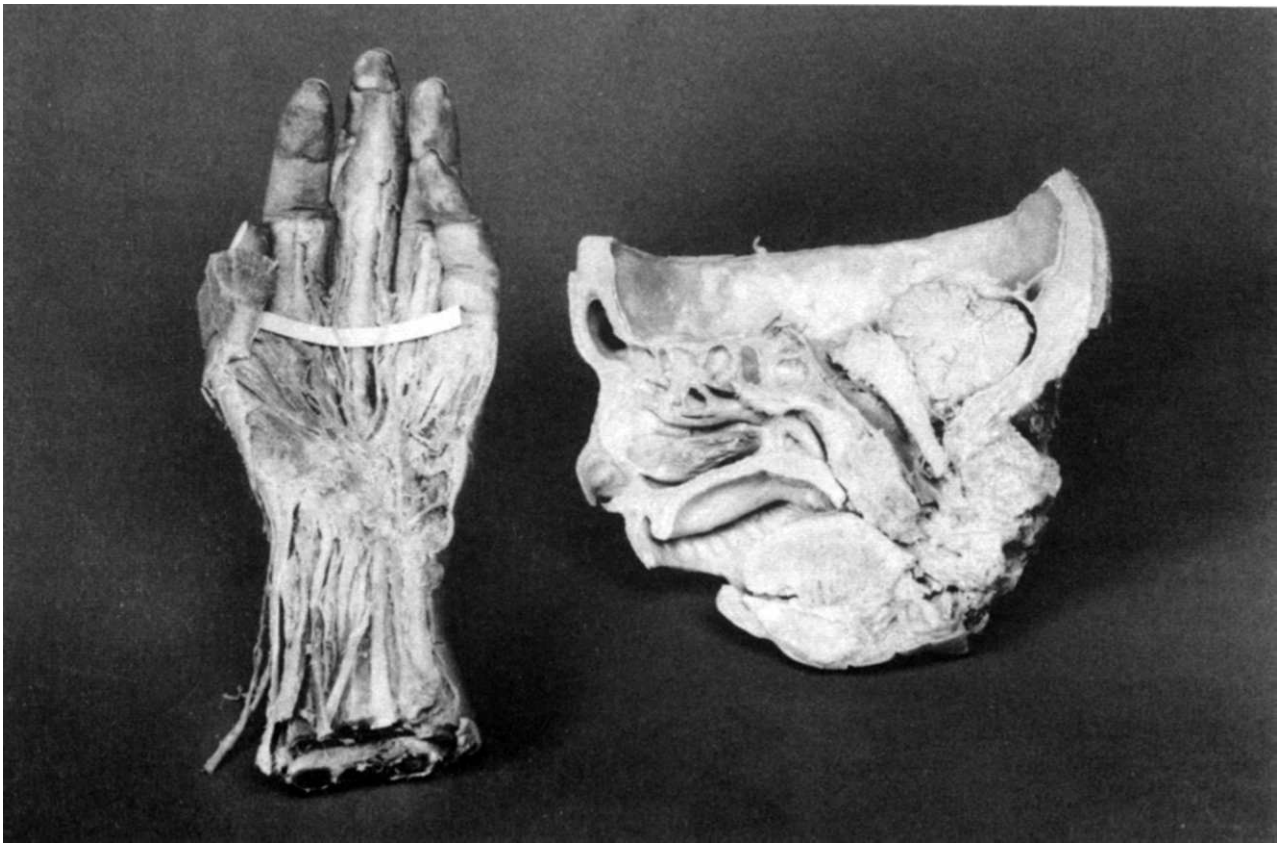

Figure 2. Plastinated human hand and hemi-cranium with cerebellum and brainstem intact.

can be handled in a classroom without rubber gloves and if dropped will not soil the carpet or break. If one chose to make slides from this plas-tinated specimen, it could be sectioned, deplasti-nated in acetone, stained and mounted in an ordinary manner. Some medical and zoological museums with large numbers of alcohol preserved specimens have begun to plastinate their entire collection so that they can more readily be utilized in their curricula.

The hand and hemi-cranium in Figure 2 illustrate that bony as well as soft tissues can be plas-tinated. Indeed, plastinated bone resists the flak-ing-away with which most of us are familiar. In the hand, the abductor pollicis brevis was cured in a reflected position and readily bends back and forth to reveal underlying structures. Two of the common digital nerves have been underlain with the light strip as an example of structures that are frequently difficult for inexperienced dissectors to display. In the sectioned head note that there is little or no distortion of the fixed specimen that has been plastinated - the indentations left by the dentures can still be seen. We have noted that instructors like to circulate through the lab with a plastinated specimen doing brief explanations and demonstrations for the students. A disadvantage is that the plastinated specimens are so natural appearing that the instructors have to be discouraged from "picking" at them as they are teaching.

Our facility includes plastinated specimens in display cases along with standard plastic models and utilizes them for practical examinations where they show their worth by not drying and discoloring during the long hours of exposure. We are also plastinating a preparation showing the early stages of electrode implantation that is done by laboratory assistants. Due to frequent personnel changes, the lab director wanted to eliminate euthanizing the extra animals that it takes to train these assistants. Medical schools that have embraced the "problem based" curriculum find that plastinated specimens enhance those efforts. Also, as a teaching institution we have frequent tours for health care professionals. A small display of plastinated specimens is usually included in those tours and they are encouraged to handle them. Since most of these people have never seen this type of preparation they are somewhat reticent to pick them up. A brief illustration of the odor-free and dry qualities results in an enthusiastic response and frequent requests for borrowing them for seminars and even patient education,

COSTS AND EQUIPMENT

We know of technicians that are plastinating with as little as a desiccation chamber, a vacuum source and a few odd vessels for dehydration. There are also facilities that have ranks of freezers, and 2 or 3 full time employees preparing specimens. One estimate is that most labs have

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spent $5,000 to $10,000 on equipment and chemicals. A technician spends at most 25-50% time looking after it, since most of the process is accomplished automatically and only needs a daily (including weekends) check on what is happening. In addition, we reprocess used alcohol and acetone through a rotary evapator to cut expenses and to lessen the waste disposal problems associated with these chemicals.

For those interested in pursuing plastination, there is an excellent organization called the International Society for Plastination. I highly recommend that you join and get their journal, *The Journal of the International Society for Plastination*.

For information write to: Harmon Bickley, PhD, Mercer University School of Medicine, Ma-con, Georgia 31207, tel: (912) 752-4071.

The plastination process is covered by several patents (v. Hagens 1977 ff.)> although the production of specimens on a non-commercial basis is virtually unrestricted.

Photographs by John Sattler, Ohio University College of Osteopathic Medicine.

REFERENCE

Von Hagens, G., Tiedemann, K. and Kriz, W. (1987) The current potential of plastination. *Anatomical Embryology,* 775,411-421.