THE USE OF METHYL METHACRYLATE FOR THE PREPARATION OF CASTS OF THE CEREBRAL VENTRICLES

TONIO J. BUGEJA

Student, Intermediate Course of Medicine and Surgery, Royal University of Malta.

Introduction

Dissection is the best way to study the anatomical relations of the cerebral ventricles; a resin cast, however, illustrates more accurately their actual size, shape and intricate anatomy.

Materials

Crystic resin is the conventionally used resin for corrosion casts; it is chemicalley a polyester cross-linked type of resin available as intermediates in the form of thick syrups to which setting agents are added (Tompsett, 1956). Epoxy resins are also sometimes used as casting resins (Roff, 1956). Vinyl resin commercially known as Vinylite and introduced by Narat in 1936 as a substitute for cellulose acetate then in use, is to-day employed in the United States with special reference to the study of liver tumours (Healey, 1960). A study of the resins available in Malta showed that methyl methacrylate, much used in dental mechanics, could be availed of to produce a detailed, beautifully coloured, rigid cast of the comparatively large cerebral cavities. Shrinkage after processing is negligible so resulting in a markedly true and well marked impression of all the structures immediately related to the ventricles. The cast produced does not warp even in warm surroundings, can be washed, and is resistant to a number of corrosive agents. The resin is easily available (being so much in use in the dental field), has a relatively long shelf-life in warm climates and above all it is very easy to mix.

Method

The method used is divisible into three distinct phases:

Phase A: Wax injection and subsequent dissection to remove the wax cast;

Phase B: Construction of a plaster of Paris negative of the wax cast, followed by the resin cast;

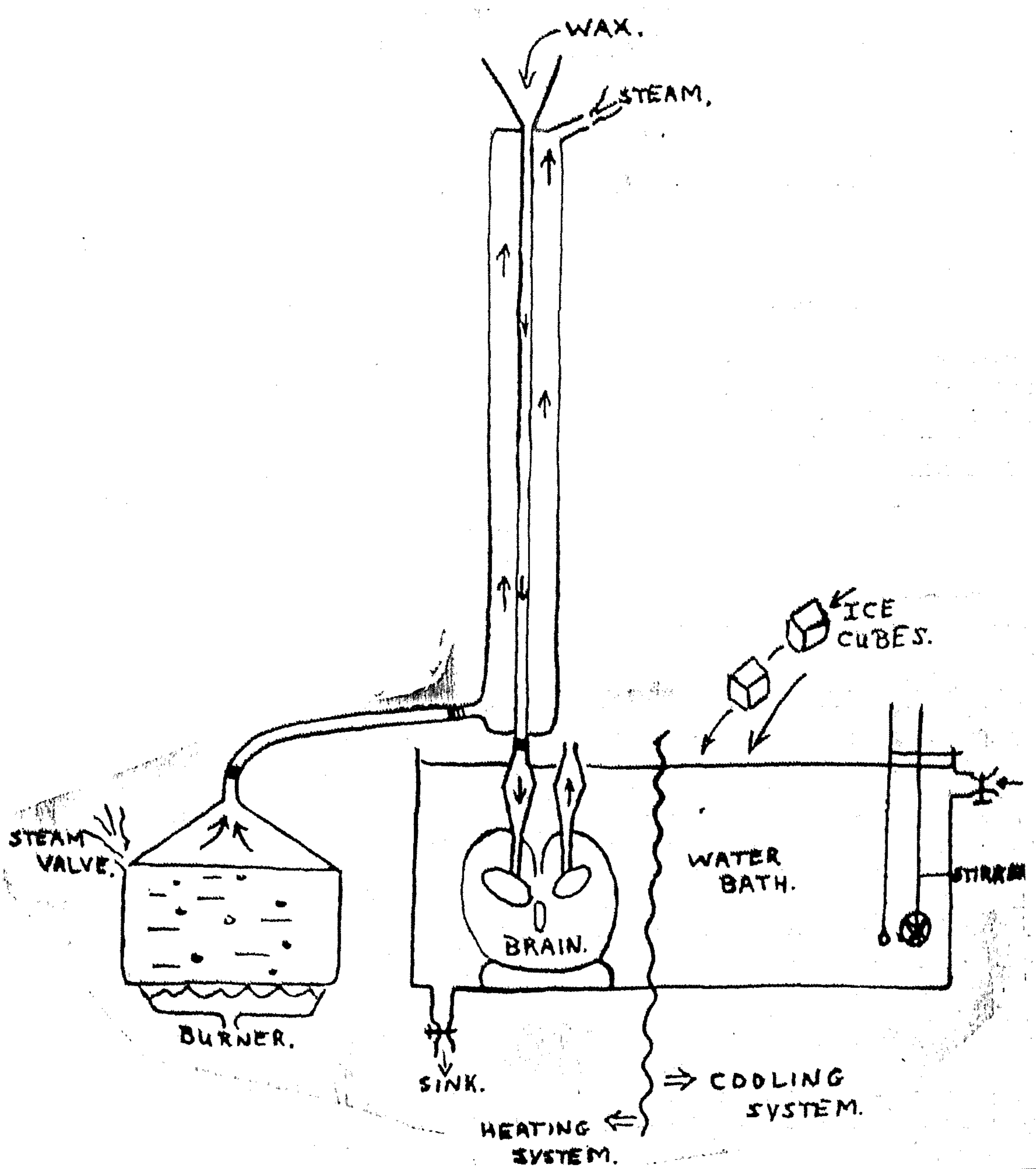
Phase C: Final pruning, spraying and mounting.

Phase A: This phase essentially entails introducing liquid wax (melting point 59°C.) into all the ventricles via the tiny interventricular connections and then cooling the wax to below 59°C. To ensure the vital fine control on the wax temperature, a simple apparatus was constructed whereby the brain's *internal* temperature was raised to 85 C.; the liquid wax at 90° C. was then injected using gravity as pressure and when the ventricular spaces were full, the whole internal system was quickly cooled to 50° C. and then gradually to 20° C. (This avoids unwanted shrinkage and cansequent cracking of the wax.)

The apparatus used (shown below) consists of:-

(a) a heating system made up of a small modified water bath (a minimum water volume renders easier complete temperature control) to raise the brain internal temperature, and a boiler-condenser system to provide a way by which molten wax can be injected under pressure into the brain;

(b) a cooling system which comes into operation to lower the brain's internal temperature; this includes running cold water and the use of ice blocks.



This phase is crucial because:

(a) if the temperature of the wax within the brain falls down prematurely at any one time to 59° C., blockage of the ventricular systems would occur; the brain is therefore left for seven hours in water at 90° C. until its internal temperature reaches 85° C.

(b) rapid cooling is necessary to ensure that no wax trickles out so leaving empty spaces after the injection process is stopped. To achieve this the brain on the outside is cooled down to 10° C. using ice blocks and very cold circulating water;

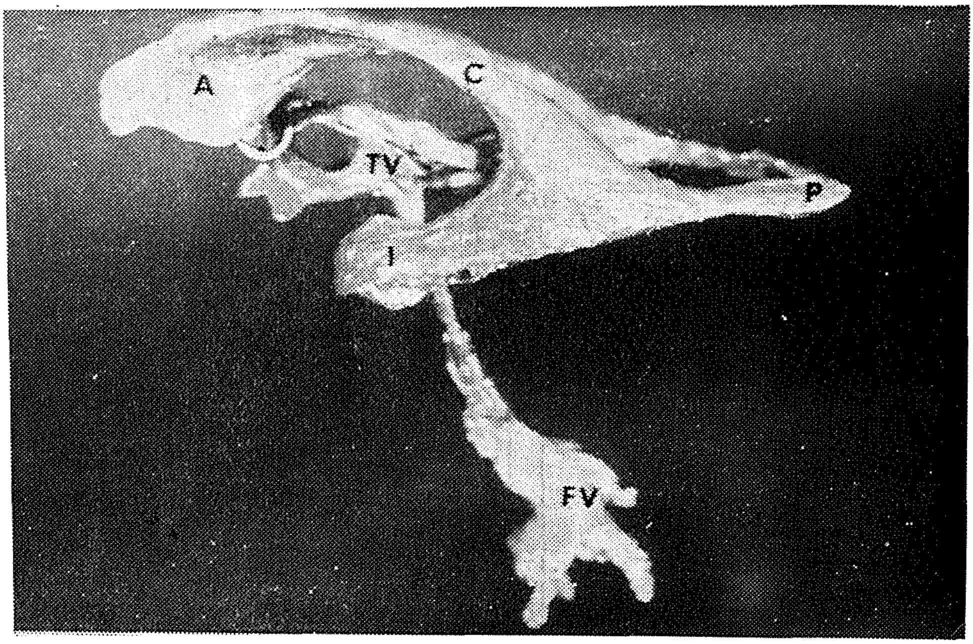


Figure I: Lateral View showing the anterior (A), posterior (P), and inferior (I) horns as well as the central part (C) of the lateral ventricle. TV indicates the third ventricle and FV, the fourth ventricle.

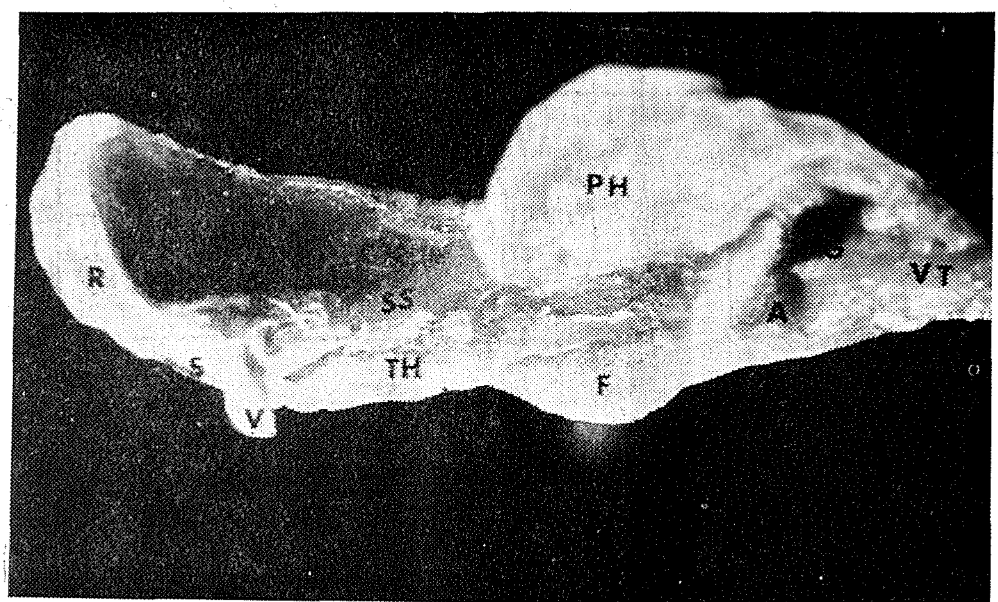


Figure 2: Inferior View of Lateral Ventricle showing impressions of calcar avis (A), caudate nucleus (CN), fornix (F), glomus chorioideum (G), pas hippocampi PH, rostrum of corpus callosum (R), septum lucidum (S), stria semi-circularis (SS), thalamus (TH), interventricular connection (V) and ventricular trigone (VT).

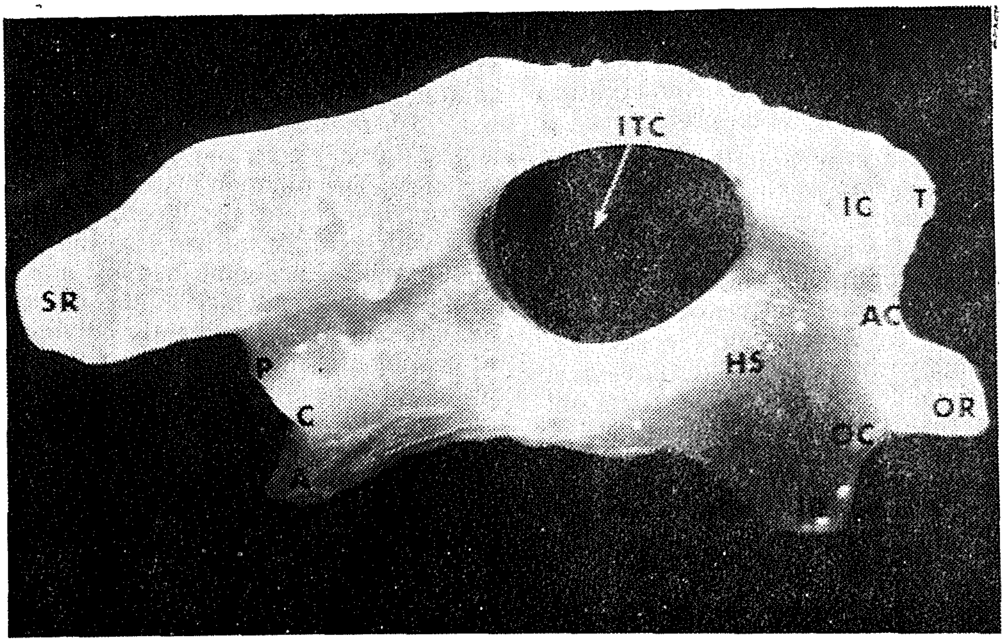


Figure 3: Lateral view of third ventricle with suprapineal (SR), pineal (P), triangular (T), optic (OR) and infundibular (IR) recesses, impressions for anterior (AC) and posterior (C) commissures and optic chiasma (OC). A indicates the aqueduct; HS, the hypothalamic sulcus; IC, the interventricular connection, and ITC, the interthalamic connexus.

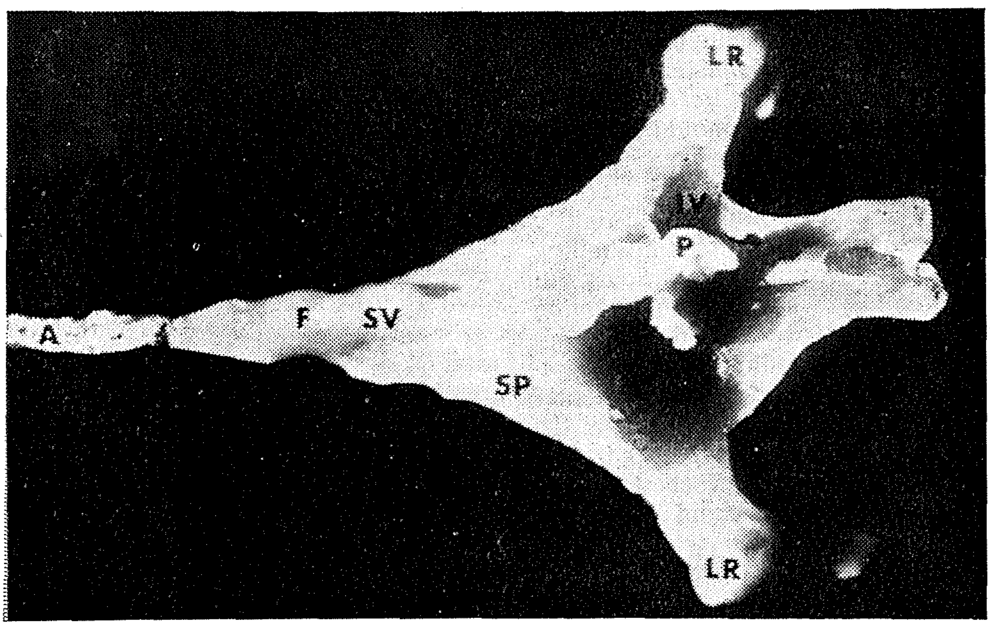


Figure 4: Dorsal view of fourth ventricle with its peak (P) and lateral recesses (LR). A indicates aqueduct; F, the impression of the frenulum veli; IV, that of the inferior and SV, that of the superior medullary velum; and SP the impression of the superior peduncle.

(c) a very well fixed brain specimen is required in order to withstand, without rupture or distortion, the temperature variations and the injection pressure;

(d) holes are accurately drilled from the external aspect of the cerebral cortex on the precentral gyrus of each hemisphere, 1.5 cm. away from the longitudinal fissure for a depth of 5 cms to produce a communication from the ventricles to the outside. This is done using a cork borer with a highly sharpened edge, having an internal diameter of 5 mm. The communication is then tested by pumping air into one hole with the brain submerged in water when air will bubble out from the other.

The brain specimen is kept for two days in cold water and then dissected to get the wax cast out. Alternatively one could use acid corrosion to remove the tissue; this is however a longer process and furthermore dissection ensures that the resultant model is a more exact replica.

Phase B: Plaster of Paris is mixed and poured into a strong metal mould, previously smeared with vaseline to help the later removal of the solid plaster. The wax cast is then gently placed in the plaster while this is still soft. The mould is closed and pressure applied to squeeze out the excess; this ensures an exact plaster negative. The metal mould, still tightly closed, is placed for an hour in boiling water so that the wax melts and floats out leaving the empty plaster. After cooling the plaster spaces are rinsed by semi-viscous separating medium which prevents the resin from sticking permanently to the plaster; it also keeps water from the plaster from becoming incorporated into the resin as this would affect the polymerization rate and colour of the resin. The resin mixture is then prepared and while still semi-fluid is forcibly pushed into the ventricular plaster spaces, the lid placed on, and great pressure applied.

The greatest advantage of methyl methacrylate is the ease with which it can be processed: the liquid monomer, consisting of pure methyl methacrylate with a small amount of hydroquinone which aids in the inhibition of polymerization during storage, is mixed wth the polymer (dispensed in the form of a powder consisting of coloured small spherical particles). The function of the monomer in the polymer is to produce a semi-fluid mass which can be pushed into the plaster mould; this is accomplished by a partial solution of the polymer in the monomer. The monomer is subsequently polymerized by heating the mixture. Although not critical, the proper ratio of monomer to polymer may be of considerable importance to the structure of the final resin; also, the resin will tend to shrink less during processing if less monomer is used (Skinner and Phillips, 1960). The approximate proportions of polymer to monomer are three to two by volume or two to one by weight.

After half an hour the mould, still under pressure and containing the resin which has started to solidify, is placed in a water bath and the water gradually heated to boiling; the mould is then left in boiling water for another two hours. After cooling, the metal mould is opened and the solid plates block with the resin cast gently eased out of one end. The resin cast is then freed by cutting off the plaster. The covering of separating medium is finally peeled off the resin cast.

Phase C: Pruning and filing off extra bits was found unnecessary; a very thin laver of Humbrol red spray paint was applied at a distance of ten inches. A mounting stand was finally designed to incorporate: (a) greatest safety during handling: this includes shock absorbers in the form of rubber foam rests, a specially arranged wire suspension and a thick perspex cover screwed down to a wooden base;

(b) simplicity in design; and

(c) a mirror affording a better view of the undersurface of the cast.

Labelled photographs of each part of the cast, maagnified to show the impressions left on it by the immediate relations, were then added. Some of these are shown below.

Conclusion

A technique is described for the use of methyl methacrylate as a resin for the preparation of casts of the cerebral ventricles. Its advantages and disadvantages are discussed. It is hoped that in future this resin will be used more for this purpose.

Acknowledgements

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