ISOLATION OF THE CHOROID PLEXUS IN VIVO*

KEMP CLARK, M.D.

Division of Neurosurgery, Department of Surgery, The University of Texas
Southwestern Medical School, Dallas, Texas

(Received for publication May 31, 1962)

The precise function of the choroid plexus has been a subject of investigation for many years. Various functions have been attributed to it, which is an indication of the confusion regarding its role. Among the functions attributed to this structure by various investigators are secretion of cerebrospinal fluid\(^1\) or of a specific component of cerebrospinal fluid,\(^2,3\) absorption of substances from the cerebrospinal fluid,\(^4\) and the transmission of arterial pulsations to the ventricular fluid.\(^5\)

Obviously, it is a functional organ and probably a significant one, as it is found within the ventricles of all mammalian species.\(^6\)

While some information has been obtained by histochemical\(^7\) techniques, most of the knowledge about the choroid plexus has come from experiments utilizing ablation of the structure. No data regarding its function had been obtained by procedures of isolation. Study of the choroid plexus as an isolated structure in vivo would be expected to yield valuable data. Therefore, a series of experiments to devise a technique to isolate it was begun. After trying several possible methods, one was evolved that has proven moderately successful.

TECHNIQUE

The technique can be divided into two parts: construction of an isolation chamber or capsule and its surgical implantation. The chamber is made from polyethylene tubing and rod. A piece from 1 to 1.5 cm. in length is cut from polyethylene tubing 1 cm. in diameter. A small segment of the wall is removed from the long axis of the tubing, making the opening through which the choroid plexus is teased into the chamber. This segment of the wall of the tubing is replaced after implantation of the capsule. The polyethylene rod, also 1 cm. in diameter, is milled to make stoppers for each end of the segment of tubing. Deep grooves are cut in the sides and ends of the rod for points of entrance and exit of the choroid plexus into the chamber (Fig. 1).

Dogs have been used as the experimental animal because of their size and availability. After the animal is anesthetized, an extensive craniectomy is performed. Most of the cortex of the lateral surface of one hemisphere and the underlying ependymal lining of the ventricle are removed. The choroid plexus is protected carefully during this operation. The area of removal of both bone and brain tissue must be large enough for the fabricated capsule to fit easily into it. A piece of plastic film is placed beneath the choroid plexus and over the remaining ependymal lining of the ventricle. The polyethylene chamber is fitted in the ventricle and the choroid plexus is teased into it through the cut in the long axis of the chamber. It is then rotated 180° on its long axis. The choroid plexus now lies inside the chamber with the removed segment of the wall of the chamber to the outside. The previously made stoppers then are fitted in position, carefully so the grooves allow the choroid plexus full access into the chamber.

All that remains to complete the isolation is to seal off the holes of entry and exit in the stoppers and to restore the segment cut out of the side of the chamber. A sealing compound is applied to the outer side of the capsule using a fine disposable pipette. Care must be taken not to extrude any of this sealer into the capsule itself.

Two substances have been used for the sealing compound. Sterile vaseline has been used for procedures of acute isolation, and methyl methacrylate dissolved in acetone\(^8\) for chronic isolation. This will set up in about 30 min. It induces a tissue reaction of moderate degree and therefore is not the ideal substance for such a use. However, successful isolation preserving viable choroid plexus within the capsule has been obtained using it (Figs. 3 and 4).

After applying the sealing compound, the completeness of the isolation is checked by filling the capsule with sterile normal saline. If the level of fluid in the capsule drops during a period of observation, additional sealer is applied. If a complete isolation is not accomplished by two applications of the sealer, it usually is fruitless to continue, as complete isolation without contamination of the choroid plexus has been found difficult to accomplish.


Aided by a grant from The National Foundation.

Fig. 1. The disassembled capsule prior to implantation.

The tubing is 1 cm. in diameter.
Fig. 2. A view of the choroid plexus as it enters the capsule. The darkening of the polyethylene capsule is caused by dye injected into it.

Following the successful sealing of the chamber, the segment removed from its side is replaced and held in place by carefully applying more of the sealer. This segment removed from the side of the capsule may have small polyethylene tubes inserted in it, so that injection of materials into it may be carried out.

Fig. 2 shows the capsule and the choroid plexus entering it.

COMMENT

Figs. 3 and 4 show the histologic appearance of the choroid plexus after successful isolation for 5 days. Successful isolation has been accomplished in about 60 per cent of the trials by this technique. Failures are caused by several factors. The choroid plexus, being fragile, may become torn or avulsed during manipulation. This has been the most common cause of failure. Contamination of the entire choroid plexus by the sealing compound is another, and particularly frustrating, cause. Surprisingly, inability to obtain an adequate seal has been the least of the problems. All of these problems will plague those who would use this technique, but, with experience, they can be reduced to a minimum.

REFERENCES


Fig. 3. Photomicrograph of choroid plexus after 5 days of isolation within the capsule. X120.
Fig. 4. Photomicrograph of choroid plexus after chronic isolation. X675.


DISCUSSION

Dr. Edgar A. Bering, Jr.: This may well prove to be an extremely useful technique where a great deal of work is now being done on the choroid plexus. Considering this preparation of Dr. Clark’s, it is well to re-
view the anatomy of the choroid plexus. The arterial blood enters chiefly in the tip of the temporal horn and flows through the glomus toward the foramen of Monro where the venous drainage is through the 3rd ventricle into the deep cerebral vein. The blood entering between these points is of very little consequence and it is this anatomical configuration that makes Dr. Clark’s preparation possible. I would like to ask two questions: 1) Can you be sure to get the glomus of the choroid plexus into the chamber? In studying the metabolic processes this is going to be extremely im-
portant. 2) Does Dr. Clark have any way of testing the blood flow through his preparation other than the histological sections?

As has been said, this can be a very useful laboratory tool. The histology of the choroid plexus resembles that of the kidney tubule and, as many physiologists have suggested, it may have similar functions. Not only have many enzymes been found by histochemists, but Papenheimer has demonstrated that Diodrast is pumped out of the cerebrospinal fluid in the 4th ventricle of the goat and he has suggested that this has been done by the choroid plexus. This particular ob-
ervation is of some importance as Diodrast and penicillin are similar chemical compounds. It may well be that penicillin is being removed metabolically from the brain and cerebrospinal fluid, which is one of the reasons why we are having so much difficulty in getting adequate levels of penicillin in the cerebrospinal fluid.

The anatomical considerations suggest the possibility that the choroid plexus might also function as a countercurrent organ as the kidney tubules do. This requires a great deal more anatomical research before it can be certain.

Dr. Kemp Clark: I would like to thank Dr. Bering for his comments. I must confess that, when he visited me in Dallas, he asked if I had checked the blood flow any other way, such as by connecting a recorder to ob-
tain a pulse wave. No, I have not done this. All we have is histological confirmation of the patency of blood vessels.

We can get the glomus in if we really try. I did not bring any slides showing this. It is much more difficult to do than it is to isolate the free part lying in the anterior part of the ventricle. We hope to apply this farther back, to incorporate the glomus and ultimately to incorporate the choroid plexus of the 4th ventricle as well.