A Technique for Surgical Exposure of the Cerebral Midline: Experimental Transcallosal Microdissection

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Dissection of the cerebral midline is usually difficult and occasionally hazardous. The area contains many vital centers, it is highly sensitive to surgical manipulation, and it encloses a rich blood supply including superficial venous sinuses, superficial and deep cerebral veins, and branching arteries from the anterior cerebral circulation. Unfortunately, it is also a common site of disease. Tumors of the 3rd ventricle, the pineal body, and subcortical structures comprising the diencephalon, are examples of problems for which a surgical remedy must be sought. In the best of hands, however, surgery in this area is associated with a high mortality. In 1922, Dandy developed a technique for transcallosal exposure of 3rd ventricular tumors. The procedure consisted of turning a right parietal bone flap, ligating the supracortical veins, retracting the paracentral lobule, and splitting the splenium of the corpus callosum. For lesions situated in the anterior portion of the 3rd ventricle, Dandy introduced an alternative approach in 1933. This involved construction of a right frontal bone flap, resection of enough frontal cortex to open the lateral ventricle, and exposure of the 3rd ventricle through the foramen of Monro. Both procedures became standard techniques and both have endured with relatively little modification. Of the two, the transcallosal approach provides better exposure and is more direct; it is generally more dangerous. The transcortical approach avoids direct confrontation with the midline blood supply but provides limited access to the surgical target, removes significant amounts of cortical tissue, and introduces the risk of postoperative epilepsy.

In experimental surgery, similar problems occur and opportunities to explore and study the vital structures in the midline have been limited. In general, standard techniques of gross midline dissection have proven too cumbersome and traumatic for refined neurophysiological studies. The surgical alternative of a transcortical exposure, on the other hand, renders the preparation unfit for the study of subcortical-cortical relationships. Consequently, many investigators have

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FIG. 1. Following routine parasagittal craniotomy, the exposed hemisphere is retracted away from the falx and the corpus callosum is identified at the base of the longitudinal fissure. Since the dissecting microscope permits the surgeon to work in narrow, deep cavities, it is not necessary to coagulate bridging supracortical veins for purposes of exposure.

FIG. 2. View of the corpus callosum: X10 magnification. A midline callosal incision is created by removing tissue through the capillary micropipette. Callosal blood supply is preserved by dissection beneath the vascular ramifications.
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confined their examination of subcortical structures to data furnished by stereotaxic studies. In recent years, however, significant inroads have been made and these include the split-brain operation and the mesial cerebral incision procedure. In the former, the midline commissures and callosum are divided with microsurgical instruments; using the latter, a fiber-splitting technique has been devised to separate the two hemispheres.

The technique reported herein is presented as a means of increasing the surgical accessibility of structures lying deep in the cerebral midline. It was designed to complement, modify and extend older techniques of transcallosal dissection; to reduce to a minimum the inherent dangers of midline dissection; and to introduce the transcallosal approach as a technique for exposing a number of important and essentially inaccessible subcortical structures. The surgical steps were developed with microdissection tools in a series of 75 cats and 25 Rhesus monkeys. The immediate laboratory rewards of the technique, as well as the clinical applications that are envisioned, are enumerated below.

**Technique**

All surgical lesions are made directly with microdissection tools and without resort to stereotaxic techniques. A parasagittal craniotomy is routinely employed to expose the midline (Fig. 1). The potential space of the longitudinal fissure is developed by gentle retraction and the corpus callosum is exposed at the base of the fissure. Care should be taken to preserve the numerous bridging veins which traverse the fissure and run to the superior sagittal sinus.

The corpus callosum is then viewed with the Zeis

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**Fig. 3.** Transcallosal exposure of the 3rd ventricle through a midline linear incision: X10 magnification. Gentle retraction causes the bridging vessels to undergo considerable elongation.
dissecting microscope at magnifications of ×5–20, and tissue is removed through the capillary micropipette under low suction (Fig. 2). At these magnifications small vascular elements are well-defined and the blood supply is preserved by dissection above, below, and around these structures. Microdissection may be utilized to create a fine line of suction-removal (incision) or to remove tissue en masse (excision).

A linear midline incision of the corpus callosum exposes the taenia choroidea of the 3rd ventricle and the two large internal cerebral veins which it enfolds (Fig. 3). The taenia choroidea can be lysed with a teasing stroke and reveals the thin cavity of the 3rd ventricle beneath. The approach affords a unique and extensive view of the 3rd ventricle chamber bordered by the columns of the fornix and the anterior commissure rostrally, the aqueduct of Sylvius posteriorly, and the mesial thalamus laterally on each side.

A callosal incision lateral to the midline enters the lateral ventricle and exposes the structures contained therein (Fig. 4). The thalamus forms a considerable extent of the ventricular floor and is recognized as the structure lying posterior to the thalamostriate vein and partially overlaid by the chroid plexus. The thalamostriate vein runs in the groove between the caudate nucleus and the thalamus and joins the internal cerebral vein at the foramen of Monro. The vessel marks the rostral limits of the thalamus and the caudal limits of the head of the caudate.

The base of the cranial cavity may be exposed by incising the massa intermedia, the floor of the 3rd ventricle and the underlying pia (Fig. 5). By removing the latero-inferior walls of the 3rd ventricle, the vessels of the circle of Willis can be directly visualized.

Discussion

In the laboratory, the transcallosal microdissection technique provides a number of advantages. The technique is delicate; it avoids transcortical incision, and it makes full use of direct surgical exposure by magnifying the field up to 20 times. In gaining access to the lateral and 3rd ventricles, access is gained to the structures within these chambers and to those which form the walls. Electrical stimulation and recording, for example, can be conducted directly. Destruction of tissue, on the other hand, can be accomplished by suction-removal through the capillary micropipette. Lesions may take the form of linear incision of tracts, small nuclear excisions or enucleation of entire structures such as the thalamus or caudate. Such circumscribed lesions are superior to electroco-
agulation lesions which are surrounded by a circumferential margin of injured tissue, raising questions as to the extent of the devitalized area and its physiological activity. Furthermore, the cortical lesion created by the stereotaxic probe is avoided by the transcallosal approach. Removal of the floor of the 3rd ventricle has been shown as a means for exposing the circle of Willis. This provides a laboratory preparation for the study of cerebral hemodynamics and may be useful in confirming and enlarging angiographic data on this subject. Finally, structures such as the choroid plexus can be directly examined at high magnifications, providing a means for novel physiological observations.

Clinically, the transcallosal microdissection technique is of potential value in the exposure and removal of a number of midline tumors. Colloid cysts of the 3rd ventricle, plexus papillomas, septum pellucidum cysts or astrocytomas, thalamic tumors, pinealomas, ependymomas, and large tumors of the sella turcica extending into the 3rd ventricle are examples of lesions immediately apparent when the ventricle in which they originate, or to which they extend, is entered. In recent years, structures such as the corpus callosum and the cerebral peduncles have been divided in an attempt to limit the spread of focal epileptogenic discharge. Although epileptic efferent pathways have not been completely or clearly identified, tractotomy by the microdissection technique may prove helpful in future attempts to isolate an epileptogenic focus anatomically. In cases of epilepsy requiring hemispherectomy, it is anticipated that techniques of this sort will permit the surgeon to interrupt hemispheral connections and thereby avoid the need to remove the diseased hemisphere. Such anatomical isolation of a diseased hemisphere could minimize two of the more serious hazards of this surgery: vascular compromise to uninvolved structures, and acute brain displacement after large alterations in intracranial volume. Finally, the accessibility of the choroid plexus through the transcallosal approach sug-

**Fig. 5.** The floor of the 3rd ventricle has been removed, exposing the circle of Willis: X10 magnification.
gests a means for bilateral and direct plexus removal in cases of communicating hydrocephalus.

Summary

The technique of transcallosal microdissection is introduced as a reasonably safe, simple and delicate approach to structures lying in the cerebral midline.

References