Extraventricular corpus callosotomy

Technical note

JACOB R. JOSEPH, B.A.,1 ASHWIN VISWANATHAN, M.D.,1,2 AND DANIEL YOSHOR, M.D.1,2

1Department of Neurosurgery, Baylor College of Medicine; and 2St. Luke’s NeuroScience Center, Houston, Texas

Corpus callosotomy offers useful palliation for selected patients with medically intractable generalized epilepsy, and with drop attack seizures in particular. In 1931 Dandy first observed a reduction in seizure frequency following the division of the corpus callosum to remove a congenital cyst in the cavum septum pellucidum of a 4-year-old boy.2 Later that decade, Van Wegenen and Herren13 described a series of patients who had undergone corpus callosotomy for the treatment of refractory seizures. Today, the procedure has become accepted as a means of reducing the frequency of severe drop attacks that typically have a multifocal origin, are difficult to localize, and hence do not possess a surgically resectable focus.1

The corpus callosum, composed of over 180 million myelinated axons, is the primary pathway for interhemispheric cerebral communication and is the critical link for the generalization of epileptic seizures.3 The septum pellucidum is found directly ventral to the midline of the body of the corpus callosum, with the lateral ventricles forming the borders on either side. The rostrum of the corpus callosum forms the anterior border of the septum pellucidum, while the splenium forms the posterior border.

The general technical aspects of corpus callosotomy have been well described.8,15 Entry into the lateral ventricles is a common occurrence with corpus callosotomy. However, while unavoidable and even necessary for some procedures, ventricular entry is generally recognized in neurosurgery as a potential cause of increased morbidity. For example, violation of the ependyma and intraventricular bleeding can increase the risk of aseptic meningitis or ventriculitis.7,14 In extreme cases, entry of blood into the ventricular system can lead to hydrocephalus.51 If symptomatic, the patient may require a ventriculostomy in the acute postoperative period or longer-term ventriculo-peritoneal shunting.5 In addition, surgical breach of the ventricular system may lead to subgaleal and subdural CSF collections, increasing the risk of CSF leakage, poorer wound healing, and other complications.6 To mitigate these potential complications, some surgeons may choose to prophylactically utilize external ventricular drainage for a brief period after callosotomy, which can introduce additional risks as well as prolong the hospital stay. For all of these reasons, in our practice, we make a strenuous effort to avoid ventricular entry when performing a callosotomy.

It has been suggested that ventricular entry can be minimized during callosotomy by recognizing the bluish ependymal lining and avoiding breaches,12 but doing so may be difficult because the ependyma is delicate and easily violated even with a precise microsurgical approach. Alternatively, the body of the corpus callosum can be divided in the strict midline to minimize these breaches.8,15 Here, we present our method for complete sectioning of the corpus callosum without entry into the lateral ventricles and discuss the relevant underlying anatomy.

Methods

Surgical Technique

After the induction of general endotracheal anesthesia, the patient is secured in the Mayfield pin holder and placed supine. The head is positioned neutrally to allow visualization of both the genu and splenium of the corpus callosum. Review of the preoperative MR imaging studies can reveal if the pericallosal arteries are directly over the septum. Neuronavigation may be helpful in cases with abnormal anatomy, both to identify the precise midline and to confirm the anterior and posterior extent of the callosotomy. A standard exposure of the corpus callosum is placed supine. The head is positioned neutrally to allow visualization of both the genu and splenium of the corpus callosum. Review of the preoperative MR imaging studies can reveal if the pericallosal arteries are directly over the septum. Neuronavigation may be helpful in cases with abnormal anatomy, both to identify the precise midline and to confirm the anterior and posterior extent of the callosotomy. A standard exposure of the corpus callosum is used, as has been described.8,15 Briefly, a rectangular bone

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Extraventricular corpus callosotomy

flap is elevated to expose the paramedian nondominant hemisphere as well as the sagittal sinus. The craniotomy is roughly centered just anterior to the coronal suture, with an anterior-posterior dimension of approximately 6–7 cm and a mediolateral dimension of approximately 3 cm. The posterior exposure may be slightly more generous in cases in which a complete, rather than an anterior, callosotomy is to be undertaken in a single stage. However, the frequent presence of critical draining veins posteriorly typically limits the utility of additional posterior cranial exposure. Care is taken to preserve all veins when opening the dura mater. Via sharp microdissection, the two cerebral hemispheres are carefully separated and the pericallosal and callosomarginal arteries are identified. The glistening-white appearance of the corpus callosum can then be visualized, and it is our practice to identify the full extent of the corpus callosum before beginning the callosotomy.

Once the callosum is exposed, neuronavigation is used to determine its exact midline; defining the midline is critical, and the location of the pericallosal arteries is not a reliable landmark. Division of the corpus callosum, begun using the bipolar cautery and Rhoton 5 suction, is performed precisely in the midline until the cleft between the two laminae of the septum pellucidum become apparent (Fig. 1). A microhook or a 9-Rhoton dissector can then be placed between the laminae of the septum pellucidum and gently traced anteriorly and posteriorly to divide the corpus callosum without entering the ventricular system (Video 1).

Video 1. Clip, superior view, showing the extraventricular callosotomy technique using the Rhoton dissector. The laminae of the septum pellucidum are visible in the midline dorsal to the corpus callosum. Click here to view with Windows Media Player. Click here to view with Quicktime.

Anteriorly, at the genu of the corpus callosum, and posteriorly, at the splenium of the corpus callosum, there is no underlying septum pellucidum or lateral ventricle (Fig. 2). These terminal portions of the callosum can be readily divided using bipolar cautery and fine subpial aspiration to complete the callosotomy without concern about ventricular entry.

Discussion

We describe a technique for dividing the corpus callosum completely without entering the ventricular system that has proven useful in a small series of patients. Elements of this method have been described previously. This extraventricular approach is based on the anatomical principle that the septum pellucidum is formed from two laminae that are generally not completely fused just beneath the corpus callosum (Fig. 3). Developmentally, the fusion of these two laminae occurs in a posterior to anterior direction, beginning around 20 weeks gestation and terminating with near-complete closure at 6 months of age. However, even in fully developed children and adults, there is typically a small cleft between the two laminae in the dorsal-most aspect of the septum pellucidum that can be separated with gentle dissection. This cleft is apparent in most patients, even those who lack a radiologically evident cavum septum pellucidum. The principle of exploiting the vestigial cavum septum pellucidum to define and open the space between the fused laminae of the septum pellucidum has been described for the anterior transcallosal transeptal interforniceal approach to the third ventricle. At the level of the frontal horns, the septum pellucidum attaches to the genu of the corpus callosum anteriorly and the rostrum of the corpus callosum inferiorly. At the level of the body of lateral ventricles, the septum pellucidum attaches to the body of the corpus callosum above and the fornices below. Once the

Fig. 1. Operative photograph, superior view, of the body of the corpus callosum.

Fig. 2. Operative photograph, posterosuperior view, of the splenium. W = lateral ventricle; X = retractor; Y = cut edge of the body of the corpus callosum; Z = cut edge of the splenium.
body of the callosum has been separated using the cavum septum pellucidum as a natural guide, the splenium and rostrum can be divided using subpial aspiration without the risk of ventricular entry.

Conclusions

For appropriately selected patients, corpus callosotomy offers useful palliation of intractable epilepsy. Although not usually associated with morbidity, entry into the ventricular system, which can occur during surgical division of the callosum, is likely to add some risk to the procedure. The described extraventricular callosotomy limits entry into the ventricles and related complications by using the vestigial cavum septum pellucidum as an anatomical landmark and space to facilitate dissection. While our experience to date cannot conclusively demonstrate improved clinical outcomes with extraventricular callosotomy, this method clearly does reduce breaches in the ventricular system and is therefore likely to reduce complications related to ventricular entry or the need for a postoperative external ventricular drain.

Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author contributions to the study and manuscript preparation include the following. Conception and design: Yoshor, Viswanathan. Acquisition of data: all authors. Drafting the article: Joseph, Viswanathan. Critically revising the article: Yoshor, Viswanathan. Reviewed final version of the manuscript and approved it for submission: all authors.

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