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Two-Part Parasagittal Craniotomy: Technical Note

John F. Burke, Seunggu J. Han, Jung Ho Han, Michael W.. McDermott

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Corresponding author: John F. Burke, john.fred.burke@gmail.com

Abstract

Introduction: Craniotomy along the midline can be done in a variety of ways. Methods include single piece craniotomy with burr holes on the midline, crossing the midline with footplates of drills using drilled troughs or bilateral burr holes, and craniotomies in multiple pieces. The authors describe a two-part parasagittal craniotomy useful for safely exposing the midline for parasagittal and inter-hemispheric lesions.

Methods: The two-part parasagittal craniotomy begins with anterior and posterior burr holes 1.5 cm lateral to the midline. Once the first bone flap is removed, the dura is dissected under direct vision from the inner table of the skull crossing the midline over to the contralateral side for the second part bone flap. In this way, the superior sagittal sinus (SSS) is dissected and protected. Bony reconstruction and closure is straightforward using recessed screws and plates as well as hydroxyapatite for filling in gaps in the bone.

Results: The two-part parasagittal craniotomy has been used in more than 200 patients in the last 24 years. During this time, no direct significant laceration of the SSS has occurred due to a dural tear in the anterior, middle, or posterior thirds while completing the craniotomy. The authors recommend this technique as an option for craniotomy around the midline of the supratentorial cranial vault.

Conclusions: The two-part parasagittal craniotomy is an option for opening the skull around the midline of the cranial vault for pathologies along the midline and inter-hemispheric fissure. Surgeons can consider this as an option to a one piece bone flap crossing midline.

Categories: Neurosurgery
Keywords: parasagittal, meningioma, falx, two-part craniotomy

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Introduction

Craniotomies for approaches to the midline of the cranial vault require safe exposure of the superior sagittal sinus (SSS) or its boundaries. This exposure is especially important for parasagittal, falcine meningiomas, and lateral and third ventricle lesions-common lesions of the midline cranial vault, which often directly involve the SSS [1-3]. In these cases, an unobstructed view of the midline reduces the need for retraction of the medial aspect of the frontal, parietal or occipital lobes, depending on the location of the target pathology [4]. Standard methods for craniotomies along the midline include attempts to expose just the lateral edge of the SSS [5] or the entire sinus by crossing the midline [2, 6]. The techniques for exposing just the lateral edge of the SSS include burr holes near or on the sinus, while those for crossing the midline include making bilateral burr holes and dissecting the SSS, or drilling a trough across the midline to visualize the sinus. These exposures can be complicated by encountering large parasagittal venous lakes close to the midline and lacerating the SSS in attempting to dissect it without direct visualization [7].

A two-part parasagittal craniotomy is an option allowing direct visualization of the epidural space during dissection across the SSS to the contralateral side. The authors provide a case example to demonstrate the technique in the hope that younger surgeons may consider this as another option for craniotomies requiring full exposure of the midline cranial vault. Informed patient consent was obtained at the time of treatment. No identifying patient data was used in this paper.

Technical Report

Prior to surgery in cases where the SSS is stenotic or occluded, the surgeon should review coronal post-contrast magnetic resonance images to ensure that no diploic venous channels that could functioning as a potential alternative venous pathway are visible on the intended craniotomy site [8-9].

Patient positioning is selected by the surgeon depending on frontal, parietal, or occipital approaches. The planned skin incision should allow exposure of the bone for 5-10 mm on the side opposite the intended surgical approach or target pathology. Once the bone is exposed, the midline can be marked out (Figure *1*) and then anterior and posterior parasagittal burr holes are placed 10-15 mm lateral to the midline (Figure *2*),

as well as the planned two-part craniotomy cut lines.

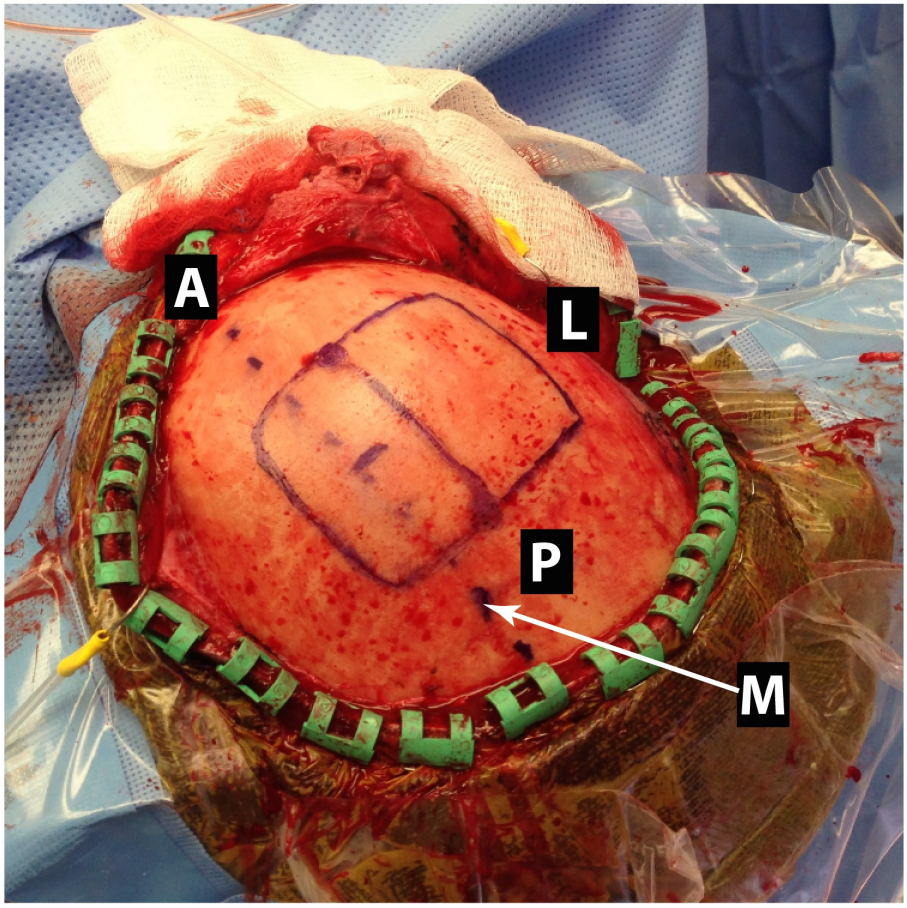


FIGURE 1: Exposure

Skin incision should allow exposure of the bone 5-10 mm on the side opposite the intended surgical approach or target pathology. Once the bone is exposed, the midline can be marked out (dashed line in Figure). The anterior (A), posterior (P), and lateral (L) aspects of the skull are identified. In addition, the midline (M) is shown.

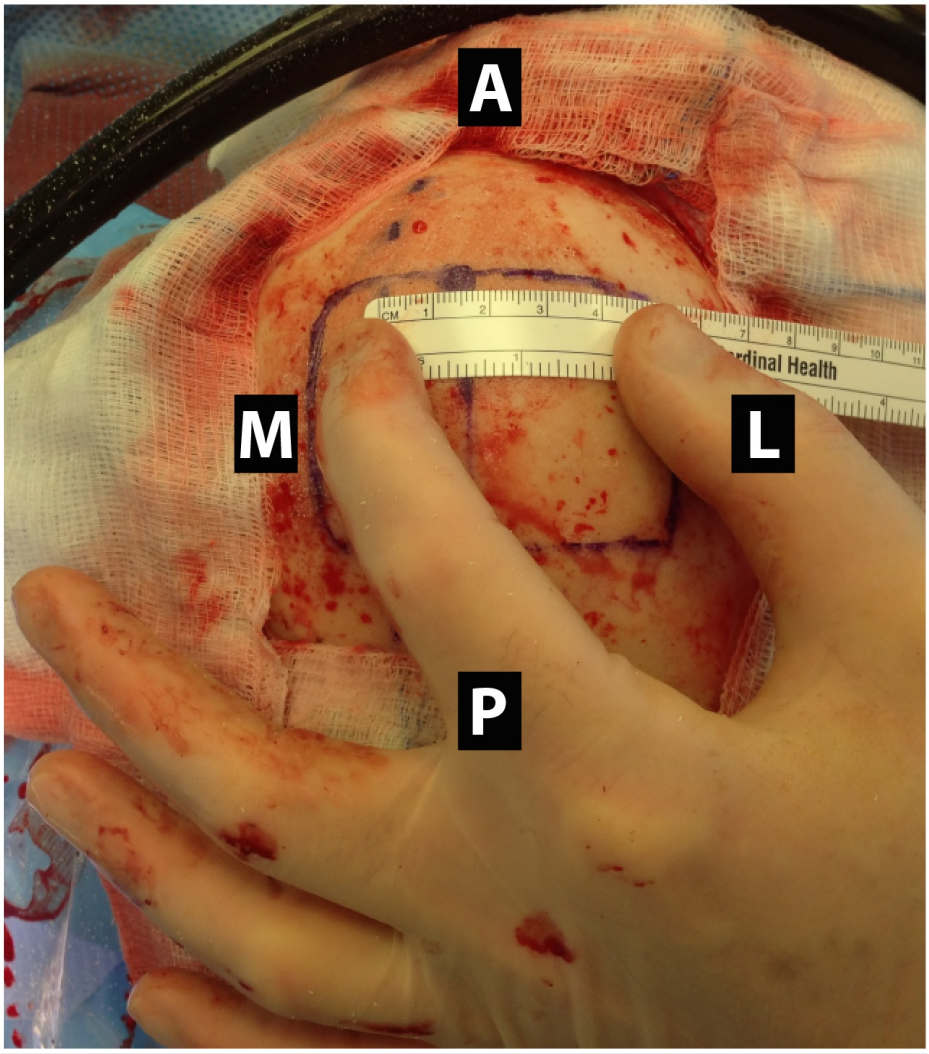


FIGURE 2: Burr holes

The anterior (shown) and posterior (not shown) parasagittal burr holes are placed 10-15 mm lateral to the midline (dashed line located at 0 cm on ruler in Figure). The anterior (A), posterior (P), lateral (L), and medial (M) aspects of the skull are identified.

This more lateral placement of burr holes may avoid large venous lakes [10] that make establishing the correct epidural plane more difficult due to venous bleeding. The first bone flap is elevated and then the epidural space can be dissected across the midline under direct vision with a Penfield #1 dissector (Figure *3*).

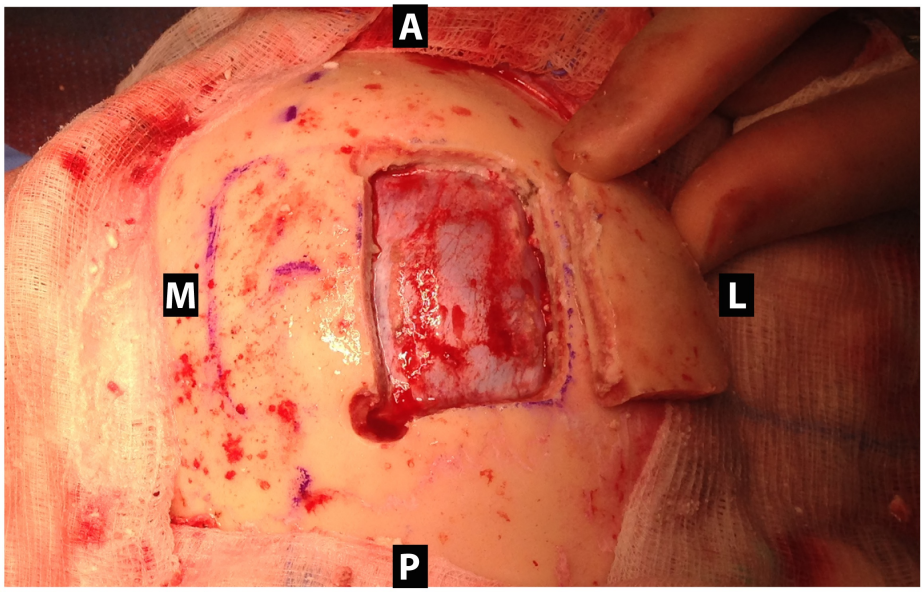


FIGURE 3: Craniotomy (first cut)

The first part of the planned two-part craniotomy is shown. The anterior (top of page) and posterior (bottom of page) burr holes mark the medial margin of the first piece of the craniotomy. The removed bone is shown to the right of the craniotomy. The anterior (A), posterior (P), lateral (L), and medial (M) aspects of the skull are identified.

If venous bleeding is encountered it can be controlled with tamponade with small cotton sponges. Estimates of the length of dissection to the opposite side can be made with a finger and thumb held on the Penfield #1 at the bone edge when the dissector is at the presumed necessary length across to the opposite side. The footplate can then be used to cut the second bone piece (Figure 4) and then hemostasis obtained with the bipolar and strips of gelfoam.

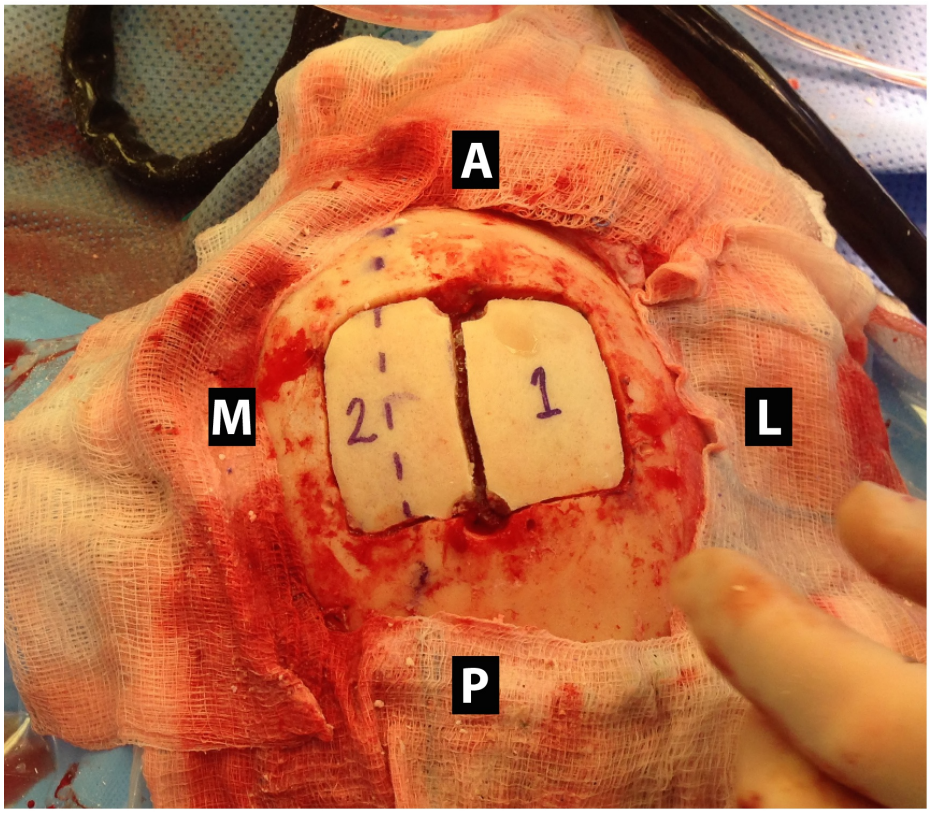


FIGURE 4: The completed craniotomy

The final craniotomy is shown. The first bone flap from the first part is marked with “1”, and the bone fall from

the second part is marred with a “2”. The midline has been re-drawn with a dashed line in the Anterior to posterior plane. The anterior and posterior burr holes are re-visualized. The anterior (A), posterior (P), lateral (L), and medial (M) aspects of the skull are identified.

Tack-up drill holes can be placed on both sides for hemostasis. The dura is then opened in a U-shaped manner up the edge of the SSS where possible and retracted with sutures to provide full access to the midline. Once the definitive procedure is completed the two bone pieces are connected one to another with titanium plates and screws (Figure *5*). If titanium plates are not available, wire, suture, or another method can be used to approximate the bone pieces. Inner or outer table fixation is possible.

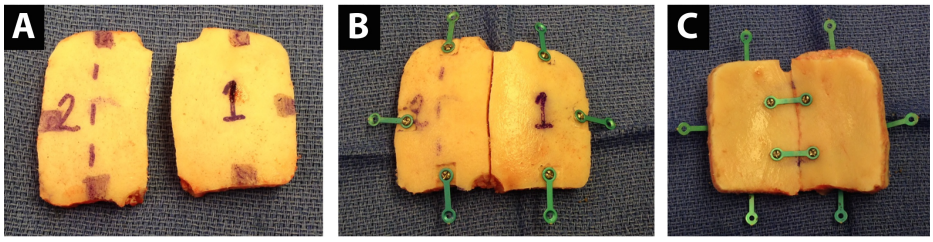
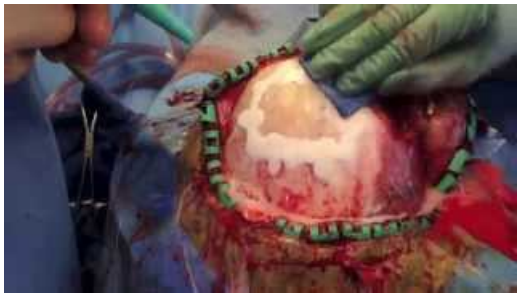


FIGURE 5: Fixation of bone pieces from two-part craniotomy

The two bone pieces are initially separated as two pieces (A), which are secured back to the skull using titanium plates and screws on the extracranial side (B) and to each other using plates and screws on the intracranial side (C).

The composite bone piece is then secured to the surrounding skull using recessed slots cut in the outer table to accommodate the plates. Gaps between bone edges can be filled with hydroxyapatite to prevent the fibrous union between bone edges that adheres to the galea causing a visible depression in non-hair bearing scalp. Excess hydroxyapatite can be sanded down using an electrocautery scratch pad with saline irrigation. A movie of summarizing the major steps in the surgical procedure is included.



VIDEO 1: Two part parasagittal craniotomy: Technical note

View video here: https://www.youtube.com/watch?v=0VSGpPlq9Jo

The senior author has used this method for the last 24 years when performing craniotomies of the cranial vault that require access to the midline. During that time, many normal variations of venous anatomy and varying degrees of dural adherence to the inner table of the skull have been encountered. As a general rule, we place the initial parasagittal burr holes 10-15 mm lateral to the midline so as to try and avoid any large parasagittal venous lakes that may bleed and make dissection of the correct epidural space via the burr holes difficult. Once the first bone flap is off, dissecting the midline with this method has allowed us to avoid any significant lacerations of the SSS and allows both easy control of venous bleeding and full unencumbered exposure of the midline. There have been no issues of mechanical failure of the two-part bone flap using titanium plate fixation. For re-operations, it is possible to remove the two pieces of bone from this approach as one piece, which simplifies re-do craniotomies. Additionally, for operations in which the two part approach was not taken, it is trivial to convert the re-operation into the two-part approach by creating an additional flap crossing midline, since this was not exposed during first operation.

In the current case, the two-part craniotomy approach was used to resect a parasagittal meningioma. The meningioma was first imaged using preoperative MRI (Figure *6*).

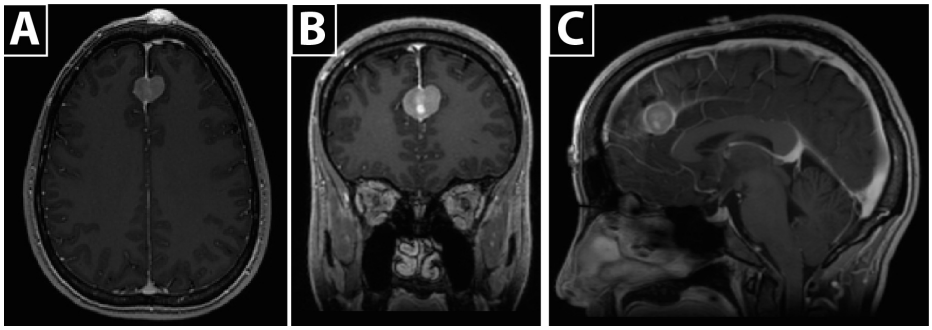


FIGURE 6: Preoperative imaging

Preoperative post-contrast T1 images of the lesion are shown in the axial view (A), the coronal view (B), as well as the sagittal view (B).

In the operating room, the tumor was first visualized (Figure 7), and then resected using bipolar cautery and simple suction (Figures 8-9).

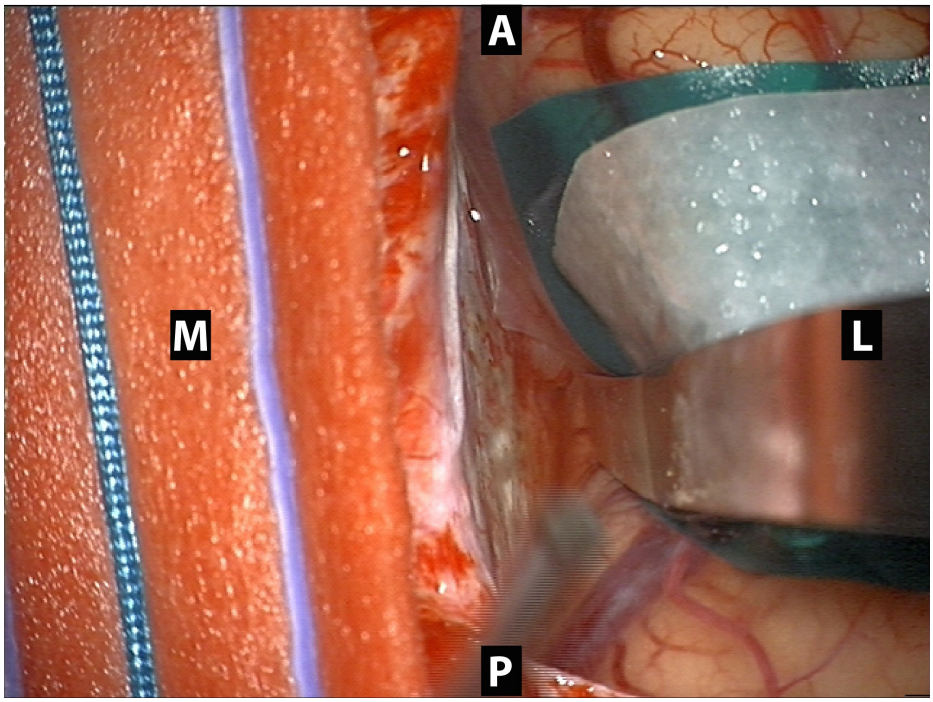


FIGURE 7: Visualization of the meningioma

Through the two-part craniotomy, the meningioma was visualized on the falx with gentle retraction of the right frontal lobe. The anterior (A), posterior (P), lateral (L), and medial (M) aspects of the exposure are identified.

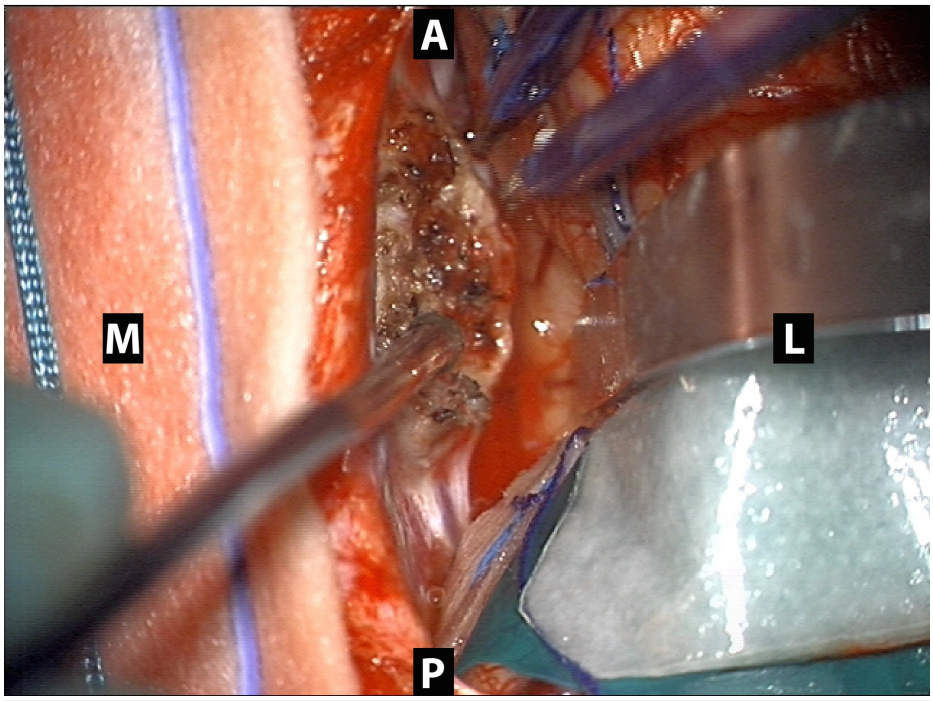


FIGURE 8: Resection of the meningioma

Using bipolar cautery and simple suction, the meningioma was easily resected, as shown. The anterior (A), posterior (P), lateral (L), and medial (M) aspects of the exposure are identified.

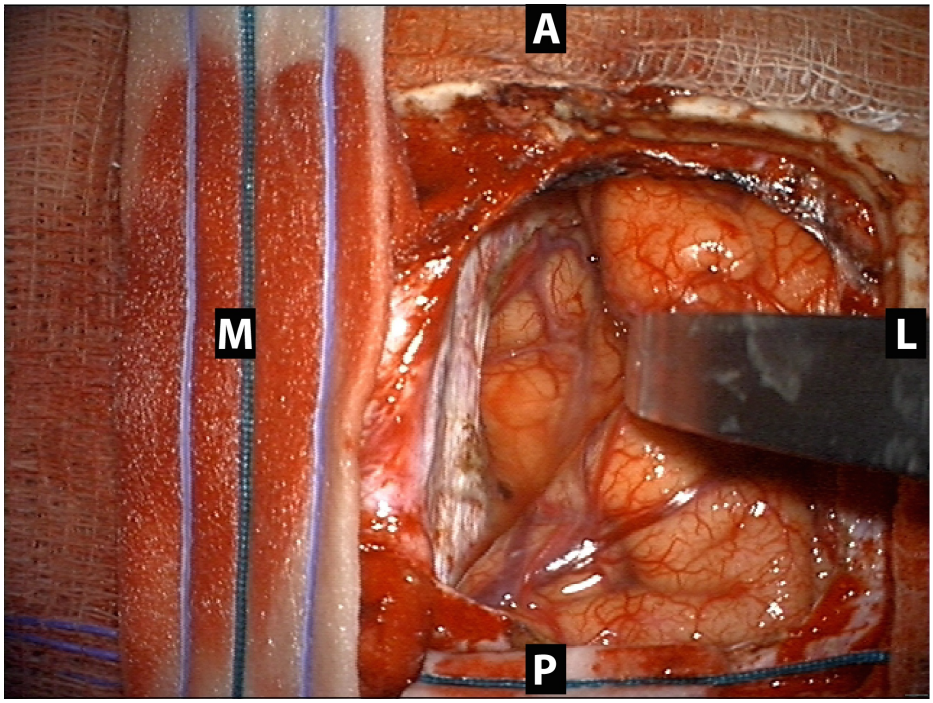


FIGURE 9: Final resection cavity

The meningioma has been completely resected and the final resection cavity is visualized. The anterior (A), posterior (P), lateral (L), and medial (M) aspects of the exposure are identified.

Using this technique, a gross total resection was obtained (Figure *10*).

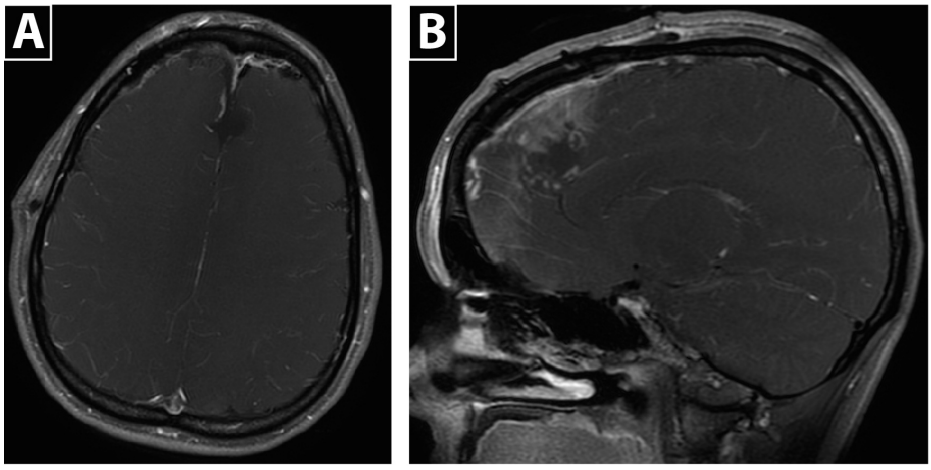


FIGURE 10: Postoperative imaging

Postoperative post-contrast T1 images of the lesion are shown in the axial view (A) as well as the sagittal view (B). When compared to Figure 6, a gross total resection is demonstrated.

Discussion

Traditional methods for ensuring adequate exposure of the midline include placing the medial aspect of vertex craniotomies as close to or on the midline of the SSS [5], or crossing the midline to the opposite side [2, 6]. Options for unilateral bone flaps include parasagittal burr holes with subsequent drilling down of the bone until the SSS is seen or placing burr holes directly on the midline. The former creates a bone defect without fully exposing the midline while the later carries a higher risk of SSS injury [7]. When the decision is made to cross the midline, a variety of techniques have been taught and in many institutions may include the two-part bone flap described here [11]. However, more traditional options include burr holes on either side of the midline and/or drilling out a trough between burr holes across the midline [1, 12-13]. In either case, visualization of the midline during dissection or drilling is more limited than what can be achieved with a unilateral craniotomy followed by epidural dissection under direct vision [4].

Conclusions

The two-part parasagittal craniotomy (Figure *11*) is an option for craniotomies of the vertex where clear exposure of the midline is required. The steps described here have proved useful in our hands and may be of value as a technique to be considered by neurosurgeons in training.

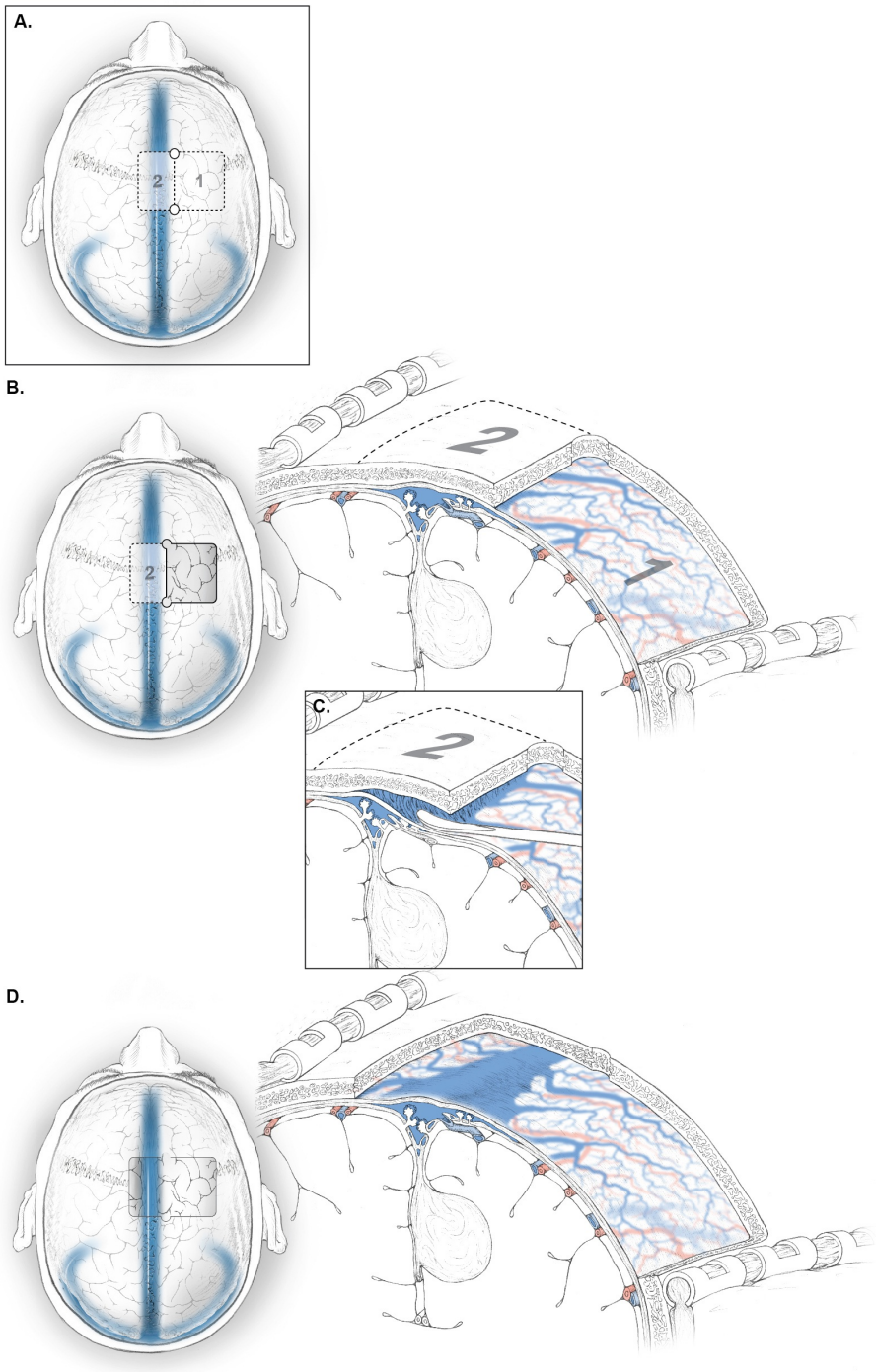


FIGURE 11: Summary of steps for two-part parasagittal craniotomy

(A) The bone is exposed and the two craniotomy sites are marked out; (B) the first bone flap is elevated; (C) the epidural space is dissected across the midline under direct vision with a Penfield #1 dissector; (D) the second bone flap is elevated.

Additional Information

Disclosures

Human subjects: Consent was obtained by all participants in this study. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could

appear to have influenced the submitted work.

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