The Extended Retrosigmoid Approach
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Learning Objectives: After completing this CME activity, the neurosurgeon should be better able to:
1. Describe the indications and surgical advantages of the extended retrosigmoid approach.
2. Explain the steps and some variations of the approach.

To access the lateral aspect of the posterior fossa, Cushing long advocated for a standard midline bilateral suboccipital craniotomy. His concern was that a unilateral approach would not provide enough brain relaxation, culminating into cerebellar herniation and brainstem compression. Dandy, on the other hand, capitalizing on the works of Woolsey, Krause, and Elsberg, supported a unilateral retrosigmoid craniotomy, which is facilitated by cerebrospinal fluid (CSF) release, cerebellar retraction, and even in some cases, partial cerebellar amputation.

The retrosigmoid approach would then significantly evolve with the introduction of the microscope and microsurgical techniques, notably with the innovations of House, Yaşargil, Oliviercrona, Jannetta, and many others. This allowed improved navigation of the cisternal anatomy of the posterior fossa, CSF release, and dissection and preservation of cranial nerves. With the emergence of skull base surgery concepts, mainly those of widening the angles of exposure by drilling bone and reducing brain retraction, Hakuba and Al-Mefty described an extended transmastoid retrosigmoid craniotomy. The sigmoid sinus is skeletonized and mobilized, increasing the ventral exposure to the brainstem and its surrounding medial structures.

The extended retrosigmoid approach thus combines both the principles of intradural arachnoidal dissections, CSF release, and cerebellar mobilization on one hand; and the skull base techniques of drilling the mastoid bone to mobilize the transverse and sigmoid sinuses on the other hand. Although there are different variations in performing the approach, we describe the steps as performed at our center, and the surgical advantages and pathologic adaptations to certain cases.

The patient can be positioned lateral (including park-bench), prone, or sitting, but we prefer the supine position to minimize any venous congestion or pulmonary stresses (Figure 1). The head is rotated laterally, which is facilitated by an ipsilateral shoulder roll. Patients with a larger habitus or whose necks are not flexible may be better approached through a lateral or a sitting position. We usually harvest a fat graft from the abdomen to secure a watertight closure at the end and to seal any potential epidural spaces, especially any communications with the mastoid air cells. Although lumbar drains are employed by many neurosurgeons, we do not routinely use them.

A wide C-shaped incision is performed, which can be curved medially to further mobilize the ipsilateral cerebellar hemisphere if more ventral exposure is needed. We elevate the skin just above the muscular fascia and retract the cutaneous flap anteriorly. Although different muscular detachment techniques are described (H-shaped, L-shaped, or straight cuts), we favor to elevate a fascial muscular flap

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that combines the temporalis muscle and fascia, and the superficial most aspect of the sternocleidomastoid (SCM) and splenius capitis muscles (Figure 2). This helps preserve an appropriately thick muscular layer to completely cover the surgical area. The muscular flap is retracted anteriorly, exposing the mastoid bone to its lower tip. The suboccipital muscles are then cut from the nuchal line caudally, exposing the occipital squama. The inferior limit is marked by submuscular fat, which is a good indicator of the area of the foramen magnum. The transverse process of C1 can be palpated below the mastoid tip and is a constant landmark between the jugular vein posteriorly and the vertebral artery anteriorly. The muscles are retracted inferiorly with...
sutures or fishhooks. The proximal part of the digastric muscle is detached to demarcate the digastric groove.

The transverse and sigmoid sinuses can be delineated with neuronavigation, and/or corroborated by several anatomical landmarks. A line from the inion to the base of the zygomatic arch, or to the top of the external auditory meatus, usually crossing along the superior nuchal line, helps outline the transverse sinus. The asterion’s position is variable and is thus not reliable in predicting the position of the transverse sinus. However, it is always posterior to the sigmoid sinus (average 1 cm). The latter can be predicted by a line anterior to the asterion, crossing the posterior aspect of the digastric groove, toward the mastoid tip.

Craniotomy is performed by skeletonizing the transverse and sigmoid sinuses and drilling the posterior aspect of the mastoid bone using a high-speed cutting drill. The bone over the venous sinuses is egg-shelled and carefully dissected and removed. The mastoid emissary vein can be skeletonized and coagulated with bipolar cautery. The dura below the transverse-sigmoid junction is dissected and separated from the overlying bone using a dental dissector. The suboccipital bone flap can then be cut, away from the venous sinuses, either with a craniotome (footplate drill) or with the round drill. The mastoid air cells are plugged with bone wax. Further caudal exposure is gained by drilling the occipital bone down to the foramen magnum.

We always open the dura initially at the level of the foramen magnum to access the cisterna magna and to release CSF. This is done by angling the microscope inferiorly and using sharp microsurgical instruments. We then open the dura over the cerebellum and curve the dural incision parallel to the transverse and sigmoid sinuses. Releasing cuts are made toward the sinuses and sutures are applied over the edges of the dura allowing a gentle mobilization

Figure 2. A and B, A muscular flap is elevated using the thickness of the temporalis muscle. C, A round drill is employed to perform a partial mastoidectomy and create a trough over the transverse and sigmoid sinuses (blue lines). The occipital bone is then dissected off the dura and the craniotome elevates the bone flap away from the sinuses (arrows). D, The dura is opened initially at the caudal aspect to release cerebrospinal fluid from the cisterna magna. Aur, auricular muscle; DG, digastric groove; SCM, sternocleidomastoid muscle. (Courtesy of the Arkansas Neuroscience Institute.)
of the sinuses. Anatomical studies have shown that mobilizing the sigmoid sinus augments the angle of exposure to the brainstem by 50%, reduces the distance to deep targets, and decreases cerebellar retraction by 50% (Figure 3). However, the sinus should only be gently mobilized, because aggressive retraction can result in thrombotic complications (1%–5%).

Cotton or Telfa patties are applied over the cerebellum and further CSF is released from the cerebellomesencephalic, cerebellopontine, and cerebellomedullary cisterns. The arachnoidal attachments of the cerebellum are cut allowing its mobilization, which combined with further medial exposure, CSF release, and bone drilling, result in decreased forces of retraction. The neurovascular structures in the cerebellopontine angle are organized according to the rule of 3 as proposed by Rhoton. Caudally, the glossopharyngeal nerve is identified as a single nerve, whereas the vagal nerve has multiple branches, and the spinal accessory nerve has a cervical branch. This complex is associated with the posterior inferior cerebellar artery. The middle neurovascular complex includes the anterior inferior cerebellar artery and cranial nerves VII and VIII. The upper neurovascular complex follows the superior cerebellar artery and the nearby trochlear and trigeminal nerves. A full extended retrosigmoid approach with adequate ventral widening has also the potential to expose the oculomotor nerve superiorly, the hypoglossal nerve inferiorly, and the abducens nerve medially (Figure 4).

The retrosigmoid approach can also be extended with further steps or combined with adjacent approaches. The posterior meatal lip can be drilled to access the internal auditory canal, the suprameatal crest to Meckel’s cave region, and the inframeatal region to the jugular foramen. It can be combined with a lateral supracerebellar approach superiorly, or a suboccipital, far lateral or jugular foramen approach inferiorly. The potential ventral exposure gained with the extended approach frequently obviates the need for larger or more involved approaches, such as the petro- or transcoclear approaches.

The approach should be tailored to the pathology in question. Although a less extended approach is needed for
trigeminal neuralgia, having a wide exposure allows for multiple angles of inspection and surgical maneuverability around the nerve. This permits us to perform the surgery without having to sacrifice the petrosal vein in almost all cases. Petroclival meningiomas can be accessed through a pretemporal approach, but a retrosigmoid approach is more suitable for tumors extending below the cranial nerve VII and VIII complex. In these cases, the transtentorial extension of the approach allows us to remove tumor in Meckel’s cave, and in the tentorial and incisural regions. The corridors between cranial nerves are exploited to their full extent after dissecting and mobilizing them. Skeletonizing the jugular bulb increases the caudal visualization for low-lying tumors. Having a large ventral exposure helps target medially located cavernomas of the brainstem, or petrous or petroclival meningiomas extending to the prepontine cistern as far medial as the contralateral abducens nerve. In vestibular schwannomas, the extended approach facilitates dissection of the facial and cochlear nerves, and easier opening of the auditory meatus for complete surgical resection.

Readings
1. The oculomotor nerve can be visualized through a retrosigmoid approach.  
True or False?

2. The asterion is always inferior to the transverse sinus.  
True or False?

3. Extending the craniotomy medially does not add any benefits to the retrosigmoid approach.  
True or False?

4. Mobilizing the sigmoid sinus results in decreased cerebellar retraction and wider ventral exposure.  
True or False?

5. Microvascular decompression for trigeminal neuralgia cannot be performed without sacrificing the petrosal vein.  
True or False?

6. Exposing the abducens nerve medially always requires a petrosal approach, since the retrosigmoid approach is very limited medially.  
True or False?

7. Exposing the transverse and sigmoid sinuses obviates the need for CSF release.  
True or False?

8. The sigmoid sinus runs posterior to the digastric groove.  
True or False?

9. The glossopharyngeal nerve is identified as a single branch, whereas the vagal nerve has multiple branches.  
True or False?

10. It is usually safe to skeletonize the sigmoid sinus with a foot-plate drill.  
True or False?