

A Simple Technique for Posterior Fossa Craniotomy in Adult

Jong Tae Park, M.D.

Department of Neurosurgery, School of Medicine, Institute of Wonkwang Medical Science, Wonkwang University, Iksan, Korea

Objective : Traditionally, standard access to the posterior fossa was a suboccipital craniectomy. After introducing the technique and benefit of posterior fossa craniotomy, several surgeons have used this procedure to manage various pathologies in posterior fossa in children. Though this approach offers several advantages over conventional suboccipital craniectomy, the elevation of bone flap is not easy in adult because of the irregular contour of inner bone surface and tight adhesion of dura to the skull. The aim of this article is to describe the technical aspects of this approach and to delineate the important landmarks for a safe and quick performance in adult.

Methods : We report on our series of twenty-five adult patients who underwent craniotomy for posterior fossa pathologies between 2002 and 2005. The maximal follow-up period was 4 years.

Results : None of the patients complained of persistent headache and no CSF leaks have occurred postoperatively. We have encountered only two cases of transient subcutaneous CSF retention after craniotomy. Three-dimensional reconstruction of the CT scan confirmed the well-fitted suboccipital bone contour after craniotomy. And patients were satisfied with the cosmetic results.

Conclusion : This method is safer and simpler. It restores normal anatomical planes and improves protection of the contents of the posterior fossa. The authors recommend craniotomy as an alternative method of access to the posterior fossa in all age groups.

KEY WORDS : Posterior fossa · Craniotomy · Craniectomy · Adult · Surgical technique .

Introduction

Access to the posterior cranial fossa lesions has traditionally been involved in permanent bone removal^{1,7,9)}. While a suboccipital craniectomy offers a simple and excellent view of the posterior fossa anatomy, it leaves the cerebellum relatively unprotected postoperatively, covered only by the meninges, muscle flaps, and scalp. Yasargil and Fox first had performed a craniotomy with burr holes to approach cerebellopontine angle and Kurpad and Cohen described a detailed technique for creating a midline bone flap in the posterior fossa in children^{3,11)}. Gnanalingham et al. have clearly shown that craniotomy significantly decreases postoperative cerebrospinal fluid leakage and pseudomeningoceles, compared with craniectomy in surgical procedures for posterior fossa tumors²⁾.

In adult, however, because of the irregular contour of inner bone surface and tight adhesion of dura to the skull, it is more or less dangerous to drill and manipulate to close or even on

the top of sinuses. Although recognized the benefits of craniotomies, most neurosurgeons still apply a traditional craniectomy in posterior fossa approaches^{2,7)}.

The authors report a simple and safe method for creating a midline suboccipital bone flap with a little risk even in adult and describe the technical aspects of this approach. Additionally, the technique has not added to any additional risk, and the cosmetic and functional results have been excellent.

Operative Technique

After the induction of general anesthesia, the patient is placed in the prone position and the head is fixed in the three-pin (Mayfield) fixation apparatus. The neck is preserved to sufficiently flexed position; a distance of one or two finger breadths must be left between the chin and the chest. Finally, the table is positioned so that the neck is parallel to the floor and the head is above the heart. The shoulders can be gently

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• Address for reprints : Jong Tae Park, M.D., Department of Neurosurgery, School of Medicine, Institute of Wonkwang Medical Science, Wonkwang University, 344-2 Sinyong-dong, Iksan 570-711, Korea Tel : +82-63-850-1261, Fax : +82-63-852-2606, E-mail : jtpark@wonkwang.ac.kr

retracted toward the feet with some tape.

The suboccipital craniotomy is begun with burr holes on either side of the most lateral edge of the designed bone flap. And then third and fourth burr holes are made just inferior and lateral to the torcular. In adult, the dura is tightly adherent to the skull, and it is dangerous to drill close to or even on top of the sinuses. Then the dura near the burr hole is carefully stripped off, using a dissector. The upper lateral cuts can be made first with ease, but lower lateral parts have some difficulty around the foramen magnum. The operator should take care to separate the inner pericranium from the bone at the foramen magnum to avoid injury to the annular sinus. This craniotomy always includes the posterior edge of the foramen magnum. Because the dura can not be stripped easily at this location, the craniotome is brought near, but not into, the foramen magnum, and the remained area should be cut with a small burr and an angled Kerrison punch. The final cut of this craniotomy should be carried over the midline sinus region and particular attention should be paid to avoid tearing the wall of venous sinuses and to minimize bleeding. The midline portion of the rostral craniotomy line is often highly vascular and has a keel that can be quite deep. The midline bony keel must be stripped off from dura with a dissector, paying attention to gently depress the dura to avoid injury to the occipital sinus and the torcular Herophili. A Kerrison punch is used to cross the midline after thinning the midline bone with an air drill.

The single bone flap is then carefully elevated with Langenbeck and periosteal elevator from around theinion. The bone sometimes tightly adheres to the dura at the midline and requires careful dissection and reflection. During this procedure, intermittently massive blood may gush out from the bone or underlying dura. But it is no problem to control these expected bleeding. Sinus bleeding can be controlled readily with the placement of Gelfoam or Surgicel over the bleeding point. Bone bleeding also must be quickly addressed and controlled using bone wax. After final elevation of the bone flap, it should literally dangle from posterior atlantooccipital membrane and adjacent venous plexus. Careful attention should be paid to detach the bone with bipolar coagulator. All exposed bone edges should be waxed. When required, the exposure is enlarged laterally and superiorly using rongeurs. In this manner, the entire bone flap can be created as a single piece.

At the end of the procedure, the bone flap is replaced in its original position and fixed using miniplates and screws (Leibinger Inc. Freiburg, Germany).

Between 2002 and 2005, twenty-five adult patients underwent craniotomy for posterior fossa lesion using this technique described here (Fig. 1). The cases in which it has been applied include cerebellar tumors, intracerebellar hemorrhage, and various traumatic lesions such as epidural hemorrhage, sub-

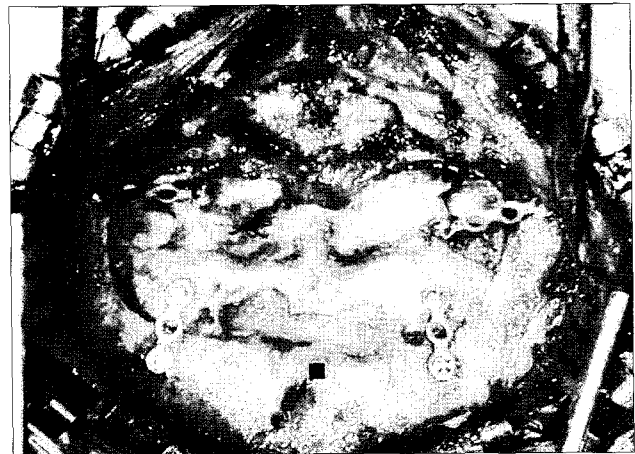


Fig. 1. Intraoperative photograph after fixation of bone flap with miniplates illustrating a technique for midline suboccipital craniotomy. After wide bilateral occipital bone exposure, two burr holes are placed far laterally on either side of the most lateral edge of the designed bone flap. And then third and fourth burr holes are made just inferior and lateral to the torcular. * : atlas, ■ : external occipital protuberance.



Fig. 2. Three-dimensional computed tomographic scan of the bony cranium demonstrating the reconstruction of the bone flap after craniotomy.

dural hemorrhage, or parenchymal hemorrhagic contusion. The maximal follow-up period was 4 years. None of the patients complained of persistent headache and no CSF leaks have occurred postoperatively in our series. We have encountered only two cases of transient subcutaneous CSF retention after this maneuver. Three-dimensional reconstruction of the CT scan confirmed the well-fitted suboccipital bone contour after craniotomy using the described method (Fig. 2). Patients were satisfied with the cosmetic results.

Discussion

Suboccipital exposure is one of the commonest neurosurgical practices for the management of different pathologies involving the posterior fossa. This is performed via either craniotomy or craniectomy. Traditional access to the posterior

fossa in either midline or lateral approaches has been involved in the permanent removal of bone^{1,7,9}. Several reports have been published regarding the fashioning of a bone flap for posterior fossa lesions^{4,5,8-10}. Yasargil and Fox first described a technique for creation and replacement of a bone flap in the posterior fossa¹¹. With improvement of high-speed drill instrumentation, others have described midline and lateral suboccipital craniotomies^{6,8,10}. After Kurpad and Cohen described their brief and lucid exposition of the technique for a midline posterior fossa craniotomy in children, many surgeons admitted craniotomy to be a better surgical choice³.

In adult, because of irregular contour of the inner bone surface and high probability of dural injury, it has been accepted to be an undisputed practice to perform a craniectomy rather than a craniotomy, removing the bone in a piecemeal fashion^{1,8}. However, neurosurgeons who routinely perform this approach in a conventional craniectomy are familiar with patients' complaining of persistent headache and immediate postoperative complications such as CSF leakage and pseudomeningocele^{2,7}.

CSF leakage after posterior fossa surgery is the one of the major problems, which is also associated with infection of the CSF and wound^{2,7}. Recently, Gnanalingham et al. have shown that craniotomy significantly decreases postoperative CSF leakage and pseudomeningocele, compared with craniectomy in children². In the postoperative period, CSF stays at the bottom around the dural closure by the gravity. They proposed that the mechanism of CSF leakage might be related to tearing of the dura after closure due to periodic dural bulging when the patient coughs and strains after craniectomy, while dural sutures might be prevented from tearing after craniotomy because of dural bulging being pressed against the bone flap².

Furthermore, the muscular attachment of deep muscles in the suboccipital region is widely stripped off at the periosteal level during the surgical approaches to posterior fossa. This area is likely to be a dead space in the muscular layer, which may act as a persistent pocket of CSF. Replacing the bone flap may help to eliminate this potential space by encouraging early reattachment of the muscles to the occipital bone flap.

The severity of the postoperative headache could be reduced by the placement of bone to the original site^{5,8}. One likely mechanism for headache after the posterior fossa approach is adhesion of cervical musculature to exposed dura at the craniectomy site^{5,9,10}. The dura of the posterior fossa is richly innervated and capable of producing headache as a result of traction during neck motion. Insertion of the rigid barrier between the dura and muscle will counter this effect and thus reduce post-operative headache.

In the long-term point of view, the craniotomy has an additional advantage. The presence of the bone flap makes the second exposure much easier and safer, diminishing the risk

of incising the dura and injuring the cerebellum during the muscle dissection⁶.

Despite these theoretical and practical advantages, the craniotomy has not won widespread acceptance, and also there are insufficient data in the literature to advocate craniotomy^{2,3}. Many neurosurgeons seem to be still reluctant to perform craniectomy. They might have thought that because a suboccipital craniotomy flap is considered to be too time-consuming and is not suitable to cope with the high probability of rapid deterioration of clinical status in posterior fossa lesion, a craniectomy is judged to be the quickest and the most reliable procedure^{1,5}. They also have considered a craniotomy as dangerous procedure by using craniotome in posterior fossa because of the irregular contour of inner bone surface and tight adhesion of dura to the skull. But, as mentioned above, because several problems related to craniectomy are decreased in severity and frequency, and fashioning a bone flap allows restoration of normal anatomical planes and provides better protection to posterior fossa contents, we are endeavoring to perform more craniotomies^{3,5,6}.

One method of posterior fossa craniotomy has been reported by Takayasu et al. in which en bloc suboccipital craniotomy, leaving the posterior margin of the foramen magnum, is performed¹⁰. They removed the remaining bony margin of the foramen magnum under an operating microscope using an air drill, Kerrison punches, and rongeurs. Yasargil also described a single burr hole technique in his book¹². However, his method seems too complicated and endangered for use by nonexperts. For that reason, we underwent a simple method for performing suboccipital craniotomy, in which a free bone flap with intact posterior bony margin of the foramen magnum is simply replaced and fixed to the original site. This technique is safe and not difficult procedure even in adults. It can be used for virtually any lesion of the posterior fossa in substitution for the previously used suboccipital craniectomy. Knowledge of the accurate location of the venous sinuses and their relations of the external landmarks is essential for the posterior fossa approaches in order to avoid inadvertent entry into the venous sinuses and get the safe and accurate bony opening. Development of the high-speed air drills decreases the possibility of the drill bit grabbing and ripping the dura and the use of a sophisticated technique makes possible this type of procedure to be more popular neurosurgical procedures. Our experience indicates that the use of this technique provides a readily available, safe, and effective practice for the management of posterior fossa lesions.

Conclusion

The suboccipital craniotomy is not only a safe and cosmetically effective procedure but also minimizes craniectomy-

related complications such as postoperative CSF leak, pseudomeningocele formation, wound dehiscence and headache. Once surgeons are familiar with this technique, it will cause no adverse effect on operative time. Midline posterior fossa craniotomy is suited for adult as well as children. Virtually, any lesion in the posterior fossa is accessible with this type of craniotomy. Preservation of the normal anatomic planes, increased protection to the posterior fossa and lack of immediate and long-term complications suggest that this method is a safe and useful approach.

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Commentary

The authors describe their simple technique for posterior fossa craniotomy in adult. Suboccipital craniotomy is popular surgical method for posterior fossa lesion. It has many theoretical and practical advantages than suboccipital craniectomy. But many neurosurgeons seem to reluctant to perform this procedure for its technical difficulty, risk of venous sinus injury and postoperative dismal hematoma. Although suboccipital craniectomy has some advantages, it has some severe complications. Using simple closure of bone flap in operation field, these complications can be diminished. Key anatomy of posterior fossa is important for procedure. Posterior fossa skull is thinnest in its paramedian area and deepest in the midline and periphery. Around the foramen magnum, its depth is somewhat thick. Variant of anatomies of occipital sinus and annular sinus also give some difficulties in surgery. But due to development of high speed -drill and neuronavigation systems, craniotomy was not so difficult and no need time than craniectomy. And the risk of sinus injury was markedly decreased for using diamond drill. So now, it is more reasonable to doing suboccipital craniotomy in many aspects. Two additional comments to this article, water-tight dura suture with pericranium or fascia & the meticulous dura tenting along the craniotomy site and bone flap are very important to prevent CSF leakage and the formation of postoperative epidural hematoma.

This article demonstrates the advantages and more simple technique of suboccipital craniotomy.

Sang-Won Lee, M.D.

Department of Neurosurgery, St. Vincent Hospital