Vertebrobasilar junction aneurysm: surgical treatment via far lateral transcondylar approach

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ABSTRACT - Aim of the study: To present a case of successful microsurgical clipping of the aneurysm within the fenestrated vertebrobasilar junction via far lateral transcondylar approach.

Background: Surgical treatment of low basilar aneurysm and vertebrobasilar (VB) junction remains one of the most challenging and most difficult procedures in neurosurgery. Saccular aneurysms of the VB junction are often associated with a fenestration of the basilar artery. Endovascular procedures are performed for the treatment of such aneurysms, but may be difficult in some cases.

Case description: A case is presented of a 53-year-old patient with VB junction aneurysm that was microsurgically clipped successfully via far lateral transcondylar approach. The patient was discharged from the hospital fully recovered 10 days after the surgery.

Conclusion: The far lateral approach adequately exposed the VB junction aneurysm for successful clipping of the aneurysm and was associated with no morbidity. It should be considered as a good alternative to endovascular treatment. In developing countries, the microsurgical procedure may be given preference because it is less expensive and does not require preoperative intra-arterial digital subtraction angiography or follow up.

Key words: vertebrobasilar junction aneurysm, far lateral transcondylar approach, transbasal approach, skull base approach, microneurosurgery

INTRODUCTION

Aneurysms of posterior circulation account for 8% to 10% of all intracranial aneurysms. One half of these are located at the basilar tip, and the rest at other locations of the posterior circulation. Aneurysms of the vertebrobasilar (VB) junction account
for 1%-2% of all intracranial aneurysms (1,2). These lesions are surgically challenging for the following reasons: the depth of exposure, the space limited by surrounding bone and brainstem, ventral location to the pontomedullary junction, and the arterial anatomy that often includes a fenestration of the basilar artery, with difficulties in getting proximal and distal control, make the task of adequate exposure and clipping difficult. Early attempts at surgical treatment of these lesions have been discouraging, associated with significant mortality and morbidity. Advances in microneurosurgery, anesthesia, critical care, instrumentation, and the advent of skull base surgery have contributed to decreasing mortality rates in surgical management of these aneurysms. Various complicated cranial base approaches have been described to achieve this goal, including numerous modifications of the transclival (3,4), transpetrous (5,6), and far-lateral approaches (7-10). Removal of the cranial base is advantageous as it reduces brain retraction. However, it may be associated with increased morbidity due to injury to cranial nerves, labyrinth, cerebrospinal fluid (CSF) leakage, occlusion of the eustachian tube, and cosmetic deformities.

CASE REPORT

A 53-year-old man, previously healthy, presented for the onset of severe headache, vertigo, nausea, vomiting, back pain and right-sided weakness followed by the loss of consciousness. He was admitted to Department of Infectious Diseases for suspected meningitis. Computed tomography (CT) scan revealed extensive subarachnoid hemorrhage and hemorrhage into the fourth ventricle, but without hydrocephalus. Computed tomography angiography (CTA) demonstrated a saccular VB junction aneurysm 7 mm in diameter with a 5-mm neck. The aneurysm projected ventrally toward the clivus (Fig. 1 A,B). The associated fenestration was not clearly apparent on initial angiogram. The patient was diagnosed as having subarachnoid hemorrhage grade IV (Hunt and Hess grading system) and was transferred to Department of Neurology. His initial management included sedation and control of blood pressure. Nimodipine was administered parenterally. He gradually improved and 10 days later, he was transferred to Department of Neurosurgery and underwent surgery for aneurysm clipping via far lateral transcondylar approach. The VB junction aneurysm was clipped uneventfully. Postoperatively there was no CSF leak or pseudomeningocele.

Far lateral transcondylar approach

The far lateral transcondylar approach was used to access the aneurysm in this case. The essential steps employed are briefly delineated below.

**Positioning and skin incision:** The patient was placed in lateral position and the head was held in three-point pins with the neck slightly flexed, the vertex angled slightly down, and the face rotated slightly ventrally, so that the ipsilateral external auditory meatus and the mastoid bone were the highest point. Positioning the head in this manner allowed for better exposure of the occipito-cervical region.

Fig. 1. (A) Preoperative CT angiography: saccular aneurysm of the VB junction pointed ventrally towards the clivus; BA, basilar artery; A, aneurysm; (B) ventrally projected aneurysm of the vertebrobasilar junction. Note that the aneurysm is within the proximal portion of the fenestration. Fenestration of basilar artery was not clearly visible; BA, basilar artery; A, aneurysm; LVA, left vertebral artery; RVA, right vertebral artery; F, fenestration.
and improved the inferior-to-superior viewing angle for the surgeon. An axillary roll was placed and the patient's contralateral arm rested on a Krauss armrest. The elevated arm was distracted inferriorly toward the foot of the table to provide more room for the surgeon to maneuver above the shoulder. All pressure points were carefully padded with gel pads. The patient was carefully secured to the operating table to allow for safe rotation of the table during the operation when needed to improve the surgeon's line of sight. Intravenous glucocorticoid agents, antibiotic drugs, and mannitol were administered at the time of skin incision.

A retroauricular 'hockey stick' skin incision started approximately 1 cm above the mastoid tip, continued superiorly to the level of superior nuchal line, then turned vertically towards the midline, and extended to the level of the spinous process of C4 vertebra (Fig. 2). The skin and the muscle layer were elevated in one layer and rolled laterally. The muscle layer consisted of the trapezius and sternocleidomastoid muscle, splenius capitis, longissimus capitis and semispinalis capitis, and in the deepest layer of rectus capitis posterior major, inferior oblique and superior oblique muscles. The suboccipital triangle, which involves the dorsal ramus of the C-1 nerve root and the horizontal segment of VA (V3), was opened by detaching the insertions of the superior and inferior oblique muscle from the transverse process of C-1 and reflecting them posteriorly. Then the C-1 lamina and VA became more apparent. The VA was covered by venous plexus (sometimes referred to as the suboccipital venous sinus) (11).

**Exposure of the extradural VA:** Exposure and control of the extradural VA is important and was achieved by identifying its extradural course from the foramen transversarium of C-2 to the occiput. The ventral ramus of the C-2 nerve root, which was found between the laminae of C-1 and C-2, was traced laterally until it crossed dorsally to the vertical segment of the VA, coursing between the foramen transversarium of C-2 and C-1 (7,12,13). As the VA exits the foramen transversarium of C-1, it was encased in a venous plexus and coursed posteriorly behind the lateral mass of C-1 in the vertebral groove, then turned medially to pierce the atlanto-occipital membrane and dura mater. Several muscular branches and the posterior meningeal artery arise from the horizontal segment of the VA, which can be safely coagulated. In rare cases, the posterior spinal artery and posterior inferior cerebellar artery can arise extradurally and can potentially be injured (7,14). Subperiosteal dissection of the VA from the vertebral groove reduced bleeding from the venous plexus by leaving the periosteal sheath around the artery intact (15). However, venous bleeding from the vertebral or epidural plexus can be controlled by the injection of fibrin glue (16). The atlanto-occipital membrane was sharply divided to expose the underlying dura mater.

**Suboccipital craniectomy and C-1 hemilaminectomy:** Lateral suboccipital craniectomy was initially performed with a high-speed drill and rongeurs (Fig. 2). The craniectomy extended toward the midline medially and to the inferior nuchal line superiorly, to the posterior rim of the foramen magnum inferiorly, and up to the occipital condyle laterally (Fig. 3 A,B). To prove more superior access to the CPA, the craniectomy was extended up to the transverse-sigmoid junction. The sigmoid sinus and jugular bulb were exposed with rongeurs and high-speed drill. The posterior condylar emissary vein was encountered as it travels from the jugular bulb and exits the condylar fossa through the condylar canal to join the extradural venous plexus. Hemostasis was achieved by packing the vein with Surgicel. Ipsilateral hemilaminectomy of C-1 improved the dural exposure inferiorly.

**Transcondylar resection:** Extradural resection of the occipital condyle is one of the key maneuvers in maximizing exposure to the ventral aspect of the cranovertbral junction while avoiding brainstem...
retraction. Partial condylar resection increases the angle of exposure, the working space at the level of the foramen magnum, and visualization of both the ventral and ventrolateral aspects of the craniovertebral junction and the contralateral aspects of the inferior clivus (10,17-24). For intradural lesions, resection of a third to half of the condyle is adequate (8,20,25-30). We removed the posterior and medial third of the condyle. If 50% or more of the condyle is resected or has been destroyed by the lesion, the instability of the craniovertebral junction increases and occipito-cervical stabilization should be strongly considered (31). Although extradural and intradural resection of the jugular tubercle aids in maximizing the intradural exposure across the anterior surface of the brainstem and mid-clivus, this maneuver was not necessary in our case.

Intradural exposure: A curvilinear incision of the dura mater was made several millimeters posteriorly to the sigmoid sinus, extending inferiorly toward the C-2 lamina, staying posterior to the VA where it approaches the dura. A dural cuff was preserved around the VA for later watertight closure. The anterior leaflet of dura mater was reflected laterally and held with tacking sutures for maximal exposure. Adequate reduction of the occipital condyle should provide a straight surgical trajectory to the craniovertebral junction in parallel to the intracranial course of the VA (10,17,32,33). The ligation of the denticulatum was cut in order to facilitate the spinomedullary junction to fall back for further exposure if necessary. These maneuvers, along with CSF drainage and administration of mannitol, sufficiently slackened the brain to offer adequate space without significant retraction of the brain. Sharp arachnoid dissection was performed and the following structures were visualized: the

Fig. 3. (A) Anatomical drawings: surface anatomy and landmarks for the far lateral transcondylar approach. View of the outer surface of the skull: 1 – a “tear-drop” osteoplastic craniotomy; 2 – craniotomy was extended laterally and ventrally by using high-speed drill and rongeurs; 3 – mastoid notch; 4 – right mastoid tip; 5 – partially resected right occipital condyle; 6 – hypoglossal canal on the contralateral side; (B) view of the inner surface of the skull: 1 – location of the aneurysm in our patient; 2 – oval foramen; 3 – internal auditory meatus; 4 – jugular foramen; 5 – right hypoglossal canal; 6 – area of the osteoclastic craniotomy, which included removal of medial 1/3 of the right condylar process; 7 – the area of “tear-drop” osteoplastic craniotomy; 8 – foramen magnum.

Fig. 4. Intraoperative microphotography: with the condyle partially drilled, the intradural exposure is much more flat and direct. The first dentate ligament is being divided to uncover the intradural vertebral artery; 1 – roots of the glossopharyngeal and vagus nerve; 2 – spinal root of the right accessory nerve; 3 – titanium vascular clip (spring) in place; 4 – right vertebral artery; 5 – brainstem. Hypoglossal rootlets emerging anteriorly to the olive and coursing toward the hypoglossal canal, located just above the occipital condyle. Note the wide triangular surgical space between the eleventh and ninth/tenth nerve complex.
fifth through 12th cranial nerves; the basilar artery; the VA; the VB junction; the posterior inferior cerebellar artery (PICA); and the anterior inferior cerebellar artery (AICA). The VA was followed superiorly to expose the VB junction and the proximal basilar artery to define the neck of the aneurysm. The aneurysm arose at the site of a fenestration of the basilar artery. Once the aneurysmal neck was identified, the right VA was temporarily clipped for 3 minutes. Complete occlusion of the aneurysm neck was performed by use of straight titanium vascular clip, with strict adherence to microsurgical technique and preservation of all cranial and spinal nerves and vascular structures (Fig. 4).

Wound closure: A primary watertight closure of the dura mater was performed. An autologous pericranial graft was harvested from the neck wound. This was supplemented with autologous fat and fibrin glue. The exposed mastoid air cells were closed with bone wax. The muscle layers were carefully reaproximated to avoid postoperative cerebrospinal fluid leakage. The patient continued to improve and on postoperative day 10 he was transferred to a rehabilitation facility with a GCS 15 (Fig. 5). The patient remained asymptomatic at 6-month clinical follow up, fully recovered, without any neurologic deficit. On follow up CT and MR angiography, there was no sign of aneurysm. The basilar artery fenestration was clearly visible (Figs. 6 and 7).

DISCUSSION

Aneurysms of the lower basilar artery and VB junction are uncommon but when present, they often are associated with a fenestration of the basilar artery. They account for 1%-2% of all intracranial aneurysms (1,2). Vertebrobasilar junction aneurysms are frequently associated with fenestration (34). The typical origin of the VB junction aneurysm is at the proximal portion of the fenestration (35-38). The incidence of fenestration when a vertebrobasilar junction aneurysm is present is reported to be 35.5% (39). The complex hemodynamics that exists within these aneurysms makes
them difficult for endovascular treatment. Endovascular treatment is frequently associated with residual aneurysm and thrombosis in the limb of fenestration (39,40). The complex anatomy of this region includes multiple small perforating arteries to the brain stem and multiple lower cranial nerves. Due to the rarity of these aneurysms, few neurosurgeons have gained significant experience with them and most reports consist of small groups of patients (1,3,41-44). Surgical access to these aneurysms is difficult with conventional neurosurgical avenues due to the depth of exposure and the location surrounded by the lower clivus, brainstem and cranial nerves. Therefore, these aneurysms have been notorious as the most difficult to treat. The suboccipital approach carries the risk of injury to the cerebellum and brainstem in addition to lower cranial nerves, with significant morbidity and some risk of mortality.

The advent of cranial base surgery with its guiding principle of resection of bone to reduce retraction of the brain has facilitated effective exposure of these „hitherto uncharted seas“. The various complicated cranial base approaches that have evolved over the last few decades access the proximal basilar artery from three principal corridors. These are the anterior-transclival (3,4), the lateral transpetrosal (41-43), and the posterior far-lateral approaches (10,17,42). With the evaluation of surgical techniques and instrumentation, operative mortality has been considerably reduced, while operative results have significantly improved when compared with the natural history of these aneurysms.

Cost considerations

In patients who are treated in developing countries, the cost of treatment should also be taken into account. Endovascular aneurysm treatment requires a sophisticated biplane angiography suite, and personnel trained to operate and maintain that unit. Additionally, the coils used for aneurysm treatment are more expensive than aneurysm clips. Patients who undergo endovascular treatment require pretreatment intra-arterial digital subtraction angiography (IADSA) and follow up studies, usually at 6 months and 18 months, when further treatment may be needed. In contrast, nowadays, microsurgical treatment can be rendered in many patients without IADSA, when a good quality CT angiography is available. Additionally, the recurrence rate after complete microsurgical aneurysm occlusion is very low, and follow up by CTA is adequate to evaluate for recurrences. If the microsurgical treatment can be provided with good outcome and in a cost-effective manner, it has some advantages over endovascular techniques.

CONCLUSION

Aneurysms of the VB junction present a formidable surgical challenge and are associated with significant mortality with traditional neurosurgical approaches. Among the skull base approaches, the extreme lateral partial transcondylar approach (with jugular tubercle resection as needed) carries lower morbidity while providing excellent exposure, and a low risk of CSF leakage. Attempts continue to refine skull base approaches and define the type of aneurysms that could be treated by the minimalistic approach with a low risk of morbidity. Vertebrobasilar junction aneurysms are frequently associated with fenestration. The complex hemodynamics that exists within these aneurysms makes them difficult for endovascular treatment, which may be more expensive in developing countries. Our experience has shown that it is possible to clip small or medium-sized aneurysms of the VB junction via the far lateral transcondylar approach with a low risk of morbidity and mortality.

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REFERENCES


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