Direct Surgery of Basilar Trunk and Verteobasilar Junction Aneurysms via the Combined Transpetrosal Approach

Volker SEIFERT

Neurosurgical Clinic, University of Leipzig, Leipzig, Germany

Abstract

Surgical access to aneurysms of the basilar trunk and vertebrobasilar junction is hampered by their direct proximity of these lesions to highly vulnerable neural structures like the brain stem and cranial nerves, as well by the bony structure of the petrous bone blocking the direct surgical approach to these aneurysms. Only recently lateral approaches directed through parts of the petrous bone have been reported for surgery of basilar trunk and vertebrobasilar junction aneurysms like the anterior transpetrosal, the retrolabyrinthine transsigmoid, as well as the combined supra-infratentorial posterior transpetrosal approach. As experience in the use of this approach is limited in the neurosurgical literature we present our surgical experiences in 11 patients with basilar trunk and vertebrobasilar junction aneurysms, operated on using the supra-infratentorial posterior transpetrosal approach. In 10 patients, including one patient with a giant partially thrombosed basilar trunk aneurysm, direct clipping of the aneurysm via the transpetrosal route was possible. In one patient with a giant vertebrobasilar junction aneurysm, the completely calcified aneurysm sac was resected after occlusion of the vertebral artery. Of the whole series, one patient died and in three patients postoperative accentuation of preexisting cranial nerve deficits occurred. Except transient cerebrospinal fluid leak in two patients, the postoperative course was uneventful in the remaining patients. Postoperative angiography demonstrated complete aneurysm clipping in ten patients and relief of preoperative brain stem compression in the patient with the giant vertebrobasilar junction aneurysm. It is concluded, that the supra-infratentorial posterior transpetrosal approach allows excellent access to the basilar artery trunk and vertebrobasilar junction and can be considered the approach of choice to selected aneurysms located in this area.

Introduction

Surgical access to aneurysms of the basilar trunk and vertebrobasilar junction is hampered by their direct proximity of highly vulnerable neural structures like the brain stem and cranial nerves, as well by the bony structure of the petrous bone blocking the direct surgical approach to these aneurysms. A number of surgical tactics consisting of different supra- and infratentorial approaches have been applied over the years in order to gain access to these treacherous lesions. Among these are the pterional,35) subtemporal,4,18,20,33) suboccipital-retromastoidal,29,33,34) far lateral,10,21,29) and transoral-transclival approach.2,3,11,35) Only recently lateral approaches directed through parts of the petrous bone have been reported for surgery of basilar trunk and vertebrobasilar junction aneurysms like the anterior transpetrosal,25) the retrolabyrinthine transsigmoid,6) as well as the combined supra-infratentorial posterior transpetrosal approach.16,21,26,27,32) As detailed reports of direct operative intervention using the transpetrosal route in these rare and difficult lesions are scarce, we present our surgical experiences in 11 patients with basilar trunk and vertebrobasilar junction aneurysms operated on using the supra-infratentorial posterior transpetrosal approach.

Materials, Methods, and Results

Over a period of 8 years, 11 patients with aneurysms of the lower basilar trunk and vertebrobasilar junction area were operated on by one surgeon (V.S.) using a supra-infratentorial posterior transpetrosal approach. The series consists of eight males and three females with an age distribution ranging from 36 to 68 years. Three aneurysms were located in the area of the vertebrobasilar junction, one of these was cal-
cified and giant in size. Two aneurysms were located at the vertebral artery below the vertebrobasilar junction, and six patients had lower basilar trunk aneurysms, including one giant aneurysm. Seven patients presented with typical clinical signs of subarachnoid hemorrhage (SAH) from their vertebrobasilar aneurysm. Clinical grade on admission was Hunt and Hess (H + H) grade II in one patient, H + H grade III in five patients, and H + H grade IV in one patient. In six patients delayed surgery after a period of 7 to 21 days after SAH was performed. One patient who suffered two recurrent hemorrhages within 12 hours after his initial SAH, was operated on early. Two patients with giant aneurysms of the basilar trunk and vertebrobasilar junction respectively presented with signs of progressive brain stem compression and cranial nerve dysfunction. One patient was operated on harboring a large incidental vertebral artery aneurysm initially diagnosed on magnetic resonance imaging, and in one patient an asymptomatic vertebrobasilar junction aneurysm was identified during the course of angiography, because of SAH from an internal carotid artery aneurysm. In 10 patients including the giant basilar trunk aneurysm, direct clipping of the aneurysm via the transpetrosal approach was possible. In the patient with a giant vertebrobasilar junction aneurysm, the completely calcified aneurysm sac was resected after occlusion of the vertebral artery. The single patient operated on early in H + H grade IV after recurrent SAH died. Transient postoperative accentuation of preexisting cranial nerve deficits occurred in three patients. Except transient cerebrospinal fluid (CSF) leakage in two patients, which stopped after temporary lumbar drainage, the postoperative course was uneventful in the remaining patients. Postoperative angiography demonstrated complete aneurysm clipping in 10 patients and relief of preoperative brain stem compression in the patient with the giant vertebrobasilar junction aneurysm.

**Surgical Technique**

Electrophysiological monitoring is performed routinely throughout the whole procedure using brain stem auditory as well as median nerve somatosensory evoked potentials. With the patient in the semi-sitting “lounging position” an L-shaped incision is performed, starting in the temporal region slightly above the ear, which curves posteriorly, finishing parallel, and slightly below the mastoid process (Fig. 1). The temporal and suboccipital musculature is incised and retracted together with the scalp using fish-hooks and self-retaining retractors, exposing the temporobasal and lateral suboccipital skull as well as the complete mastoid. A combined supra-infratentorial craniotomy is performed (Fig. 2). After the bone flap has been elevated, complete unroofing of the sigmoid sinus is performed with the aid of the high speed drill and the surgical microscope, followed by a radical posterior petrosectomy with sufficient exposure of the presigmoid dura from the superior petrosal sinus to the level of the jugular bulb. During this procedure, the integrity of the semicircular canals must be preserved of which the posterior semicircular canal has the highest risk of

*Neurol Med Chir Suppl (Tokyo) 38, 1998*
being injured during extensive drilling of the posterior petrous bone. After completion of the extradural bone work, the temporal dura is incised parallel to the transverse sinus and the floor of the temporal lobe (Fig. 3). The presigmoid dura in Trautmann's triangle covering the posterior fossa is thereafter incised up to the superior petrosal sinus which is ligated using small hemoclips and cut. The temporal lobe is slightly elevated and the tentorium is transected. Section of the tentorium is performed parallel to the petrous bone in the direction of the trochlear nerve which can be seen in the depth of the operating field, covered by its arachnoid sheath and coursing in front of the anterior margin of the tentorium. Preservation of the vein of Labbé during elevation of the temporal lobe as well as during cutting of the tentorium is absolutely mandatory. After the tentorium has been cut completely, the sigmoid sinus as well as the remaining part of the tentorium can now be retracted by a self-retaining retractor exposing the clival and juxtaclival region and with it the basilar artery from the upper basilar region down to the level of the vertebrobasilar junction and ipsilateral vertebral artery (Fig. 4). After proximal and distal control of the aneurysm bearing vessel has been achieved, the origin of the aneurysm is dissected and clipped using a routinely available aneurysm clip (Fig. 3). After inspection of the area adjacent to the aneurysm clip has confirmed patency of perforators, watertight closure of the dura is achieved by a fascial and muscular graft augmented by fibrin glue. The bone flap is repositioned and secured with titanium micro-plates. The craniectomy defect is filled with a pedicled temporalis muscle flap. However, for the last two patients we have covered this area

Fig. 3 Intraoperative sketch of transpetrosal approach after completed combined supra-infratentorial craniotomy and posterior petrosectomy. Incision in temporobasal dura with slight elevation of dorsal temporal lobe. Additional incision of presigmoid dura, prior to section of superior petrosal sinus.

Fig. 4 Intraoperative sketch illustrating transpetrosal clipping of a large lower basilar trunk aneurysm. Transection of superior petrosal sinus and tentorium allows retraction of sigmoid sinus and wide exposure of the vertebrobasilar junction and basilar artery.

Fig. 5 Vertebrobasilar junction aneurysm as seen through the combined transpetrosal approach immediately prior to clip application.
with a titanium mash molded according to the outer appearance of the mastoidal bone and fixed with titanium micro-screws. This procedure has given an excellent cosmetic result. The surgical wound is closed in layers in the typical manner with insertion of a subcutaneous drain.

**Illustrative Case**

This 37-year-old female was admitted because of a recent SAH. On arrival in our clinic she was in H + H grade II. Cerebral panangiography revealed a large lobulated aneurysm originating from the lower basilar trunk, approximately 5 mm above the vertebrobasilar junction (Fig. 6). Seven days after the initial SAH a spiral angio-computed tomography scan with three-dimensional reconstruction of the posterior circulation was performed. This examination excellently demonstrated the anatomical and topographical relation of the large aneurysm in regard to the parent basilar artery (Fig. 7). As the lower part of the basilar artery deviated to the right side, a right-sided combined supra-infratentorial transpetrosal approach was performed one day later. After transection of the tentorium and slight retraction of the sigmoid sinus, the aneurysm was approached without problems, and, after sharp dissection of partly dense arachnoid adhesions, could be clipped using a fairly long and straight aneurysm clip. Apart from transient, incomplete diminished hearing on the right side, the postoperative course of the patient was uneventful. Control angiography 2.5 weeks after surgery revealed complete clipping of the aneurysm (Fig. 8).

**Discussion**

The conceptual advantage of aggressive removal of parts of the posterolateral skull base as the mastoid...
and petrous bone, lies in the fact, that it allows a completely flat and tangential approach to the clival and juxta-clival region including the basilar trunk and vertebrobasilar junction, parallel to the cranial nerves, with almost complete avoidance of retraction of neural tissue. Advances in skull base surgery, including access to deep lying neurovascular complexes like e.g. the basilar trunk and vertebrobasilar junction, are primarily based on the application of innovative skull base approaches, for which the supra-infratentorial transpetrosal approach, gradually developed as a combination from standard otosurgical and neurosurgical approaches, stands as an excellent example. The first description of a combined supra-infratentorial approach to vertebrobasilar aneurysms was presented by Kasdon and Stein in 1979. Their approach included transection of the transverse sinus and tentorium with subsequent exposure of the vertebral artery and vertebrobasilar junction. Using this approach, two patients with aneurysms of the vertebral and lower basilar artery were treated successfully by the authors. In 1982, Hashi and coworkers reported on the first use of the transpetrosal combined supra-infratentorial approach to vertebrobasilar aneurysms. Although their exposure was based on the initial work presented by Kasdon and Stein, they considered the division of the transverse-sigmoid sinus a serious drawback of their procedure, limiting it to the side of non-dominant venous return. Considering the surgical techniques of transpetrosal exposure of Morrison and Hakuba and coworkers, they refrained from transection of the sigmoid sinus. Instead, after posterior petrosectomy with sparing of the labyrinth and exposure of a limited area of the presigmoid dura, the superior petrosal sinus was divided, the tentorium transected, and the vertebrobasilar area exposed. Using this approach two aneurysms of the vertebral artery and one aneurysm of the vertebrobasilar junction could be clipped successfully. In 1985, Kawase and coworkers described their experience using a transpetrosal approach for aneurysms of the lower basilar artery in two patients. However, the technique employed by Kawase, differs significantly from the technique described above, being basically an anterior transpetrosal approach directed through the middle fossa and Kawase’s triangle. In 1986, Sekhar and Estonilloy extensively described the surgical anatomy of the transtemporal approach to the skull base. In the clinical section of their article, demonstrating the applicability of the transtemporal approach for the exposure of vertebrobasilar aneurysms, the authors reported on the surgical treatment of vertebral artery aneurysms in two patients. In 1988, Gianotta and Maceri reported on their experience using a retrolabyrinthine transsigmoid approach in three patients with vertebrobasilar aneurysms. The authors performed a radical modified mastoidectomy exposing an area bordered superiorly by the floor of the middle fossa and the superior petrosal sinus, inferiorly by the jugular bulb and anteriorly by the posterior semicircular canal. By removing the bone over the sigmoid sinus and a few centimeters behind it, the posterior fossa dura anterior and posterior to the sigmoid sinus was exposed and the sinus divided. Using this exposure, which avoided transection of the tentorium, two aneurysms of the basilar artery trunk and one vertebrobasilar junction aneurysm were clipped successfully. In the same year, Solomon and Stein summarized their experiences of surgical approaches to aneurysms of the vertebral and basilar arteries. Among their group of 44 patients, five patients with midbasilar aneurysms were treated using a combined supra-infratentorial exposure, with transection of the sigmoid sinus and tentorium. In 1992, Rosenberg and coworkers reported on three patients with aneurysms of the vertebrobasilar circulation, who were operated on using a retrolabyrinthine transsigmoid approach, identical to the one initially described by Gianotta and Maceri. Using this exposure the authors were able to successfully obliterate an aneurysm of the lower basilar trunk as well as an aneurysm of the vertebrobasilar junction. Also in 1992, Spetzler and coworkers presented their surgical results in 46 cases of tumorous and vascular lesions of the petrous and clival region, operated on using a combined supra- and infratentorial approach. Among the nine vascular lesions treated, there were two patients with midbasilar artery aneurysms, in whom both lesions could be clipped using the retrolabyrinthine, presigmoid variation of the combined exposure. King and coworkers in 1993 presenting their results of the transpetrosal approach in various petroclival lesions, reported on three patients with basilar trunk aneurysm and one patient with a vertebrobasilar junction aneurysm operated on using this exposure. In 1993, summarizing their results of the application of skull base approaches to complex cerebral aneurysms in 22 patients, Origitano and coworkers from Al-Mefty’s group reported on one patient with a giant aneurysm of the basilar trunk as well as another patient with an aneurysm located at the vertebrobasilar junction in whom surgery was performed via the transpetrosal approach. One aneurysm was successfully clipped, while the giant aneurysm was trapped. In 1994, Mizoi and coworkers presenting their surgical results in five patients with basilar trunk...
aneurysms, in whom temporary balloon occlusion of the basilar artery was used as an adjunct to aneurysm clipping, included two patients operated on via a combined supra-infratentorial transpetrosal approach. Finally in 1994, Sekhar and coworkers detailed their surgical results of cranial base approaches in 38 intracranial aneurysms. Among these cases, three vertebrobasilar aneurysms were approached successfully via the transpetrosal presigmoid approach. These data from the literature are in good agreement with our experiences in the use of the transpetrosal route for basilar trunk and vertebrobasilar junction aneurysms in eleven patients so far. However, indications for this approach must be considered cautiously, and weighted against the possible application of other more routine approaches to vertebrobasilar aneurysms. However, as almost all aneurysms of the upper third of the basilar trunk are relatively easy accessible by either the pterional and subtemporal approach, and most aneurysms of the vertebral artery can be satisfactorily reached by the retrocondylar far lateral approach, aneurysms of the lower basilar trunk and vertebrobasilar junction are located in a sort of “no man’s land.” For this region, those supra- or infratentorial approaches can only be applied with difficulties and considerable risk of damage to the neighboring neurovascular structures of the brain stem and cranial nerves. Having applied the combined supra- and infratentorial transpetrosal approach in over 40 patients over a period of 9 years in a large variety of tumors of vascular clivus-related lesions, the excellent exposure and almost retraction-free access to lower basilar trunk and vertebrobasilar junction aneurysms is one of the most pleasant experiences in the use of this approach. Under the prerequisite of adequate knowledge of the complex anatomy of the petrous bone and experience in skull base approaches the application of this procedure for surgery of selected vertebrobasilar aneurysms is straightforward, without relevant approach-related complications, and, following anatomic closure of the petrosectomy defect, excellent cosmetic result.

References

92 V. Seifert


Address reprint requests to: V. Seifert, M.D., Department of Neurosurgery, University of Leipzig, Johannisallee 34, 04104 Leipzig, Germany.