TECHNICAL NOTE

Combined Pre- and Retrosigmoid Approach for Petroclival Meningiomas with the Aid of a Rotatable Head Frame: Peri-Auricular Three-Quarter Twist-Rotation Approach: Technical Note

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ABSTRACT

We used the combined subtemporal presigmoid and suboccipital retrosigmoid multidirectional approach with the aid of a rotatable head frame (periauricular three-quarter twist-rotation approach) in 20 cases of petroclival meningiomas. Patients were placed in the lateral decubitus (park-bench) position. The head is twisted, rotated, and positioned 30 degrees face down in the Sugita rotatable head frame. By rotating this head frame, a 30- to 60-degree face-down position can be obtained when the suboccipital retrosigmoid route is used. Alternatively, the straight lateral or slightly brow-up position is obtained when the subtemporal presigmoid route is used. This twist-rotation approach provides multiple trajectories through the petroclival region with minimal drilling of the petrous bone, fatigue of the surgeon, and retraction of the brain.

KEYWORDS: Petroclival meningioma, rotatable head frame, multidirectional approach

Petroclival meningiomas are difficult to remove through a single surgical approach. Many surgeons have used various types of "combined" approaches with extensive drilling of the bone and frequent tilting of the operating table.[1–5] By tilting the operating table, however, nuchal twisting and flexing are avoided. We used a rotatable head frame for the combined subtemporal presigmoid and suboccipital retrosigmoid multidirectional approach. The surgical techniques are described; the

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method should be avoided in cases complicated by cervical spondylosis.

TECHNIQUE

The patient is placed in the lateral decubitus position (park-bench position), and the upper half of the body is tilted upward 30 degrees. The patient's head is rotated face down 30 degrees, tilted vertex down 15 to 30 degrees (according to the extent of tumor encroachment on the brain stem), and flexed chin down 15 degrees so that the nuchal muscles are extended adequately. This position is maintained while the patient's head is fixed in the four-pin, Sugita head frame,[6] which can be rotated more than 90 degrees at maximum (Fig. 1). The pins are placed on the skull so that the head can be rotated down (face down) 60 degrees (Fig. 2, left) and rotated up (brow up) 30 degrees (Fig. 2, right).

An umbrella-shaped incision is made with the handle of the umbrella immediately in front of the tragus of the ear. The posterior arc of the incision extends to the nuchal midline from C_3 to C_5, according to the required extent of the posterior fossa craniotomy (Fig. 2). In the initial stage of the craniotomy procedure, the patient's head is rotated 60 degrees face down. The surgeon stands in front of the back of the patient (Fig. 3, left), and the retrosigmoid suboccipital craniotomy is performed. The medial margins of the lateral and sigmoid sinus are exposed down to the condylar fossa, and the posterior rim of the foramen magnum is removed with rongeurs. Near the foramen magnum, the dura is opened. The cerebrospinal fluid is aspirated to help shrink the brain for the later subtemporal approach. This dural opening is extended to the junction between the transverse and sigmoid sinuses.

Next, the patient's head is rotated back to the straight lateral or slightly brow-up position. The surgeon moves to the vertex of the patient's head (Fig. 3, right). A temporobasal craniotomy, incorporating the bone over the lateral sinus, is performed. The outer table of the mastoid process is stripped off and preserved for later closure of the craniotomy. The rest of the mastoid bone is drilled off to expose the sigmoid sinus. These procedures are the same as in the conventional presigmoid posterior transpetrosal transtentorial approach.

When tumor invades the cavernous sinus, a subtemporal anterior petrosectomy is performed

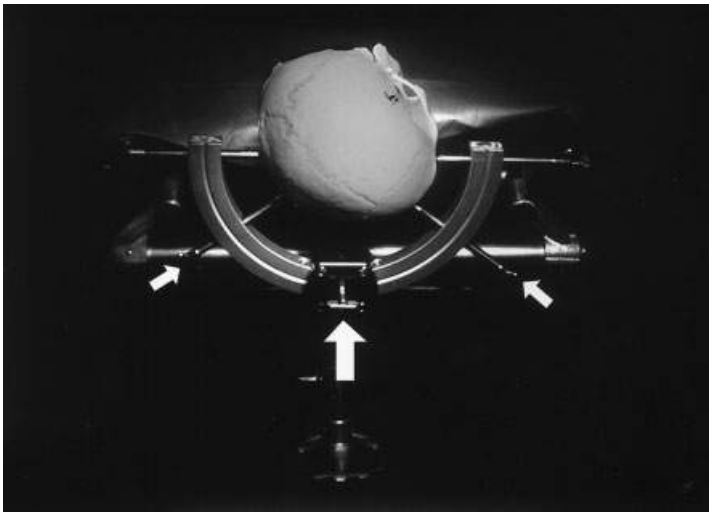

Figure 1 Sugita head frame. The Sugita head frame can be rotated between the two pins (small arrows) by loosening the lock of the device (long arrow).

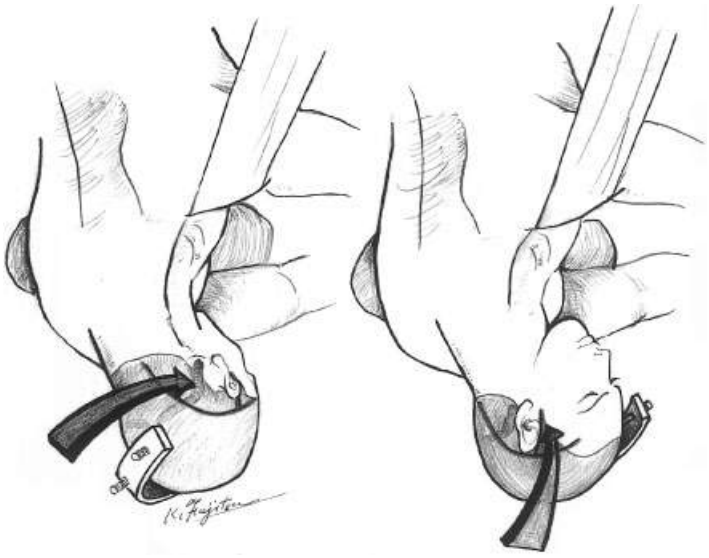

Figure 2 Umbrella-shaped incision and periauricular three-quarter twist-rotation approach. By increasing the degree of the face-down position, the retromastoid posterior fossa route is entered (left, arrow). By rotating the frame back, a straight lateral or slightly brow-up position is obtained for the subtemporal route (right arrow). Via this subtemporal route, both the presigmoid posterior transpetrosal and anterior transpetrosal approach are possible.

instead of a posterior petrosectomy. In such cases the anterior petrosectomy and tentorial incision are performed in the subdural space, not in the epidural[7]space. If the surgeon intends to perform both an anterior and posterior petrosectomy,[2] drainage of the petrosal vein should be maintained carefully through either end of the petrosal sinus. The exposed transverse and sigmoid sinuses are covered

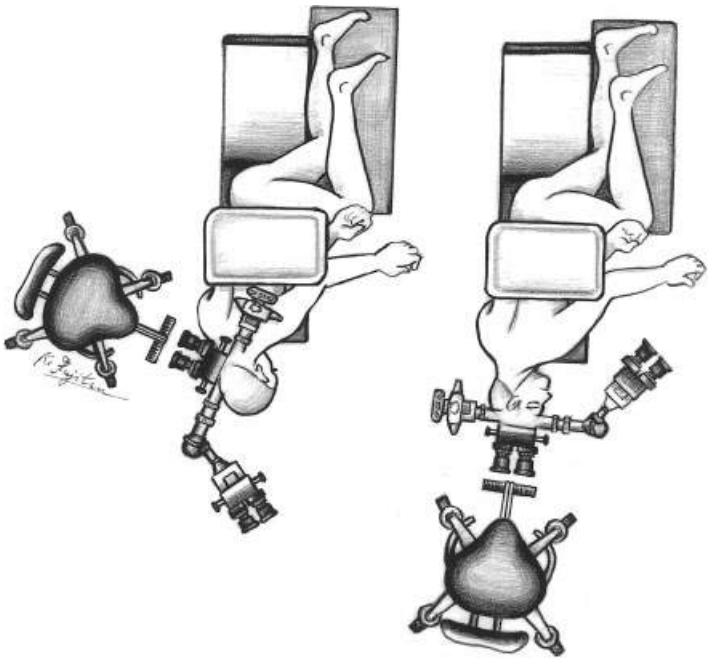

Figure 3 Surgeon's position change. The surgeon sits in front of the back of the patient when using the suboccipital route (left) and moves to the vertex when working in the subtemporal route (right).

with cottonoids and should be kept wet by frequent irrigation with normal saline solution.

The following intradural procedures are conducted with the aid of a ceiling-mounted operating microscope. The surgeon frequently changes his position by driving a lightweight mobile chair. For the first step of the intradural procedure, the patient's head is set in the straight lateral or slightly brow-up position. The surgeon sits in front of the vertex of the patient (Fig. 3, right). Then, the presigmoid posterior transpetrosal route is approached because this route is better suited for obliteration of the feeding arteries than the suboccipital route. The petrosal sinus is ligated and cut near its lateral end, and the incision is extended to the tentorial edge. Feeding arteries from the tentorial edge are coagulated and cut with careful attention paid to the trochlear nerve. The connection of the vein of Labbé with the lateral sinus should be preserved carefully and protected by the posterior half of the cut tentorium.

Observation before attack is most important in this multidirectional combined approach. By rotating the patient's head suitably and by changing the surgeon's position between the vertex and the back of the patient, the tumor surface is carefully observed between the rostral and caudal poles. For the suboccipital approach, the patient's head is fixed 30 to 60 degrees in the face-down position. The surgeon sits in front of the patient's back (Fig. 3, left).

For a deep-seated petroclival meningioma, the trigeminal, facial, acoustic, and lower cranial nerves are observed over the relevant surface area of the tumor. Between each cranial nerve, the tumor is partially debulked near its attachment. The feeding arteries are coagulated and cut. After this devascularization procedure is performed as extensively as possible, the tumor is debulked substantially between the nerves. An ultrasonic aspirator or large blade microscissors may be used for this portion of the procedure. The cranial nerves are carefully covered with oxidized cellulose gauze and cottonoids through either the subtemporal or suboccipital route. After the tension on these stretched nerves is decreased substantially, the tumor is dissected from each nerve. The tumor often extends to Dorello's canal. Careful curettage is required near this structure.

Near the last stage of the decompression procedure, the rest of the tumor is dissected from the brain stem. In some cases the pia-arachnoid plane of the brain stem is partially lost. Even in such cases, however, total dissection from the brain stem is possible without major neurological deficits unless the brain stem perforating arteries are obliterated. To avoid perforator injury, bipolar coagulation should be avoided as much as possible during brain stem dissection. The petrosal vein and its major tributaries also should be preserved.

After the skull base dura invaded by tumor has been resected, the dura of the temporal convexity is closed water-tight. The craniotomy bone flaps, including the outer table of the mastoid bone, are fixed with the aid of microtitanium plates. When dural involvement extends to the lateral petrosal region, the dura around this region is resected and replaced by the fascia obtained from the temporal muscle or fascia lata.

OUTCOMES

Between 1993 and 2003, 20 cases of petroclival meningioma underwent the periauricular three-quarter twist-rotation approach. In all cases the tumor was large, encroaching on the trigeminal nerve at the rostral pole and on the lower cranial nerves at the caudal pole. The facial and acoustic nerves were observed on the dorsal surface of the tumor in 3 cases and were displaced ventrally in the remaining 17 cases. In 17 cases tumor removal included resection or electrocoagulation of the invaded dura of the petroclival region. There were no recurrences during a follow-up period from 4 months to 10 years (mean, 37 months).

In three cases the tumor had invaded the posterior cavernous sinus. An intradural anterior petrosectomy[7] was performed instead of a posterior

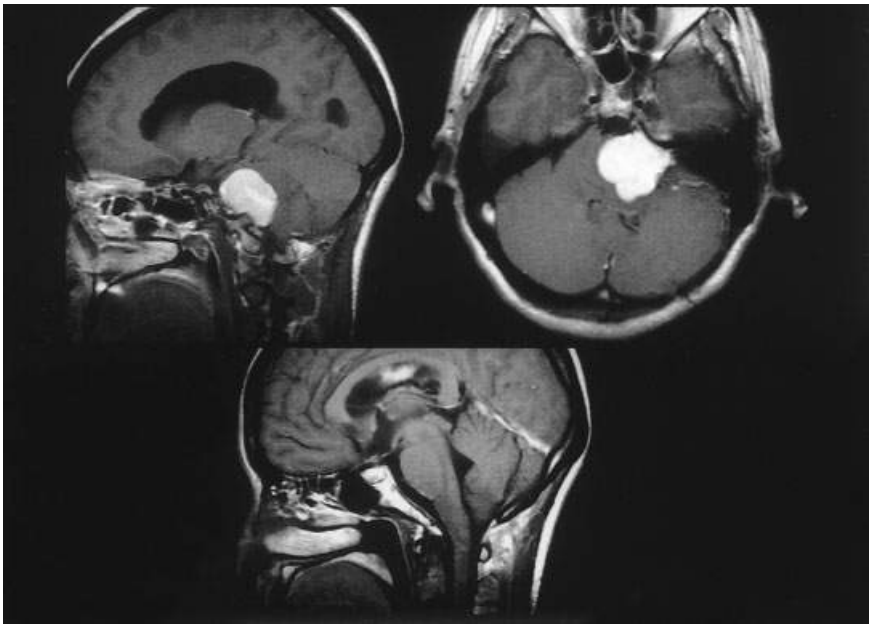

Figure 4 Preoperative sagittal and axial MRIs (upper left and right) show that the tumor attachment is ventral to the facial and acoustic nerves. Through the ''twist-rotation'' approach (lower), both the posterior and superior lips of the acoustic canal were drilled and the tumor was totally removed.

petrosectomy. In these three cases, the cavernous portion of the tumor was subtotally removed, and the residual tumor was treated by stereotactic radiosugery. During follow-up periods of 4 months, 5 years, and 9 years, respectively, there was no regrowth of the residual tumor.

There were no deaths or major neurological deficits. Minor neurological deficits were as follows. Mild cerebellar ataxia (possibly due to operative injury of the middle cerebellar peduncle) of the ipsilateral upper limb was observed in one case. Incomplete Wallenberg's syndrome was observed in two cases. The trochlear nerve was accidentally sectioned in two of these three cases. In both cases the nerve was sutured, and diplopia improved after 6 months. In one case (Fig. 4), mild facial nerve palsy and hearing loss were present after the patient's initial operation at another hospital. These deficits were unchanged after the second operation at our institution. In this and another case, temporary ipsilateral abducens nerve paresis was observed postoperatively but disappeared in 1 and 3 months, respectively. Hearing disturbance was unchanged in two cases, and mild facial nerve palsy followed surgery in these two patients.

ILLUSTRATIVE CASE

A 52-year-old woman operated on at another hospital 2 years earlier had her tumor partially removed. Hoarseness, swallowing disturbance, facial nerve palsy, and hearing loss followed the operation. The hearing loss and mild facial paresis were still present before the second operation at our institution.

During the second operation, the tumor was seated ventral to the facial and acoustic nerves, encroaching rostrally on the trigeminal nerve, caudally on the lower cranial nerves, and medially on Dorello's canal. The tumor attachment was ventral to and between the porus of the acoustic canal and the jugular foramen (Fig. 4, top). Through the twist-rotation approach, both the posterior and superior lips of the acoustic canal were drilled 1 cm to trace the facial nerve, and the tumor was

totally removed (Fig. 4, bottom). Immediately after surgery, the preoperative cranial nerve impairments were unchanged, and ipsilateral abducens nerve paresis occurred. Six months postoperatively, the abducens nerve paresis disappeared and her facial nerve paresis was improving.

DISCUSSION

A large petroclival meningioma is difficult to remove through a single approach. Many workers have used various types of "combined" approaches that involve extensive exposure of the sigmoid sinus by extensive drilling of the bone in the petrous region.[1–5] In the trans-sigmoid approach in the sitting position, the sigmoid sinus is cut and the drainage of the vein of Labbé is maintained through the transverse sinus to the confluence of the sinuses.[8] This approach is a combined subtemporal and suboccipital multidirectional wide approach. It is contraindicated when the ipsilateral transverse sinus is hypoplastic.[9] Because our combined pre- and retrosigmoid approach does not require transection of the sigmoid sinus, obstruction of this sinus is not a contraindication.

When a surgeon uses a combined subtemporal and suboccipital approach[5] in the lateral position with a conventional head holder, the sides of the operating table must be tilted up and down frequently during surgery. However, only limited tilting of the operating table is possible. Moreover, even at maximum tilt, the posterior fossa is quite difficult to approach because nuchal twisting and flexing are limited. Therefore, the use of a rotatable head frame is mandatory for our approach. For this reason, we named it the "twist-rotation" approach.

Generally speaking, the principal advantage of the presigmoid posterior transpetrosal transtentorial approach is that the main feeding artery can be obliterated during an early stage of the approach. However, in this approach, the posterior surface of the pyramidal apex is also difficult to observe. Drilling the pyramidal apex (anterior petrosectomy[7]) is necessary to manipulate the tumor attachment on the posterior surface of the pyramidal apex or the tumor invasion into the cavernous sinus. This extended drilling almost always leads to obstruction of the drainage of the petrosal vein into the cavernous sinus. Therefore, an anterior petrosectomy should not be performed when the petrosal sinus has been cut in its lateral end through the posterior petrosal approach. When tumor invades the cavernous sinus, an intradural subtemporal anterior petrosectomy and tentorial incision should be chosen. A fairly good view of the posterior surface of the pyramidal apex is obtained through the suboccipital approach. The technical disadvantages of this approach, however, are that the working distance is rather long and many cranial nerves impede access to the pyramidal apex. Moreover, early control of the feeding arteries is difficult to obtain through the suboccipital approach.

In summary, combining the subtemporal pre- and suboccipital retrosigmoid approach offers advantages and overcomes the disadvantages of each individual approach. In our combined approach, not only should the patient's head be rotated frequently, but the surgeon also should move between the vertex and the back of the patient. The surgeon should always assume the best position to obtain the best view, without stressing or straining his or her neck and backbone. A comfortable posture is most important to prevent fatigue and to maintain skill and concentration. For this purpose, a lightweight and easily mobile chair is essential, and a ceiling-mounted operating microscope is desirable. The height of the chair should be adjustable with a pedal (Fig. 2).

The rotatable head frame, however, must be used carefully in cases complicated by cervical spondylosis. We used this head frame in one case in which cervical spondylosis complicated the petroclival meningioma. For preoperative test positioning in this case, the patient's head was kept twisted and rotated 45 degrees for several minutes and was then rotated back to the straight lateral position and maintained there another several minutes. During this maneuver, the patient made no complaints.

Postoperatively, no neurological impairment referable to the cervical spondylosis resulted. Nevertheless, we do not recommend the use of a rotatable head frame[10] in cases of associated cervical spondylosis. In such cases, the angle of surgical approach should be adjusted by tilting the operating table. Intraoperative neurophysiological monitoring also may be helpful.

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Commentary

Fujitsu and colleagues describe a novel technique for varying the positioning of a patient's head during skull base surgery using the freedom of rotation offered by the Sugita head holder. They applied this approach to a series of patients with petroclival meningiomas. The authors approached these tumors with combined transpetrosal approaches tailored to the anatomy of each individual patient. Because different parts of the surgery require different trajectories, the angle at which the surgeon must work also changes. To maintain the most comfortable working position for the surgeon, the authors rotated the head holder during surgery.

Skull base approaches such as these typically take a long time, and the procedures can be tiring. During any operation, a comfortable surgeon is more likely than an uncomfortable one to do a good job. During these sorts of surgeries, the need for the surgeon to be comfortable is redoubled. The surgeon should always seek to maintain a comfortable position by working in a neutral neck position, by using armrests, and by securing the patient firmly in the bed for easy rotation so that the surgeon can stay in the same place. The authors detailed a variety of other methods that they use to promote the surgeon's comfort, including use of an operating chair and a ceiling-mounted microscope. We also support the use of an adjustable operating chair in particular.

The authors detail an umbrella-shaped incision that provides broad exposure of the petrous area. This combined approach is somewhat complicated, but the authors' results justify the effort. This article represents a nice addition to the technical literature on this topic.

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