4.0 Retrosigmoidal approach

History of the lateral suboccipital approaches

The suboccipital method of gaining access to the lateral posterior fossa and cerebellopontine angle was first used successfully by Sir Charles Ballance in 1894, who operated on a *"fibrosarcoma of the meninges"* attached to the dural covering of the posterior surface of the petrous bone. The operation was carried out in two stages and the tumor was extracted by finger dissection between the sensitive neurovascular structures. The patient survived with residual trigeminal and facial nerve injury [Ballance 1894].

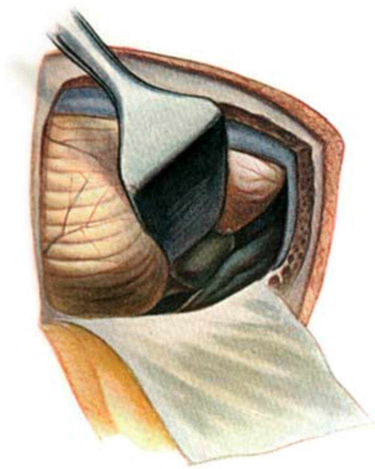


Fig. 4.0.1 *In 1903, Krause described a unilateral exposure for skull base tumors and his name has been identified with the unilateral suboccipital approach, regardless of the many modifications that followed. Note the placement of the craniotomy exposing the transversal and sigmoidal sinus.*

Nevertheless, the surgical treatment of cerebellar and extracerebellar tumors was characterized by a very high mortality rate due to the rough and crude procedures used. During the early period of neurosurgery, other attempts at removal of space-occupying lesions within the lateral posterior fossa were so unsuccessful that surgeons were reluctant to undertake these operations. In 1893, Allen Starr published 15 cases of cerebellar tumors with only one instance of complete tumor removal and neurological recovery of the patient. On account of these frustrating results, Hermann Oppenheim classified cerebellar lesions as inoperable and reported a more than 70% mortality rate [Starr 1893, Oppenheim 1902].

Concerning extracerebellar lesions of the cerebellopontine angle such as acoustic neurinomas and meningeomas, the prevailing mortality for an operation in the hands of most skilled surgeons ranged from 58% by Victor Horsley to 83.8% by Fedor Krause as presented at the International Neurological Congress in 1913. Such failures have been attributed to several factors including the undeveloped preoperative diagnostic tools, limited optical control, and the use of fingers in enucleating the neoplasm. Krause also advocated a blunt finger dissection causing associated injury to several sensitive neurovascular structures (Fig. 4.0.1). His crude surgical technique resulted in a mortality rate ranging from 67% to 88% [Krause 1913].

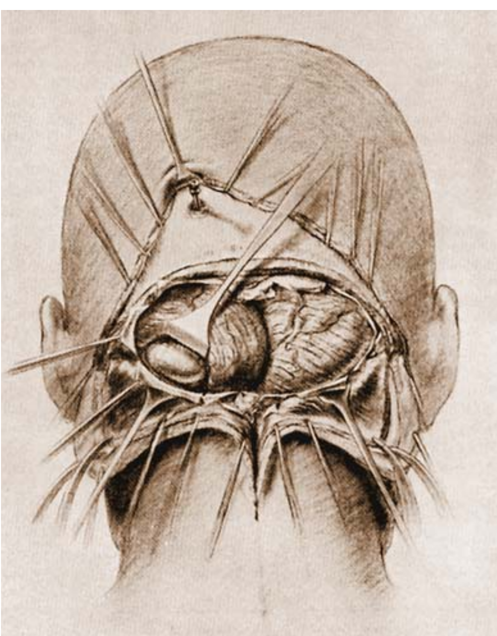


Fig. 4.0.2 *Cushing's operation for approaching an acoustic neurinoma. His bilateral exposure through a crossbow incision allowed effective decompression of the posterior fossa. Note the puncture of the left lateral ventricle avoiding increased intracranial pressure during surgery.*

At the beginning of the 20th century, surgeons sought a safe and less invasive approach to the cerebellopontine angle, especially for removal of benign acoustic neurinomas (Fig. 4.0.2). Harvey Cushing, in 1905, described a bilateral exposure of the cerebellar hemispheres through a "crossbow incision" resulting in avoidance of brain stem compression during surgery. On the basis of his experience on cadaver dissection, Charles H. Frazier, in 1905, also recommended a bilateral approach, exposing the unilateral posterior fossa with resection of the outer part of the cerebellar lobe [Cushing 1905, Frazier 1905].

As a means to preserve the brain stem and vital vessels, Cushing introduced the palliative concept of intracapsular subtotal removal of tumors of the cerebellopontine angle. His first encounter with an acoustic neurinoma was in 1906. Later he described this frustrating experience as the *"gloomy corner in neurologic surgery"*. However, using his developed techniques in 187 patients suffering from acoustic neurinomas, he was able to lower the previously unacceptable mortality rate to a more reasonable level of 13%. However, an additional 40% of patients eventually died within 5 to 10 years because of subsequent tumor recurrence after subtotal resection [Cushing 1932].

In 1917, the same year in which Cushing presented his classical monograph on „Tumors of the Nervus Acusticus", Walter E. Dandy, impressed by the potential curability of benign tumors, described a more aggressive surgical approach for total removal (Fig.4.0.3). His approach consisted of a unilateral suboccipital craniectomy, internal tumor decompression and complete removal of the encapsulated neurinoma [Dandy 1925]. In 1941, Dandy published his series of 46 patients with a mortality rate of 11%; however, all patients lost their hearing on the operated side and 95% had an additional facial paralysis [Dandy 1941]. In 1939, Gilbert Horrax, another of Cushing's assistants, and James L. Poppen reported their results with a 5-year mortality rate of 18%; however, 65% of the surviving individuals were neurologically intact after complete removal of the acoustic neurinomas [Horrax & Poppen 1939]. In Herbert Olivecrona's series, which totalled 415 cases, complete recovery of the facial nerve was observed in 29% with small tumors compared with only 7% with large neurinomas [Olivecrona 1949]. E. Stephens Gurdjian and Ludwig J. Kempe reported very similar results, approaching the cerebellopontine angle through a unilateral suboccipital exposure (Fig. 4.0.4, 4.0.5) [Gurdjian 1964, Kempe 1970].

A tremendous development in preoperative assessment and the revolutionary use of microneurosurgical techniques after introduction of the surgical microscope resulted in a marked improve-

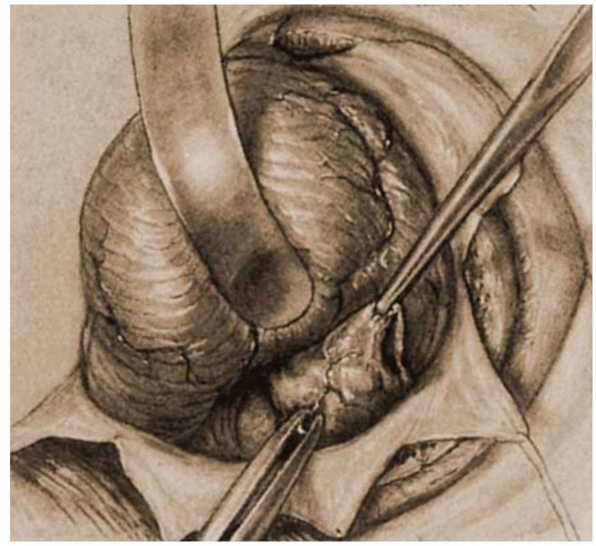


Fig. 4.0.3 *Unilateral access to an acoustic tumor described by Dandy in his article "An operation for the total removal of cerebellopontine (acoustic) tumors", published in 1925. His approach illustrated "the method by which traction on the excavated capsule of the lower pole strips the remaining tumor from the brain stem and brings into view the vessels which cross from the brain stem".*

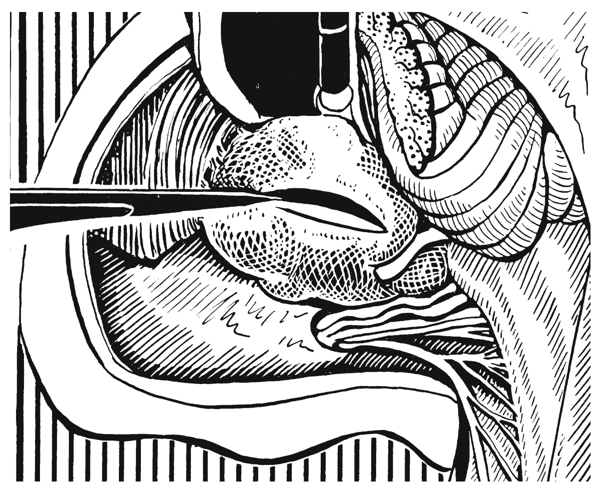


Fig. 4.0.4 *Gurdjian's unilateral suboccipital approach to a cerebellopontine tumor after partial resection of the cerebellar hemisphere. Note the use of an illuminated retractor of a type suggested by Frazier in 1928, allowing better visualization of the surgical field.*

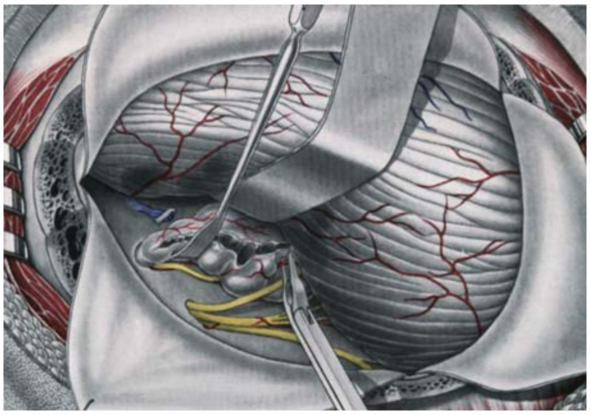


Fig. 4.0.5 *Macrosurgical removal of an acoustic neurinoma, as demonstrated by* KEMPE *in 1970. Note the careful dissection of the facial nerve.*

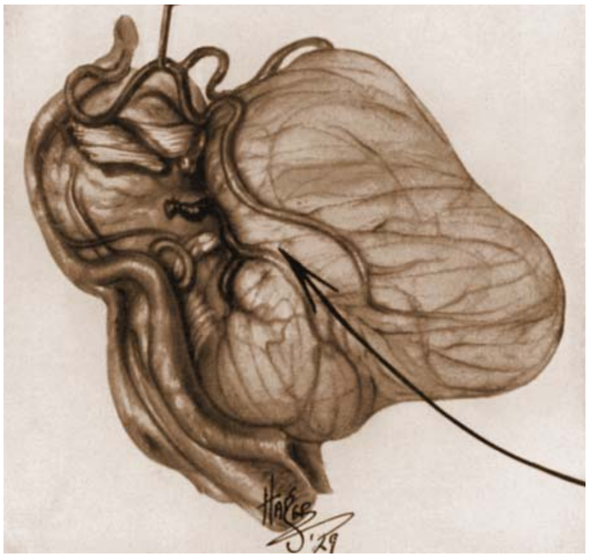


Fig. 4.0.6 DANDY*'s unilateral exposure of the fifth nerve. In this case, a caudal loop of the SCA caused severe tic douloureux.*

ment in postoperative results. Using a transmeatal retrosigmoidal approach, ROBERT W. RAND and THEODORE KURZE reported in their series of 140 patients operated between 1964 and 1980, 100% preservation of the facial nerve in cases with small acoustic tumors [RAND & KURZE 1980]. Also other pioneers of modern microneurosurgery published their first results of acoustic neurinomas operated with a lateral suboccipital approach [YASARGIL 1976, KOOS 1976, SAMII 1981].

At that time, not only neurosurgeons but also otological surgeons were familiar with operative removal of acoustic neurinomas. In 1968, WILLIAM HOUSE reported 133 cases in which a lateral suboccipital translabyrinthine approach was used for moderate and large tumors. UGO FISCH, another proponent of the microotologic technique, published his results using pre- and retrosigmoidal approaches in the early 1970s [HOUSE 1968, FISCH 1970].

The lateral suboccipital approach was also used by the above-mentioned authors for other space-occupying lesions of the lateral posterior fossa such as meningeomas, epidermoids, chordomas, chondromas. By different variations, lesions of the tentorium [SAMII 1981], petrous bone [YASARGIL 1980], clivus [HAKUBA 1977], and foramen magnum [PERNECZKY 1986] were successfully treated.

In 1934, WALTER E. DANDY postulated that arterial compression and distortion of the trigeminal nerve might be the cause of the trigeminal neuralgia [DANDY 1934]. Employing a unilateral suboccipital craniectomy, he exposed the sensory root of the trigeminal nerve at the root entry zone into the pons (Fig. 4.0.6). He described

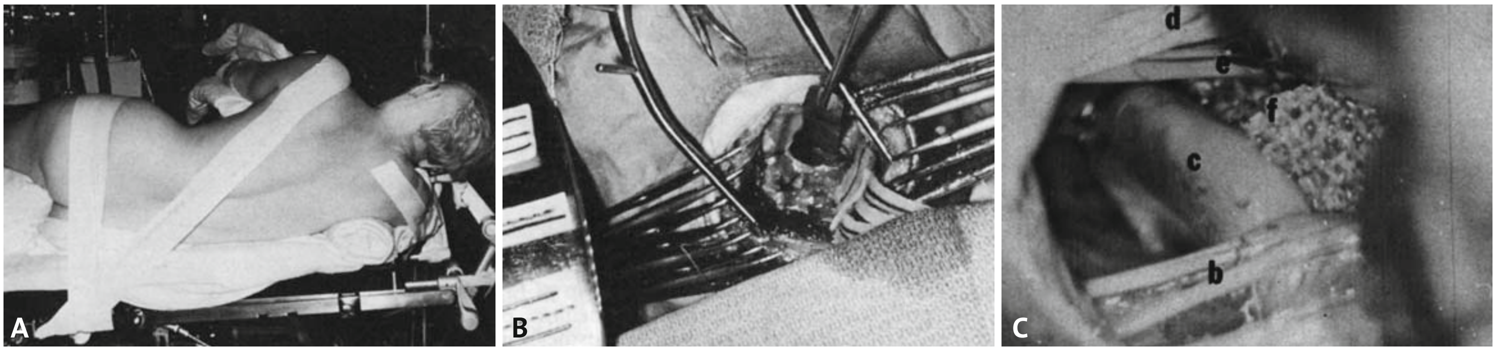


Fig. 4.0.7 JANNETTA*'s microsurgical decompression of the seventh nerve causing hemifacial spasm. Note the lateral decubitus or so-called park bench position exposing the left retroauricular area (A). After performing a limited retrosigmoidal craniotomy (B), the cerebellopontine angle was approached using microsurgical techniques. Intraoperative microphotograph (C) showing the lower cranial nerves. Note the prosthesis (f) between the facial nerve (e) and vertebral artery (c) achieving effective vascular decompression.*

66 of his 215 patients as having vascular abnormalities in relation to the sensory root and demonstrated the superior cerebellar artery as affecting the nerve in more than 30% of his patients who suffered from trigeminal neuralgia. The vascular compression theory failed to gain acceptance at that time; however, W. JAMES GARDNER in 1959 cited DANDY's prior observations and suggested that the mechanical factor could be important in causing severe neuralgia [GARDNER 1959]. As a result, he developed the neurovascular decompression operation for tic douloureux. This operation was further refined by PETER J. JANNETTA and ROBERT W. RAND in 1966 (Fig. 4.0.7) [JANNETTA & RAND 1967]. In 1962, GARDNER described a neurovascular compression mechanism at the brain stem exit zone of the facial nerve as the most frequent cause of hemifacial spasm. In his original operation, GARDNER placed a small square of gelfoam between the compressing vessel and the facial nerve, via a retrosigmoidal approach [GARDNER 1962]. Etiology and microsurgical treatment of the hemifascial spasm was also described by JANNETTA and coworkers [JANNETTA 1970, 1977].

The first successful operation on an aneurysm of the vertebral artery or its branches via suboccipital craniotomy was performed by HENRY SCHWARTZ in 1946 and reported in 1948 [SCHWARTZ 1948]. The majority of cases were treated by unilateral craniectomy using a sitting or semiprone park bench position as descibed by CHARLES DRAKE and WALLACE HAMBY (Fig. 4.0.8) [DRAKE 1965, HAMBY 1969]. In 1984, YASARGIL described a paramedian infracerebellar keyhole approach for aneurysms of the posterior inferior cerebellar artery in the first volume of his pioneering work „Microneurosurgery" (Fig. 4.0.9) [YASARGIL 1984].

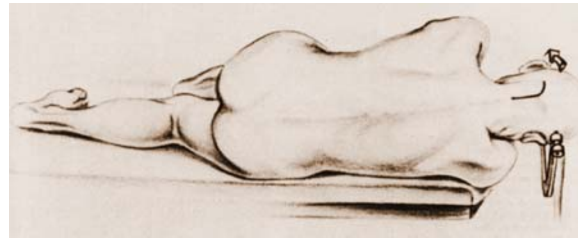
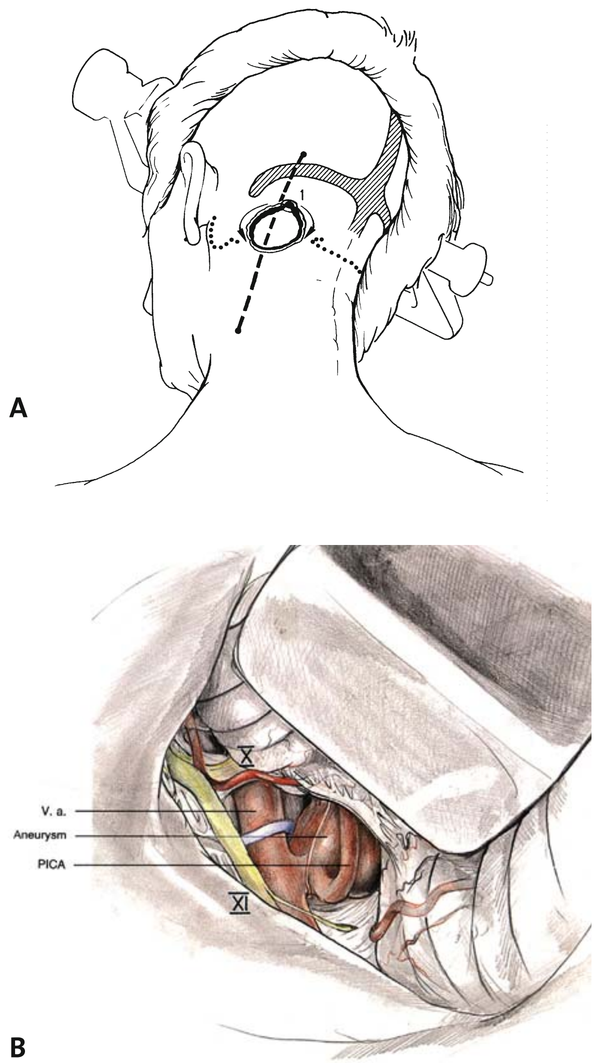


Fig. 4.0.8 *Park bench positioning of a patient treated for an aneurysm of the vertebral artery. Note the so-called hockey stick skin incision, published by DRAKE in 1979.*

A



B

Fig. 4.0.9 *YASARGIL's paramedian infracerebellar access for a small aneurysm of the PICA, described in his book "Microneurosurgery" published in 1984. Note the sitting position of the patient (A). Through the retrosigmoidal craniotomy, YASARGIL approached the aneurysm in a minimally invasive manner avoiding crude retraction of the cerebellar hemisphere (B).*

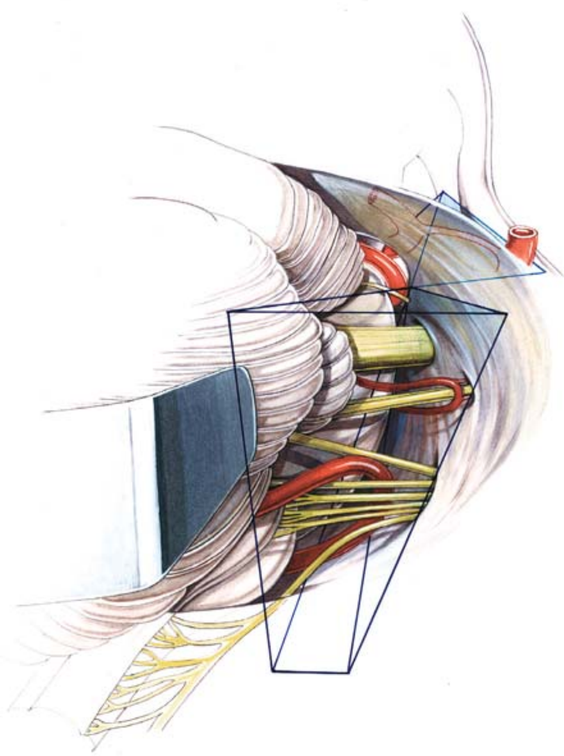


Fig. 4.0.10 *Artist's drawing demonstrating the cerebellopontine angle as a virtual pyramid. This virtual construction also helps to understand how anatomical structures are displaced in the case of space-occupying lesions within the posterior fossa.*

Use of the keyhole concept in the lateral suboccipital, retromastoidal approaches and general anatomical construction of the cerebellopontine angle

As described above, the surgical outcome after lateral suboccipital approaches improved markedly with the use of modern microneurosurgical techniques. However, the first reports already realized the value of retromastoidal exposures using the concept of keyhole surgery. Due to the small surface of the suboccipital area, an extended craniotomy and dural opening could not be used; nevertheless, surgeons were able to overview almost the entire posterior fossa.

In creating these limited lateral suboccipital, retrosigmoidal approaches, some anatomical characteristics should be described in detail.

The cerebellopontine angle is situated between the posterior surface of the petrous temporal and the petrosal surface of the cerebellar hemisphere. The third through the twelfth cranial nerves are located near or within the angular space between the two limbs of the cerebellopontine fissure formed by the petrosal cerebellar surface folding around the pons and middle cerebellar peduncle.

Compared with the suprasellar area, the cerebellopontine angle can also be defined as a pyramid-shaped space, but inclined anteromedially with its apex extending to the posterior clinoid process and the base facing the inner surface of the squamosal part of the temporal and occipital bones. The superior side corresponds to the retrosellar area including the CN III and the inferior surface of the tentorium, with the CN IV running through it. The inferomedial side is close to the foramen magnum, including the vertebral artery and the CN XII. The anterior and posterior sides are represented by the posterior surface of the petrous bone and the petrosal surface of the brain stem and cerebellum, respectively. The majority of vital structures, such as the superior cerebellar, anterior inferior, posterior inferior cerebellar arteries, and the third to twelfth cranial nerves, are confined in the medial third of the pyramid (Fig. 4.0.10).

Approaching the anatomical structures of the cerebellopontine angle, different target regions require different variations in the shape, placement and size of the retrosigmoidal craniotomy (Fig. 4.0.11).

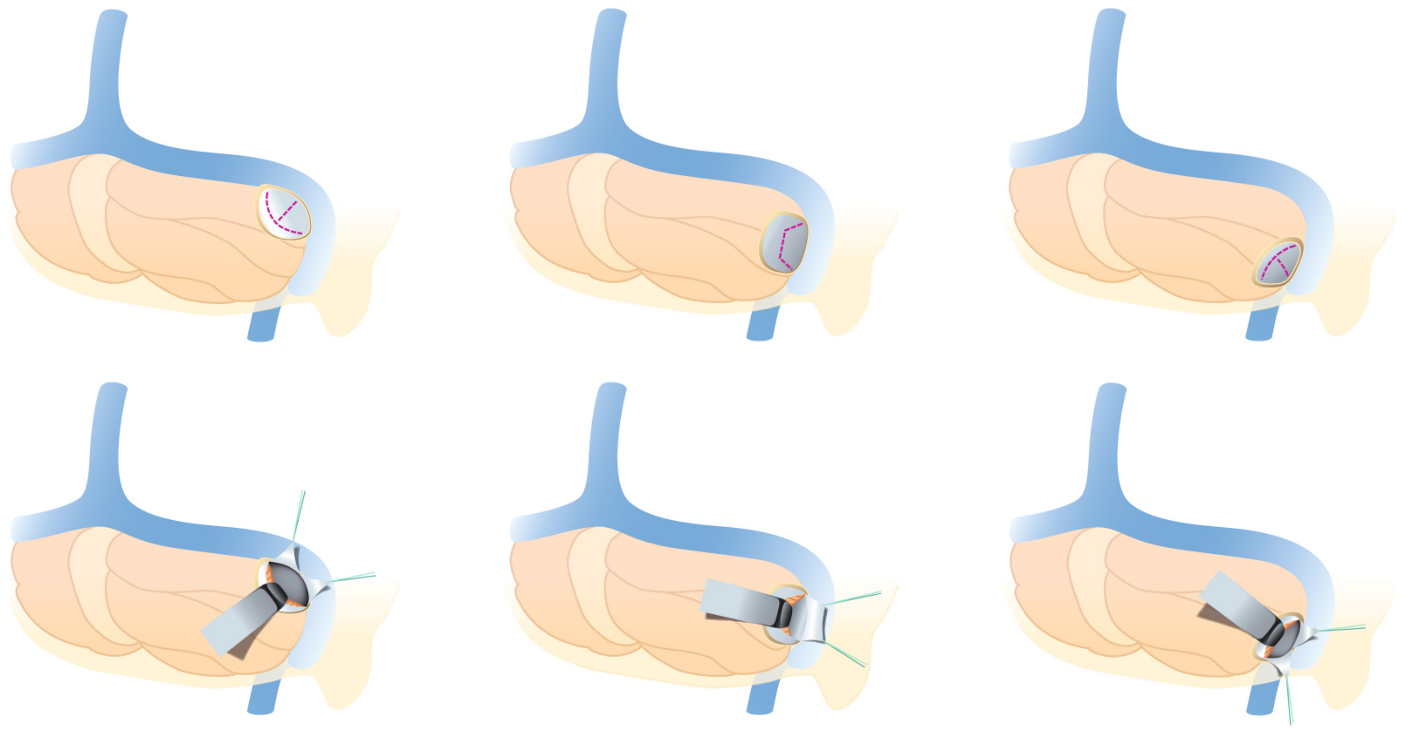


Fig. 4.0.11 *Superior, central and caudal variants of the retrosigmoidal approach. The different variations each require a different performance of the craniotomy, dural opening and a different placement of the cerebellar retractor.*

Superior variation	Central variation	Caudal variation
Transversal sinus Sigmoid sinus Superior petrosal sinus Angle between the posterior surface of the petrous bone and the tentorium Tentorial incisura Upper petrosal and lateral tentorial surface of the cerebellum Posterolateral surface of the mesencephalon CN III, CN IV, CN V, CN VI CN VII, CN VIII Basilar apex, incl. perforators PCA, SCA Petrosal vein of Dandy	Transversal sinus Posterior surface of the petrous bone IAC Petrosal surface of the cerebellum Flocculus Posterolateral surface of the pons CN V, CN VI, CN VII CN VIII, CN IX, CN X, CN XI BA, AICA, PICA, incl. perforators Bochdalek's choroid plexus of the fourth ventricle	Transversal sinus Posterior surface of the petrous bone and craniocervical junction Foramen magnum Jugular foramen Petrosal and suboccipital surface of the cerebellum Posterolateral surface of the medulla oblongata CN VII, CN VIII, CN IX, CN X CN XI, CN XII BA, vertebrobasilar junction, VA PICA, incl. perforators Bochdalek's choroid plexus of the fourth ventricle

Table 4.0.1 *Anatomical structures exposed by different variations of the lateral suboccipital, retrosigmoidal approach.*

For observation of the upper neurovascular complex, the superior variation should be performed. The craniotomy is placed at the transition of the transverse sinus into the sigmoid sinus and the size of the triangular craniotomy should be ca. 10 to 20 mm. The dural opening should allow safe dissection in the angle between tentorium and the posterior surface of the petrous bone. Exposing the trigeminal nerve, the spatula is placed parallel to the superior petrosal sinus.

For exposure of lesions of the midportion of the cerebellopontine angle such as acoustic neurinomas, the craniotomy should be placed below the transverse sinus just medial to the sigmoid sinus. The size of the craniotomy according to this central variation of the retrosigmoidal approach ranges from 15 to 20 mm and the shape should be quadrangular. The dural opening should be done in a curved fashion with its base toward to the sigmoid sinus. The brain spatula is placed parallel to the sigmoid sinus retracting and protecting the lateral surface of the cerebellum.

Exposing the lower neurovascular complex and the foramen magnum, the craniotomy should be performed more caudally along the sigmoid sinus. The size of the caudal variation of the craniotomy should be ca. 20 mm, with a triangular form allowing a nontraumatic placement of the brain retractor.

Surgical technique

1. Patient positioning

Patient positioning for lateral suboccipital, retromastoidal approaches is highly controversial. The sitting, prone, supine or park bench positions for exposure of the lateral posterior fossa offer different advantages and drawbacks; however, positioning of the patient does not particularly affect the surgical options offered by the lateral suboccipital approach.

According to our experience, we use the simple supine position for the majority of our patients. During surgery, the surgeon remains at the ipsilateral shoulder of the patient, providing an efficient working position. Advantages of this positioning are the simplicity of the technique for both surgeons and nurses, and comfort for the patient. Venous and CSF congestion is minimal compared with the prone or semiprone park bench positions and the position supports the gravity-related self-retraction of the cerebellar hemisphere. After removal of CSF, the cerebellum usually sinks spontaneously and subsequently, significant retraction of the cerebellar hemisphere is not necessary. However, this positioning has also considerable limitations especially in patients with very short necks and prominent shoulders. In such cases, the excessive cervical twisting required with this approach may cause kinking of the main cervical vessels, making a prone position necessary.

Step 1

The head is elevated above the level of the thorax. This maneuvre facilitates additionally the cranial venous drainage and decompresses the larynx, the ventilation tube and the main cervical vessels (Fig. 4.0.12).

Step 2

The head is carefully rotated 75°–100° to the contralateral side and the ipsilateral shoulder is elevated with a cushion (Fig. 4.0.13). The degree of exact rotation depends on the precise location of the lesion. Dissecting toward the brain stem, a rotation of ca. 75° is sufficient. On the other hand, if the surgeon has to overview the lateral aspect of the posterior fossa including the internal auditory canal and Meckel cave, the head requires a rotation of more than 90°. To some degree, the availability of new-generation, electrically motorized operating tables enables readjusting of patient posi-

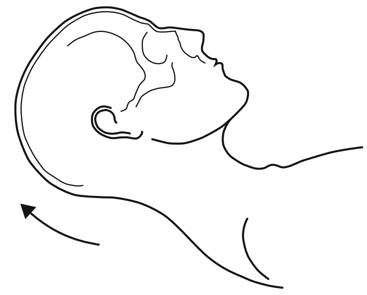


Fig. 4.0.12

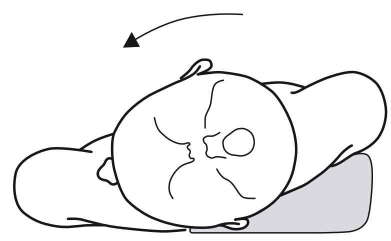


Fig. 4.0.13

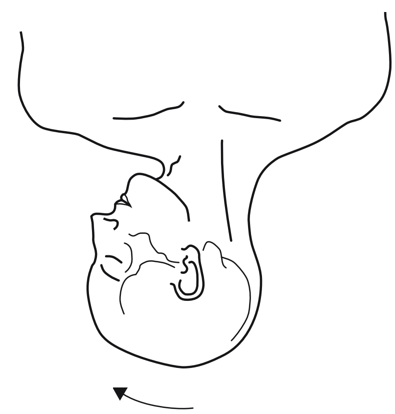


Fig. 4.0.14

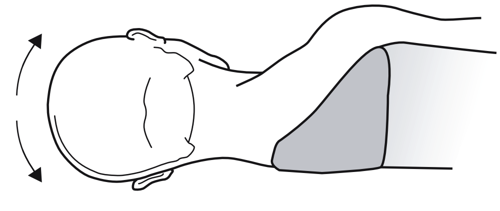


Fig. 4.0.15

tioning during surgery and with an additional tilting of the operating table, an effective rotation of up to 120° can be achieved.

Step 3

In a third step, the head may be anteroflected about 10° in order to achieve an efficient working position for the surgeon without disturbance of the ipsilateral shoulder. However, special care should be taken not to compress the ventilation tube and the larynx (Fig. 4.0.14).

Step 4

The degree of lateroflexion depends on the exact surgical target. When exposing the cerebellopontine angle with structures around the IAC according to the central variation of the retrosigmoidal approach, the head should be positioned in the horizontal plane without lateroflexion. Approaching the foramen magnum region through the caudal variation, the head should be elevated to ca. 10°–15°. When exposing the inferior surface of the tentorium and the upper neurovascular structures of the cerebellopontine angle via the superior variation of the craniotomy, the head should be minimally depressed, allowing optimal visualization during surgery (Fig. 4.0.15).

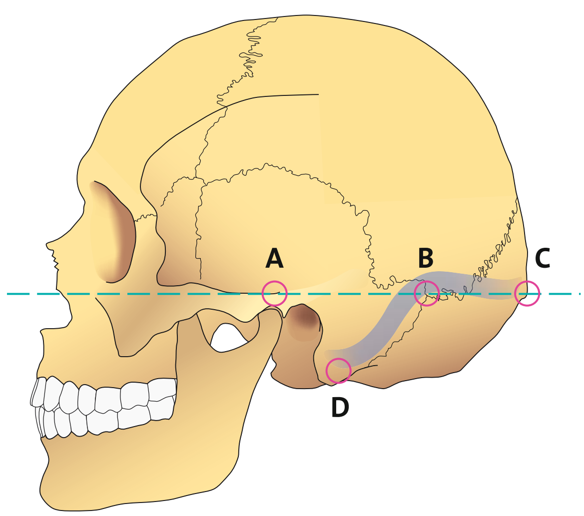


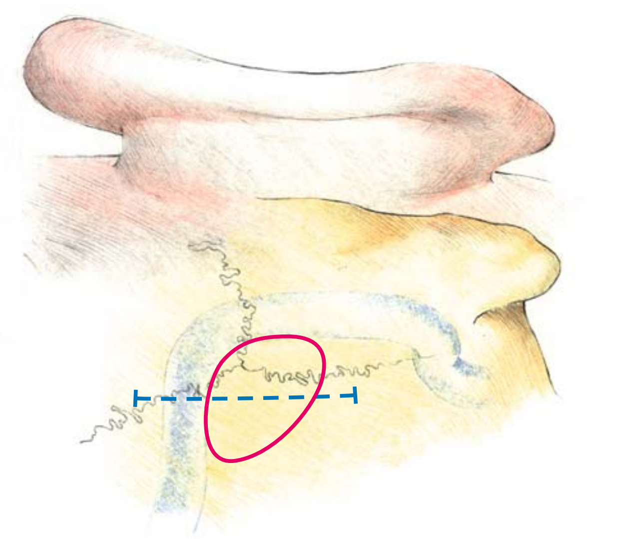
Fig. 4.0.16 *Definition of the transversal and sigmoid sinus, according to the anatomical landmarks of the retroauricular-retromastoidal region. Note the supramastoid crest (A), asterion (B), external occipital protuberance (C) and the mastoid process (D).*

2. Anatomical landmarks and orientation

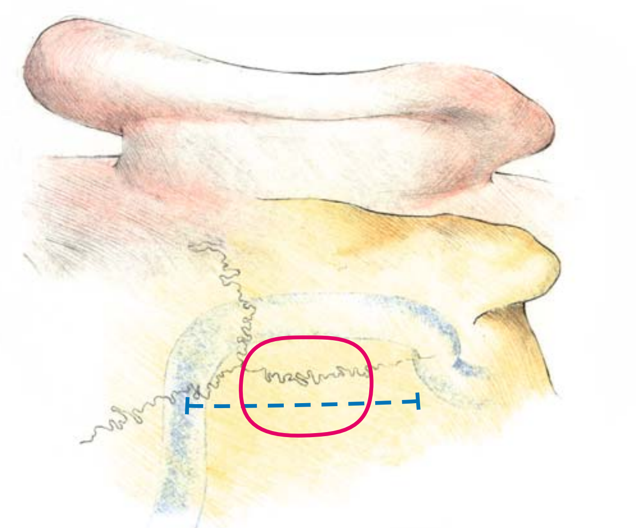
For preoperative orientation, the important anatomical landmarks of the lateral temporooccipital osseous skull such as the zygomatic arch, external auditory meatus, suprameatal crest, mastoid process and incisura, asterion and the external occipital protuberance are precisely defined. Special attention must be given to the course of the transverse and sigmoid sinus. There are several tricks for accurate localization of the transition of the transversal to the sigmoidal sinus as a key to the exact craniotomy. We emphasize a definition according to the landmarks of the zygomatic arch, supramastoid crest, mastoid process, asterion, and the external occipital protuberance (Fig. 4.0.16). In addition, the appearance of emissary veins and alterations in the level and material of the dura may help to provide accurate sinus definition. However, despite careful orientation, variations of the sinusoid vessels can create surprising difficulties during the first steps of the operation.

After the essential orientation, the borders of the craniotomy are marked with a sterile pen. As described above, taking into consideration the target region, we can distinguish three main variations in the placement of the craniotomy (Fig. 4.0.17). For the central part of the cerebellopontine angle as a target region, the craniotomy should be placed below the transverse sinus just medial to the sigmoid sinus (B). For the upper and lower neurovascular complex as target point, the craniotomy should be placed superiorly (A) or caudally (C) with its anterior border closing the sigmoid sinus, respectively. The diameter of the craniotomy may range from 10 to 20 mm.

After definition of the craniotomy, the hair is shaved retroauricullary according to the line of the skin incision which is ca. 30 to 50 mm in length; the skin is disinfected carefully.



A



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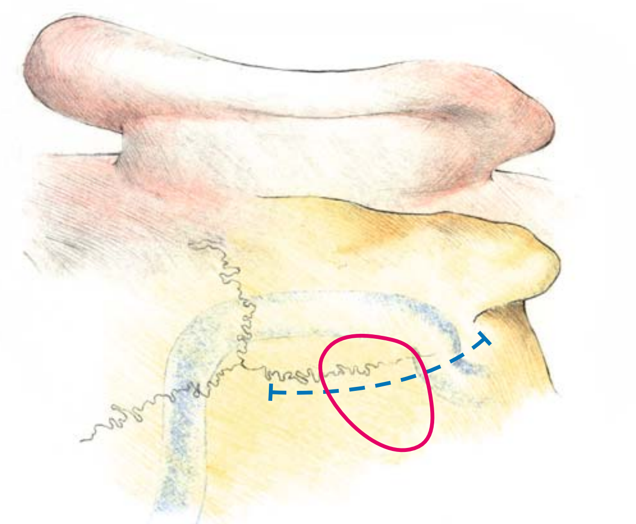


C

Fig. 4.0.17 *Definition of the craniotomy according to the anatomical landmarks of the retroauricular-retromastoidal area and according to the target region.*

A: superiorly placed approach for the upper neurovascular complex including the CN V and SCA.

B: centrally placed craniotomy for the AICA and the facial-vestibulocochlear complex.

C: caudally placed approach for the lower neurovascular structures with the CN IX, CN X, CN XI, CN XII and the PICA.

Note the occipitomastoid, parietomastoid and lambdoid sutures with the asterion and the precise definition of the transversal and sigmoid sinus.

3. Craniotomy and dural opening

Step 1

Right side. A straight or slightly curved skin incision within the retroauricular area is made. The skin incision should be created over the posterior third part of the planned craniotomy, otherwise the retracted muscular layer may hinder intradural visualization. In the further course of the operation, this maneuvre provides easy application of the operating microscope and surgical dissection with microinstruments (Fig. 4.0.18).

Step 2

After bilateral retraction of the skin and the subcutaneous tissue, the sternocleidomastoid fascia is incised in a longitudinal straight fashion. The insertion of the sternocleidomastoid muscle is then freed, exposing the occipitomastoidal area. In cases with thick muscular layers or a caudal extension of the craniotomy, the splenius capitis, longus capitis and superior oblique muscles are separated from their attachments to the bone. Note that the muscular tissue should be freed carefully to the anterior mastoid region, but forcibly in the posterior occipital direction, allowing optimal exposure after craniotomy. Special care is taken to observe the occipital artery when it appears from the arterial sulcus of the occipital bone. Emissary veins are also usually exposed in the mastoid area, indicating the close course of the sigmoid and transverse sinuses. Local hemostasis should be performed rapidly and precisely (Fig. 4.0.19).

Step 3

After bone exposure, a tiny groove is usually visible according to the asterion, which is usually located at the inferior margin of the transverse sinus just posterior from the transition into the sigmoid sinus. Other bony structures such as the occipitomastoid, squa-

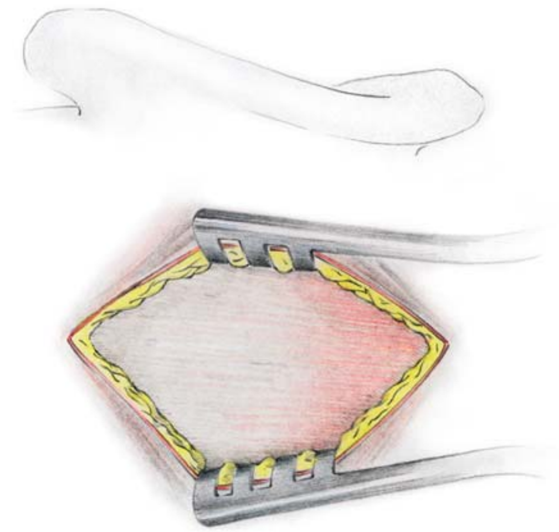


Fig. 4.0.18

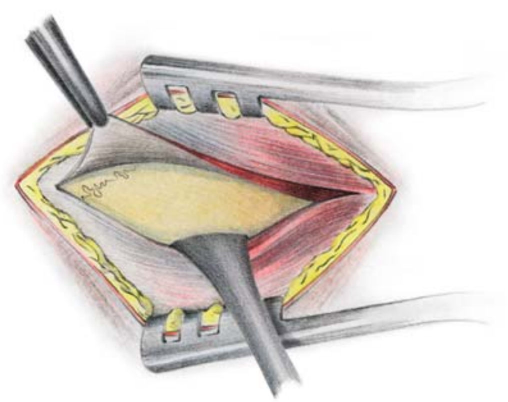


Fig.4.0.19

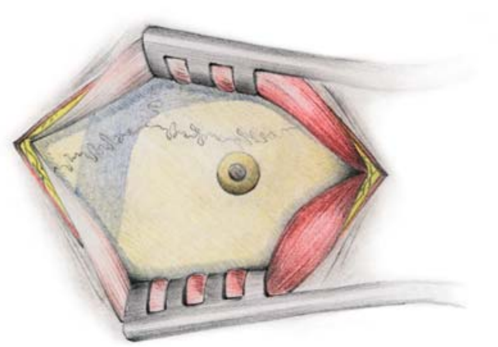


Fig. 4.0.20

Fig. 4.0.21

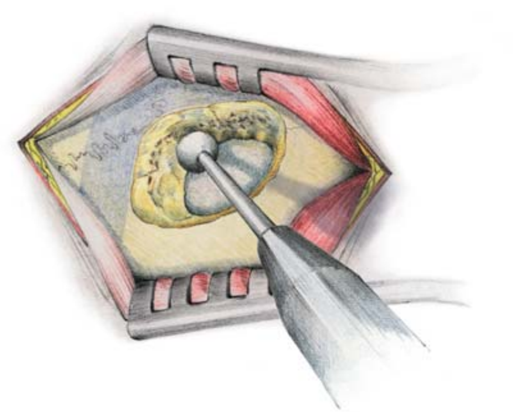


Fig. 4.0.22

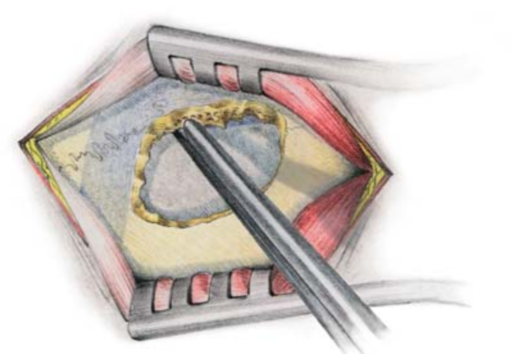
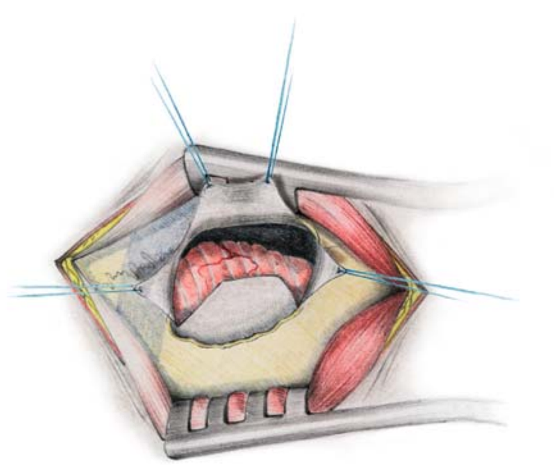


Fig. 4.0.23



mosal and lambdoid sutures and the mastoid incisura may also help to identify the course of the sigmoid sinus. After identification of the important bony landmarks, a burr hole is placed according to the occipitomastoid suture, just caudally from the asterion. We prefer an osteoclastic craniotomy using high-speed drill avoiding a hazardous osteoplastic procedure near to the prominent sinusoid vessels (Fig. 4.0.20).

Step 4
Further bone is removed with the high-speed drill exposing the edge of the sigmoid sinus (Fig. 4.0.21).

Step 5
An important step of the approach is the removal of the inner edge of the craniotomy using fine punches whilst protecting the dura. With careful removal of this inner bone edge, the angle for visualization and manipulation can significantly increase, allowing a direct line of sight down the posterior surface of the petrous bone. For exposure of the cerebellopontine angle, a square-shaped craniectomy is sufficient according to placement of the brain spatula and to the main direction of surgical dissection (Fig. 4.0.22).

Step 6
The dura should be opened in a curved fashion with its base toward the sigmoid sinus. The free dural flap is fixed laterally with two sutures; other dural elevation sutures are not required. In some cases, according to the individual situation, minimal enlargement of the dural opening may be necessary in a Y-shaped form (Fig. 4.0.23).

4. Intradural dissection

Step 1

Right side. Dissection shown on fresh human cadavers. Arterial vessels are prepared with red, veins with blue colored solution. After opening the dura mater, the cerebellar surface can be observed. Note a prominent superficial vein running from the suboccipital to the tentorial surface of the cerebellum. In this case, the craniotomy was performed close to the junction between the transversal and sigmoid sinus (Fig. 4.0.24).

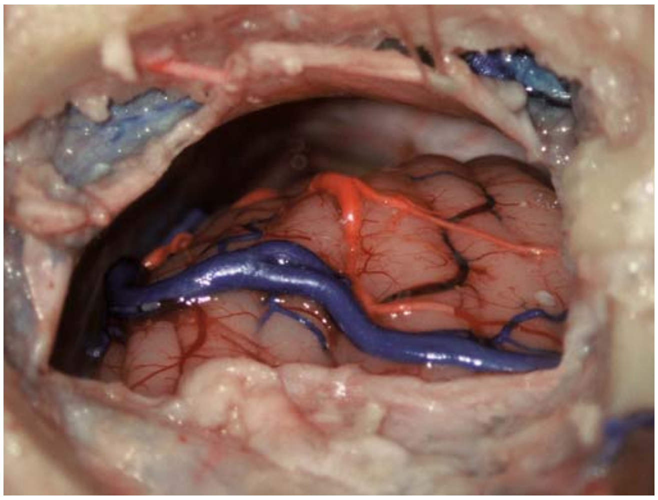


Fig. 4.0.24

Step 2

After gentle mobilization of the cerebellum, the angle between the tentorium and the posterior surface of the petrous bone can be approached according to the course of the superior petrosal sinus. After opening the arachnoid membranes, adequate amounts of CSF should be aspirated supporting gravity-related self-retraction of the cerebellar hemisphere. The spatula is placed parallel to the superior petrosal sinus protecting the upper lateral surface of the cerebellum (Fig. 4.0.25).

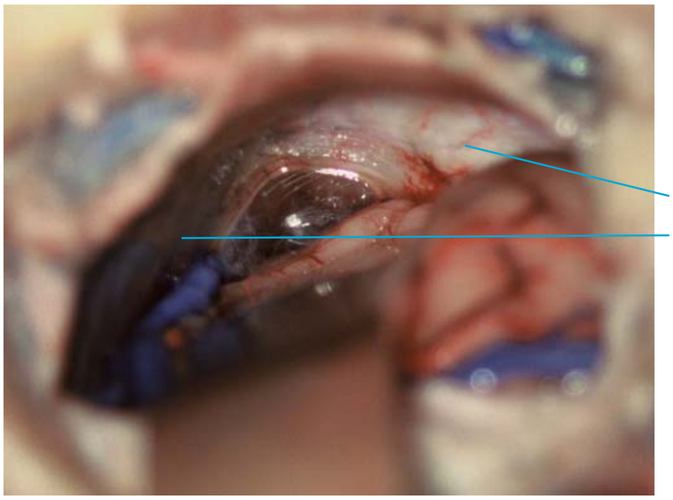


Fig. 4.0.25

Step 3

After aspiration of CSF, the petrous vein of Dandy and the CN V are exposed. The upper neurovascular complex can be optimally exposed with the superior variation of the retrosigmoidal approach (Fig. 4.0.26).

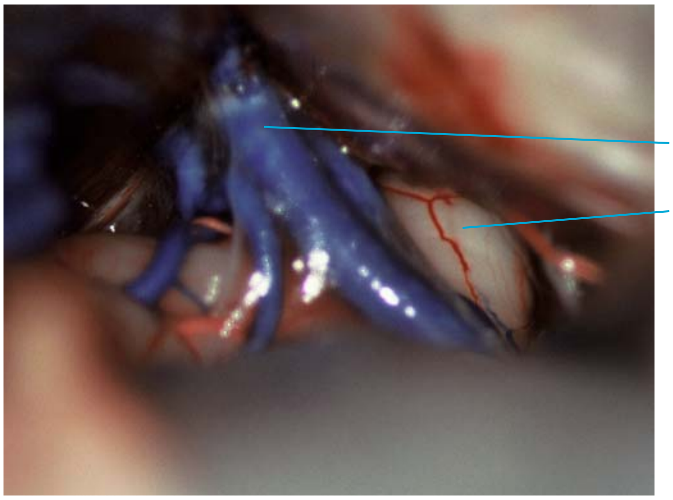


Fig. 4.0.26

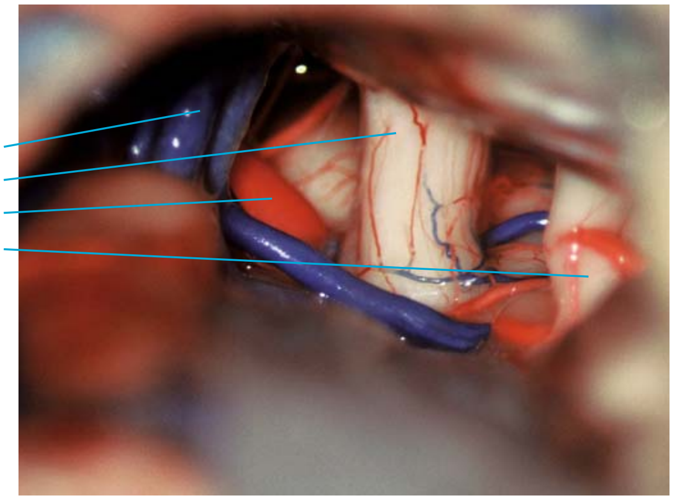


Fig. 4.0.27

Step 4

After further dissection of arachnoidal membranes within the upper cerebellopontine angle, the relationship between the petrous vein, CN V, CN VII and CN VIII becomes evident. Note a prominent SCA close to the CN V (Fig. 4.0.27).

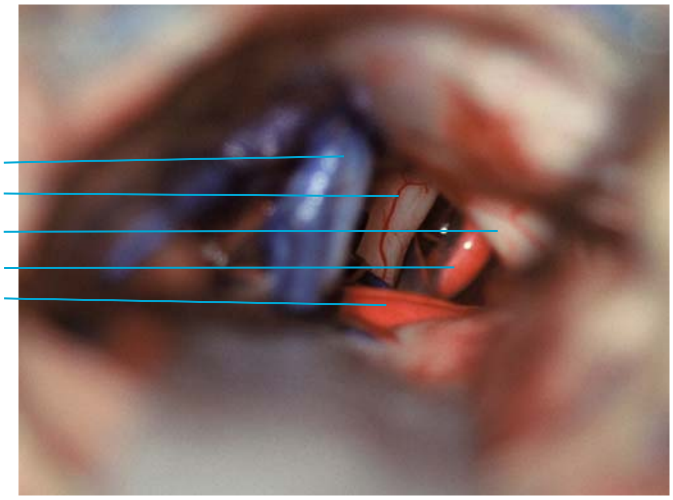


Fig. 4.0.28

Step 5

Between the petrous vein and CN V, a deep-seated area with the CN III is approached. Note the double SCA and the PCoA (Fig. 4.0.28).

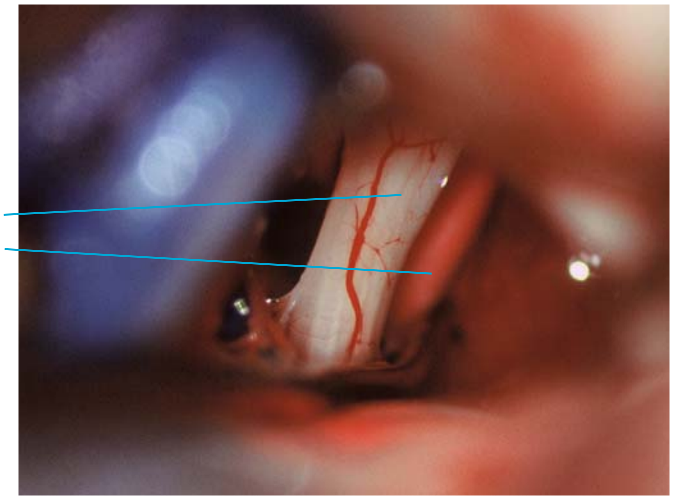


Fig. 4.0.29

Step 6

Higher magnification of the CN III. In the background, the PCoA appears (Fig. 4.0.29).

Step 7
Dissecting in a caudal direction from the CN V, the facial and vestibulocochlear nerves are exposed. Note the flocculus (Fig. 4.0.30).

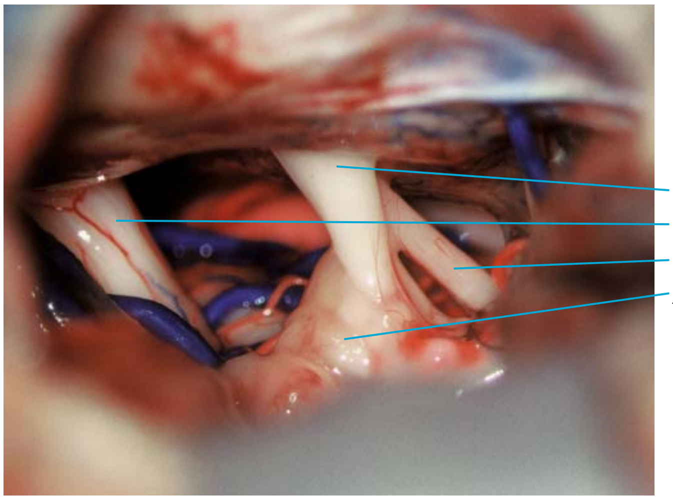


Fig. 4.0.30

Step 8
Focusing into the deep-seated prepontine area, the BA and the CN VI are visualized. Note the venous vessels of the anterolateral surface of the pons (Fig. 4.0.31).

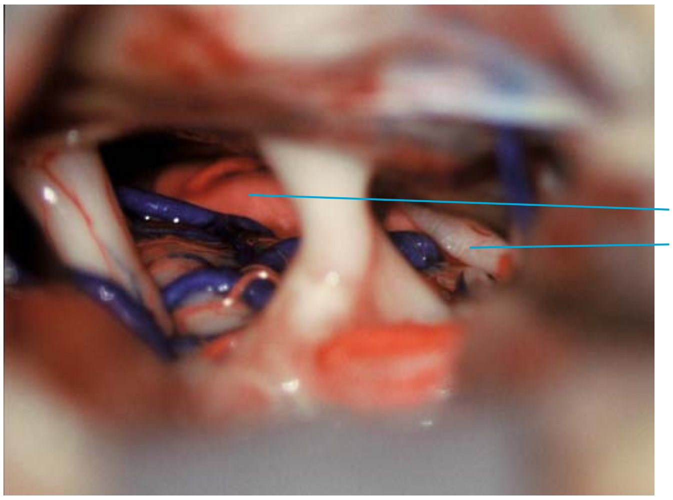


Fig. 4.0.31

Step 9
In a more caudal course of dissection, the region of the jugular foramen is approached. Note the loop of the AICA between the facial and glossopharyngeal nerves. Bochdalek's choroid plexus of the fourth ventricle appears close to the CN X (Fig. 4.0.32)

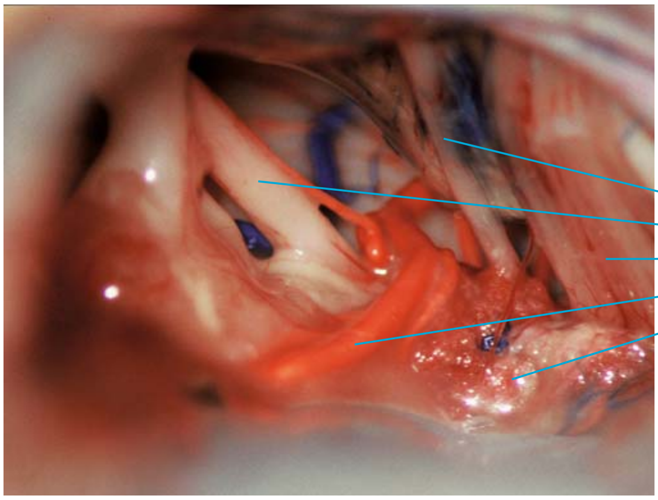


Fig. 4.0.32

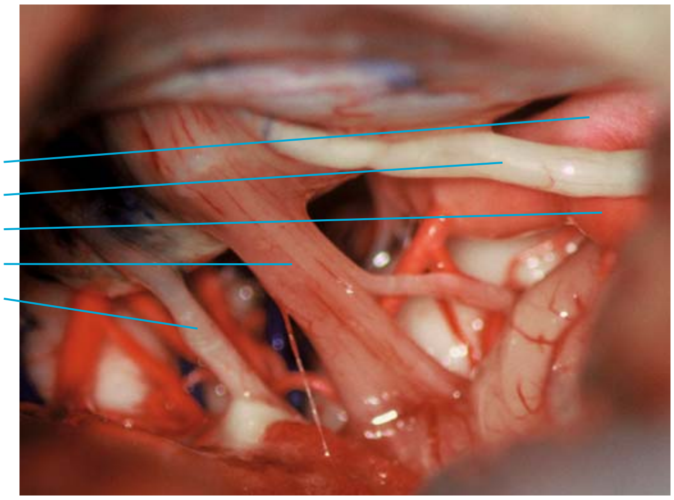


Fig. 4.0.33

Step 10
Exposure of the lower cerebellopontine angle with the CN IX, CN X and CN XI. Note the origin of the PICA from the VA (Fig. 4.0.33)

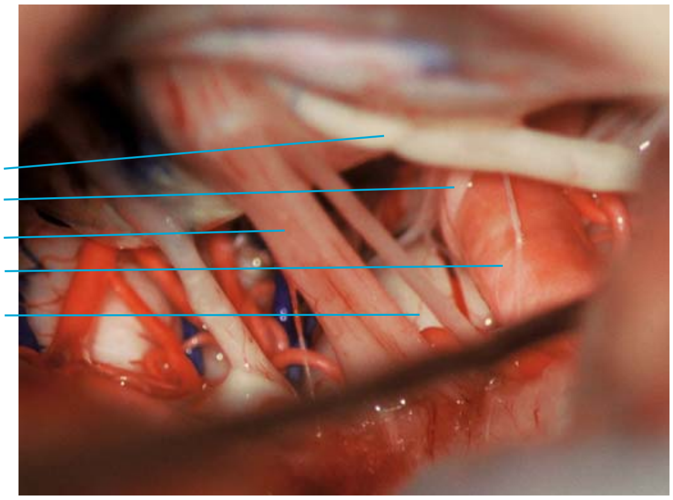


Fig. 4.0.34

Step 11
Center of attention is the surface of the VA with fibers of the hypoglossal nerve. Note the anterolateral surface of the medulla oblongata (Fig. 4.0.34)

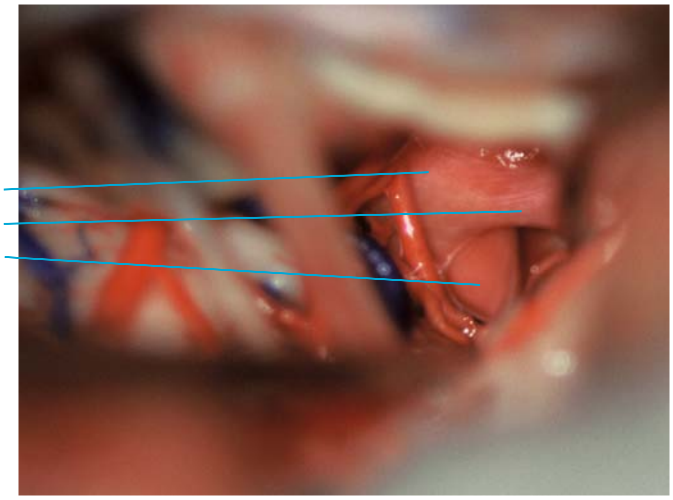


Fig. 4.0.35

Step 12
Dissecting along the anterior foramen magnum, the junction of both vertebral arteries can be well visualized (Fig. 4.0.35)

5. Dura, bone and wound closure

After completion of the intracranial procedure, the intradural space is filled with Ringer solution at body temperature. The dural incision is closed with interrupted or continuous sutures. If tension has developed in the dural plane, a small piece of muscle can be used for a watertight closure; in other cases, plastic material may be required. A plate of gelfoam is placed extradurally and the craniectomy is closed with bone cement. After final verification of hemostasis, the muscle and subcutaneous layers are closed with interrupted sutures and the skin with running or interrupted sutures. A suction drain is not necessary.

Potential errors and their consequences

- Inadequate preoperative planning with the consequence of inadequate exposure of the target region and significant deterioration in efficiency of surgical exposure of the target region. As the most important part of procedure, planning is the task of the surgeon!
- Special attention should be paid to patient positioning. Inadequate positioning may cause compression of the main cervical vessels resulting in hypoperfusion or severe venous congestion in the posterior fossa.
- Inadequate placement of the surgical approach causing injury to the transverse or sigmoid sinus with severe venous bleeding. The approach must be determined after accurate surgical orientation according to anatomical knowledge and preoperative planning.
- Inadequate removal of CSF with severe contusion of adjacent portions of the cerebellar hemisphere due to spatula pressure. Increasing pressure within the posterior fossa may cause severe neurological deterioration.
- Injuries to sensitive nerves and vessels in the lateral posterior fossa during microsurgical dissection.
- Inadequate hemostasis within the surgical site with subsequent postoperative rebleeding.
- Inadequate dural closure with postoperative CSF fistula. In most cases, nasoliquorrhea occurs because of frequently opened mastoid cells.
- Inadequate extracranial hemostasis causing postoperative soft tissue hematoma.

Tips and tricks

- Special care should be given to preoperative planning and patient positioning according to the precise localization of the lesion. Note that laterally located lesions need less rotation but medially located lesions require more head rotation.

- Make a careful anatomical orientation and use the three steps of marking with a sterile pen: 1. osseous structures and superficial neurovascular structures; 2. placement of craniotomy; 3. skin incision.

- To provide the intradural manipulation allowing a direct line of sight down the posterior surface of the petrous bone, the next three details are important:
  1. The skin incision should be created over the posterior third part of the craniotomy, otherwise the retracted suboccipital muscles may hide the intradural surgical dissection (Fig. 4.0.36).
  2. The attachment of the sternocleidomastoid and splenius capitis muscles should be mobilized forcibly in the posterior and gently in the anterior mastoidal direction, protecting the intradural visualization (Fig. 4.0.37).
  3. Removal of the anterior inner edge of the craniectomy over the sigmoid sinus under protection of the dura using fine punches. The angle for visualization can also significantly increase with careful removal of this inner bone edge (Fig. 4.0.38).

- The dura should be opened in a “C” shaped, semilunar fashion and held toward the sigmoid sinus with two sutures. It is easy to gain better visualization of the foramen magnum or tentorium with a caudal or cranial enlargement of the dural opening (Fig. 4.0.39).

- The first step of the intradural dissection should be the opening of the cerebellomedullar cistern and sufficient drainage of CSF.

Fig. 4.0.36

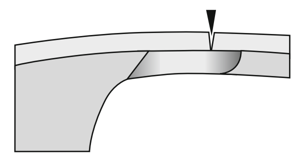


Fig. 4.0.37

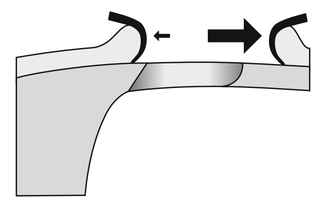


Fig. 4.0.38

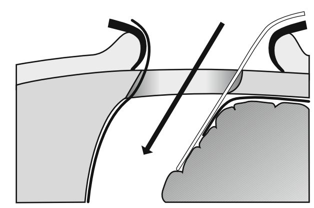


Fig. 4.0.39

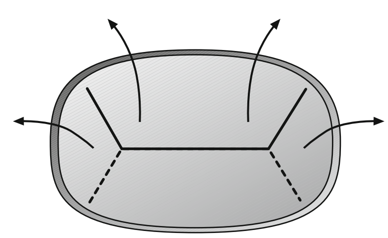
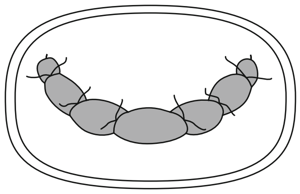
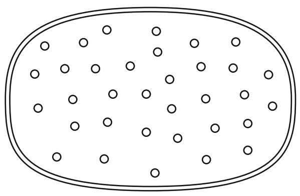


Fig. 4.0.40



- After finishing the intracranial procedure, the dural opening should be closed watertight using interrupted or running sutures. If tension has developed, which is very frequent, a small piece of muscle can be sewn into the dural closure. In other cases, plastic graft material should be used (Fig. 4.0.40).

Fig. 4.0.41



- The bony opening of the craniectomy should be closed with bone cement avoiding muscle ingrowth and attachment to the dura mater with subsequent postoperative cervical pain (Fig. 4.0.41).
- Because of the limited approach, a suction drain is not recommended.