Transpetrosal approach

Classification

The basic concept of this approach is the combination of the anterior- and posterior-petrosal approaches uniting the infra- and supratentorial surgical fields, thereby providing wide surgical exposure.

Both the anterior and posterior approaches have the potential of exposing the cerebellopontine angle and the petroclival region.

see Anterior transpetrosal approach

Anterior transpetrosal transtentorial approach

see Combined posterior transpetrosal approach

Minimum transpetrosal approach

see Posterior petrosal approach

see Posterior transpetrosal approach

see Subtemporal transpetrosal approach

Subtemporal medial transpetrous approach

Temporal occipital transtentorial transpetrosal ridge approach

Transpetrosal transtentorial approach

Presigmoid approach.

Resection of the petrous temporal bone to various degrees has overcome the limitations associated with traditional exposures of the posterior fossa. The combination of transpetrosal procedures with other approaches has resulted in many options for obtaining wide surgical exposure of the petroclival region. Nevertheless, the improved access to the posterior fossa through the transpetrosal route comes at the price of increased morbidity. The variations of the transpetrosal approaches are numerous, and the resulting nomenclature can be quite confusing. Frequently, these variations overlap with one another and have minor distinguishing nuances.

All of these approaches have been categorized under the broad terms of anterior and posterior transpetrosal approaches.

Indications

Transpetrosal approach indications.

Advantages

Spares sinus and otologic apparatuses. Minimizes cerebellar and temporal lobe retraction.

Position

1. patient supine, ipsilateral shoulder roll

2. elevate thorax 10°: reduces venous distension

3. flex knees

4. Mayfield 3 pin head-holder: close to true AP with single pin on forehead

5. head positioned to place the petrous base at highest point of field:

a) head rotated 40–60° from vertical

b) head abducted towards contralateral shoulder

c) neck extended 15°: allows gravity to retract frontal lobe away from skull base.

Skin incision

Reverse question mark starting from zygomatic arch 1 cm anterior to tragus, arcing posteriorly over ear, descending to 0.5–1 cm medial to mastoid notch.

Temporalis muscle and periosteum reflected anteriorly and inferiorly.

Craniotomy

see Petrosectomy.

History

The early foundation of the retrolabyrinthine lateral petrosectomy has its roots in the otolaryngology literature. These early approaches were limited in exposure by the tentorium superiorly and the sigmoid sinus posteriorly. Although the concept of a transtentorial approach was originally combined with a complete labyrinthectomy, Hakuba and colleagues described the expansive exposure afforded by sectioning the tentorium and superior petrosal sinus and mobilizing a skeletonized sigmoid sinus. This maneuver serves as the key step in allowing for the full, combined supra- and infratentorial exposure that the posterior petrosal approach provides. In contrast to Hakuba et al.'s approach, which used a partial labyrinthectomy, modern approaches often preserve the entire labyrinth

(retrolabyrinthine approach). For added exposure, the latter can be combined with the anterior petrosal approach, allowing for the preservation of hearing and an enhanced view of the surgical target [1)].

Technique

see Al-Mefty O, Fox JL, Smith RR. Petrosal Approach to Petroclival Meningiomas. Neurosurgery. 1988; 22:510–517 [2)].

Skin incision

For a combined supra-infratentorial posterior transpetrosal approach the incision should expose a large part of the lateral aspect of the temporal and partially the suboccipital bones with a question-mark incision starting three fingers above the posterior root of the zygomatic process, moving posterosuperiorly and posteroinferiorly surrounding in a semicircular fashion the pinna, descending until two fingers below and behind the mastoid tip.

The whole flap is reflected anteroinferiorly trying to carefully identify the posterior wall of the external auditory canal. Some periosteal layers can be kept intact just in case we need some autologous duroplasty.

The underlying bone should be cleaned enough in order to identify relevant anatomical landmarks for the next step of the approach. Among these structures the squamous, occipitomastoid, parietomastoid sutures, the spine of Henle, posterior wall of external auditory canal, supramastoid crest, temporal line and mastoid tip, as well as the asterion should be clearly identified.

Mastoidectomy. Posterior petrosectomy

When planning a combined supra- infratentorial petrosectomy, there are different ways to combine the petrosectomy and craniotomies. Some authors promote performing initially the subtemporal and suboccipital craniotomies followed by the mastoidectomy, while others defend starting with a complete petrosectomy and then performing the combined craniotomies. The order for the bony work will mainly depend of the personal experience and preferences.

A deep knowledge of the external surface of the mastoid part of the temporal bone remains mandatory in order to perform the accurate mastoidectomy. This external surface is only «the tip of the iceberg», however the success of the exposure will depend of the chosen initial drilling area. The first important landmark to recognize is the asterion, whose identification will let the surgeon recognizing the supramastoid crest, parietomastoid, lambdoid and occipitomastoid sutures. The spine of Henle just posterior to the posterior wall of the external auditory canal, the mastoid tip and the posterior root of the zygoma will be the other superficial limits for the initial mastoidectomy. Thus, the mastoid tip, posterior root of zygoma and asterion will mark the ‘superficial triangle of attack’. Once identified these landmarks, a good starting point is to perform a 14mm-burr hole at the level of asterion, with the aim of confirming the presence of the underlying transverse-sigmoid sinuses junction.

Mastoid drilling may start at the level of the outer table, or it can be accurately elevated and

preserved with an oscillating saw. The latter maneuver has been shown to decrease the CSF leakage rates and add a more cosmetic result. As described by Fukushima, this cosmetic mastoidectomy is performed by cutting through the outer table of the bone, with the zygomatic root, external auditory meatus, and mastoid tip as the limits for resection [3)].

Once removed the outer table, a 5-6mm cutting drill is used to go deep within the 'triangle of attack'. We recommend starting at the level of the temporal line in an anteroposterior direction. This landmark usually coincides with the middle fossa dura mater.

The next step will consist on the sigmoid sinus skeletonization. This venous structure has no surface anatomical landmarks, thus it is usually recommended to drill in an oblique direction from the asterion to the mastoid tip. When the bone starts showing a cortical appearance in the depth it is recommended to use a diamond drill. The traced line between the posterior root of zygoma and the mastoid tip just posterior to the external auditory canal is the next part to be drilled so as to complete the 'deep triangle of attack'. The deep drilling should be taken progressively and gradually being extended from extreme to extreme trying to avoid creating deep and narrow cavities that would obscure our three-dimensional understanding.

A relevant anatomic structure that will be seen next is the mastoid antrum in an anterosuperior location. This cavity shows a medial wall given by the lateral extension of the labyrinth, which actually is the lateral semicircular canal. At this stage the cutting drill should be avoided, and careful skeletonization of the sigmoid sinus, middle fossa and CPA dura mater as well as the lateral semicircular canal should be performed with a thin diamond drill. The mastoid cells drilling, labyrinth identification in the medial aspect of the mastoid antrum, and the middle fossa and CPA dura mater from the superior petrosal sinus to the jugular bulb represent the bony work we have defined as mastoidectomy or posterior petrosectomy with retrolabyrinthine extension.

Transcochlear extension The last and most aggressive extension of this approach involves drilling the cochlea and subsequently sacrificing all the inner ear structures except the facial nerve that at least has to be skeletonized (transotic) or even mobilized (transcochlear). The posterior wall of the internal auditory canal is drilled and its dura mater opened exposing the inferior vestibular and acoustic nerves. Delicately moving these nerves, the facial meatal segment shows a relative anterior position compared to the cochlear nerve, while the superior vestibular remains hidden anterior to the inferior vestibular nerve. The mastoid facial canal must be accurately drilled throughout all its length with the aim of setting the mastoid segment of the nerve free. The lateral semicircular canal ampulla is opened and drilled exposing the junction between the mastoid and tympanic segments. At this point the greater petrosal nerve should be identified and sectioned at the level of the geniculate ganglion. This maneuver will let us mobilizing the meatal, labyrinthine, tympanic and mastoid segments of the nerve out of our surgical corridor, thus exposing the lateral wall of the cochlea. It is important to try to preserve as far as possible the chorda timpani of the mastoid segment

Surgical exposure

Transpetrosal approach progressively flatten the temporal bone to maximize surgical exposure and to minimize retraction on the cerebellum.

The surgical corridor between the cerebellum and the petrous bone is also progressively widened during transpetrosal approaches.

Resection of the petrous bone to various degrees provides different levels of access to lesions of the

posterior fossa. Although their nomenclature can be confusing, the numerous variants of the transpetrosal approaches can be classified broadly into anterior and posterior groups.

Tentorial resection

The tentorial resection extends from 5 to 10 mm anterior to the junction of the sigmoid sinus and the superior petrosal sinus (“sinodural point”) to the trigeminal fibrous ring and the dural sleeve of CN IV. Temporal bridging veins enter the transverse sinus no more than 5 mm anterior to the sinodural point. The CN IV should be freed from its tentorial dural sleeve while avoiding disruption of the posterior cavernous sinus. The clinical data demonstrate a total resection rate of 78.3%, intraoperative estimated blood loss < 400 ml at a rate of 80.9%, and a venous congestion rate of 0%.

Understanding the anatomical relationship between the tentorium and temporal bridging veins and CNs IV-VI allows neurosurgeons the ability to develop a combined petrosal approach to PCMs that will effectively supply a wide operative corridor after resecting the tentorium, while significantly devascularizing tumors [4].

Asaoka et al described:

1) mastoidectomy preceding craniotomy for minimal bone loss;

2) removal of the tentorium over the tumor for achieving devascularization and wide exposure;

3) water-tight dural closure by using autologous fascia graft, non-penetrating titanium clips, and multi-layered technique for avoiding postoperative cerebrospinal fluid leakage. The video can be found here: http://youtu.be/zMlNE8kMcHA [5]

Complications

Cerebrospinal fluid leak

Although the combined petrosal approach has significant advantages for medium to large petroclival lesions, it carries the risk of a few major complications. The cerebrospinal fluid leak rate with this approach has been reported to be as high as 15%.

A technique involves a fascial graft to the presigmoid-subtemporal defect, fixated with a long microtitanium plate over the cranial base side. The fascial graft is augmented by covering it with an abdominal fat graft and a vascularized pericranial flap. This technique was performed in 23 patients after surgical resection of petroclival meningiomas with only 1 postoperative cerebrospinal fluid leak (4.4%) [6].

With petrosal thirteen patients harboring large petroclival meningiomas there was no mortality in this series, and total removal was achieved in all but two patients. Morbidity included cranial nerve deficit, pulmonary embolism, and hemiparesis [7].

References

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