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Original Research Article

Anatomical Landmarks for Safe Surgeries in Petroclival Region of Skull Base by Intradural Anterior Petrosectomy Via Transylvian-Transtentorial Route: A Cadaveric Study

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Abstract

Objectives: The Petroclival lesions are difficult to excise surgically because of their location. Anterior petrosectomy by an extradural subtemporal route is the standard procedure for removal of Petroclival meningiomas but has many complications. This cadaveric study was done to identify landmarks for safe surgeries using intradural approach via the transylvian-transtentorial route for petroclival lesions. As neurosurgeons are more comfortable with transsylvian approaches and the corridor is definitely wider through this approach.

Patients and Methods: This study was conducted in the department of anatomy over a period of two years. Cadaveric anterior intradural petrosectomy was conducted in 13 complete unfixed heads (26 sides), important anatomical landmarks for anterior intradural petrosectomy were identified and distance between these landmarks were measured and recorded as D1 to D7.

Results: Cadaveric dissection of skull was performed on 13 cadavers (26 sides). Eight males (16 sides) and five females (10 sides). No significant difference was found in measurements between males and females.

In most specimens the distance was between 10-13 mm from the entry of the third nerve to the fourth nerve. In practice a cut on the tentorial edge > 1.7 cm will not injure the fourth nerve. The distance of dura cut from tentorial edge to superior petrosal sinus was 09 to 22 mm (mean 13.96 mm). Total dura to be cut from tentorial edge was 21 to 40 mm (mean 27.57 mm). Distance from petrous ridge to superior medial edge of internal auditory meatus (IAM) was found to range from 05 to 15 mm (mean 09.03mm). Internal carotid artery (ICA) was found at a minimum distance of 04 mm with a mean of 08.88mm from the point of drilling on petrous ridge. The distance from lateral edge of gassarian ganglion (GG) to the arcuate eminence was between 16 to 28 mm (mean 21.5 mm)

Conclusions: In order to avoid injury to nerves, ICA and brainstem, dura should be cut at right angles just proximal to fourth nerve, arcuate eminance (AE) identified and dura stripped. Drilling should be done from petrous ridge, not more than 05mm deep, not more than 04 mm laterally, should not exceed 07 mm towards GG and should lie inside the line joining arcuate eminence (AE) to petrous ridge.

Keywords: Petroclival Region; Gassarian Ganglion (GG); Internal Carotid Artery (ICA), Arcuate Eminence (AE); Intradural Anterior Petrosectomy; Internal Auditory Meatus (IAM).

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Introduction

Neurosurgical procedures in the petroclival region of skull base require unique knowledge of local anatomy. The petroclival lesions are difficult to excise surgically because of their location, subtemporal corridor to these lesions has been well described [1-3]. With further advances in skull base surgery, extension of middle fossa approaches has

become the key to accessing regions notoriously challenging, such as the cerebellopontine angle [4-6], petroclinoid area [7-9], upper basilar artery [10,11] and posterior cavernous sinus [12]. Anterior petrosectomy by an extradural subtemporal route is the standard procedure for removal of petroclival meningiomas [13-14]. This extradural approach has some hazards like traction injury of greater superficial petrosal nerve (GSPN), post-operative CSF leak due to difficult dural closure at the skull base and inability to tailor the resection of the petrous bone as per requirement in an individual case. The extradural approach results in a formal anterior petrosectomy, which may be too extensive and pose an unnecessary risk to the critical structures. This cadaveric study was done using intradural approach via the transylvian-transtentorial route for petroclival lesions [13]. This entails a tentorial incision and an intradural tailored petrosectomy. Furthermore, neurosurgeons are more comfortable with trans-sylvian approaches and the corridor is definitely wider through this approach.

Review of Anatomy

The petrous apex is the medial part of the temporal bone. Anteriorly, it is articulated to greater wing of sphenoid, posteriorly occipital bone and laterally fused with squamous portion of temporal bone. The apex forms the posterior margin of foramen lacerum and base is formed by bony labyrinth. Anterior surface is limited by foramen lacerum, sphenopetrous fissure, facial nerve hiatus and arcuate eminence. Posterior surface is limited by petroccipitalis fissure, superior lip of Juglar foramen and posterior border of internal auditory canal (IAC). Inferior surface is limited by foramen lacerum, petro-occipitalis fissure and medial lip of carotid canal, Jugular foramen and sphenopetrous fissure. The three surfaces point towards the clivus region. The petrous bone may be pneumatic, diploic or sclerotic. The petrous segment of the internal carotid artery (ICA) is the anterolateral limit of the anterior petrosectomy approach [2,15,16]. The middle meningial artery at the foramen spinosum and the arcuate eminence are superficial landmarks at the floor of middle fossa. The petrous carotid artery lies in the Glasscock triangle. The greater superficial petrosal nerve (GSPN) followed posteriorly from the facial hiatus leads to Gassarian ganglion (GG). The superior semicircular canal (SSC) lies beneath the arcuate eminence, perpendicular to the petrous ridge and forms angle of approximately 120^0 with the GSPN. The meatal plane, the flat area of the bone that overlies the internal auditory canal lies in the angle between the Gassarian ganglion and the arcuate eminence.

Objectives

This cadaveric study was done to identify landmarks for safe surgeries using intradural approach via the transylvian-transtentorial route for petroclival lesions. As neurosurgeons are more comfortable with trans-sylvian approaches and the corridor is definitely wider through this approach.

Patients and Methods

This study was conducted in the department of anatomy over a period of two years. Cadaveric anterior intradural petrosectomy was conducted on 13 complete unfixed heads (26 sides), important anatomical landmarks for anterior intradural petrosectomy were identified and distance between these landmarks were measured and recorded.

Surgical technique of the intradural anterior petrosectomy in cadavers: Skull was cut circumferentially between glabella and just above inion with autopsy saw. Meninges were stripped from skull cap. Posterior attachment of the tentorium was cut and with the help of curved scissors, brain was cut at brain stem above tentorium. Supratentorial brain was removed. The tentorium, cranial nerves and brainstem was left intact. The tentorial edge was identified and identification of 3rd & 4th nerve was made as shown in Figure 1. Distance between third nerve entry into the dural fold and fourth nerve entry into tentorium was measured and labelled as D1. Dura was cut at right angle on the tentorial edge just posterior to 4th nerve entry. Tentorium was cut behind fourth nerve upto the superior petrosal sinus on the petrous ridge and distance was measured from this cut edge upto superior petrosal sinus (SPS) and labelled as D2 as shown in Figure 2 and 3. The tentorial leaf was reflected anteriorly to expose the petrous bone. Distance of dura cut from petrous margin to arcuate eminence was labelled as D3 as shown in Figure 4. Dura on the petrous bone dissected in the region of Meckel's cave and Gasserian ganglion was exposed. Distance from lateral edge of Gassarian ganglion to the point of petrous ridge corresponding to IAM was measured and labelled as D4 as shown in Figure 5. Bone was drilled lateral to GG on the petrous ridge laterally upto petrous ICA and reaching upto anterio superior margin of internal auditory meatus. Distance from petrous ridge at the level of internal

acoustic meatus to 5th nerve was measured and labelled as D5 as shown in Figure 6 and 7. Thickness of bone drilled to expose the petrous carotid artery from petrous ridge was measured and labelled as D6. Distance between lateral edge of GG to AE was labelled as D7 as shown in Figure 8.

Results

Cadaveric dissection of skull was performed on 13 cadavers (26 sides). Eight males (16 sides) and five females (10 sides). No significant difference was found in measurements between males and females. The mean values of all the parameters studied in this cadaveric dissection are depicted in Table 1.

In most of specimens the distance was between 8-17 mm from the entry of the third nerve to the fourth nerve. In practice a cut on the tentorial edge > 1.7cm will not injure the fourth nerve. The distance of dura cut from tentorial edge to superior petrosal sinus was 09 to 22 mm (mean 13.96 mm). Total dura to be cut from tentorial edge was 21 to 40 mm (mean 27.57 mm). Distance from petrous ridge to superior medial edge of IAM was found to range from 05 to 15 mm (mean 09.03 mm). Internal carotid artery was found at a minimum distance of 04mm with a mean of 08.88 mm from the point of drilling on petrous ridge. The distance from lateral edge of GG to the arcuate eminence was between 16 to 28mm (mean 21.5 mm).

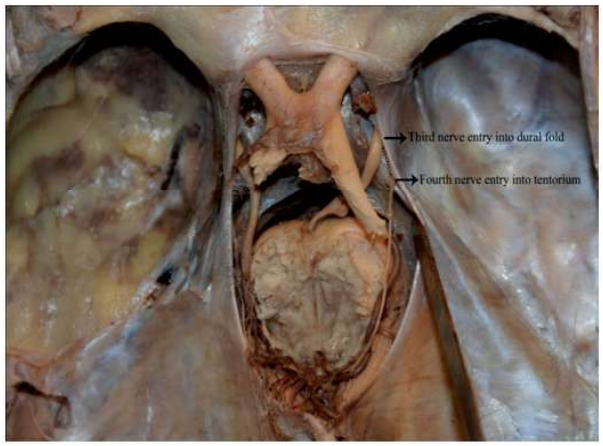

Fig. 1: 3rd and 4th nerve entering tentorial margin

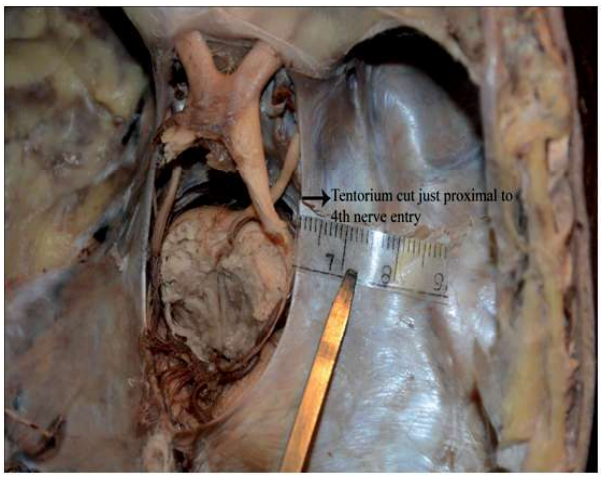

Fig. 2: Showing cut tentorial margin just proximal to 4th nerve entry

Table 1: Morphometric measurements in case of anterior intraduralpetrosectomy

Distance From	To	Mean(mm)	SD	Min(mm)	Max(mm)
Angle subtended on the tentorial edge posterior to 4th nerve entry to cut dura		90^0	.0000	90^0	90^0
Third nerve entry into the dural fold	Fourth nerve entry into tentorium	11.730	2.237	8	17
Dura Cut from Tentorial edge	Superior petrosal sinus	13.961	4.132	9	22
Tentorial edge	Total length of dura to be cut upto AE	27.576	5.352	21	40
Lateral edge of GG	Point of petrous ridge corresponding to IAM	11.4231	2.08179	7	15
Petrous ridge	Superior medial edge of IAM	9.0385	2.4410	5	15
Distance from drilling point of petrous	Petrous ICA	8.884	2.355	4	13
Arcuate eminence	Lateral edge of GG	21.5000	3.3015	16	28

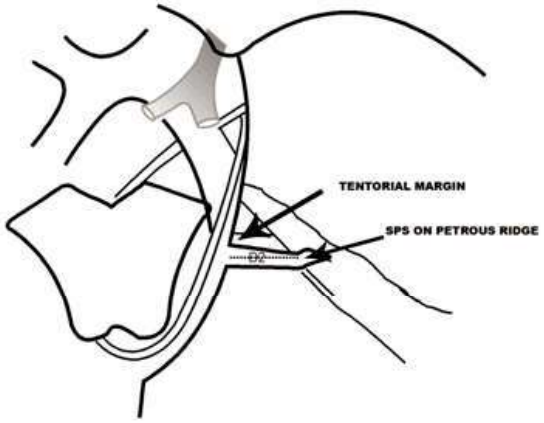

Fig. 3: Distance of dura cut from margin of tentorial edge upto superior petrosal sinus on the petrous ridge (D2).

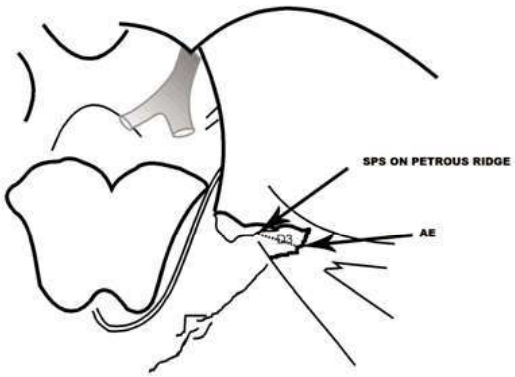

Fig. 4: Distance of dura cut from petrous margin to AE (D3)

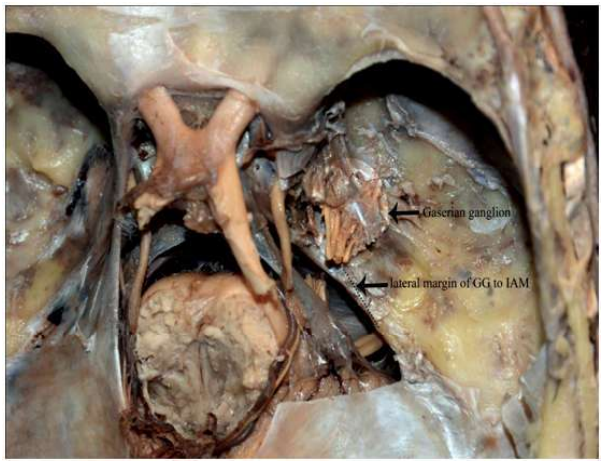

Fig. 5: Distance from lateral margin of GG to petrous ridge perpendicular to IAM

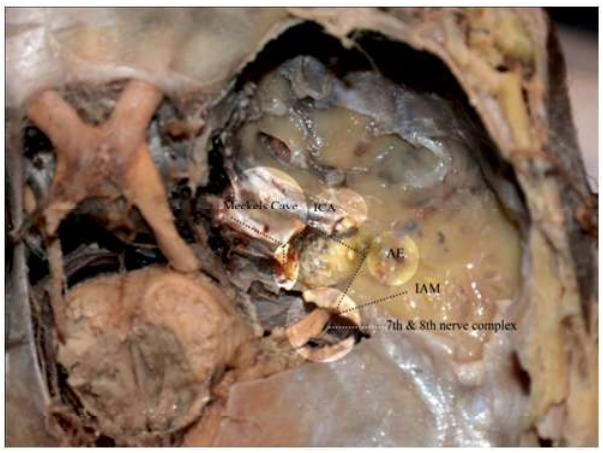

Fig. 6: Showing drilling from petrous ridge upto petrous ICA on the anterio-medially and AE postero laterally and depth upto IAM

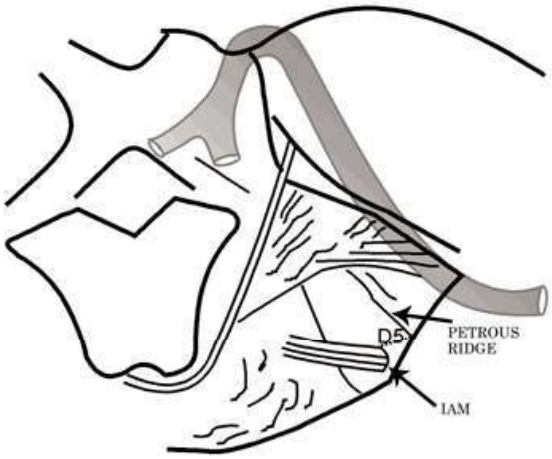

Fig. 7: Distance between anterio-superior margin of IAM to the petrious ridge (D5)

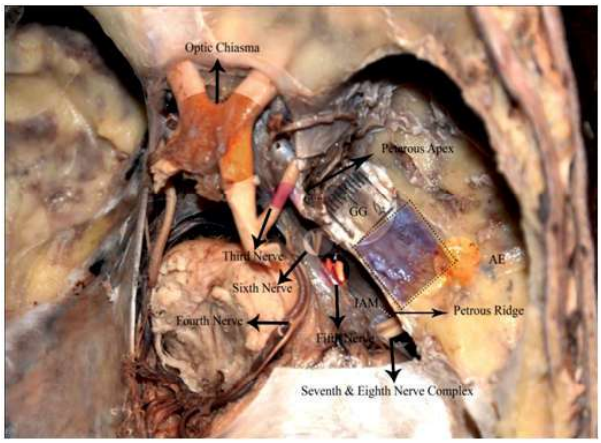

Fig. 8: Showing complete drilling upto petrous ICA, AE and IAM and lateral edge of GG

Discussion

The present study was designed to have an anatomical basis for an intradural anterior petrosectomy. In this cadaveric study we determine that the tentorial sectioning should be at 90^0 to the tentorial edge to allow optimal exposure of the gassarian ganglion and petrous ridge upto AE. In practically all the specimens the distance between the point where 3rd nerve passed under the tentorial edge and the fourth nerve contact with the tentorial edge was less than 17mm. Hence, tentorial edge sectioning approximately 1.7 cm from 3rd nerve entry would be safe in all cases.

The average distance from the tentorial edge to the AE was found to be 27.6 mm (20 to 40 mm). After identification of the lateral edge of gassarian ganglion the petrous bone is drilled in a lateral and posterior direction. The distance from lateral edge of gassarian ganglion to point of petrous ridge corresponding to IAM was always more than 07 mm (mean 11 mm) and the vertical distance from petrous ridge to superior medial edge of IAM was 05 to 15 mm (mean 09 mm) and the distance from the lateral edge of gassarian ganglion to AE was between 16 to 28 mm.

In all the specimens, petrous carotid artery was anterior to the point of drilling with a minimum horizontal separation of 04 mm. In five specimens the bone covering the petrous carotid at the level of gassarian ganglion was found to be deficient which implies that drilling should always proceed in Posterio-lateral direction.

As per the cadaveric dissection and measurements in the present study, the following protocol for intradural anterior petrosectomy is proposed; after a fronto-temporo-orbito-zygomatic (FTOZ) craniotomy, the sylvian fissure is split widely to allow the temporal lobe to fall posteriorly and laterally. The tentorial edge is exposed posterior to the 3rd nerve contact with the edge after the 3rd nerve is identified entering the occulomotor triangle. Our measurements have demonstrated that if the tentorium is cut more than 17 mm behind the 3rd nerve contact with the tentorial edge, the 4th nerve which lies under the tentorial edge will not be injured. The tentorial edge is sectioned at a 90^0 angle and this cut has to be about 02-04 cm to expose the gassarian ganglion and the petrous ridge. It is not necessary to go upto arcuate eminence. The petrous bone is then drilled lateral to the lateral edge of gassarian ganglion in posterior and lateral direction. The lateral drilling should be less than 07 mm to avoid injury to internal auditory meatus (IAM) and the depth of drilling at this level should be less than 05mm. The petrous carotid artery lies anteromedial to the petrous ridge and drilling should be less than 04 mm from the petrous ridge to avoid injury.

Major disadvantage of extradural approach is that the resection of the petrous bone cannot be tailored as per requirement in an individual case. In many cases the entire drilling of the anterior petrous bone may not be required.

Steiger et al. [17] described a custom tailored transdural-transpetrosal approach, in which the degree of bone resection was intradural and therefore could be extended or restricted as per need. However, this sub-temporal approach entails some degree of temporal lobe retraction and risk of injury to the vein of Labbe.

Gupta et al. [18] described a new surgical technique of single flap FTOZ for approaching petroclival lesions. FTOZ combined with removal of the lesser wing of sphenoid provides an excellent exposure of the skull base with direct visualization of the temporal pole and the floor of the middle fossa. After dural opening, one has direct visualization of the optic nerve and carotid artery without any brain retraction. Wide opening of the sylvian fissure coupled with mobilization of the temporal veins draining into the spheno parietal sinus allows the temporal lobe to be mobilized from medial to lateral and in an antero-posterior direction. This manoeuvre requires minimal retraction and there is no traction or pressure on the vein of Labbe. The trajectory obtained is along the floor of the middle fossa from an antero-lateral direction. The tentorial edge is visible in the antero-posterior direction and permits wide opening of the tentorium for gaining access to the posterior fossa. This approach provides better access and control of vascular supply to the tumors from the middle meningeal and tentorial vessels.

Intradural petrosectomy, as described in this approach allows a tailored removal of the bone as dictated by the extent of the pathology. It is technically simple and is quite safe. There is no risk of injury to the GSPN. Since the bony removal is from medial to lateral, the apex to posteriorly, one can stop as soon as the surgeon finds that the tumour can be delivered into the space created. The anterolateral approach also provides access to the middle fossa dura and in case of meningiomas, the blood supply to the tumour can be coagulated before tumour removal.

Conclusion

In our study, it was found that there is wide variation between individual measurements. In order to avoid injury to nerves, ICA and brainstem, dura should be cut at right angles just proximal to fourth nerve, AE identified and dura stripped. Drilling should be done from petrous ridge, not more than 05 mm deep, not more than 04 mm laterally, should not exceed 07 mm towards GG and should lie inside the line joining AE to petrous ridge. In many cases bone may be deficient over carotid and drilling can injure carotid if more anterolateral drilling is done.

Conflict of interest: None.

Source of support: Nil

References

1. Miller CG, van Loveren HR, Keller JT, Pensak M, el-Kalliny M, Tew JM Jr. Transpetrosal approach: surgical anatomy and technique. Neurosurgery 1993;33:461–469.
2. Kawase T, Toya S, Shiobara R, Mine T. Transpetrosal approach for aneurysms of the lower basilar artery. J Neurosurg. 1985;63:857–61.
3. Al-Mefty O, Fox JL, Smith RR. Petrosal approach for petroclivalmeningiomas. Neurosurgery. 1988;22:510–517.
4. House WF. Surgical exposure of the internal auditory canal and its contents through the middle, cranial fossa. Laryngoscope. 1961;71:1363–85.
5. House WF, Hitselberger WE, Horn KL. The middle fossa transpetrous approach to the anterior-superior cerebellopontine angle. Am J Otol. 1986;7:1–4.
6. Kanzaki J, Shiobara R, Toya S. Extented middle cranial fossa approach for acoustic tumors. Rev LaryngolOtolRhinol (Bord). 1981;102:389–92.
7. Kawase T, Shiobara R, Toya S. Anterior transpetrosal transtentorial approach for spheno petroclival meningiomas: surgical method and results in 10 patients. Neurosurgery. 1991;28:869–75.
8. Kawase T, Toya S, Shiobara R, Mine T. Traspetorsal approach for aneurysms of the lower basilar artery. J Neurosurg. 1985;63:857-61.
9. Slater PW, Welling DB, Goodman JH, Miner ME. Middle fossa transpetrosal approach for petroclival and brainstem tumors. Laryngoscope. 1998;108:1408–12.
10. Aziz KM, van Loveren HR, Tew JM Jr, ChicoineMR. TheKawase approach to retrosellar and upper clival basilar aneurysms. Neurosurgery. 1999;44:1225–34.
11. Kawase T, Bertalanffy H, Otani M, Shiobara R, Toya S. Surgical approaches for vertebro-basilar trunk aneurysms located in the midline. ActaNeurochir (Wien). 1996;138:402–10.
12. Fukushima T, Diaz J, Hirahara K. Extradural total petrous apex resection with trigeminal translocation for improved exposure of the posterior cavernous sinus and petroclival region. Skull Base Surg. 1996;6:95–103.
13. Gupta SK. Trans-sylviantranstentorial approach for skull base lesions extending from the middle fossa to the upper petro-clival region. British journal of Neurosurgery. 2009;23(3):287-92.
14. Gupta T, Gupta SK. Anatomical delineation of a safety zone for drilling the internal acoustic meatus during surgery for vestibular schwanomma by ret rosigmoidsuboccipitalapproach.Clinical Anatomy. 2009;22:794-99.
15. Rhoton AL Jr, Pulec JL, Hall GM, Boyd AS Jr. Absence of bone over the geniculate ganglion. J Neurosurg. 1968;28:48–53.
16. Glasscock ME III. Middle fossa approach to the temporal bone: an otologic frontier. Arch Otolaryngol. 1969;90:15–27.
17. Steiger HJ, Hanggi D, Stummer W, Winkler PA Custom-tailored transdural anterior transpetrosal approach to ventral pons and retroclival regions J Neurosurg. 2006;104:38– 46.
18. Gupta S.K. Salunke P. Intradural anterior petrosectomy for petroclivalmeningiomas- A new surgical technique and results in 5 patients. J Neurosurg. 2012;117(6):1007-12.