

Approach to The Lateral Clivus and Mid-And-Lower Basilar Artery Via Petrous Apex Resection - A Cadaver Study-

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Abstract : Eight operations were done on four formalinixed cadavers to assess the technical feasibility of an approach which provide remove more than half of the clivus via extradural drilling out of the petrous apex. This approach also provides exposure of the midandlower parts of the basilar artery, its branches,

vertebrobasilar junction, the sixth nerve, and anterior face of pons and medulla without the need for division of the tentorium, manipulating or removing the inner ear organs and vestibulocochlear nerve.

Key words : Skull base, Clivus, Petrous bone, Basilar artery

INTRODUCTION

Approaches to the apex of the petrous temporal bone and clivus still remain challenging problems; surgical exposure of those areas is extremely limited if destruction of important structures is to be avoided. In this cadaver study, a middle fossa approach to the clivus and midposterior fossa structures via extradural drilling of the petrous apex is presented.

OPERATIVE TECHNIQUE

Eight operations were performed on four formalinixed cadavers. In supine position, the head was turned approximately 20 degrees to the contralateral side, and a questionmark shaped incision beginning from the zygomatic arch, including the posterior half of the pterion and extending down to the retroauricular area was made (Figures 1 a and b). The skin and temporalis muscle were reflected inferiorly and a temporobasal craniotomy extending to the posterior half of the pterion was accomplished. The temporal lobe was extradurally elevated, the dura propria of the third branch of the trigeminal nerve, the greater superficial petrosal nerve and the spinous foramen were identified. The middle men-

ingeal artery was cut at its entrance to the cranium, the greater superficial petrosal nerve was transected and the bony roof of the carotid canal, approximately 3 - 4 mm behind the spinous foramen, was unroofed until the edge of the dura propria of the mandibular nerve was reached, to a length of 1 cm by using a highspeed drill. The petrous apex posterior to the internal carotid artery and inferior to the dura propria of the fifth nerve was then drilled out since there were no more vital structures at this part of the bone. The area drilled is shown in Figure 2. The structures of the inner ear, namely, the cochlea, vestibulocochlear nerve, geniculate ganglion, and the semicircular canals lay lateral to the line drawn from the spinous foramen parallel to the midline, thus they could not intervene the surgeon's approach (Figure 3). Observing the pearly line of the occipitosphenoïdal synchondrosis indicated that the lateral part of the clivus had been reached (Figure 4). It was then possible to drill out more than half of the clivus, revealing the anteromedial face of the posterior fossa dura and the inferior sagittal sinus. Upon opening the dura, the first structure on seen was either the sixth nerve or the basilar artery, depending upon the amount of clival bone removed.

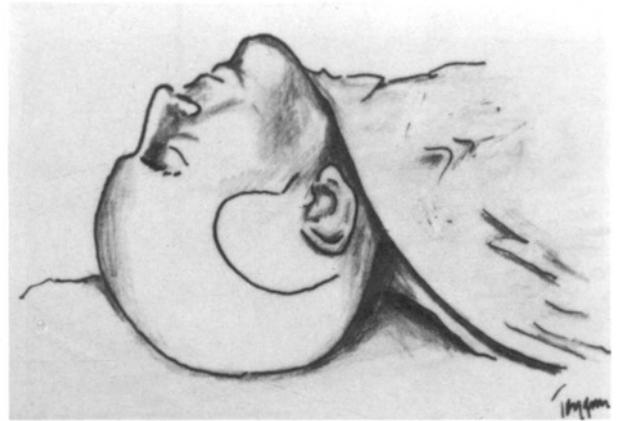
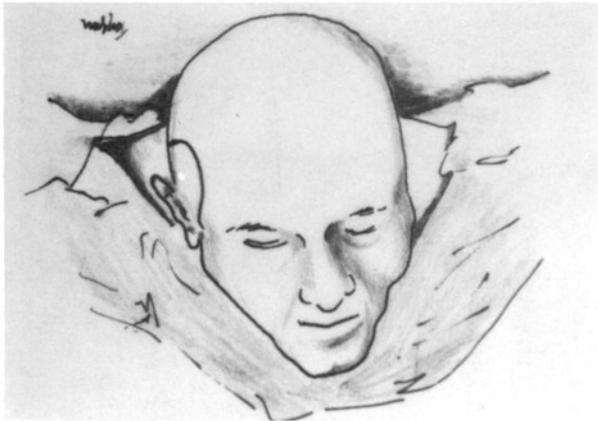


Fig. 1 : Positioning of the head, a) view from above, b) lateral view

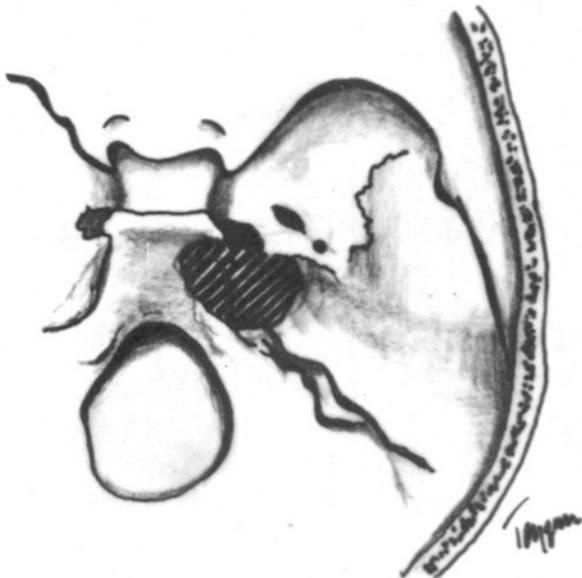


Fig. 2 : Shaded area illustrates the bony segment to be drilled

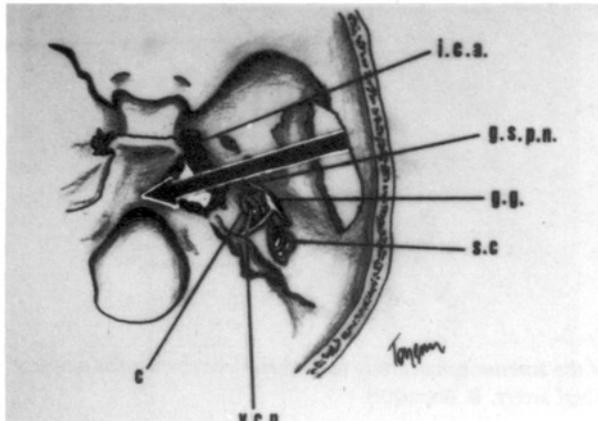


Fig. 3 : Arrow shows the direction of the microscope. Note that the projections of important structures of the inner ear and vestibulocochlear nerve lie lateral to the drilled petrous apex (i.c.a.: internal carotid artery, g.s.p.n.: greater superficial petrosal nerve, g.g.: geniculate ganglion, s.c.: semicircular canals, v.c.n.: vestibulocochlear nerve, c: cochlea).

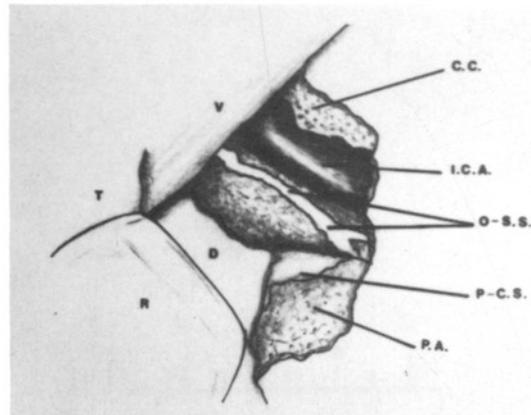


Fig. 4 : The pearly line of the occipito-sphenoidal synchondro sis (O.S.S.) is evidence that the lateral part of the clivus has been reached. The drilling process is then carried out towards the midline (I.C.A.: Internal carotid artery, C.C.: Partially unroofed carotid canal, V: Dura propria of the fifth nerve, D: Anterior aspect of posterior fossa dura, T: Dura over the temporal lobe, P.A.: Partially drilled petrous apex, P-C.S.: Petroclival synchondrosis).

The sixth nerve, basilar artery, anterior inferior cerebellar artery (A.I.C.A.), and anterior face of the pons could easily be seen upon widening the dural opening (Figures 5 a,b, and 6 a,b). It was then possible to trace A.I.C.A. (or labyrinthine artery, when originated from the basilar artery) laterally to the internal acoustic canal, by extending the bony removal, to provide safer limits for widening the bony window. When the axis of the microscope was directed inferiorly, the union site of both vertebral arteries, the perforating branches of both the vertebral and basilar arteries, the origin of the anterior spinal artery, and the anterior face of the medulla could also be observed (Figures 7 a and b).

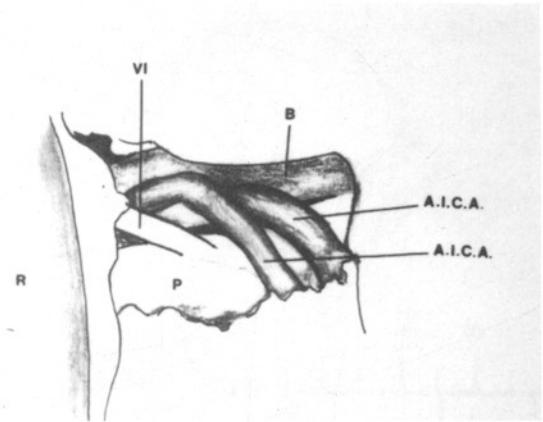
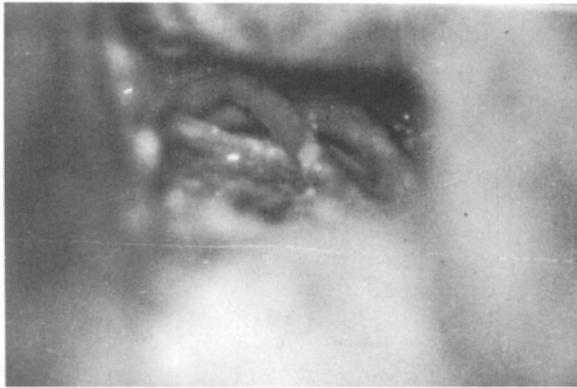


Fig. 5a, b : Appearance following widening of the dural exposure. The sixth nerve and duplicated A.I.C.A. which is a common variation (the more rostral artery is frequently misdiagnosed as the labyrinthine artery) are seen (B: Basilar artery, VI: The sixth nerve, P: Pons, R: Retractor).

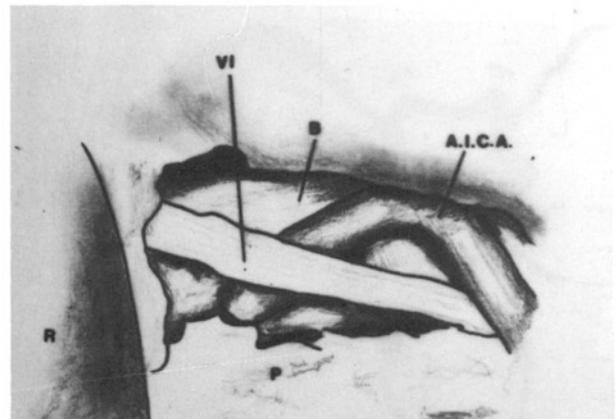


Fig. 6a, b : The view under higher magnification reveals the basilar artery (B), the sixth nerve (VI) and the origin of the superiorly retracted anterior inferior cerebellar artery (R: retractor, P: pons).

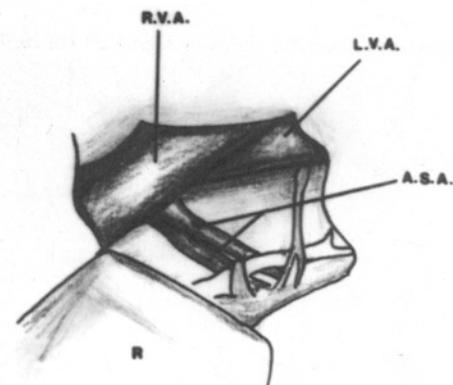


Fig. 7a, b : With the operating microscope directed inferiorly, the origins of the anterior spinal artery (A.S.A) and vertebrobasilar junction can be seen (R.V.A.: Right vertebral artery, L.V.A.: Left vertebral artery, R: Retractor).

DISCUSSION

Although many authors have described various intradural and extradural surgical methods beyond the classical ones, lesions localized at the clivus, petrous apex or anterior face of the brain stem still present challenging surgical problems.

The suboccipital route to the clivus may require intolerable retraction of the cerebellum, and direct visualization of the front of the brainstem is limited. The subtemporal route may cause haemorrhagic infarction of the temporal lobe by damaging the bridging veins during retraction (3), and exposure of the lower third of the basilar artery and midclival area is limited. Anterior approaches carry the risk of cerebrospinal fluid leakage and meningitis, beyond their limited exposure and depth of the operative field (1), but are particularly suited to extradural tumours.

The infratemporal approach introduced by Fisch provides wide exposure of midline structures, but necessitates anterior reposition of the facial nerve, subluxation or resection of the mandibular condyle, subtotal petrosectomy and obliteration of the middle ear cleft (2). There is a potential danger of damaging the maxillary division of the fifth nerve, and ipsilateral hearing loss is inevitable.

House and Hitselberger and House et al pioneered the extradural transpetrosal approach to the clivus, and called it the "transcochlear approach" (5,6). Since the cochlea should be removed and facial nerve displaced, this method gives rise to ipsilateral hearing loss and the risk of facial weakness.

The transpetrosal transtentorial approach, presented by Hakuba et al. (4) is a sophisticated method for access to the clivus. Despite good exposure, it necessitates removal of the endolymphatic duct, posterior semicircular canal and medial part of the horizontal semicircular canal, opening the posterior part of the antrum without manipulating bony ossicles, and partial opening of the roof of the internal auditory meatus, beyond the need of performing a radical mastoidectomy. Thus, it is not an easy method even for an experienced surgeon.

Sekhar et al. developed a subtemporal-preauricular infratemporal approach and have successfully used this method for large cranial base tumours (8,9,10). This excellent method, along with other

techniques such as total petrosectomy or the subtemporal-infratemporal-basal subfrontal approach should be reserved for extensive tumours of the base.

In 1985, Kawase et al. introduced a "transpetrosal approach for lower basilar artery" (7). Our method can be considered a more medial version of this approach, which permits removal of the lateral part of the clivus and more direct access to midline structures of the posterior fossa, without involving the auditory canal. In the approach presented by Kawase, the medial border of the drilled bone segment is the gasserian ganglion. However, we drilled out the bone under the dura propria of the ganglion, creating a gap which was bordered by the carotid artery anteriorly, the frontal face of the posterior fossa dura inferiorly, the lateral aspect of the clivus medially and the trigeminal ganglion superiorly. When the tip of the petrous bone is entirely drilled, then this gap permits extradural removal of more than half the width of the clivus, without the need to divide the tentorium. When the dura was opened, this approach provided a rather large exposure, from the upper parts of the pons superiorly to the bulbous at the vertebrobasilar junction level inferiorly, and from the basilar artery medially to the internal acoustic meatus laterally. Although this study may point the way to new operative studies, it makes no claim to have brought a new surgical method for clival lesions. It was designed just to establish the technical feasibility of such an approach.

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