Acta Neurochir (Wien) (1995) 136: 212–216

Acta Neurochirurgica
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Printed in Austria

Middle Fossa Sub-Gasserian Ganglion Approach to Clivus Chordomas

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Summary

A modified lateral subtemporal, transpetrous apex and sub-Gasserian ganglion approach was found to be most suitable for clival chordomas. The approach selection was based on the typical anatomical relationship of chordomas in terms of site of origin, pattern of growth and neural and vascular displacements. The approach was suitable to deal with tumour anterior and lateral to the brain stem, the clival part of the tumour and its sub-cavernous sinus extensions. The carotid artery was under control. The approach had the advantage of being simple and relatively quick and of its familiarity to general neurosurgeons. The tumour could be excised radically and extension of anterior, posterior and inferior exposure was possible.

Keywords: Chordoma; clivus; subtemporal; internal carotid artery.

Introduction

Clival chordomas are relatively rare and present formidable neurosurgical problems. Radical surgery is considered to be the most acceptable form of treatment because these tumours are generally resistant to radiotherapy and chemotherapy [24, 26]. The principal aspects of the approach discussed in this report have been described earlier for tumours and vascular lesions located in the petroclival region [10–12, 18]. The approach was found to be suitable in 5 cases with clival chordomas.

Anatomical Considerations

Chordomas frequently arise from the clivus in the region of spheno-occipital synchondrosis. Due to the location and relatively slow growth these tumours are often detected only when they are large in size. The more common presentation of a chordoma is in the form of involvement of one half of the clivus by its destruction and eccentric spread. The tumour is essentially extradural in nature. In this series despite the huge sizes of the tumours and apparent intradural extensions on magnetic resonance imaging (MRI), dural integrity was preserved in its entirety. This anatomical feature added to the safety of dissection of the tumour anterior to the brain stem and from cranial nerves in the posterior fossa and in the cavernous sinus. The tumour grows in the petroclival area and in the subcavernous sinus region by destruction of the petrous apex and clival bone. The precavernous and cavernous segments of the carotid artery were always displaced along the anterior border of the tumour [6]. The involvement of the cavernous sinus and internal carotid artery was observed to be of the nature of displacement rather than invasion by the tumour. The root of the fifth nerve and Gasserian ganglion, and the 3rd and 4th cranial nerves of the cavernous sinus were elevated on the dome of the tumour [6]. The relationship of the tumour with the sixth cranial nerve could not be adequately ascertained but the nerve was displaced on the dome and not encased by the tumour in 3 cases where the relationship could be studied during surgery. The clival involvement was seen to extend inferiorly to the ipsilateral occipital condyle in 2 cases.

Operative Technique

The patient was placed in the lateral position and a continuous external drainage of cerebrospinal fluid by lumbar subarachnoid catheter placement was set up. The approach was by a subtemporal route centered on the external auditory meatus. A low temporal craniotomy was performed. A zygomatic arch osteotomy was done to elevate the temporalis muscle out of the exposure. The root of the zygomatic arch and the base of the petrous pyramid were drilled to obtain a basal exposure along the anterior face of the petrous bone. By an intradural exposure and elevation of the

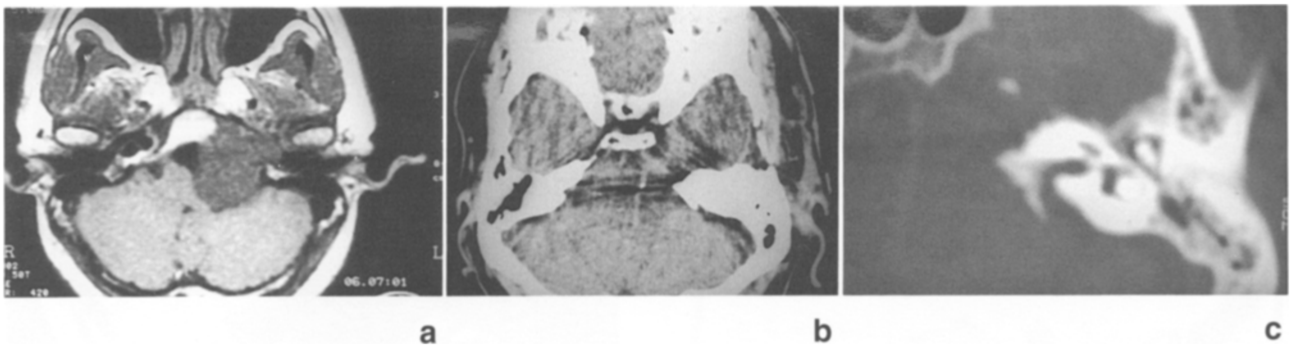


Fig. 1. (a) T1-weighted MRI shows the large hypo-intense petro-clival chordoma. Note the relationship of the tumour to the clivus and petrous apex. (b) Post-operative CT scan shows resection of the tumour. Part of the petrous apex was destroyed by the tumour and a part was drilled away during surgery. (c) Bone window of the post-operative scan showing the part of the petrous apex medial to the internal auditory meatus drilled away during surgery. The part of the petrous apex housing the cochlea is left undisturbed

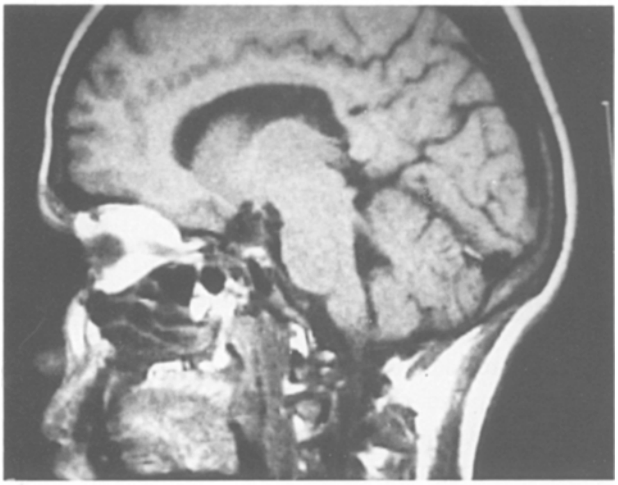
temporal lobe, the middle fossa floor and the tentorium were exposed. An incision was made in the tentorium which began at its free edge at the level of the posterior edge of the cerebral peduncle and then directed anterolaterally towards the lateral aspect of the superior petrosal sinus. A triangular flap of the tentorial dura was then everted over the superior petrosal sinus providing a wide window from a subtemporal view to the infratentorial structures [7]. By this manoeuvre the fourth and fifth cranial nerves and the petrosal vein were protected from inadvertent injury and were exposed widely. The tentorial dural flap was then either resected by cutting parallel to the superior petrosal or everted over the middle fossa floor. The Gasserian ganglion was then exposed by taking an incision over the superior dural cover of Meckel's cave after identification of the trigeminal root. The Gasserian ganglion and the trigeminal root were elevated superiorly by the tumour. The superior petrosal sinus was packed with surgicel close to the cavernous sinus. The root of the trigeminal nerve and the Gasserian ganglion were then mobilized superiorly. Underneath the medial and inferior dural cover of the Gasserian ganglion was the most prominent bulge of the tumour. The rest of the operation was carried out in the extradural compartment. The bone of the petrous apex was exposed and drilled laterally as was required, frequently up to the medial end of the internal auditory meatus taking care to preserve the cochlea. The internal carotid artery was identified in the petrous apex and was exposed and protected. The soft, relatively avascular and extradural nature of the tumour helped in widening the exposure. The tumour was removed initially by intratumoural debulking which released the stretch on the neural and vascular structures which were then dissected free. The clivus was directly in the line of the exposure and could be drilled widely.

Anterior extension of the exposure by removal of the bone of the middle fossa floor, unroofing of the mandibular division of the trigeminal nerve, eustachian tube and tensor tympani muscle, resection of the glenoid fossa alone or along with the condyle of the temporo-mandibular joint and exposure of a part or isolation and anterior mobilization of the entire petrous carotid artery could be performed. Lateral and inferior extension of the exposure by additional lateral drilling of the petrous bone, resection of the coch-

Table 1. *Clinical Features*

Case	Age/Sex	Duration of symptoms (months)	Cranial nerves affected	Other symptoms	Histology	Extent of resection
1	34/M	8	2–11	hemiparesis	chordoma	total
2	35/M	24	5, 6, 8, 9–12	hemiparesis	chordoma	total
3	40/M	16	5, 6, 8	–	chondrosarcoma	subtotal
4	55/F	2	5, 6	–	chordoma	total
5	29/M	6	2–6	scatato speech	chordoma	subtotal

a



b

Fig. 2. (a) T1-weighted MRI showing the large clival chordoma. Note the relationship of the tumour to the carotid artery. (b) Post-operative MRI showing tumour removal

lear and labyrinthine bone and whenever indicated mobilization of the facial nerve was possible. Posterior extension of the exposure could be obtained by additional drilling of the mastoid bone, labyrinthectomy and posterior mobilization of the sigmoid sinus.

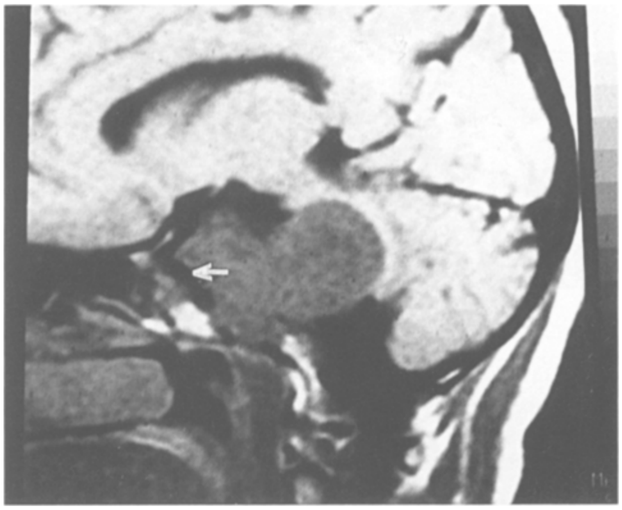


Fig. 3. MRI showing the large petroclival chordoma displacing the precavernous and cavernous segment of the petrous carotid anteriorly (arrow head). The lesion has destroyed the petrous apex and part of the clivus

Material and Methods

Five cases treated by the described approach are reviewed in this report. Of these four were chordomas and one was a chondrosarcoma. We have grouped these two varieties of tumours (i.e., chordoma and chondrosarcoma) together because of their clinical, anatomical, radiological, and surgical resemblance [2, 9, 16, 26]. Histological differentiation between chordomas and chondrosarcomas was made on routine haematoxylin and eosin staining. Due to non-availability of suitable antigens, immunohistochemical studies were not performed [3].

Table 1 summarises the clinical features in the five cases presented.

Results

The tumour was always soft and relatively avascular with areas of entrapped bony segments and bone destruction. The chondrosarcoma was relatively firm and gritty and had a bony feel. In 3 patients zygomatic osteotomy was done while in all partial drilling of the root of the zygomatic arch and superior aspect of the base of the petrous pyramid was carried out. The carotid artery was identified, dissected and isolated after partial tumour debulking in all cases. This dissection was relatively easy, and there was no instance in which the artery ruptured during the dissection. The pattern of tumour spread wherein the third and fourth cranial nerves, Gasserian ganglion and the root of the fifth nerve were displaced superiorly over the dome of the tumour, precavernous and posterior ascending segment of the cavernous carotid artery was displaced anteriorly and the brain stem posteriorly, was observed uniformly in all cases. The dura anterior to the brain stem and in the subcavernous sinus region was intact in all cases. The tumour portion adjoining the carotid artery was isolated by a well defined periosteal layer. Anterior extension of the exposure wherein the floor of the middle fossa was removed, tensor tympani muscle and eustachian tube, horizontal and superior portion of the vertical segment of the intrapetrous carotid artery were exposed in one case. The petrous apex was drilled up to the medial wall of the internal auditory meatus avoiding the cochlea in 3 cases and including the cochlea for provision of additional inferior exposure in 2 cases. The labyrinthine and the tympanic segments of the intrapetrous facial nerve were exposed and mobilised posteriorly after sectioning the greater superficial petrosal nerve in 1 case [8]. The sigmoid sinus was not unroofed in any case. During the dissection the fourth cranial nerve in 2 and the sixth cranial nerve in one were inadvertently cut. The facial nerve fibres were damaged partially in one case. All other cranial nerves could be anatomically preserved. The sixth cranial nerve could not be identified beyond the site of its dural entry point in two cases. In the other 3 cases it was displaced over the dome of the tumour and was in close proximity to the fifth cranial nerve. Gross total resection of the tumour was possible in 3 and subtotal resection was done in 2 patients (Figs.1 a–c and 2 a, b). In one patient residual tumour was inadvertently left behind in the subcavernous part and infratemporal fossa, while in another part of the tumour near the occipital condyle could not be adequately exposed (Fig. 3). All operations were carried out in one stage. There was no mortality in this series. Except for facial nerve paresis in one patient, (loss of 4th nerve function in two cases and 6th nerve in one) no additional morbidity was created by the operation.

Discussion

Cranial chordomas are rare, histologically benign, slow growing tumours which usually present between the 3rd and 5th decades of life. Due to the characteristic site and pattern of growth, the tumours are usually large when first diagnosed and have relatively innocuous presenting symptoms [9, 13, 16, 20–22, 24, 26]. The location of these tumours in proximity to vital neural and vascular structures and widespread extensions makes radical surgical removal difficult and the ultimate clinical course malignant.

Chordomas and chondrosarcomas are often easily diagnosed radiologically due to the following features: their specific location; the frequently associated destructive and erosive bone changes; varying amounts of extracellular mucinous matrix; entrapped bony trabeculae; small dystrophic calcification; areas of necrosis; and recent and old haemorrhages [9, 14, 15, 17, 24, 28]. In addition to other characteristic radiological features, a pre-operative presumption of the nature of the tumour could be made on the basis of the arterial displacements [6]. Such information can sometimes be critically important in planning the operation in terms of the surgical route, need for arterial exposure and control.

Satisfactory surgery on petroclival tumours continues to be difficult. A large number of surgical approaches have been described and successfully used to deal with clival chordomas. Anterior trans-oral [23], trans-facial [19], trans-basal [4], trans-cervical [27] and other such approaches have the disadvantage of inadequate exposure of the lateral extensions of the tumour and are more often employed as tumour debulking procedures. Lateral routes have the advantage of wider tumour exposure and control over the carotid artery. Most of the lateral procedures described for resection of clival chordomas involve relatively complex and extensive skull basal dissection, exposure and mobilization of the carotid artery [24, 25], facial nerve [11], sigmoid sinus [1], and temporomandibular joint [5, 24, 25].

The principal aspects of the approach used in this report have been described earlier [10–12, 18]. It was observed that combined intra- and extradural exposure made dissection of the tumour from the cranial nerves and brain stem relatively safe and under direct vision. Zygomatic osteotomy and basal temporal exposure and lumbar drainage of cerebrospinal fluid made temporal lobe elevation relatively safe. The inclusion of an intradural route for the primarily extradural tumour, although against the principles of skull base surgery, was found to significantly increase the exposure which appeared critical for the safe dissection anterior to the brain stem and radical resection of the tumour. Direct lateral and basal exposure was the shortest surgical route to the tumour located in the clivus and adjacent areas. As the tumour adjoining segments of the internal carotid artery were displaced anteriorly by the tumour the direct lateral route was more appropriate for its safety. It was observed that the arteries and nerves were relatively easily dissected free from the tumour probably because their involvement was only compressive and not invasive in nature. The petrous apex and clival bone were eroded, precavernous and cavernous segments of the internal carotid artery were displaced anteriorly and the Gasserian ganglion was elevated on the dome of the tumour in all cases. These anatomical features were utilised in developing a sub-Gasserian ganglion exposure. The tumour being soft and relatively avascular could then be removed by debulking and blunt dissection. The dura protected the brain stem and cranial nerves and an intact periosteal sheath protected the internal carotid artery. Reconstruction of the region was easy and safe.

Conclusion

The described middle fossa approach, although not new, appeared to be ideal to deal surgically with the more characteristic form of clival chordomas. This approach could be used and exposure widened depending upon the extent of the tumour.

Acknowledgements

The author wishes to acknowledge the help of Dr. Ranjit D. Nagpal for critically evaluating the manuscript. Dr. Sunil K. Pandya was the guiding force. Dr. A. P Karapurkar was the source of encouragement. Dr. Naina Goel did the proof reading.

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