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The Far Lateral-Combined Supra- and Infratentorial Approach: Clinical Experience

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Summary

Four patients underwent a far lateral-combined craniotomy procedure for extensive tumors of the clivus and craniocervical junction. Their presentation, operative, and clinical course are discussed. All patients had improved at their follow-up examination (mean follow-up, 10.7 months). This approach can now be applied to extensive tumors of the petroclival region and craniocervical junction to decrease morbidity.

Keywords: Far lateral-combined approach; supratentorial; infratentorial; skull base.

Introduction

We describe our experience with an extensive approach that combines exposure to the petroclival region via a transpetrosal-transtentorial route with exposure of the anterior rim of the foramen magnum and ventral brain stem by a far lateral, suboccipital, transcondylar route. Based on our cadaveric prosection model [2], a far lateral-combined supra- and infratentorial approach permits complete tumor resection during a single operation. The patient is thus spared multiple exposures to anesthesia. Furthermore, if staging is necessary, the surgery can be performed to traverse the bony cranial barrier first, followed by tumor resection. This approach was used with four patients who had massive intradural space-occupying neoplasms that were ventral to the brain stem and extended from the mesencephalon down to the craniocervical junction. The intraoperative techniques for exposing this region of the skull base and the rationale for its use in the neurosurgical management of these complex lesions are summarized.

Case Material and Methods

Between April 1991 and February 1992, four patients underwent a variation of the far lateral-combined approach (Table 1). Two patients had schwannomas, one of which was a recurrent cystic tumor; one patient had a meningioma; and one patient had an enteric cyst. The patient with the meningioma required a two-stage procedure; the other three patients underwent a single operation.

Illustrative Case Report

A 35-year-old, right-handed, Native American female sought treatment after experiencing worsening right ear hearing loss and mastoid fullness for several months. She also had experienced dysphagia and her tone of voice had changed. The function of right cranial nerves VII, VIII, IX, X was impaired, and she had bilateral gaze nystagmus, right upper extremity dysmetria, and gait ataxia.

Radiographic studies, including enhanced computed tomography (CT) and magnetic resonance (MR) imaging, revealed a right cerebellopontine angle mass. The lesion involved the full extent of the petroclival region down to the craniocervical junction and jugular bulb. The brain stem was deformed markedly. Cerebral angiography revealed collateral venous drainage via the left sigmoid sinus and jugular bulb system (Figs. 1, 2).

The procedure was performed while the patient was under general anesthesia. Cranial nerve VII, brain stem auditory potentials, and somatosensory evoked potentials (SSEP) were monitored. Standard methods of relaxing the brain, including hyperventilation, lasix, and mannitol, were used as necessary. All patients given barbiturates titrated to burst suppression on compressed spectral array electroencephalography.

The patient was positioned as described in an earlier report [2] and underwent a far lateral-combined approach. The petrosectomy, which included translabyrinthine-transcochlear-transotic exposure to gain an unobstructed view of the clivus, was incorporated [7].

The external auditory canal was transected and oversewn in two layers. The extended facial recess was entered, and the chorda tympani and greater superficial petrosal nerves were divided. This division allows the facial nerve to be transposed after its mobilization from the fallopian canal posteriorly [6, 7]. The base of the cochlea was drilled away, and the entire tympanic portion of the temporal bone was removed. The jugular bulb was exposed inferiorly by removing the bone that separates it from the internal carotid artery at the skull base anteriorly. A triangular window of dura, anterior to the internal auditory canal and adjacent to the anterior petrous tip and clivus, was thus delineated [4, 7]. Bone was also removed from

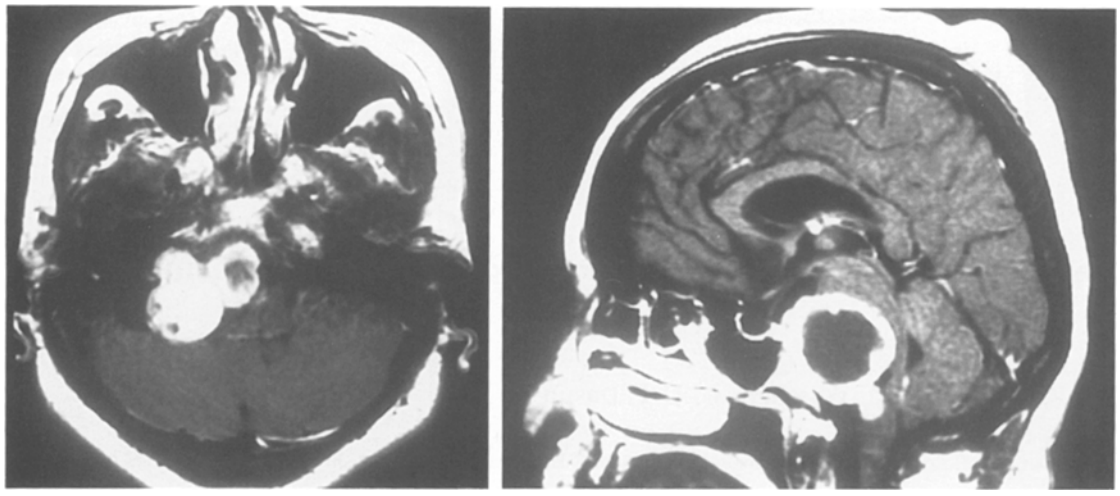

Fig. 1. (a) Axial and (b) sagittal views of gadolinium-enhanced magnetic resonance images demonstrate petroclival tumor extending from the superior clivus to the craniocervical junction with marked brain stem displacement

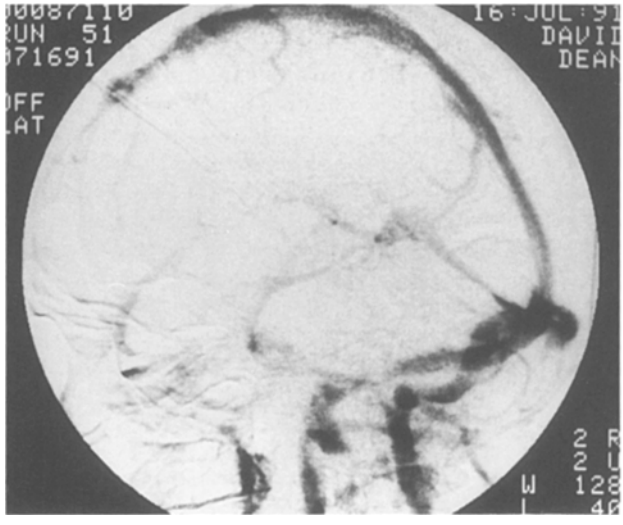

Fig. 2. Digital subtraction angiogram revealing collateral venous drainage via both sigmoid and jugular systems

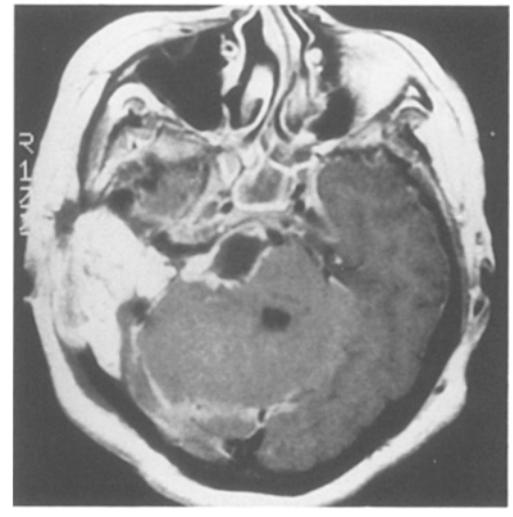

Fig. 3. Postoperative enhanced axial magnetic resonance image of case example reveals fat graft in petrous region and rim of postoperative enhancement

the floor of the middle fossa plate down to the horizontal segment of the internal carotid artey. This additional bone removal permitted the most anterior extent of the cerebellopontine angle to be exposed.

To minimize brain retraction on this patient, as in patients 1 and 3 in this report, the sigmoid sinus was sacrificed because preoperative angiography documented the presence of adequate collateral venous drainage. Sinus pressure was recorded from a 25-gauge needle transducer inserted into the sinus before and after its occlusion proximal to the clip. Temporary occlusion did not cause more than at 10 mm Hg rise in intrasinus pressure, thereby permitting the sigmoid sinus to be divided safely [10].

Results

The tumor was excised completely in all four patients, as judged intraoperatively and by postoperative gadolinium-enhanced MR imaging studies (Fig. 3). There were no deaths. Three patients had transient paresis of cranial nerves VII, IX, X, and XI, and one patient experienced only transient deficits of cranial nerves IX, X, XI. Three patients experienced some form of cerebrospinal fluid (CSF) malabsorption, which was manifested as hydrocephalus on their

Table 1. *Clinical Summary of Four Patients Treated with the Far Lateral-Combined Approach*

Pt.	Age/ Sex	Presenting symptoms	Diagnostic studies	Hydro-cephalus	Pathological diagnosis	Location/ extent of lesion	Procedure	Complications	Length of follow-up	Outcome
1	71/ M	gait ataxia dysmetria deafness facial nerve paresis jugular foramen syndrome	enhanced MRI/ angiography	yes	cystic schwannoma	middle clivus to foramen magnum posterior fossa/ jugular foramen	far lateral, translab, combined	transient paresis on CN VII, IX, X, XII	15 mo	improved
2	35/ F	gait ataxia right dysmetria dysphagia bilateral gaze nystagmus cranial nerves VII, VIII, IX, X, XII deficits	enhanced MRI/ angiography	yes	schwannoma	upper clivus to cranio-cervical junction and jugular foramen	far lateral, transcoch-lear, combined	transient paresis of CN VII, IX, X XII	10 mo	improved
3	54/ F	gait ataxia dysmetria dysphagia cranial nerves VII, VIII, IX, X, XI deficits	enhanced MRI/ angiography	yes	meningioma	upper clivus to cranio-cervical junction	far lateral transcoch-lear, combined	transient paresis of CN VII, IX, X, XII	15 mo	improved
4	25/ F	gait ataxia dysmetria cranial nerve VII deficit hemiparesis	enhanced MRI/ angiography	no	enteric cyst	middle clivus to cranio-cervical junction	far lateral retro-labyrinthine (sigmoid preserved)	transient paresis of CN IX, X, XI	3 mo	improved, hearing preserved

initial presentation (Table 1). The two patients with schwannomas had ventriculoperitoneal shunts placed before their tumor surgery. In the intensive care unit, the patient with the meningioma required postoperative ventricular drainage, which was later weaned completely.

Patients with cranial nerve VII impairment later underwent a gold-weight reanimation procedure [5] to enhance corneal protection of their transiently denervated eyelids. Two patients required tracheostomies, which were weaned successfully at a 2-months follow-up examination. Follow-up was obtained in all patients (mean follow-up, 10.8 months), all of whom now function independently.

Discussion

Our technique for the far lateral-transcondylar route is similar to that recently described by Bertalanffy and Seeger [3]. We also drill the posterior third of the occipital condyle, lateral mass of the atlas, and jugular tubercle, in addition to exposing the vertebral artery completely at the first occipital vertebra. This bone removal permits safe transposition of the vertebral artery during dural opening and retraction.

The combined supra- and infratentorial approach [10] had the advantages of minimizing cerebellar retraction and of permitting the direct identification of the facial nerve during the course of the transcochlear exposure. When the divided proximal sigmoid sinus and tentorium are elevated as a single structure, the upper clivus is readily visible. The posterior temporal lobe can be elevated safely without risk to the vein of Labbé. The use of the combined approach in conjunction with subtemporal exposure allows exquisite visualization of the anterosuperior brain stem, middle fossa, cavernous sinus, and Meckel's cave.

Division of the sigmoid sinus, however, requires preoperative angiographic verification of adequate collateral venous drainage. Using preoperative angiography and intraoperative pressure monitoring, we have avoided any potential complications from dividing the sigmoid sinus.

The most frequent complications associated with extensive skull base surgery are cranial nerve deficits and CSF leaks [1, 8–10]. Seventh cranial nerve pareses have been treated successfully with oculoplastic procedures that protect the cornea while eye closure is recovering from surgical manipulation of the facial nerve. The incision employed for this extensive skull base approach incorporates the advantages of a well-vascularized myocutaneous flap, which improves coverage of the resultant bony defect and minimizes the potential for the CSF fistula to develop. In addition, the early anticipation and detection of postoperative lower cranial nerve deficits have led us to perform an early tracheostomy and to provide an enteral feeding access when possible.

As outlined by the stepwise dissection model [2] and these four cases, the far lateral-combined approach easily can be used with other skull base approaches to maximize exposure of the petroclival region and foramen magnum and to minimize brain retraction. We advocate the far lateral-combined supra- and infratentorial approach for patients who harbor extensive cranial base pathology that involves the skull base from the superior petroclival area down to the region of the craniocervical junction and jugular foramen. The approach can be tailored to the needs of each patient to permit complete tumor resection with an acceptable rate of morbidity.

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