SURGERY OF CRANIOCERVICAL MENINGIOMAS

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ABSTRACT

Objective: *To study the different surgical approaches to craniocervical meningiomas in different locations in the area of the foramen magnum, whether anterior, posterior, antrolateral or posterolateral*

Methods: *Twenty six patients with craniocervical meningiomas were operated upon during the period from 2000 to 2009 using the standard posterior approach for posterior lesions (14 cases), extreme lateral approach without drilling of the occipital condyle in the antrolateral and posterolateral lesions(6 cases) and transcondylar approach for anterior lesions (6 cases).*

Results: *This study included 16 females and 10 males, the patients' age ranged from 23 to 64 years with a mean of 51.8 years. Tumor size ranged from2 to 6.4 in its maximum diameter. Tumor location was posterior in 14 patients, lateral in 6 patients and anterior in 6 patients. Total tumor resection was done in 23 (88.4%) patients and subtotal in 3 (11.6%) patients. Postoperative complications included transient lower cranial nerves affection, transient hemiparesis. There was no mortality in this study. The follow up period ranged from 6 months to 4.8 years.*

Conclusion: *Surgical approach to craniocervical meningioma has to be tailored according to the location of the tumor. Posterior tumors are safely totally removed through the slandered suboccipital approach. Posterolateral and antrolateral tumors are easily removed via the postero lateral retrocondylar approach without drilling of the occipital condyle benefiting from the working space given by lateral displacement of the brain stem. Anteriorly located tumors are better approached through the extreme lateral transcondylar approach to avoid brain stem retraction.*

Key words: *Foramen magnum, meningioma, occipital condyle, suboccipital approach.*

INTRODUCTION

The craniocervical region is defined as: anteriorly, the area extending from the lower third of the clivus to the upper border of C2 body, laterally; from the jugular tubercle to the C2 lamina, and posteriorly; from the anterior border of the occipital squama to the spinous process of C2.[7,12,16,24,29]

Craniocervical meningiomas (CCMs) occount for 1% to 3.2% of all meningiomas, 6% to 7% of all posterior fossa meningiomas and 75% of benign extramedullary tumors at the foramen magnum.[2,9,20]

Resection of CCMs presents a great challenge. Because of their proximity to important vascular and neural structures, complete removal of the tumor often entails high degree of difficulty and postoperative complications.[1,3,5]

CCMs are often large at diagnosis due to their slow-growth rate and wide subarachnoid space at that region leading to a long interval between the first symptom and diagnosis.[2,14,33]

Early reports about surgery of craniocervical menigiomas were often disappointing with a high rate of disability due to lower cranial nerves, vertebral artery and brain stem damage.[1,10,31]

Here, we describe our experience in approaching CCMs over a period of about 9 years. We discuss the suitable approach according to the location of the tumor and present our results.

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METHODS

This study included 26 patients with craniocervical meningiomas operated on during the period from December 2000 to February 2009. 16 patients were females and 10 were males (table1). The age of the patients ranged from 23 to 64 years with a mean of 51.8 years (table I). Clinical evaluation was done using the McCormick scale: grade I: neurologically normal with mild focal deficit; grade II: presence of sensorimotor deficit impairing quality of life; grade III: more sever neurological deficit requiring cane; grade IV: severe deficit requiring wheelchair, not independent. Table (II) shows the distribution of patients according to the McCormick scale. The most common presenting manifestations included neck pain, headache, sensory motor deficit, ataxia and sphencteric disturbance (table III). MRI and CT scan were done for all patients. Tumor location was posterior in 14 patients, lateral in 6 patients and anterior in 6 patients. The maximum tumor diameter ranged from 2cm to 6.4 cm with a mean of 3.4 cm. Relation of the tumor to the vertebral artery and the pica was adequately studied in all patients. Calcification was seen in the CT scan in 8 patients. Associated hydrocephalus was seen in 2 patients and was not treated before tumor resection. In one patient the hydrocephalus resolved and in the other patient it needed ventriculoperitoneal shunt in the postoperative period.

Location of craniocervical meningioma and choice of surgical approach:

The tumor is considered posterior if its insertion is

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posterior to the dentate ligament; lateral if the insertion of the tumor is between the midline and the dentate ligament and anterior if the tumor is inserted on both sides of the anterior midline. Posterior meningiomas push the neuroaxis anteriorly and are easily approached through the conventional posterior suboccipital approach. Lateral meningiomas displace the neuroaxis posteriorly and to the opposite side thus opening a working space in the area lateral to the neuroaxis and eliminating the need for drilling of the occipital condyle making the posterolateral retrocondylar approach enough for reaching the entire tumor.(18,19) Anterior meningiomas push the neuroaxis posteriorly making the space between it and the lateral margin of the foramen magnum narrow and this needs drilling of part of the occipital condyle to avoid retraction on the brain stem and upper spinal cord.(4,5,6,30) The location of the meningioma in relation to the vertebral artery is crucial for anticipation of the position of the lower cranial nerves and their safety during tumor resection. If the tumor is caudal to the vertebral artery, the lower cranial nerves are pushed cranially and posteriorly and at that time we do not have to look for them and we start by debulking the tumor and they will come into view at the upper pole of the tumor. If the tumor is growing cranial to or on both sides of the vertebral artery the lower cranial nerves may be displaced at any direction and care should be taken at every stage of tumor resection to look for them for their protection. If the dura around the vertebral artery opening is infiltrated it is better to leave a cuff of it around the artery not to injure the artery because the tumor is always infiltrating the adventitia.(6)

Surgical techniques

Conventional posterior suboccipital approach

This approach was used in posteoirly located meningiomas which are posterior to the plane of the dentate ligament and medial to the vertebral arteries. We used the lateral position with head elevated 30 degrees to avoid air embolism which may occur in the semisitting position. The skin is incised in the midline starting from the occipital protuberance down to the upper cervical vertebrae according to the extent of the tumor. The midline avuscular plane is opened up to the occipital protuberance and down to C2 spinous process or according to the caudal extension of the tumor. Suboccipital creniectomy is then performed using the air drill and Kerrison rongeurs. The posterior arch of C1 is then removed. We can remove other laminae if the tumor is extending more caudally. The dura is then opened in a Y-shaped fashion and retracted by stitches.

Far lateral retrocondylar approach

This approach was used for lateral tumors. The posterolateral approach is a lateral extension of the conventional posterior suboccipital approach. Skin incision is the same as the posterior approach but is curved laterally on the tumoral side just below the occipital protuberance toward the mastoid process. The posterior muscles are divided along the occipital crest and retracted laterally to expose the occipital bone, the posterior arch of the atlas and the C2 lamina or as far caudally as required. The vertebral artery is then exposed to safely remove the posterior arch of C1lateral to the lateral mass. Exposure of the vertebral artery horizontal segment (V3) is started from the midline keeping dissection in a subperiosteal plane and going laterally towards the atlas groove. The medial border of the groove is marked by the decrease in height of the posterior arch of the atlas. After good exposure of the posterior arch of the atlas the V3 segment of the vertebral artery is elevated from the atlas groove. The V3 segment is surrounded by venous plexus and the artery and vein are enclosed in a periosteal sheath which provides protection against injury of the vertebral artery. Venous bleeding, if occur, can be controlled by direct bipolar coagulation and surgicel. The occipitoatlantal membrane covering the atlantal groove may be calcified or ossified making it difficult to expose the V3 portion of the vertebral artery. Care should be taken not to injure the artery. After full exposure the artery is then gently mobilized cranially to expose the lateral mass of the atlas.

The lower part of the occipital bone is then removed laterally to the sigmoid sinus and the lateral margin of the foramen magnum is drilled as lateral as possible. The posterior arch of the atlas is resected from the midline to the transverse process and part of the other side of the posterior arch is also resected to prevent compression of the neuroaxis against it during manipulating the tumor.

Posterolateral transcondylar approach

This approach was used for anterior meningiomas. It is the same like the lateral approach except for the drilling of the occipital condyle and the lateral mass of the atlas. We found that no more than 25% of the condyle is to be resected for reaching the anterior tumors. Drilling of the lateral mass of the atlas is required if the tumor grows caudal to the vertebral artery, drilling of the occipital condyle and jugular tubercle is required if the tumor grows cranial to the vertebral artery and drilling of both the condyle and the lateral mass is done if the tumor encircles the vertebral artery from both sides.

Duara is then opened in a curvilinear fashion starting inferolaterally and running vertically at a paramedian level (1cm from the midline) then curving twards the superolateral corner.

Three important structures are identified before starting tumor resection; the vertebral artery, the accessory nerve and the dentate ligament. The vertebral artery is identified by following the V3 segment where it pierces the dura the first dentate ligament is sectioned and the first cervical root if needed is sectioned distal to its connection to the accessory nerve.

Tumor resection can be preceded according to the relation of the tumor to the vertebral artery. If the tumor is caudal to the vertebral artery, the lower cranial nerves are always pushed upwards and posteriorly and are easily identified at the upper pole of the tumor at the end of tumor resection. Resection should start at the caudal end of the tumor trying to release the tumor attachment and devascularize the tumor. Debulking of the tumor is done with the help of an ultrasonic aspirator. A small sheath of the tumor is left with its capsule adherent to the neuroaxis to be dealt with at the end of the procedure after securing a good working space and better hemostatic condition.

If the tumor is cranial to the vertebral artery, care should be taken to the lower cranial nerves because its displacement cannot be anticipated. It is safer to follow these nerves from the jugular foramen with careful debulking of the tumor. The vertebral artery branches namely the pica anatomy should be carefully studied in the preoperative investigation and care should be taken during surgery to avoid its injury.

If the tumor grows on either side of the vertebral artery and infiltrate the dural entrance point of the artery, we resect as much as possible leaving a small cuff of the dura attached to the artery.

RESULTS

Tumor was totally removed in 23 patients; 14 posterior leasions, 5 lateral lesions and 4 anterior lesions,and subtotally removed in 3 patients; one lateral lesion due to the adherence to the vertebral artery and 2 anterior lesions, one due to the occurrence of sever bradycardia and it was the order of the anesthetist to stop operation and in one patient due to a defect in the ultrasonic aspirator we left a small residual anterior to the medulla to avoid retraction (table I). The clinical status improved in 10 patients to a higher McCormick grade and deteriorated in 5 patients in the immediate follow up period. Two of these 5 patients improved and three remained worse by one grade according to the McCormick grading (table I). The most commonly encountered complication was transient unilateral lower cranial nerves palsy which improved in the first postoperative week. One patient developed persistent hypoglossal nerve palsy with tongue deviation and hemiatrophy. CSF leak from the wound occurred in three patients and responded to repeated lumber drain. Postoperative hydrocephalus occurred in one patient and required ventriculperitoneal shunting (Table IV). During the long follow up period, no recurrence occurred and the 3 patients with subtotal removal are being followed with no growth and radiosurgery is to be considered once increase in size occurs.

Table I: Summary of 26 patients

Patient	Age	Gender	Location	Size	McCormick (preop.)	Approach	Extent of resection	McCormick (postop.)
1	46	F	Posterior		GI	Posterior	Total	GI
2	23	F	Posterior		GIII	Posterior	Total	GII
3	44	F	Posterior		GI	Posterior	Total	GI
4	56	F	Posterior		GII	Posterior	Total	GI
5	63	M	Lateral		GII	Retrocondylar	Total	GIII
6	58	M	Posterior		GIII	Posterior	Total	GII
7	29	F	Anterior		GI	Transcondylar	Subtotal	GII
8	64	F	Posterior		GII	Posterior	Total	GI
9	60	F	Lateral		GII	Retrocondylar	Subtotal	GII
10	58	M	Posterior		GI	Posterior	Total	GI
11	46	F	Anterior		GII	Transcondylar	Total	GI
12	39	M	Posterior		GIV	Posterior	Total	GVI
13	54	F	Anterior		GII	Transcondylar	total	GII
14	33	M	Posterior		GII	Posterior	Total	GII
15	38	F	Lateral		GII	Retrocondylar	Total	GII
16	33	F	Posterior		GI	Posterior	Total	GI
17	45	F	Anterior		GIII	Transcondylar	Total	GII
18	57	M	Lateral		GII	Retrocondylar	Total	GII
19	48	M	Posterior		GIII	Posterior	Total	GII
20	39	F	Anterior		GI	Transcondylar	Subtotal	GI
21	41	M	Posterior		GIV	Posterior	Total	GIII
22	50	F	Lateral		GII	Retrocondylar	Total	GII
23	49	F	Lateral		GIII	Retrocondylar	Total	GII
24	36	M	Posterior		GII	Posterior	Total	GII
25	60	M	Anterior		GI	Transcondylar	Total	GI
26	46	F	Posterior		GIII	Posterior	Total	GII

Table II: Distribution of patients according to the McCormick scale.

grade	No. of patients
Grade I	7
Grade II	11
Grade III	6
Grade IV	2
Total	26

Table III: Clinical presentation of 26 patients with foramen magnum meningiomas

Clinical presentation	No. of patients
Neck pain	19
Headach	13
Sensorymotor deficit	18
Ataxia	11
Sphencteric disturbance	9
Wasting of small muscles of the hand	3

Table IV: Operative complications

Complication	No. of patients
Transient lower cranial nerves palsy	8
Persistent hypoglossal nerve palsy	1
CSF leak	3
Hydrocephalus	1
Pyramidal tract injury	2

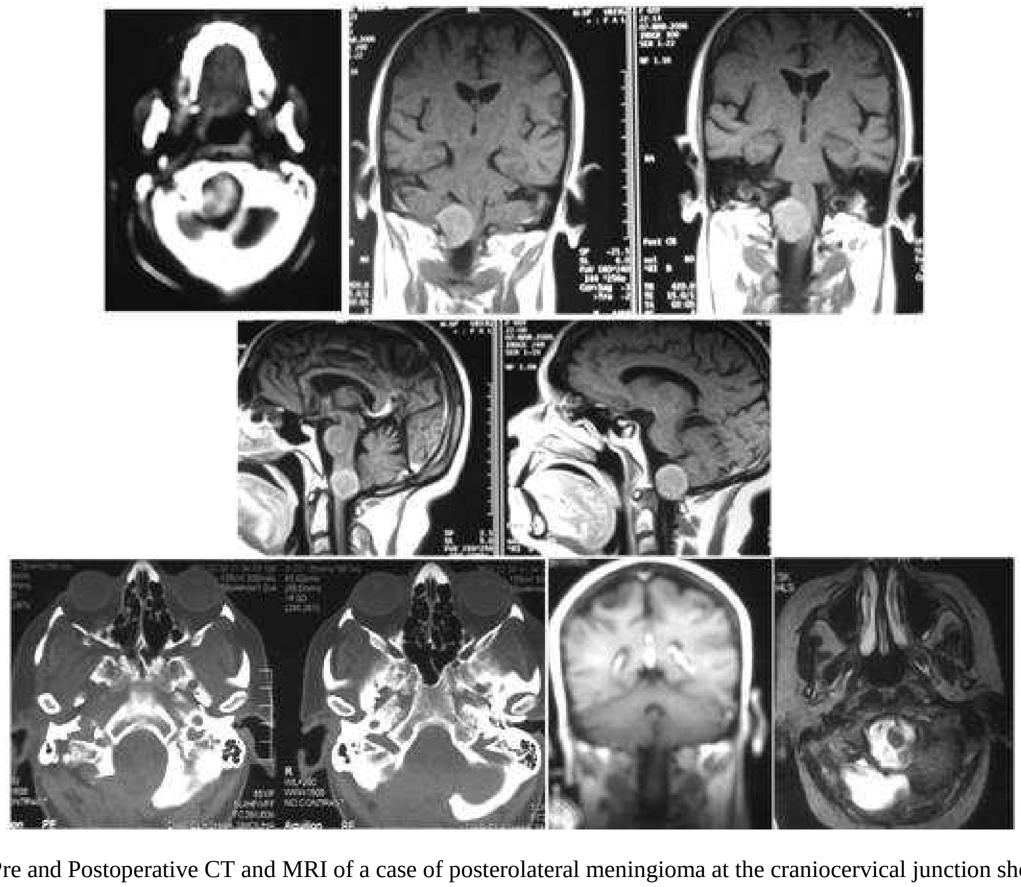

Fig 1: Pre and Postoperative CT and MRI of a case of posterolateral meningioma at the craniocervical junction showing total removal (notice the extent of bone removal)

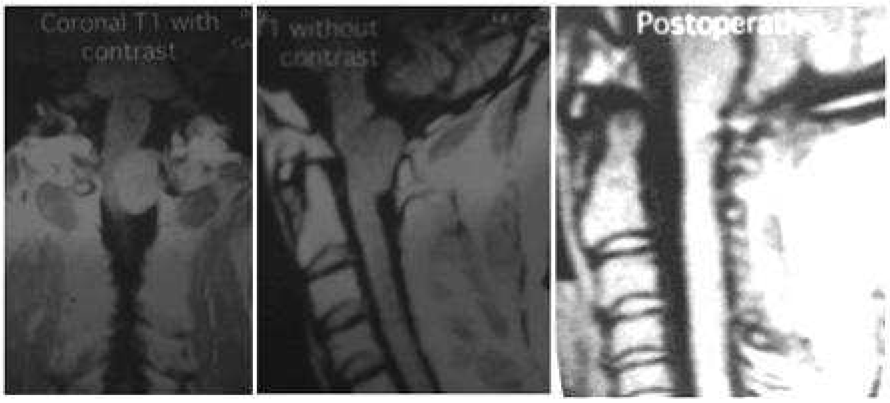

Fig 2: Pre and postoperative MRI of a case of posterior foramen magnum meningioma

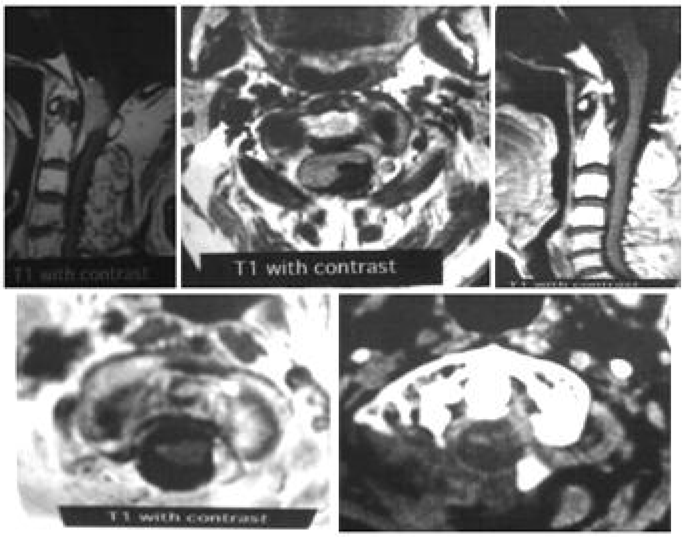

Fig 3: pre and post operative MRI of a case of anterior foramen magnum meningioma. Notice the extent of condylar excision in the postoperative CT scan

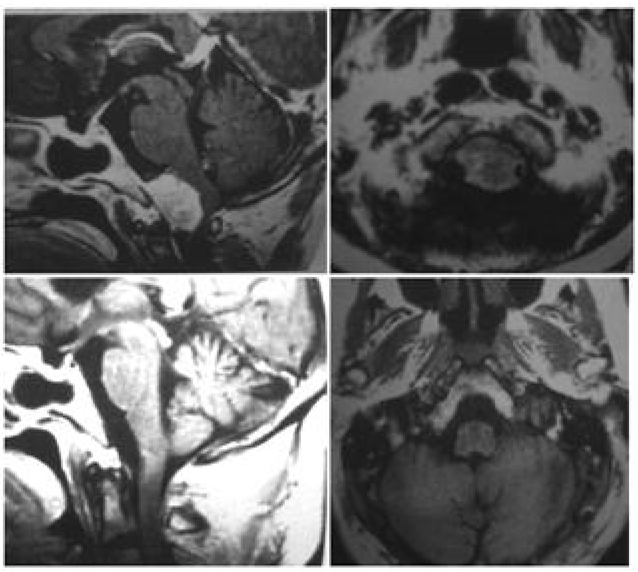

Fig 4: pre and post operative MRI of a case of anterior foramen magnum meningioma.

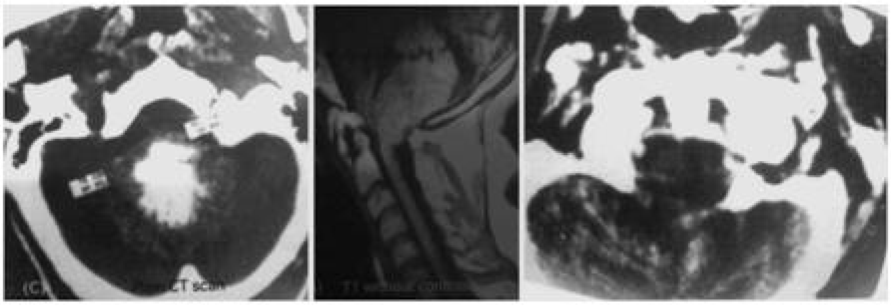

Fig 5: preoperative CT scan and MRI showing huge posterior foramen magnum meningioma. Postoperative CT scan after total exision.

DISCUSSION

Craniocervical meningiomas are challenging lesions due to the important vascular and neural structures in this area. Its close relation to the vertebral artery and its important branches and to the brain stem and offsetting lower cranial nerves make its resection hazardous.(26,27)

Different surgical approaches are being in use for resection of craniocervical meningiomas including anterior and posterior approaches.

Anterior approaches

The anterior transoral approach used by Crockard et al(10) has the advantage of being a direct way for the anterior lesions but its great disadvantage is the high risk of post operative cerebraspinal fluid leakage and meningitis. Also its lateral extension is limited and the occurrence of postoperative instability and velopalatine instability made this approach not widely used for meningiomas.(10,24) In our experience this approach is only suitable for extradural lesions.

The anterolateral retropharyngeal approach used by other author(8) has the disadvantage of being limited cranially and laterally by the carotid artery and dural closure is difficult. It also has high rate of complication as accessory nerve injury and injury of the sympathetic chain leading to Horner's syndrome.(8,15,21) This approach has not gained popularity except in some selected cases due to the previous limitations and complications.

Posterior approaches

Although some authors are reporting about the posterior approach in resection of the anteriorly located craniocervical meningiomas,(13) yet the high rate of operative complications due to the possibility of retraction on the neuroaxis and the limited working space make the posterolateral transcondtlar more easy and safe.(5,22,30)

There is no debate about the posterior craniocervical meningiomas as regards to the approach. Standered posterior suboccipital approach with removal of the posterior arch of the atlas and upper cervical vertebra according to the caudal extension of the tumor is well known and agreed by neurosurgeons.(8)

The posterolateral approach, whether transcondylar or retrocondylar is suitable for lateral and anterior meningiomas.(5,30,22,32) In lateral meningiomas there is obviously no need for drilling the occipital condyle.(8,26,30) For anterior meningiomas drilling of the posterior 25% of the occipital condyle is enough for good exposure and total removal of the meningioma.(5,30) The amount of condylar drilling depends on the degree of tumor extension to the contralateral side in anterior meningiomas. Drilling of the posterior 25% of the occipital condyle is enough for anterior meningiomas and does not affect stability.(5)

Extent of tumor resection

The limiting factors against complete tumor removal are adhesions to the neural structures and encasement of the vertebral artery. In this study subtotal removed occurred in 3 patients; one lateral lesion due to the adherence to the vertebral artery and 2 anterior lesions one due to the occurrence of sever bradycardia and it was the order of the anesthetist to stop operation and in the other one due to a defect in the ultrasonic aspirator, we left a small residual anterior to the medulla to avoid retraction. The rate of subtotal removal in the literature was around 16%.(2,7,8,11,14) The main causes of incomplete tumor removal were the adhesions due to previous subtotal removal, so that, the best chance for the surgeon and the patient is the first operation that we should be as radical as we can. The second cause is the aggressiveness of the tumor. In intradural extradural lesions the rate of total removal is less than pure intradural lesions.(2,11) In T2 weighted MRI the presence of edema may indicate an aggressive tumor and one has to be cautious during dissection of the tumor from the brain stem.(19)

Advanced microneurosurgical techniques, adequate intraoperative facilities and neuroimaging are crucial for excision of tumors in the craniocervical junction

Conclusions

Surgical approach to craniocervical meningioma has to be tailored according to the location of the tumor. Posterior tumors are safely totally removed through the standered suboccipital approach. Posterolateral and antrolateral tumors are easily removed via the postero lateral retrocondylar approach without drilling of the occipital condyle benefiting from the working space given by lateral displacement of the brain stem. Anteriorly located tumors are better approached through the extreme lateral transcondylar approach to avoid brain stem retraction.

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