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Surgical treatment of jugular foramen meningiomas

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ABSTRACT

Object: We present our experience with surgery of jugular foramen meningiomas with special consideration of clinical presentation, surgical technique, complications, and outcomes.

Methods: This retrospective study includes three patients with jugular foramen meningiomas treated by the senior author between January 2005 and December 2010. The initial symptom for which they sought medical help was decreased hearing. In all of the patients there had been no other neurological symptoms before surgery. The transcondylar approach with sigmoid sinus ligation at jugular bulb was suitable in each case.

Results: No death occurred in this series. All of the patients deteriorated after surgery mainly due to the new lower cranial nerves palsy occurred. The lower cranial nerve dysfunction had improved considerably at the last follow-up examination but no patient fully recovered. Two of three patients with preoperatively impaired yet functional hearing deteriorated after surgery with no subsequent cranial nerve VIII function improvement. In one case postoperative stereotactic radiosurgery was performed due to non-radical tumour resection (Simpson Grade IV) and tumour remnant proved stable in the 4-year follow-up. None of the patients have shown signs of tumour recurrence in the mean follow-up period of 56 months.

Conclusions: Jugular foramen meningiomas represent one of the rarest subgroups of meningiomas and their surgical treatment is associated with significant risk of permanent cranial nerve deficits.

1. Introduction

Jugular foramen meningiomas are one of the rarest subgroups of meningioma and first published series did not include these lesions [1,2]. They are presumed to arise from arachnoid cells lining the jugular bulb [3]. Fewer than 140 cases of jugular foramen meningioma (mostly single cases and short series) have been reported in the literature [4–6]. Al-Mefty named these meningiomas ''jugular fossa meningiomas'' to separate them from other meningiomas that only pass through the jugulare foramen and did not arise from the jugular fossa [7].

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Differential diagnoses of jugular foramen tumours include glomus jugulare tumours and schwannomas of the lower cranial nerves. Surgical management of jugular foramen meningiomas pose a formidable challenge due to the proximity and involvement of lower cranial nerves and the jugular bulb, their propensity to invade bone producing hyperostosis and their tendency to extend extracranially [3]. Based on these characteristics the radical removal of these tumours is difficult and carries a significant risk of postoperative neurological deterioration. In this article we present our experience with surgery of jugular foramen meningiomas in regard to clinical and radiological features, surgical technique used, complications and surgical outcomes.

2. Materials and methods

We retrospectively reviewed 3 cases of jugular foramen meningioma treated by the senior author (A.M.) in our centre between 2005 and 2010. Patients who were diagnosed as having posterior petrous meningioma with dural attachment localized between the internal acoustic meatus and jugulare foramen (inframeatal tumour) or clival meningioma extending into jugular fossa were excluded from our cohort. The most important demographic and clinical features in our series are outlined in Table 1. Our cohort included 3 women. The average age was 54 years (range 46–61 years). The first sign of the disease was hypoacusis in all cases. None of the patients had obturative hydrocephalus diagnosed. Radiographic evaluation included brain Magnetic Resonance Imaging (MRI) and temporal bone Computed Tomography (CT). MR studies were used to define the local anatomy of the jugular foramen, extensions of the tumour and its relationship to neighbouring structures. CT scanning were obtained for analysis of bone involvement and calcification within the tumour. Digital Subtraction Angiography (DSA) was performed in order to evaluate the position and patency of the jugular bulb, dominance and tributaries of the transverse and sigmoid sinuses, and the vertebrobasilar arterial system. Audiology examination with pure tone audiometry and Auditory Brainstem Response (ABR) was performed in all three patients.

2.1. *Surgical technique*

The choice of surgical approach was determined by the tumour's characteristics and the type of tumour extension identified. Jugular foramen meningiomas like glomus jugulare tumours frequently invade bone and obliterate sigmoid sinus and jugulare bulb. For these tumours modifications of cranio-cervical approach were used. The general approach consists of:

- identification of the internal carotid artery, external carotid artery, internal jugular vein, and the 9th, 10th, 11th and 12th cranial nerves in the cervical region;
- the sternocleidomastoid muscle is dissected, mobilized and reflected inferiorly, C1 transverse process and vertebral artery are exposed, the facial nerve is identified at the entrance to the parotid gland;
- a mastoidectomy is followed by posterior petrosectomy (retrolabyrinthine or translabyrinthine in case of preoperative deafness);
- a small craniectomy is performed and to further expand the exposure, the posterior part of the occipital condyle and the jugular tubercle are removed, thus opening the jugular foramen dorsolaterally;
- the sigmoid sinus and jugulare vein are ligated at a location proximal to the mastoid emissary vein and distal to the tumour obstruction; the inferior pole of the tumour is dissected off the internal carotid artery and the jugular vein and extradural tumour is removed;
- the dura mater is opened posterior to the sigmoid sinus with counter-cut towards jugular foramen; then intradural tumour extension is exposed;
- the procedure is completed with microsurgical radical resection of the tumour;
- fatty tissue is harvested and artificial dura mater together with fibrin glue are used to obtain a watertight closure at the end of the procedure.

Intraoperative monitoring consisted of lower cranial nerves monitoring, brainstem auditory evoked potentials and facial nerve monitoring. Lumbar drainage was placed for 5 days in order to avoid cerebrospinal fluid leakage.

The extent of tumour resection was evaluated based on the intraoperative findings and postoperative brain MRI (made 3 months after the operation). The grade of tumour resection was classified according to the Simpson's classification [8]. The patient's condition was assessed at discharge from the department along with a long-term follow-up based on neurological examination and brain MRI in all of the patients. The postoperative outcome was analysed using the Karnofsky Performance Status (KPS) [9] to measure the degree of disability. The postoperative follow-up period was 41, 56 and 96 months (Figs. 1 and 2).

Table 1 – Clinical presentation of three patients with jugular foramen meningioma.

Case no.	Sex	Age (years)	Size of tumour (mm)	Initial symptoms	Duration of symptoms (months)	Other neurological deficits	Jugular bulb patency (DSA)[a]
1	F	61	25 × 22 × 20	Decreased hearing	6	–	Not patent
2	F	54	23 × 23 × 17	Decreased hearing	6	Cerebellar ataxia	Not patent
3	F	46	20 × 18 × 15	Decreased hearing	12	–	Not patent

[a] DSA = digital subtraction angiography.

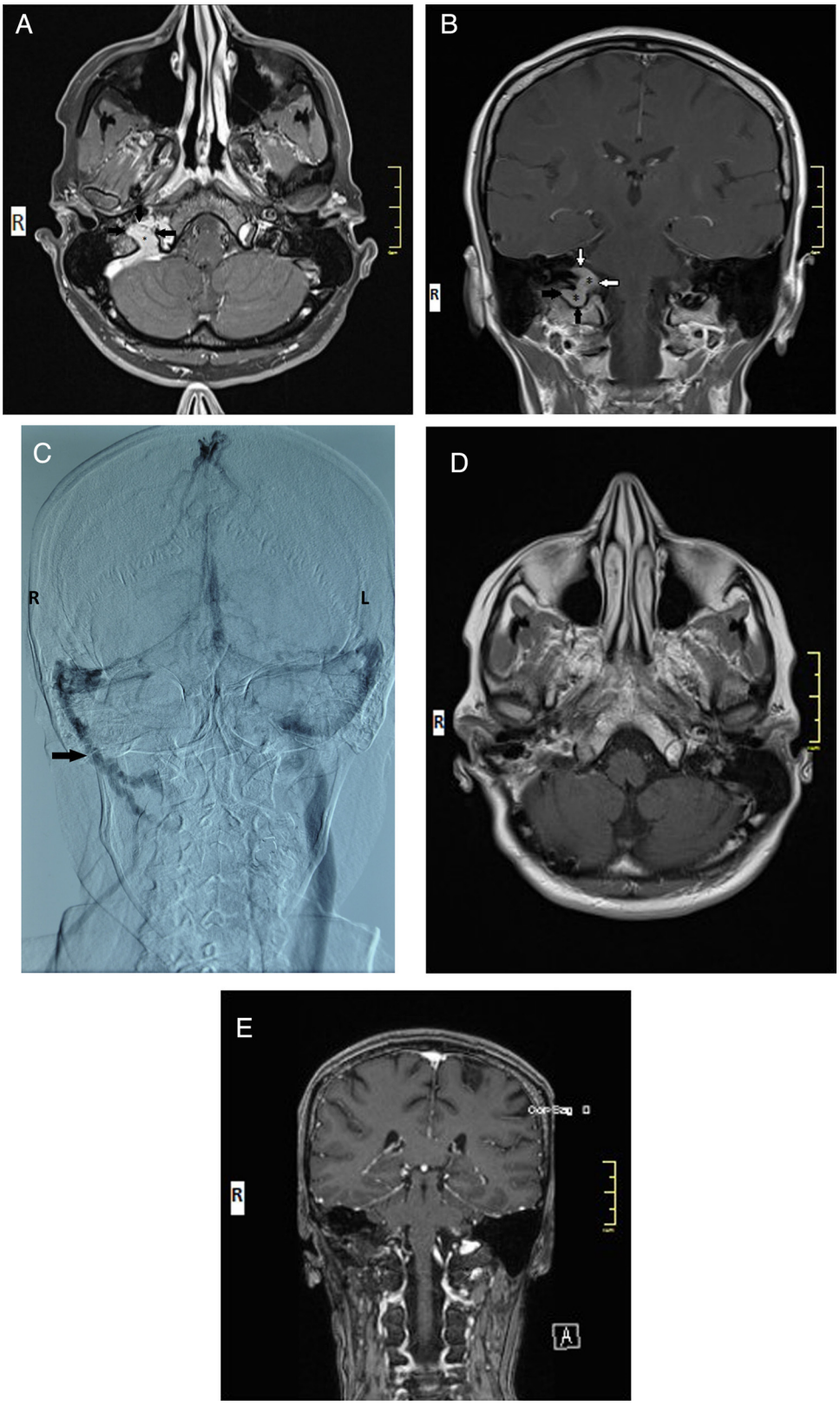

Fig. 1 – Case 3 (46 years). Preoperative axial (A) and coronal (B) T1 contrast enhanced MR image demonstrating the right jugular foramen meningioma (asterisks), enlargement of the jugular fossa (black arrows) and tumour extension in the posterior fossa (white arrows). Preoperative angiography (C) revealing the jugular bulb and the jugular vein occlusion and development of collateral venous channels (black arrow). Postoperative axial (D) and coronal (E) T1 contrast enhanced MR image obtained after complete resection of the tumour. The tumour was approached via the transjugular route.

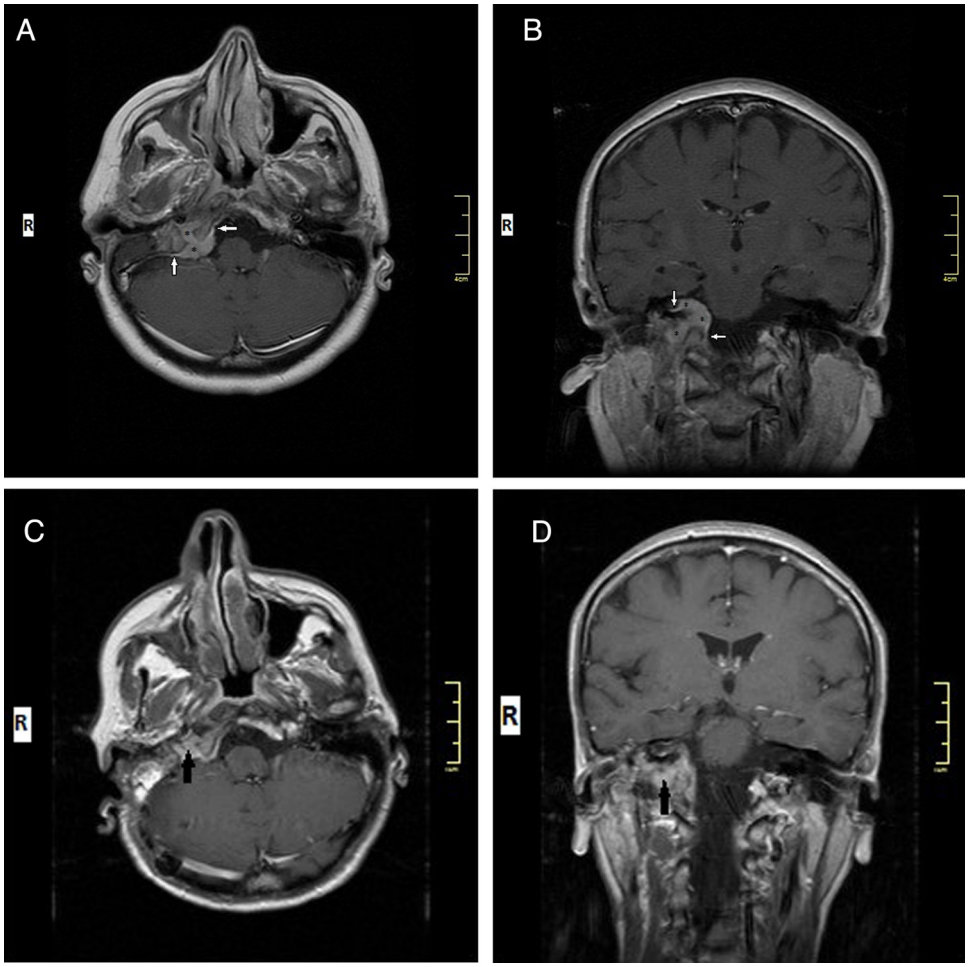

Fig. 2 – Case 1 (61 years). Preoperative axial (A) and coronal (B) T1 contrast enhanced MR image revealing the right jugular foramen meningioma (asterisks) with enhancement of the dura (the dura-tail) (white arrows). Postoperative axial (C) and coronal (D) T1 contrast enhanced MR image obtained 4 years after radiosurgery of incompletely resected tumour showing the tumour remnant in the jugular fossa (black arrow).

3. Results

Intraoperatively the jugular bulb was completely occluded by tumour in all of the patients (Table 2). Gross-total resection (Simpson Grade II) was achieved in 2 cases. In one patient Simpson Grade IV resection was done: a tumour layer tightly adjacent to the lower cranial nerves was left owing to the high risk of severe postoperative deficits. Stereotactic radiosurgery was then elected for this patient and no further tumour progression was found in the 4-year follow-up. There was no tumour recurrence in other 2 patients.

Early and late postoperative results are summarized in Table 3. There was no operative mortality. All the patients deteriorated after surgery due to new lower cranial nerves deficits. However cranial nerves IX and X palsies significantly diminished during follow-up, it proved permanent in all cases. Significant postoperative hearing impairment occurred in 2 patients and remained stable in the follow-up. In one patient postoperative facial nerve palsy occurred (grade IV on the House and Brackmann scale [10]) and it showed gradual improvement in the follow-up. One patient experienced cerebrospinal fluid leakage which resolved with a use of repeated lumbar drainage. A nasogastric tube was kept in

Table 2 – Surgical findings in 3 patients with jugular foramen meningioma.

Case no.	Jugular bulb patency intraoperatively	Surgical approach	Extent of resection (according to Simpson grading scale)	Histopatology
1	Not patent	Transjugular	IV	Meningioma meningotheliale
2	Not patent	Transjugular	II	Meningioma meningotheliale
3	Not patent	Transjugular	II	Meningioma transitionale

Table 3 – Early and late surgical results.

Case no.	New postoperative CN deficit or preoperative CN deficit worsened	Follow-up (months)	CN deficit improved in the follow-up	CN deficit stable in the follow-up	Tumour recurrence	Outcome (Karnofski scale)
1	n.VIII n.IX n.X n.XI n.XII	40	n.IX n.X	n.VIII n.XI n.XII	–	80
2	n.VIII n.IX n.X	78	n.VIII n.IX n.X	–	–	80
3	n.VII[a] n.VIII n.IX n.X n.XII	49	n.VII[b] n.IX n.X n.XII	n.VIII	–	90

[a] Grade IV on the House–Brackmann scale.
[b] Grade III on the House–Brackmann scale.

place for a week in every patient. If swallowing function was preserved oral nutrition was started over 1 week after surgery.

4. Discussion

Jugular foramen meningiomas are one of the rarest subgroups of meningioma and most reports contain descriptions of single cases. The largest published series including 28 patients was reported by Huang et al. [4]. Arnautovic and Al-Mefty [7] elected to name these meningiomas ''jugular fossa meningiomas'' to emphasize that the jugular foramen and jugular fossa are two distinct anatomical entities: the jugular foramen is an opening in the skull that connects the posterior cranial fossa and the jugular fossa. Jugular foramen meningiomas are presumed to arise from arachnoid cells lining the jugular bulb [3]. They may extend into three different directions: primarily anteriorly with patent jugular bulb, posteriorly behind patent jugular bulb, or they can totally occlude the jugular bulb. Jugular foramen meningiomas may extend into the posterior cranial fossa or extracranially [11]. The preoperative radiological diagnosis helps to differentiate meningiomas from more common jugular foramen lesions such as schwannomas and glomus jugulare tumours [12]. Glomus jugulare tumours display a salt-and-pepper appearance on T1-weighted MR images which represents their rich vascularity and show inhomogeneous contrast enhancement. Occasional meningiomas and schwannomas are described as being moderately vascular but not as much as the highly vascular glomus jugulare tumours. Meningiomas frequently invade the bone, producing hyperostosis and thickness of the jugulare spine and jugular tubercle, while glomus jugulare tumours tend to erode and destroy the bone. Both glomus jugulare tumours and meningiomas tend to invade the jugular bulb and the jugular vein whereas schwannomas tend to compress the sinus and vein, and rarely display frank bone invasion. Furthermore schwannomas often assume a dumbbell shape.

The choice of surgical approach is determined by the type of the tumour's characteristics and extension identified. For these tumours modifications of cranio-cervical approach are used depending on the patency and dominance of the involved jugular bulb [7,13–16]. The suprajugular approach which is a presigmoid infralabyrinthine route, is used if the tumour extends anteriorly to the patent jugular bulb. The retrojugular approach, a transcondylar, transtubercle, retrosigmoid route is selected if the jugular bulb is patent and the tumour extends predominantly behind it. Total occlusion of the jugular bulb by the tumour's intraluminal extension dictates the transjugular approach which was used in our patients. Surgical results presented in this paper suggest a considerable risk of life-threatening postoperative complications. In the series conducted by Arnautovic and Al-Mefty [7] three of eight patients experienced the ninth and 10th cranial nerves deficits and three other patients who displayed these deficits preoperatively remained unchanged immediately after surgery. Due to the considerable risk of the postoperative lower cranial nerves deficits non-radical tumour resection is sometimes considered [6]. Ramina et al. [13,17] reported total tumour removal in only 5 out of 10 cases of jugular foramen meningioma, due to unexplained high number of aggressive and anaplastic lesions in their series. In the other series radical resection in all patients was demonstrated [3,7]. However, in the series of Molony et al. [3], there was a 25% recurrence rate during the follow-up period, and in the series of Vrionis et al. [18] recurrence rate reached 75% in the mean follow-up period of 8 years. This strongly suggests that surgery was non-radical in those cases and radiosurgery can be considered as an early adjuvant therapy in the situation of non-radical meningioma dissection [19].

5. Conclusion

Jugular foramen meningiomas are extremely rare cranial base tumours that require extensive preoperative evaluation. With the use of skull base approaches, careful perioperative

planning and intraoperative neurophysiological monitoring radical removal of the lesion can be achieved. The main concern pertaining to surgical treatment of jugular foramen meningiomas is permanent deficits of lower cranial nerves.

Conflict of interest

None declared.

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None declared.

Ethics

The work described in this article has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans; Uniform Requirements for manuscripts submitted to Biomedical journals.

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