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Jugular Foramen Schwannomas: Surgical Approaches and Outcome of Treatment

ABSTRACT—Twelve cases of schwannomas of the jugular foramen that involved surgery in our department between 1983 and 1997 are described. Eight were women and 4 were men (mean age, 40 years), and the duration of their symptoms, the most predominant of which were hearing loss and tinnitus, ranged from 1 month to 20 years (median, 8.5 months). Depending on their radiological and surgical features, tumors were classified as type A, a tumor primarily at the cerebellopontine angle with minimal enlargement of the jugular foramen (n = 5); type B, a tumor primarily at the jugular foramen with or without intracranial extension (n = 4); type C, a primarily extracranial tumor with extension into the jugular foramen (n = 0); or type D, a dumbbell tumor with both intracranial and extracranial components (n = 3). A retrosigmoid suboccipital craniectomy (RSSOC) was performed for type A tumors; for types B and D, the RSSOC or staged infratemporal fossa approach (ITFA)/RSSOC was used. Total removal was achieved in 6 cases, near total removal in 3, and subtotal removal in 3. The most common complication was lower cranial nerve dysfunction (n = 5). The follow-up period ranged from 6 to 173 (mean, 48) months, and there was no recurrence. Two patients showed regrowth of the tumor after subtotal resection, however. In 1 of these, the residual tumor had progressed within 12 months of initial surgery; it was again resected and linac radiosurgery was successful. In the other, the residual mass had progressed within 8 months of initial surgery, and the pathological report indicated malignant peripheral nerve sheath tumor. Conclusively, type A tumors could be totally resected with the retrosigmoid approach alone. For type B and D tumors, however, combined ITFA and retrosigmoid approach showed the better results. In spite of our limited data, cases showing adhesion to critical structures can be managed by subtotal or near total resection followed by radiosurgery to reduce postoperative complications.

Schwannomas originating from the ninth, tenth, or eleventh cranial nerve are rare, accounting for 0.17 to 0.72% of all intracranial tumors and 1.4 to 2.9% of all intracranial schwannomas.[1–3] When the exact site of origin of the tumor cannot be determined, the term "jugular foramen schwannoma" is used. To date, 124 such cases have been reported worldwide. Besides the Kaye et al series[4] of 13 cases and the Pluchino et al series[5] of 12, most reports have been of one, two, or three cases.[2,6,7] The presenting symptoms of these tumors vary, and diagnosis according to clinical symptoms and signs is difficult. There are numerous surgical approaches to resection of these tumors,[1,8–12] and to identify the most effective approach to treatment, the authors made a retrospective analysis of the patterns of clinical presentation, surgical approaches, and treatment

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outcome in 12 patients with jugular foramen schwannomas who underwent surgery at Seoul National University Hospital between 1983 and 1997.

CLINICAL MATERIAL AND METHODS

Patients with tumors confirmed to have originated from the glossopharyngeal, vagus, or accessory nerve or with tumors of indefinite intraoperative origin but with strong radiological and surgical evidence of having originated from one of those three cranial nerves were included in this study. Schwannomas of hypoglossal nerves were excluded.

The study population consisted of 12 patients (4 men and 8 women) who underwent surgery between 1983 and 1997. Mean age at the time of diagnosis was 40 (range, 17 to 61) years. The mean follow-up period was 48 (range, 6 to 173) months.

The authors reviewed the clinical records of these patients, analyzing their clinical symptoms and signs, radiological features, surgical approaches, extent of resection, and treatment outcome. We used the classification scheme of Kaye[4] and Pellet,[7] which is based on the radiological and operative findings.[4,13] Tumors that were primarily intracranial with only a small extension into bone were classified as type A; those that were located mainly within bone, with or without an intracranial component, were type B; those that were primarily extracranial with only a minor extension into bone or posterior fossa were type C; type D accounted for those with significant intracranial and extracranial portions (dumbbell shape).

We analyzed differences of clinical manifestations, surgical results, extent of removal, and postoperative complications according to Kaye and Pellet's classification. The extent of removal was determined according to the surgeon's opinion and postoperative imaging study: gross total removal (GTR) when residual tumor was present neither in the operative field nor on postoperative contrast imaging, near total removal (NTR) for small islets of residual tumor, and subtotal removal (STR) for resection of more than 90%. We also assessed tumor progression and mean time to progression during mean follow-up of 48 months.

RESULTS

Incidence

Twelve patients (4 men and 8 women) underwent surgery at Seoul National University Hospital between 1983 and 1997. Their mean age was 40 (range, 17 to 61) years. These tumors accounted for 0.36% of all brain tumors (12 out of 3330) and 4.7% of intracranial schwannomas (12 out of 257) operated on during the same period.

Clinical Presentation

The most common initial symptoms were tinnitus and hearing loss (n = 8); next were vertigo, facial prickling, hoarseness, and visual disturbance. The duration of symptoms ranged from 1 month to 20 years (median, 8 months; mean, 40 months). The most common neurological deficits on presentation were hearing loss (n = 9) and lower cranial nerve palsy (n = 9). Other neurological signs were trigeminal nerve sign (n = 5), cerebellar dysfunction (n = 4), facial nerve palsy (n = 2), and extraocular movement disorder (n = 2) (Table 1).

Radiological Features

Computerized tomography (CT) was performed in all cases and magnetic resonance imaging (MRI) in 10. Enlargement and erosion of the jugular foramen was seen in 2 cases on plane skull film and in 7 on bone algorithm CT scan. Cystic degeneration was observed in 5 cases, but there was no calcification. On MRI, moderate- to high-contrast enhancement was noted in all patients, but on CT, there was no contrast enhancement in 2 cases. Angiography was performed in 3 cases, and in 1, staining of the posterior auricular artery revealed a vascular tumor. Preoperative diagnoses were jugular foramen schwannomas in 9 cases, acoustic neuroma in 1, epidermoid in 1, and ependymoma in 1. According to Kaye and Pellet's classification, 5 tumors were type A (primarily intracranial with only a small extension into bone), 4 were type B (main mass within the bone, with or without intracranial component), and 3 were type D (dumbbell tumor with both intracranial and extracranial component). None were type C (primarily extracranial with extension into the jugular foramen) (Figs. 1–3). There was no statistically significant correlation between presenting clinical features and type of tumor (Table 2).

Surgical Approaches and Operative Findings

Twelve patients underwent a total of 20 operations. Ventriculoperitoneal shunt was performed in 1 case, and thyroplasty for lower cranial dysfunction was performed in 1 case (Table 3). Type A tumors were approached by standard lateral RSSOC; type B and D tumors were approached by suboccipital craniectomy alone or combined staged ITFA and suboccipital craniectomy. In 1 type D tumor, we used the extreme lateral suboccipital transcondylar approach. In 1 type B tumor in which surgery involved only suboccipital craniectomy, the residual tumor had progressed 12 months after subtotal resection and 1 year after stereotactic radiosurgery was seen

Table 1. Clinical Features of 12 Cases

Case	*Age, Sex*	*Type*	*Initial Sx*	*Sx Duration*	*Neurological Deficits*	*Preoperative Dx*
1	38, F	A	hearing disturbance	4 y	papilledema, HL, facial hypesthesia, ataxia	acoustic neurinoma
2	31, F	A	visual disturbance	10 mo	papilledema, APD, 6th CN palsy	ependymoma
3	48, M	A	hearing disturbance	5 y	HL, LCN dysfunction	jugular foramen schwannoma
4	61, F	B	dizziness	1 mo	facial hypesthesia, HL	jugular foramen schwannoma
5	45, M	A	facial hypesthesia	4 mo	facial hypesthesia, LCN dysfunction	epidermoid
6	43, F	B	tinnitus	7 mo	HL, LCN dysfunction	jugular foramen schwannoma
7	41, F	D	tinnitus	20 y	nystagmus, HL, facial hypesthesia, ataxia LCN dysfunction	jugular foramen schwannoma
8	35, F	B	hoarseness	16 mo	trapezius weakness, LCN dysfunction	jugular foramen schwannoma
9	17, M	A	hearing disturbance	4 mo	facial palsy, HL, LCN dysfunction, ataxia	jugular foramen schwannoma
10	40, F	B	hearing disturbance	6 mo	facial hypesthesia, HL, ataxia	jugular foramen schwannoma
11	40, F	D	tinnitus	1 y	LCN dysfunction, nystagmus, ataxia, trapezius weakness	jugular foramen schwannoma
12	40, M	D	hearing disturbance	1 mo	hearing loss, LCN dysfunction	jugular foramen schwannoma

Sx, symptom; CN, cranial nerves; APD, afferent pupillary defect; HL, hearing loss; LCN, lower cranial nerves.

to have shrunk. In 1 case involving a type D tumor, three operations were performed; tumor progression was seen 8 months after initial surgery that involved the ITFA and subtotal resection. Histopathology indicated benign schwannoma. The second operation involved the combined staged ITFA and lateral suboccipital approach, and only subtotal resection was possible. Histopathologically, malignant peripheral nerve sheath tumor was indicated. This patient underwent radiotherapy and the disease stabilized.

GTR was achieved in 6 cases (type A, n = 3; type B, n = 2; and type D, n = 1). NTR was performed in three cases (type A, n = 2; type B, n = 1). Three cases involved STR (type B, n = 1; type D, n = 2). In 1 type B tumor resected with retrosigmoid approach alone and 1 type D tumor resected with extreme lateral transcondylar approach, inadequate exposure led to incomplete resection of tumor. The other common reason for incomplete resection was adhesion of the tumor to the brain stem and cranial nerves. In 9 cases, we were able to confirm the nerve of origin; these nerves were the glossopharyngeal in 6 cases, the vagus in 1, and the accessory nerve in 2.

Postoperative Complications

The follow-up period ranged from 6 to 173 months (mean, 48 months) with no operative mortality. The most common postoperative complication was lower cranial nerve palsy, seen in 5 cases. Two of these cases involved newly developed deficits, and in the remaining 3 there was aggravation of preexisting neurological deficits. Repeated aspirations occurred in 3 cases; in 1 of these, aspiration pneumonia developed. Swallowing difficulty and frequent aspiration tended to improve during the follow-up period, and in only 1 patient was thyroplasty needed. Cranial nerve palsy also developed in the facial (n = 3) and abducens nerves (n = 1), and 1 case involved tinnitus. In all cases the palsy normalized during follow-up, at which time improvement of preexisting neurological deficits was observed in 1 case each of visual disturbance, facial hypesthesia, and swallowing difficulty.

DISCUSSION

Clinical Presentation

Jugular foramen schwannomas commonly occur between the third and sixth decades of life, mainly in women.[4,14,15] This was true in our series; 8 of 12 patients were women, and 10 of 12 were between their third and sixth decades. The most common symptom was hearing loss, followed by lower cranial nerve dysfunction. In our series, 4 cases presented with hearing loss, and 5 presented with tinnitus and vertigo. Thus, 75% of pa-

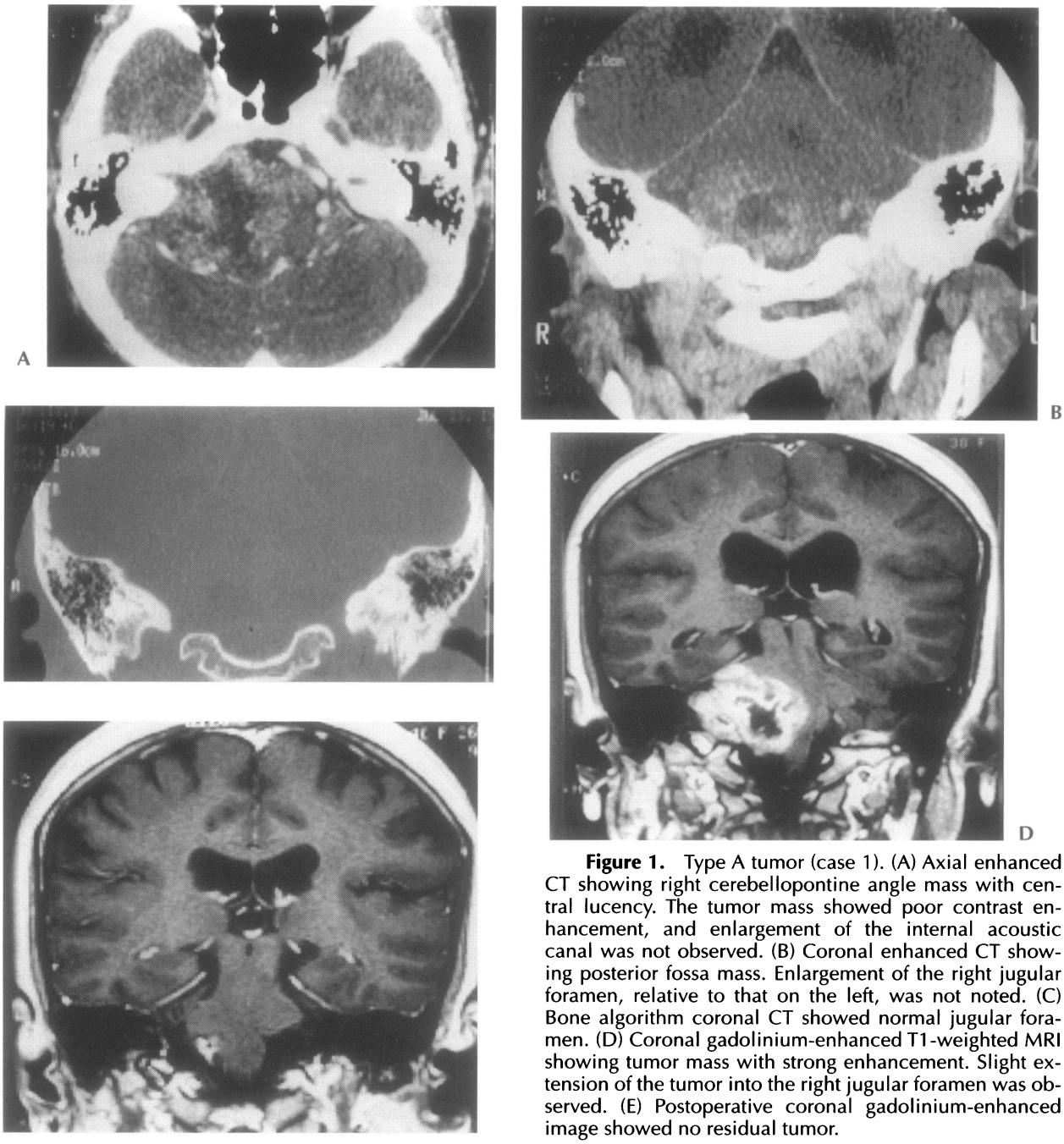

Figure 1. Type A tumor (case 1). (A) Axial enhanced CT showing right cerebellopontine angle mass with central lucency. The tumor mass showed poor contrast enhancement, and enlargement of the internal acoustic canal was not observed. (B) Coronal enhanced CT showing posterior fossa mass. Enlargement of the right jugular foramen, relative to that on the left, was not noted. (C) Bone algorithm coronal CT showed normal jugular foramen. (D) Coronal gadolinium-enhanced T1-weighted MRI showing tumor mass with strong enhancement. Slight extension of the tumor into the right jugular foramen was observed. (E) Postoperative coronal gadolinium-enhanced image showed no residual tumor.

tients showed eighth cranial nerve–related symptoms. Only 1 patient (8%) presented with lower cranial nerve dysfunction (hoarseness), although neurological examination revealed dysfunction of this nerve in 9 patients (75%). Visual disturbance because of increased intracranial pressure (n = 1) and trigeminal nerve symptoms (n = 1) were rare. Kaye et al[4] reported that presenting symptoms varied according to the growth pattern of tumors. Sensorineural hearing loss, vertigo, and ataxia were more common in type A tumors; in types B and C, jugular foramen syndrome (loss of taste in the posterior one third of the tongue, vocal cord paralysis, dysphasia, weakness of the sternocleidomastoid and trapezius muscle) was more common.[4] In our series, however, there was no statistically significant correlation between tumor type and clinical presentation (Table 2).

Lang[16] described syndromes associated with space-occupying lesions around the jugular foramen. As a tumor in this area grew, initial palsy of the ninth, tenth, and eleventh cranial nerves demonstrated the following symptoms: paralysis of the stylopharyngeus; loss of taste in the posterior one third of the tongue; loss

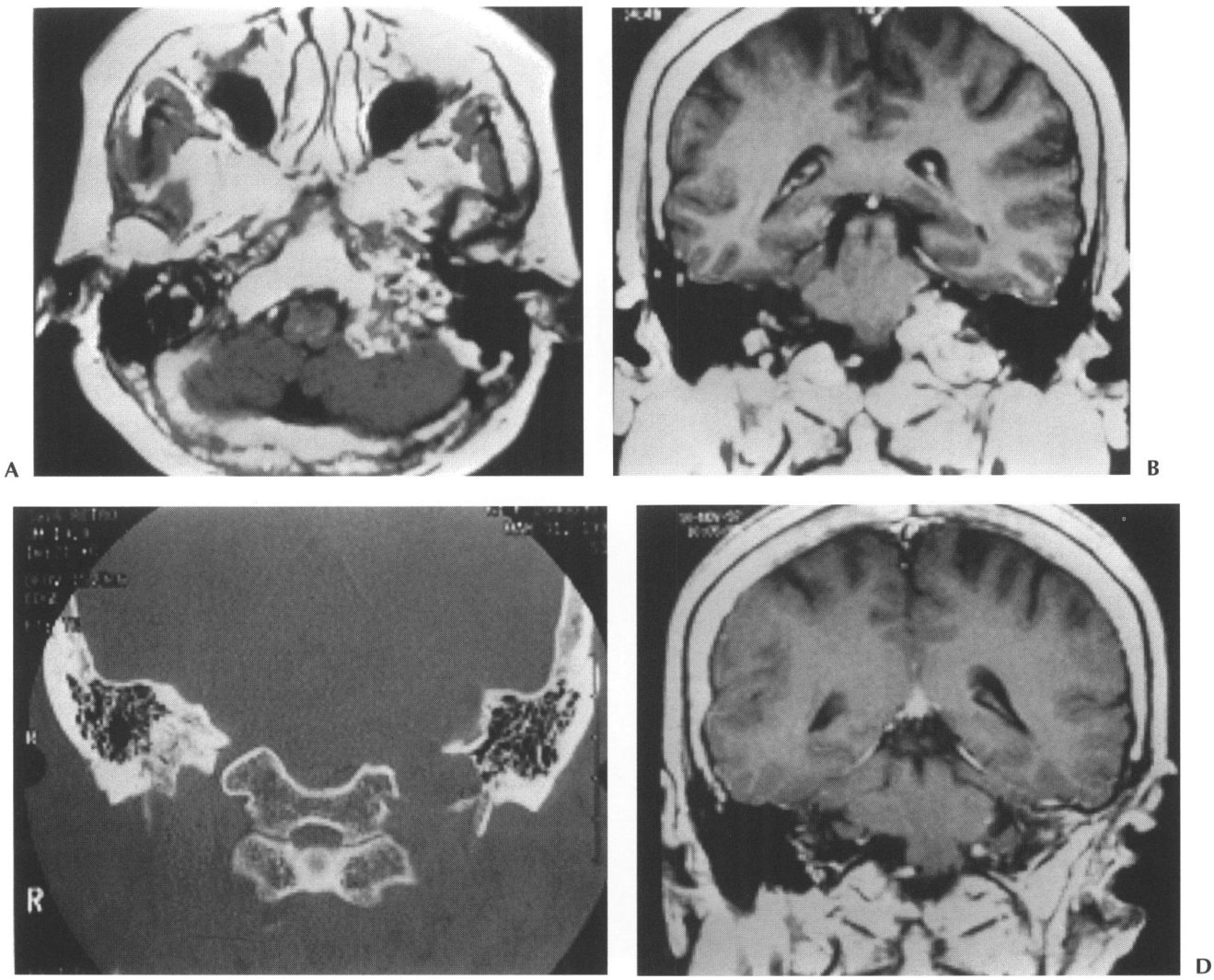

Figure 2. Type B tumor (case 4). (A) Axial gadolinium-enhanced T1-weighted MRI showing tumor mass in the left jugular foramen. (B) Coronal gadolinium-enhanced T1-weighted MRI showing tumor mass with strong enhancement. There was no extracranial tumor extension. (C) Bone algorithm axial CT showed enlargement of the left jugular foramen. (D) Postoperative coronal gadolinium-enhanced image showed no residual tumor.

of touch, temperature, deep sensation at the base of the tongue, auditory tube, pharynx, and tonsil; disturbance of swallowing and speech; and pain radiating to the ear, eye, angle of the jaw, and tonsillar region (Vernet's syndrome). As the tumor enlarged, hypoglossal nerve palsy subsequently developed (Collet's syndrome), and with the involvement of the sympathetic nerve plexus around the internal carotid artery, ptosis, miosis, and enophthalmos developed (Villaret's syndrome).[16] In our series, hypoglossal nerve palsy was seen in 1 patient, but there were no symptoms of sympathetic involvement.

Table 2. Presenting Clinical Features According to Tumor Group

	Type of Tumor		
Presenting Symptoms	***A***	***B***	***D***
Deafness, vertigo, tinnitus	3	3	3
Ataxia	2	1	2
Lower cranial nerve dysfunction	3		

Radiologic Features and Preoperative Differential Diagnosis

Preoperative diagnosis was difficult before the era of MRI. Enlargement and erosion of the jugular foramen seen on plain skull film or CT scan helped diagnose jugular foramen schwannomas, but for tumors that were primarily intracranial (type A), the foramen was not enlarged, and it was therefore difficult to dif-

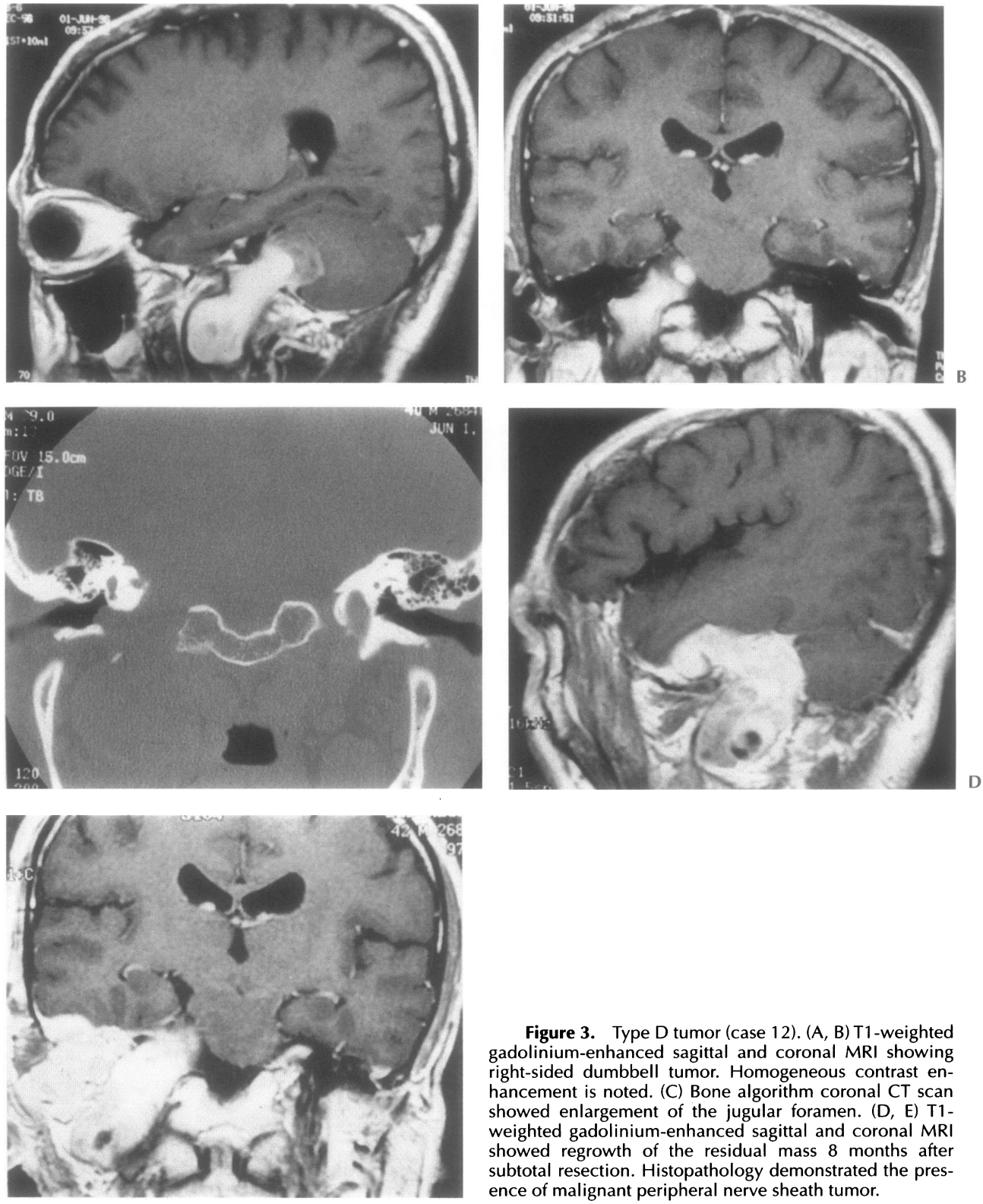

Figure 3. Type D tumor (case 12). (A, B) T1-weighted gadolinium-enhanced sagittal and coronal MRI showing right-sided dumbbell tumor. Homogeneous contrast enhancement is noted. (C) Bone algorithm coronal CT scan showed enlargement of the jugular foramen. (D, E) T1-weighted gadolinium-enhanced sagittal and coronal MRI showed regrowth of the residual mass 8 months after subtotal resection. Histopathology demonstrated the presence of malignant peripheral nerve sheath tumor.

ferentiate these tumors from others in the cerebellopontine angle.[4,15] Enlargement of the jugular foramen was indicated by scalloping, together with a sclerotic margin, but without the irregular bone destruction which differentiates jugular foramen schwannomas from glomus jugulare tumors.[17] On pre-enhanced CT scans, the presence of tumors was indicated by a mass of low or iso density. After contrast enhancement, tu-

Table 3. Surgical Treatment and Outcome

Case	Approach: Extent of Removal	Nerve of Origin	Complications	Follow-up (mo)
1	SOC: NTR	IX	transient 6th, 7th CN palsy, transient swallowing difficulty, aspiration pneumonia, decreased G/R	14
2	SOC: GTR	XI	none	21
3	SOC: NTR	IX	transient 7th CN palsy hoarseness & aspiration (partially improved) trapezius atrophy	22
4	ITFA & SOC: GTR	IX	transient 7th CN palsy, aspiration, vocal cord paralysis	41
5	SOC: GTR	unidentified	transient tinnitus	12
6	1. SOC: STR 2. SOC: NTR 3. SRS	IX	hoarseness (partially improved)	47
7	SOC & ITFA: GTR	unidentified	none	173
8	SOC & ITFA: GTR	X	none	37
9	SOC: GTR	IX	hoarseness (partially improved)	97
10	ITFA & SOC: NTR	IX	none	24
11	Extreme lateral SOC: STR	XI	none	12
12	1. ITFA: STR 2. ITFA & SOC: STR	unidentified	none	24

SRS, stereotactic radiosurgery; SOC, suboccipital craniectomy; CN, cranial nerve; G/R, gag reflex.

mors were moderately enhanced and cystic changes were frequent. In jugular foraminal schwannomas, the internal acoustic canal is generally normal; rarely, it is enlarged.[12,15]

Because of the absence of bony or air artifact, MRI is advantageous for the diagnosis of skull base tumors. For the diagnosis of small tumors, and for evaluating the extent of tumors and the relationship between them and adjacent brain stem, cranial nerves, and vessels, MRI is superior to CT scanning.[2,17–19] The mass is low or iso-signal intense on T1-weighted images, and on T-2 weighted images, signal intensities vary, with or without cystic change. Tumors are usually moderately enhanced after contrast enhancement.

Angiography usually reveals a jugular foramen schwannoma as an avascular mass,[14,20] and superior medial displacement of the anterior inferior cerebellar artery, inferior medial displacement of the posterior inferior cerebellar artery, and obstruction of the internal jugular vein are often seen.[8]

Even if the clinical presentation of these tumors leads to an erroneous diagnosis, several radiological clues distinguish these tumors from others that involve the cerebellopontine angle. These include acoustic neurinomas, meningiomas, metastatic tumors, glomus jugulare tumors, epidermoid cysts, choroid plexus papillomas, ependymomas, chordomas, exophytic pontine gliomas, and cerebellar hemangioblastomas. Acoustic neurinomas can be differentiated by widening of the internal acoustic canal; hyperostosis, rather than bony erosion, and tumor blush on angiography are characteristics of meningiomas.[17] In metastatic tumors, irregular bony destruction is frequently observed. In cases of glomus jugulare tumors, irregular bony destruction and jugular bulb invasion, rather than compression, are important points of differential diagnosis.[13] Epidermoid cysts may be confused with cystic schwannomas, even on MRI.[6,21,22] Preoperative diagnostic accuracy in our series was 75%; in 3 of 12 patients, postoperative and preoperative diagnosis differed. Preoperative diagnoses were acoustic neurinoma, ependymoma, and epidermoid cyst. Because of tumor location, we misdiagnosed type A jugular foramen schwannoma as cisternal acoustic neurinoma without enlargement of the internal acoustic canal, or as ependymoma of the cervicomedullary junction, and, because of the prominent cystic nature of jugular foramen schwannoma, as epidermoid cyst.

Surgical Approaches

Constantly evolving surgical approaches to the petrous bone, a better understanding of skull base anatomy, improved electrophysiological monitoring, and microsurgical techniques have made possible the total removal of these tumors. Various approaches to resection, depending on tumor location and extension,

have been described. They include the transmastoid,[23] cervicomastoid,[20] petro-occipital transsigmoid,[17] combined extradural-posterior petrous and suboccipital,[24] and the infratemporal approaches.[25] Arenberg and McCreary[26] and Neely[27] used a suboccipital approach, but many authors have reported that for complete resection, removal of the petrous bone was needed. Gacek[23] and Call and Pulec[28] reported that for intracranial tumors, the transmastoid approach is better than a posterior fossa craniectomy; potential complications associated with posterior fossa surgery are thus avoided. Samii et al[20] stated that because in certain cases hearing improved following tumor removal, any approach causing hearing loss is not recommended. In type A tumors, standard lateral suboccipital craniectomy provides good exposure. In type C, the ITFA, combined with otolaryngology for neck dissection, is suitable.[25] This approach provides direct access to the jugular foramen and neck, so control of major blood vessels and cranial nerves is much easier. If the tumor is extradural, even if less than 2 cm in size, the type A ITFA is adequate.[20] If intradural tumor extension is more than 2 cm, this approach does not offer a direct view of the brain stem, so in these cases, combined suboccipital craniectomy and the type A ITFA is more logical.[9,20] In type B and D tumors, total removal is difficult, and suboccipital craniectomy involving either the translabyrinthine, transcochlear, or infralabyrinthine (retrolabyrinthine) approach has been advocated, depending on the hearing function. Pellet et al[7] reported that the suboccipital approach provides for only incomplete tumor removal and the risk of recurrence is very high and that the transcochlear approach provides good exposure of intraosseous and intracranial portions. However, an infratemporal tumor extension cannot be resected effectively using the transcochlear approach alone.[7] They therefore suggested that for exposure of these type B and D tumors, the widened transcochlear approach, which complements the transcochlear and infratemporal approaches, is best. This enlarges the route of access to the region, with disinsertion of the sternocleidomastoid, digastric, and stylohyoid muscles; removal of the petrous bone in order to displace the facial nerve, resection of the auditory canal, and subluxation of the temporomandibular joint and zygomatic process are involved.[7] Some authors have recommended a two-stage combined neuro-otological approach,[29,30] but others have resected these tumors in a single stage.[10,20] Samii et al[20] reported that a single-stage cervicomastoid approach is the method of choice for type B, C, and D tumors. Fisch and Pillsbury[25] recommended surgery in two stages: the first involving the infratemporal approach for removal of the extracranial tumor extension and the second for removal of the intracranial extension using the suboccipital approach.

In our series, type A tumors (n = 5) were approached via suboccipital retrosigmoid approach, and gross total resection was possible in three cases (60%). In two type A tumors (40%), NTR was possible. In all the type A tumors, more than 99% resection was thus achieved. For type B tumors (n = 4), the staged ITFA and suboccipital approach were used in three cases (total resection in two cases and near total resection in one), and the suboccipital approach was used in one (subtotally resected). The approach to type D tumors (n = 3) was extreme lateral suboccipital, infratemporal, or staged combined suboccipital and infratemporal, respectively. Total resection was possible in only one case, where this was achieved by two-stage surgery, and the remaining two cases were resected subtotally. In type B and D tumors, resected with retrosigmoid approach or extreme lateral transcondylar approach, inadequate exposure led to incomplete resection of tumor. Our surgical approach to the type B and D tumors varied because of evolution of thinking and the patient's desire to avoid extensive surgery or postoperative complications. Because of the shorter operation time, less operative risk, and the availability of a good otolaryngologist, we preferred a two-stage operation.

COMPLICATIONS

Possible major complications include cerebrospinal fluid (CSF) leakage, the subsequent risk of meningitis, and lower cranial nerve deficits. A CSF leak and subsequent risk of meningitis is much reduced by watertight dural closure, sealing with fascia lata or lyophilized dura, the application of fibrin glue, postoperative lumbar drainage, no local drainage, and vigorous antisepsis. This requires considerable effort: the operation time is long, the surgical approach is extensive, and two medical teams are involved. When the ITFA is used, a muscle rotational flap is helpful. In our series, there was neither CSF leakage nor meningitis.

Difficulty in swallowing is very common and problematic. Kaye et al[4] reported that in 13 surgical cases of jugular foramen schwannoma, all patients experienced swallowing difficulty and sputum retention. Lower cranial nerve deficits such as breathing difficulty, dysphagia, and hoarseness do not usually produce major disability, although the involvement of two or more lower cranial nerves, especially in combination with the ninth and tenth nerves, may cause aspiration. Aspiration pneumonia may be a severe and life-threatening complication. Samii et al[20] reported that patients with slowly progressive lower cranial nerve deficits compensate well, but patients with normal preoperative cranial nerve function show low toleration for postoperative deficits of acute onset. In patients with lower cranial nerve deficits, a nasogastric tube is kept in place. If these complications last longer than 1 week, a tracheostomy is performed. For intractable aspiration, or if a prolonged recovery period is anticipated, a gastrostomy is required. For aspiration, a cartilage implant or

injection of Gelfoam or Teflon into the vocal cords and resection of the paralyzed pharyngeal wall are advocated.

In our series, there was no operative mortality. Aggravation of preoperative lower cranial nerve deficits occurred in three cases, and newly developed deficits occurred in two. Aspiration pneumonia occurred in one case. Clinically significant permanent lower cranial nerve deficits were noted in three cases; other deficits were transient and improved during follow-up. Even in patients with permanent lower cranial nerve deficits, aspiration improved. These results are much better than those described in the literature, and this may be due to our policy of avoiding unnecessary aggressiveness in cases with adhesion between a tumor and adjacent brain stem or cranial nerves or when high postoperative morbidity is predicted.

TREATMENT OUTCOME

Kaye et al[4] reported that because tumors tend to recur rapidly and reoperation is likely to increase cranial nerve deficits due to postoperative scarring, complete excision of a lesion is essential. Tan et al[14] reported that in 11 of 14 patients, complete excision was achieved; in all 3 in whom resection was subtotal, tumor recurred. Samii et al[20] reported that in all patients in a group of 16, total resection was achieved without significant complications, and total removal led to excellent surgical results followed by a long tumor-free interval or cure. In our series, total resection was achieved in 6 of 12 patients; resection was near total in 3 and subtotal in 3. We noted tumor progression in 2 of the 3 patients in whom resection was subtotal. One patient showed tumor regrowth 12 months after surgery and subsequently underwent radiosurgery. One year later, the tumor had become smaller. In the other patient, regrowth had occurred within 8 months of surgery; malignant peripheral nerve sheath tumor was identified. No tumor recurrence was observed in totally and near totally resected patients during a mean 27-month follow-up period. The effectiveness of radiotherapy for acoustic neurinomas has been previously reported, but no report has shown that the efficacy of radiotherapy for jugular foramen schwannomas is statistically significant.[3,31] This seems to be due to the relatively small number of patients in each series. Wallner et al[3] reported one case of glossopharyngeal neurinoma treated with conventional radiotherapy; in this patient, tumor growth recurred 3.5 years after irradiation. Kida et al[32] and Pollock et al[1] reported the results of radiosurgery for nonacoustic schwannomas. The latter group[1] stated that tumor size decreased in one of four patients in whom a jugular foramen schwannoma recurred during follow-up of 7 to 19 months and who underwent radiosurgery. Two of four showed no change in tumor volume, and the tumor became larger in one. In one patient in our series, radiosurgery was effective for tumor control.

CONCLUSION

For the treatment of patients with jugular foramen schwannomas, early diagnosis and an appropriate surgical approach are mandatory. The goal of surgery is both complete excision and preservation of function. Complete excision of these lesions leads to excellent surgical results, but in cases with adhesion between a tumor and adjacent brain stem or cranial nerves and in those that defy complete resection or where high postoperative morbidity is predicted, near total or subtotal resection is a good treatment option. Although only one example with limited follow-up is given, in patients with residual tumors, radiosurgery seemed to provide effective tumor control.

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