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Intracanalicular Meningioma: Clinical Features, Radiologic Findings, and Surgical Management

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Objective: Intracanalicular meningiomas are extremely rare, and only 36 cases have been reported to date. The aim of this study is to describe the clinical, radiologic, and histopathologic features of 13 intracanalicular meningiomas highlighting important aspects of tumor diagnosis and treatment.
Study Design: Retrospective study.
Setting: Quaternary referral otology and cranial base private center.
Patients: Thirteen consecutive patients with pathologically confirmed intracanalicular meningioma surgically treated between December 1988 and July 2006. The follow-up of the series ranged from 13 to 60 months.
Interventions: Nine patients with unserviceable hearing were operated on through the translabyrinthine approach. Four patients underwent enlarged middle cranial fossa approach with the intention of preserving their hearing.
Results: Total tumor removal was achieved in all cases. The postoperative facial nerve function was either excellent or good (House-Brackmann Grade I or II) in 10 cases (77%) and acceptable (Grade III) in one case. Two patients with preoperative facial paresis showed no improvement in their facial nerve function. In patients who underwent surgery via the enlarged middle cranial fossa, hearing was preserved at the preoperative level in two cases, but serviceable hearing was lost in the remaining two.
Conclusion: Primary meningiomas of the internal auditory canal are extremely rare. On account of a lack of specific symptoms and the limited diagnostic findings, preoperative diagnosis of intracanalicular meningioma still represents a diagnostic challenge. Intraoperative findings may help in differentiating meningiomas from other intracanalicular lesions.
Key Words: Internal auditory canal—Meningioma—Surgery—Radiologic findings.
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Meningiomas account for approximately 20% of all intracranial neoplasms and represent the second most common tumor of the cerebellopontine angle (CPA) after vestibular schwannoma (VS), constituting 3 to 12% of all neoplasms at this site (1–4). Today, with the use of magnetic resonance imaging (MRI) with gadolinium and the increased awareness of otolaryngologists, more cases of small and intracanalicular tumors are discovered. However, the occurrence of a meningioma within the internal auditory canal (IAC) remains exceedingly rare. The first reported case of a histologically proven IAC meningioma was by Virchow in 1863, as stated by Harvey Cushing (5). A century later, Singh et al. (6) described the second case of intracanalicular meningioma in a patient with preoperative facial palsy and hearing loss. Since then, 34 additional histologically confirmed cases of intracanalicular meningioma have been reported in association with the literature as single cases or sometimes in small series (6–24).

The aim of this study is to highlight the clinical, radiologic, and histologic features, as well as the management and follow-up of 13 cases of intracanalicular meningioma, and to relate our findings to those reported in association with the literature. This is the largest series of intracanalicular meningiomas currently reported in association with the literature.

METHODS

A retrospective analysis of all patients with CPA tumors managed at the Gruppo Otologico Piacenza-Rome between December 1988 and July 2006 was performed. Of 1,738 CPA tumors, 139 were posterior fossa meningiomas, 13 (9.3%) of which were meningiomas of the IAC and the subjects of this study. All patients underwent a complete otologic and neurologic examination and hearing assessment by pure-tone audiometry, speech discrimination score (SDS), and

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auditory brainstem response audiometry. All patients underwent either gadolinium-enhanced magnetic resonance imaging and high-resolution computed tomography without contrast administration. The magnetic resonance images were reviewed by a single neuroradiologist for mass location with respect to the IAC and CPA, signal intensity of the lesions, type of contrast enhancement, and the presence of bony and dural changes. Computed tomographic scans were obtained for analysis of bony changes at the level of the IAC and labyrinthine structures. The preoperative and postoperative facial nerve (FN) function was graded according to the House-Brackmann scale (25). Hearing results were evaluated according to both the guidelines of the American Academy of Otolaryngology–Head and Neck Surgery (26) and the modified Sanna classification (Table 1) (27). Pure-tone average was calculated as the mean of 500, 1,000, 2,000, and 4,000 thresholds. The extent of tumor removal was classified according to the Simpson scale (Table 2) (28). All tumors were graded pathologically according to the World Health Organization 1993 classification system (29). The follow-up (consisting of clinical evaluation, hearing tests, and serial computed tomographic and MRI scans) of the series ranged from 13 to 60 months (mean, 20.8 ± 13.6 mo).

RESULTS

Demographic and Clinical Features

The data from the records of 13 consecutive patients with pathologically confirmed IAC meningiomas treated surgically by the senior author (M.S.) formed the basis of this study. Two of the patients in this study had been previously reported (16). No patient had evidence of neurofibromatosis Type II. There were nine female and four male cases. Mean age at surgery was 44.8 years, with a range from 26 to 75 years. Eight (61.5%) tumors were on the right side, and five (38.5%) were on the left side. The mean time between the onset of symptoms and the diagnosis was 31 months (range, 7–96 mo). The most common symptoms at the time of presentation included hearing loss (84.6%), tinnitus (69.2%), unsteadiness (46%), vertigo (38.4% of cases), aural fullness (15.3%), FN paresis (23%), and hemifacial spasm (7.6%). Twelve patients had a combination of two or more symptoms at the time of diagnosis, whereas the remaining patient presented only one complaint (i.e., vertigo). Relevant information on the subjects is provided in Table 3.

TABLE 1. *Modified Sanna classification for reporting hearing results (27)*

Class	PTA (dB)	SDS (%)
A	0–20	100–80
B	21–30	79–70
C	31–40	69–60
D	41–60	59–50
E	61–80	49–40
F	≥81	39–0

PTA indicates pure-tone average; SDS, speech discrimination score.

TABLE 2. *Classification of tumor resection according to Simpson's grading (28)*

Grade	
I	Total resection of the tumor with excision of its dural and bony attachment
II	Total resection t of the tumor and coagulation of its dural attachment
III	Total tumor resection without resection or coagulation of its dural attachment and its extradural extension (e.g., infiltrated sinus or bone)
IV	Subtotal tumor resection

Radiologic Findings

In nine patients, the tumors were confined to the IAC with no measurable extension into the CPA, and in four patients, a limited extrameatal portion between 0.2 and 0.5 mm was recorded. Magnetic resonance imaging findings of tumors revealed all lesions isointense on T1-weighted images and isointense to slightly hypointense on T2-weighted images. Magnetic resonance T1-weighted images with gadolinium demonstrated homogeneous and intense enhancement in all cases. Bony and dural changes were absent. Labyrinthine bone invasion was not detected in any of the cases.

Treatment and Outcomes

Nine patients with nonserviceable hearing were operated on through the translabyrinthine approach. Four patients with preoperative serviceable hearing (Cases 4, 6, 7, and 10) had hearing-preserving surgery via the enlarged middle cranial fossa approach. Hearing was preserved at the preoperative level (Class A) in two patients, whereas serviceable hearing was lost in the other two cases. Before the operation, 11 of the 13 patients presented with Grade I FN function, one with Grade II, and the remaining one with Grade III. The FN was anatomically preserved in all cases. Facial nerve results are detailed in Table 4. Good FN function (Grades I and II) was achieved in 77% of cases, whereas acceptable function (Grade III) was achieved in 23% of cases 1 year after tumor removal. The two patients with preoperative facial paresis showed no improvement in their FN function. Otherwise, there were no complications in this series. Total tumor removal (Simpson Grades I and II) was achieved in all cases. The histologic examination of the tumors revealed the following subtypes: meningioendothelial (five cases), transitional (four cases), angiomatous (three cases), and fibroblastic (one case). To date, no recurrence or residual tumors have been observed at neuroradiologic controls.

DISCUSSION

Meningiomas are firm, thinly encapsulated, slow-growing benign tumors with a tendency to invade dura and infiltrate bone. They arise from the arachnoid villi, which are predominantly found along the sigmoid sinus, superior and inferior petrosal sinuses, torcular

TABLE 3. *Relevant characteristics of patients with meningioma of the internal auditory canal*

Patient	Sex	Age at surgery (yr)	Preoperative symptoms	Location	Extracanalicular size (mm)	Surgical approach	Intraoperative findings	Preoperative hearing class [Sanna/ AAO-HNS]	Postoperative hearing class [Sanna/ AAO-HNS]	Histology	Follow-up (mo)
1	M	38	HL, tinnitus, unsteadiness	Filling IAC	—	TLA	Dura infiltrated, IAC bony wall invasion	D/C	DE	Transitional	13
2	F	40	HL, tinnitus vertigo, transient FN paresis	Filling IAC	0.5	TLA	—	F/D	DE	Meningothelial	14
3	M	42	HL, vertigo, aural fullness	Filling IAC	0.5	TLA	Enlarged IAC, encasement of and adherence to FN and VCN	E/D	DE	Transitional	60
4	M	54	HL, tinnitus, unsteadiness	Filling IAC	—	EMCF	Tumor adherent to FN and VCNs	B/B	DE	Fibroblastic	15
5	F	75	HL, FN paresis tinnitus, vertigo	Filling IAC	0.2	TLA	Tumor adherent to FN	E/D	DE	Meningothelial	24
6	F	26	FN paresis, unsteadiness	Lateral IAC	—	EMCF	IAC bony walls invasion	A/A	A/A	Angiomatous	13
7	F	54	Vertigo	Filling IAC	0.3	EMCF	—	A/A	A/A	Transitional	13
8	F	48	HL, tinnitus, vertigo	Filling IAC	—	TLA	Tumor adherent to FN, FN between the T and surgeon	E/D	DE	Meningothelial	13
9	F	30	HL, tinnitus, unsteadiness	Medial IAC	—	TLA	—	D/D	DE	Angiomatous	21
10	F	45	HL, aural fullness, vertigo	Filling IAC	—	EMCF	Encasement of CN	B/A	DE	Meningothelial	17
11	F	54	HL, tinnitus unsteadiness	Lateral IAC	—	TLA	—	F/D	DE	Meningothelial	14
12	M	32	HL, tinnitus, unsteadiness, hemifacial spasm	Filling IAC	—	TLA	Enlarged IAC, FN between the T and surgeon	D/D	DE	Angiomatous	16
13	F	45	HL, tinnitus, unsteadiness	Filling IAC	—	TLA	Tumor adherent to FN, Encasement of CN	D/D	DE	Transitional	38

M indicates male; F, female; HL, hearing loss; FN, facial nerve; IAC, internal auditory canal; T, tumor; DE, dead ear; CN, cochlear nerve; VCN, vestibulocochlear nerve; TLA, translabyrinthine approach; EMCF, enlarged middle cranial fossa approach; AAO-HNS, American Academy of Otolaryngology–Head and Neck Surgery; —, no data available.

TABLE 4. *Preoperative, immediate postoperative, and final facial nerve function according to the House-Brackmann Scale (25)*

Patient	Preoperative	Immediately postoperative	Follow-up
1	I	I	I
2	I	I	I
3	I	VI	I
4	I	VI	II
5	III	VI	III
6	II	II	II
7	I	I	I
8	I	II	I
9	I	I	I
10	I	III	III
11	I	II	I
12	I	VI	III
13	I	III	I

herophili, and jugular foramen. It is presumed that intracanalicular meningiomas may arise from arachnoid granulations situated along the dural lining of the neural foramina (30).

Castellano and Ruggiero (31) classified posterior fossa meningiomas according to their site of dural implant into five groups: cerebellar convexity, tentorium, posterior surface of the petrous bone, clivus, and foramen magnum. Desgeorges et al. (32) adopted this classification and further subdivided posterior petrous meningiomas based on the exact site of implant in relation to the IAC and labyrinth. They designated meningiomas located anterior to the IAC, tumors centered on the IAC, and tumors located posterior to the IAC. Different combinations of the above are common. Pure intracanalicular meningiomas are not considered in the classifications as separate entities because they are very rarely encountered.

Meningiomas usually spare the soft tissues as they grow, only to encircle the nerves and the vessels they encounter (16). Their clinical manifestations, therefore, are caused by compression of adjacent neural structures rather than parenchymal involvement (4,23). This peculiarity of meningiomas enables them to be asymptomatic while they grow in size in areas with ample space such as the CPA. However, in the face of an intracanalicular meningioma, the tumor tends to become symptomatic early in its course, possibly because of two factors: first, there is limited space available for the sessile growth of the tumor, and second, the propensity of a meningioma to invade the labyrinthine bone with resultant FN and/or inner ear dysfunction (16).

On the basis of a compilation of the English literature (Table 5) and present series, intracanalicular meningiomas occur more frequently in women (male-to-female ratio, 1:1.6). The usual age of initial presentation ranges between 14 and 75 years, with a mean age of 49.5 ± 12.2 years. Clinically, the symptoms caused by intracanalicular meningiomas replicate those of the much more common VSs, with hearing loss ranging from mild to total being the most common presenting symptom (85.4%) along with tinnitus (54%), vertigo (33.3%), unsteadiness (20.8%), and aural fullness (8.3%). Although less frequent, FN dysfunction may also be an early symptom of intracanalicular meningioma and seems more common with meningiomas than with VSs. Including our cases, 20.8% had FN symptoms preoperatively; 16.6% presented with facial weakness and 4% with hemifacial spasms.

The biggest issue regarding intracanalicular meningioma is the diagnostic difficulty in distinguishing these tumors from VSs preoperatively. Other less common tumors in the IAC differential diagnosis include hemangioma, epidermoid, facial schwannoma, lipoma, and metastasis.

Meningiomas of the CPA can usually be differentiated from VSs on MRI. Unlike VSs, most CPA meningiomas topographically originate from the posterior surface of the petrous bone anteriorly or posteriorly to the IAC, and they are large, sessile, and with a broad base of attachment along the posterior petrous surface. Computed tomographic images may visualize areas of hyperostosis of the adjacent bone and intratumoral calcification. On MRI, VS and meningioma appear isointense or slightly hypointense on T1-weighted images. On T2-weighted images, VSs are usually hyperintense, while meningiomas more often appear isointense and very rarely slightly hyperintense (16,33,34). Meningiomas can be distinguished from schwannoma also by the presence of irregular borders and because they enhance more intensely with gadolinium. In addition, the frequently encountered "dura tail" sign after gadolinium administration is more frequently associated with meningioma. However, these characteristic features in pure intracanalicular meningiomas are difficult to record.

On the basis of the extension pattern, masses of the IAC can be classified as 1) purely intracanalicular; 2) intracanalicular with CPA extension; 3) intracanalicular with invasion of the surrounding bone; and 4) intracanalicular with both CPA extension and invasion of the surrounding bone. Although it is extremely difficult to differentiate meningiomas from VSs of the purely intracanalicular type (Fig. 1A and B), some extension patterns may provide information for a correct diagnosis. Cerebellopontine angle extension of small intracanalicular meningiomas usually has a broad base (Fig. 2A and B), whereas in VSs, a spherical shape (ice cream appearance) is often detected. A broad-based extension of the tumor into the CPA was observed in four cases of our series. Asaoka et al. (21) retrospectively noticed some radiologic findings that should give rise to suspicion of intracanalicular meningioma such as intracanalicular dural enhancement in the coronal section of contrast-enhanced MR images. The same authors noticed that the dilation of the IAC is a more common radiologic finding with VSs, whereas the presence of bone invasion around the IAC is suggestive of meningioma.

In fact, meningiomas can invade the labyrinth and the cochlea and infiltrate into surrounding petrous bone marrow spaces and air cells. Meningiomas show a

TABLE 5. *Review of the English literature*

Study	Age/ sex	Major symptoms	Location	Extension into CPA	Surgical approach	Intraoperative findings	Outcome of surgery
Singh et al. (6)	14/M	HL, facial weakness	Filling the IAC, GG	No	MFA/Transmastoid	Tumor adherent to FN and VCN	FN paralysis
Brookler et al. (7)	70/F	HL, dizziness, tinnitus, occipital pain	Filling IAC, PSC ampulla	Yes	TLA	7-mm protrusion into CPA	Recurrent tumor 7 mo later, FN function normal
Langman et al. (8)	54/M	HL	Filling IAC	Yes	TLA	Tumor attached to the walls of the IAC	FN function normal
Atlas et al. (9)	26/F	Anacusis, vertigo	IAC	No	TLA	Walls of IAC destroyed	FN function normal, subtotal removal
Hodgson and Kingsley (10)	49/F	HL	IAC	No	RS	Tumor anterior to FN and VCN	FN function normal, incomplete resection
Bohrer and Chole (4)							
Case 1	52/M	Tinnitus	Filling IAC	No	MFA	Tumor adherent to SVN	Hearing and FN function normal
Case 2	66/F	HL, vertigo	Filling IAC	No	TLA	—	FN function normal
Zeitouni et al. (11)	60/F	Aural fullness, dizziness	Filling IAC	Yes	TLA	2- to 3-mm protrusion into CPA	FN function normal
Haught et al. (12)	51/F	HL, tinnitus	Lateral IAC	No	TLA	FN and CN inferiorly displaced	FN function normal
Kawamura et al. (13)	63/M	HL	Filling IAC	Yes	MFA	Tumor attached to the dura at the inferior wall of IAC	DE, FN palsy
Ishikawa et al. (14)	55/M	HL, tinnitus, FN weakness, dizziness	Filling IAC, vestibule	Yes	TLA	7-mm protrusion into CPA	Transient FN weakness
Dinh et al. (15)	53/F	HL, vertigo, tinnitus, hemifacial spasms	Filling IAC	No	RS	Tumor anterior to FN and VCN	FN weakness, hearing preserved
Caylan et al. (16)							
Case 1	42/M	HL, aural fullness, vertigo	Filling IAC	No	TLA	Enlarged IAC, tumor adherent to FN	Grade I FN function
Case 2	46/M	Anacusis, unsteadiness	Filling IAC	No	TLA	Tumor attached to inferior meatal wall, adherent to FN	Grade I FN function
Rinaldi et al. (17)	60/F	HL, tinnitus, unsteadiness, FN weakness	Medial IAC	No	RS	Enveloping FN and VCN	Transient FN weakness, HL
Breuer et al. (18)							
Case 1	53/M	Anacusis	Lateral IAC	Yes	EMFA	5-mm protrusion into CPA	FN Grade II
Case 2	62/M	Anacusis	Filling IAC	Yes	EMFA	2-mm protrusion into CPA	FN Grade II
Case 3	54/F	HL (PTA 40, SDS 52%)	Lateral IAC	Yes	EMFA	2-mm protrusion into CPA	FN function normal HL (PTA, 54; SDS, 70%)

(Table continues next page)

TABLE 5. (*Continued*)

Study	Age/ sex	Major symptoms	Location	Extension into CPA	Surgical approach	Intraoperative findings	Outcome of surgery
Case 4	52/M	HL (PTA, 52; SDS, 45%)	Filling IAC	No	EMFA	—	FN function normal HL (PTA, 68; SDS, 50%)
Martinez Deveza et al. (19)	48/F	HL, tinnitus, unsteadiness	Filling IAC	No	TLA	—	Grade V FN function
Hilton et al. (20)	38/F	HL, vertigo, sudden FN paralysis (Grade III)	Filling IAC	No	TLA	Tumor at posterior wall of IAC	FN function unchanged
Asaoka et al. (21)							
Case 1	66/M	HL (PTA, 50; SDS, 56%), tinnitus	Filling IAC	No	MFA	Displacing FN posteriorly, tumor origin at anterior wall of IAC	FN function normal, hearing preserved (PTA, 50; SDS, 20%)
Case 2	39/M	Anacusis	Filling IAC, invasion of petrosal bone and cochlea	Yes	TLA	FN engulfed in the tumor	Transient (Grade III) FN weakness
Case 3	67/F	HL, Grade III FN function	Filling IAC	Yes	TLA	FN engulfed in the tumor, origin near the porus acusticus	Incomplete resection (tumor left on the FN)
Magliulo et al. (22)	50/M	HL, tinnitus	Medial IAC	No	RS-TLA	—	Grade I FN function
	56/F	Tinnitus	Filling IAC	No	RS	Adherent to FN and VCN	Grade I FN function, hearing unchanged
Nakamura et al. (23)							
Case 1	27/F	Tinnitus, vertigo, H1[a]	Porus acusticus	Yes	RS	Dorsocaudal displacement of FN and CN	FN function normal, hearing preserved (H2)
Case 2	43/F	Anacusis, vertigo	Filling IAC	Yes	RS	Tumor adherent to FN and VCN	FN function normal
Case 3	44/M	HL (H1), tinnitus, vertigo	Filling IAC	No	RS	FN and VCN within tumor	DE, FN function normal
Case 4	53/F	HL (H2), tinnitus	Filling IAC	Yes	RS	Dorsal displacement of FN	Hearing preserved (H4), FN function normal
Case 5	55/F	HL (H2), vertigo, tinnitus	Filling IAC	Yes	RS	Infiltration of CN	DE, FN function normal
Case 6	55/F	tinnitus, vertigo (H1)	Filling IAC	Yes	RS	Dorsal displacement of FN and CN	Hearing preserved (H2), FN function normal
Case 7	58/F	HL (H2), tinnitus	Filling IAC	Yes	RS	FN and CN within tumor	Hearing preserved (H2), FN function normal
Case 8	59/M	HL (H1), tinnitus	Filling IAC	Yes	RS	FN and CN within tumor	Hearing preserved (H3), FN function normal
Laudadio et al. (24)	53/M	HL, tinnitus, vertigo	Filling IAC	No	RS	Adherent to FN and VCN	FN Grade III (hearing not reported)

HL indicates hearing loss; FN, facial nerve; IAC, internal auditory canal; GG, geniculate ganglion; PSC, posterior semicircular canal; SVN, superior vestibular nerve; DE, dead ear; TLA, translabyrinthine approach; RS, retrosigmoid lateral suboccipital approach; MFA, middle fossa approach; EMFA, extended middle cranial fossa approach; CN, cochlear nerve; VCN, vestibulocochlear nerve; CPA, cerebellopontine angle; —, no data available.

The authors reported hearing results according to the Hannover Audiological Classification.

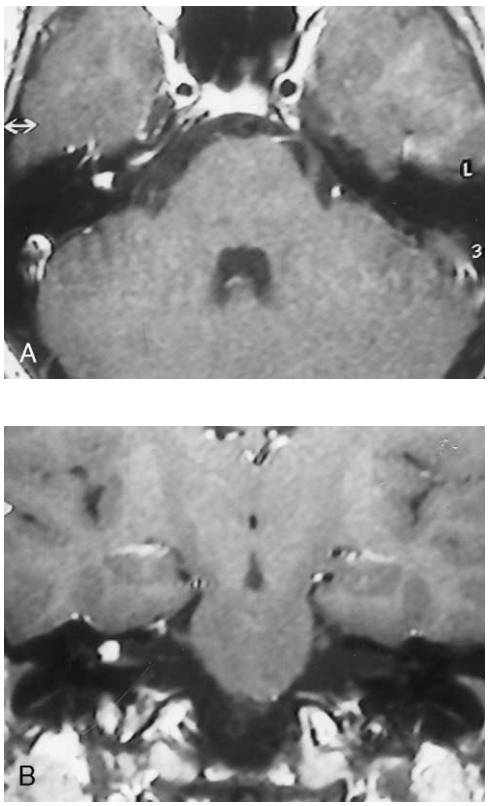

FIG. 1. Axial (*A*) and coronal (*B*) MR T1-weighted images with gadolinium showing a small intracanalicular mass located at the fundus of the internal auditory canal [Case 6]. Magnetic resonance imaging appearance was highly suggestive of an intracanalicular vestibular schwannoma. At surgery, a soft friable and hypervascular mass was detected, and the neoplasm was histologically proven to be a meningioma.

marked tendency to invade dura and lateral portions of the temporal bone through the lateral end of the IAC (8,30). Nager and Masica (30) described the tendency of meningiomas to penetrate along the vestibulocochlear nerve fibers into the cochlea, vestibule, and semicircular canals. This phenomenon has been also described by Brookler et al. (7), who reported the case of an intracanalicular meningioma located at the fundus of the IAC, which invaded the vestibule and the ampulla of the posterior semicircular canal. At a later date, Ishikawa et al. (14) described a meningioma of the IAC with extension into the vestibule. Because of a lack of specific symptoms and the limited diagnostic findings, preoperative diagnosis of intracanalicular meningioma still represent a diagnostic challenge. In fact, approximately 90% of the reported cases of intracanalicular meningiomas, including those of our series, were preoperatively suspected to be VSs.

The primary goal of surgical treatment of intracanalicular meningiomas should be to achieve safe and total tumor removal (Simpson Grade I or II) with preservation of FN function and conservation of serviceable hearing whenever possible. As a less invasive alternative to surgical excision, stereotactic radiosurgery has been reported to be an effective therapy to control intracranial meningiomas (35,36). All the patients in our series were informed of the risks and benefits of surgical excision, stereotactic radiosurgery, or observation with serial imaging.

The possible surgical alternatives for intracanalicular meningiomas include the retrosigmoid approach, the middle fossa approach, or the translabyrinthine approach, depending on the presence of serviceable preoperative hearing, tumor location within the IAC, and surgeon's preference. Most patients reported in association with the literature were surgically managed either with the translabyrinthine approach (13 cases) or the retrosigmoid approach (13 cases); the middle cranial fossa approach was used in 8 patients. The patient reported by Singh et al. (6) underwent a initial surgery by using the middle cranial fossa approach; a transmastoid approach was then used to remove a residual tumor. In one of the two patients reported by Magliulo et al. (22), a combined retrosigmoid-translabyrinthine approach was adopted.

In cases with preoperative unserviceable hearing and in elderly patients or patients with bad general condition, we aimed for minimal cerebellar retraction and a faster procedure, with the enlarged translabyrinthine approach being our chosen route. In cases with good preoperative hearing level, we used the enlarged middle cranial fossa approach. This approach provides

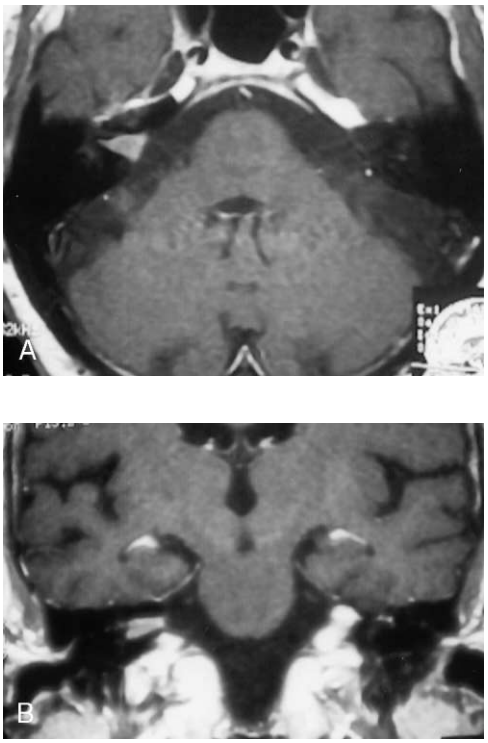

FIG. 2. Axial (*A*) and coronal (*B*) MR T1-weighted images with gadolinium showing an intracanalicular mass slightly extending to the cerebellopontine angle. A preoperative diagnosis of intracanalicular meningioma was suspected on the basis of the broad base shape of the CPA portion of the tumor [Case 5].

extradural access to the entire IAC so that even laterally placed tumors can be safely removed. The disadvantage of the enlarged middle cranial fossa approach is that the FN may lie between the tumor and the surgeon so that increased manipulation of FN may result. We did not use the retrosigmoid approach because it does not entirely expose the dura and the lateral compartment of the IAC. It must not be forgotten that leaving the dura behind increases the risk of recurrence. Intraoperatively, a meningioma may be suspected in view of unusual features, including bone invasion, soft and friable mass with high vascularity, posteriorly displaced FN, and strong adherence to the facial and vestibulocochlear nerves. The diagnosis of intracanalicular meningiomas in our cases was suspected intraoperatively and later confirmed histologically in seven (53.8%) cases. When preoperative or at least intraoperative suspicion arises with respect to the mass being an intracanalicular meningioma, surgical removal of the tumor requires special consideration.

The dura surrounding the tumor should be resected with sufficient margins to obtain Simpson Grade I of meningioma removal and reduce the chance of recurrence because this dura is usually infiltrated by tumor. In cases of bony invasion, these areas require drilling until normal bone is observed. When faced with VSs, the position of the FN is generally predictable, with the nerve displaced anteriorly and medially. Variability at the site of origin of a meningioma within the IAC may alter the location of the FN, which may be displaced posteriorly (4,8,16,23,24). An intracanalicular meningioma may also be firmly adherent to the facial and/or vestibulocochlear nerves, which may require meticulous sharp dissection. In the present study, the FN was displaced posteriorly (between the surgeon and the tumor) in two cases (15.3%). Tenacious adherences between the tumor and the facial-vestibulocochlear nerve complex were found in 46.1% (six] of our cases. Similar observations have been described in other series (6,16,17,21–24). A postoperative deterioration of FN function was observed in three patients (23%) in the present series and in 28.5% of the cases reported in association with the literature.

The review of the literature revealed 20 hearing-preserving operations. Detailed data on hearing results were not available in most of the studies. Furthermore, comparison of hearing outcomes in different series is difficult to achieve because various hearing classification systems have been used in each report. However, serviceable hearing (PTA $\leq$ 40 dB and SDS $\geq$ 60%) was preserved in approximately 14% of patients who were operated on with the intention of preserving hearing (4,15,18,22,23). In our series, hearing was preserved in two of the four patients in which hearing preservation was attempted. Examination of the literature demonstrated that complete resection was possible in 91.6% of cases.

Only two subtotal tumor removals (9,10) and one recurrence (7) have been reported until now; thus, a radiologic follow-up can be scheduled after 1, 3, and 5 years in a fashion similar to that adopted for VSs.

CONCLUSION

Although uncommon, meningiomas should always be considered in the differential diagnosis of intracanalicular tumors. Despite the advances in radiologic imaging, differentiation of tumor types for small intracanalicular lesions remains difficult on account of the small number of differentiating features. Intraoperative findings may help in differentiating meningiomas from more common VSs. Total removal with resection of the dura and bone should be accurately accomplished to reduce the chance of recurrence.

REFERENCES

1. Thomsen J. Cerebellopontine angle tumours, other than acoustic neuromas. *Acta Otolaryngol* 1976;82:106–11.
2. Brackmann DE, Bartels LJ. Rare tumors of the cerebellopontine angle. *Otolaryngol Head Neck Surg* 1980;88:555–9.
3. Moffat DA, Saunders JE, McElveen JT Jr, et al. Unusual cerebello-pontine angle tumours. *J Laryngol Otol* 1993;107:1087–98.
4. Bohrer PS, Chole RA. Unusual lesions of internal auditory canal. *Am J Otol* 1996;17:143–8.
5. Cushing H. *Tumors of the nervus acusticus and the syndrome of the cerebellopontine angle*. Philadelphia, PA: Saunders, 1917:222.
6. Singh KP, Smyth GDL, Allen IV. Intracanalicular meningioma. *J Laryngol Otol* 1975;89:549–52.
7. Brookler KH, Hoffmann RA, Camins M, et al. Trilobed meningioma: Ampulla of posterior semicircular canal, internal auditory canal and cerebellopontine angle. *Am J Otol* 1980;1:171–3.
8. Langman AW, Jackler RK, Althaus SR. Meningioma of the internal auditory canal. *Am J Otol* 1990;11:201–4.
9. Atlas MD, Fagan PA, Turner J. Calcification of internal auditory canal tumors. *Ann Otol Rhinol Laryngol* 1992;101:620–2.
10. Hodgson TJ, Kingsley DP. Meningioma presenting as a mass in the internal auditory canal. *Neuroradiology* 1995;37:479–80.
11. Zeitouni AG, Zagzag D, Cohen NL. Meningioma of the internal auditory canal. *Ann Otol Rhinol Laryngol* 1997;106:657–61.
12. Haught K, Hogg JP, Killefer JA, et al. Entirely intracanalicular meningioma: Contrast-enhanced MR findings in a rare entity. *AJNR Am J Neuroradiol* 1998;19:1831–3.
13. Kawamura S, Yamada M, Nonoyama Y, et al. Intrameatal tumours presenting as a hearing disturbance: Case reports of meningioma and lymphoma. *Acta Neurochir (Wien)* 1998;140:675–9.
14. Ishikawa N, Komatsuzaki A, Tokano H. Meningioma of the internal auditory canal with extension into the vestibule. *J Laryngol Otol* 1999;113:1101–3.
15. Dinh DH, Clark SB, Whitehead M, et al. Intracanalicular meningioma. *South Med J* 2000;93:618–21.
16. Caylan R, Falcioni M, De Donato G, et al. Intracanalicular meningiomas. *Otolaryngol Head Neck Surg* 2000;122:147–50.
17. Rinaldi A, Gazzeri G, Callovini GM, et al. Acoustic intrameatal meningiomas. *J Neurosurg Sci* 2000;44:25–32.
18. Breuer T, Gjuric M, Wigand ME. Extended middle fossa surgery for meningiomas within or at the internal auditory canal. *Am J Otol* 2000;21:729–34.
19. Martinez Devesa PM, Wareing MJ, Moffat DA. Meningioma in the internal auditory canal. *J Laryngol Otol* 2001;115:48–9.
20. Hilton MP, Kaplan DM, Ang L, et al. Facial nerve paralysis and meningioma of the internal auditory canal. *J Laryngol Otol* 2002; 116:132–4.
21. Asaoka K, Barrs DM, Sampson JH, et al. Intracanalicular meningioma mimicking vestibular schwannoma. *AJNR Am J Neuroradiol* 2002;23:1493–6.
22. Magliulo G, Zardo F, Bertin S, et al. Meningiomas of the internal auditory canal: Two case reports. *Skull Base* 2002;12:19–26.
23. Nakamura M, Roser F, Mirzai S, et al. Meningiomas of the internal auditory canal. *Neurosurgery* 2004;55:119–27.
24. Laudadio P, Canani FB, Cunsolo E. Meningioma of the internal auditory canal. *Acta Otolaryngol* 2004;124:1231–4.

25. House JW, Brackmann DE. Facial nerve grading system. *Otolaryngol Head Neck Surg* 1985;93:146–7.
26. American Academy of Otolaryngology–Head and Neck Surgery Foundation, Inc. Committee on Hearing and Equilibrium guidelines for the evaluation of hearing preservation in acoustic neuroma [vestibular schwannoma]. *Otolaryngol Head Neck Surg* 1995;113:179–80.
27. Sanna M. Session III. Grading systems for preoperative and postoperative hearing. In: Kanzaki J, Tos M, Sanna M, Moffat DA, Kunihiro T, Inoue Y, eds. *Acoustic Neuroma Consensus on System for Reporting Results*. New York, NY: Springer Verlag, 2003:169–71.
28. Simpson D. The recurrence of intracranial meningioma after surgical treatment. *J Neurol Neurosurg Psychiatry* 1957;20: 22–39.
29. Kleihues P, Burger PC, Scheithauer BW. The new WHO classification of brain tumours. *Brain Pathol* 1993;3:255–68.
30. Nager GT, Masica DN. Meningiomas of cerebello-pontine angle and their relation to the temporal bone. *Laryngoscope* 1970;80: 863–95.
31. Castellano F, Ruggiero G. Meningiomas of the posterior fossa. *Acta Radiol* 1953;104:1–157.
32. Desgeorges M, Sterkers O, Sterkers JM, et al. Posterior surface of petrous bone meningiomas: Choice of surgical approach and comparison between standard microsurgical techniques and the use of a microscope-guided laser. In: Tos M, Thomsen J, eds. *Acoustic Neuroma*. Amsterdam, The Netherlands: Kugler Publications, 1992.
33. Bassi P, Piazza P, Cusmano F, et al. MR cisternography of the cerebellopontine angle and internal auditory canal in diagnosis of intracanalicular acoustic neuroma. *Neuroradiology* 1990;31:486–91.
34. Maurer PK, Okawara SH. Restoration of hearing after removal of cerebellopontine angle meningioma: Diagnostic and therapeutic implication. *Neurosurgery* 1988;22:573–5.
35. Debus J, Wuendrich M, Pirzkall A, et al. High efficacy of fractioned radiotherapy of large base-of-skull meningiomas: Long term results. *J Clin Oncol* 2001;19:3547–53.
36. Nicolato A, Foroni R, Pellegrino M, et al. Gamma knife radiosurgery in meningiomas of the posterior fossa. Experience with 62 treated lesions. *Minim Invasive Neurosurg* 2001;44:211–7.