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MR Imaging of Primary Tumors of Trigeminal Nerve and Meckel's Cave

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MR imaging features of 11 primary tumors of the trigeminal nerve and Meckel's cave were analyzed. The tumors consisted of two trigeminal schwannomas, five meningiomas, one lipoma, and three epidermoid tumors. The trigeminal schwannomas had homogeneously decreased signal intensity on T1-weighted images and increased signal intensity on T2-weighted images. Three of the five meningiomas had signal intensity similar to that of surrounding brain on both T1- and T2-weighted images. One meningioma had decreased signal intensity on T1-weighted images and increased signal intensity on T2-weighted images. The other had relatively low signal intensity on both T1- and T2-weighted images owing to heavy calcification demonstrated on CT. The lipoma had homogeneous signal intensity that was isointense with orbital and subcutaneous fat on both T1- and T2-weighted images. The epidermoid tumors had decreased signal intensity on T1-weighted images and markedly increased signal intensity on T2-weighted images. In addition, the epidermoids had an insinuating growth pattern and minimal mass effect. The extent of involvement in the trigeminal nerve distribution was well demonstrated in each case.

Because of its multiplanar capability, exquisite anatomic detail, and characteristic tissue signal intensity, we conclude that MR is helpful in the differential diagnosis of primary tumors of the trigeminal nerve and Meckel's cave and in the evaluation of tumor involvement for preoperative planning.

Primary tumors of the trigeminal nerve and Meckel's cave are rare lesions, representing less than 0.5% of histologically proved intracranial tumors. Approximately one-third of these lesions are trigeminal schwannomas with the remainder consisting of meningiomas, lipomas, and epidermoid tumors [1–5].

We describe the MR appearance of 11 primary tumors of the trigeminal nerve and Meckel's cave and discuss differential diagnosis and relevance for preoperative planning.

Subjects and Methods

Eleven patients, ranging in age from 13–70 years old, with symptoms of trigeminal neuralgia (seven), diplopia (four), ptosis (two), headaches (one), and seizures (one) were studied. All four patients with symptoms of diplopia had sixth nerve palsy, and one of these had additional third and fourth nerve palsies. All the examinations were performed with a 0.5-T superconductive unit. Inversion recovery (2000–3050/500/40, TR/TI/TE), relatively T1-weighted (400–800/20-26), and T2-weighted (2000–2300/80–120) spin-echo pulse sequences were used. Axial T1- and T2-weighted images were obtained in all cases. Extra planes with various pulse sequences were obtained in most of the cases. Slice thickness was 5 or 10 mm. Pathologic confirmation was available in all cases.

Results

Two patients with trigeminal schwannomas were imaged. Both tumors were smoothly marginated, had low signal intensity on T1-weighted images, and high

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signal intensity on T2-weighted images (Figs. 1 and 2). Signal intensity on T2-weighted images was mildly heterogeneous in case 1 and moderately heterogeneous in case 2 (Fig. 2).

Three patients with trigeminal epidermoids were imaged. All three tumors were low in signal intensity on T1-weighted images and had moderately high heterogeneous signals on T2-weighted images (Fig. 3). In addition, all three tumors had lobulated margins with an insinuating growth pattern and minimal mass effect. Extension into the mandibular and maxillary divisions of the trigeminal nerve was demonstrated in one patient who also had seventh nerve palsy owing to the extremely large size of the tumor.

One trigeminal lipoma was imaged. MR signal intensity was tissue-specific for lipomas by virtue of isointensity with orbital and subcutaneous fat on both T1- and T2-weighted images (Fig. 4). Involvement of the mandibular division was demonstrated (Fig. 4D).

Five trigeminal meningiomas were imaged. Three of the five had signal intensity that was isointense with surrounding normal brain parenchyma on both T1- and T2-weighted images (Fig. 5). One meningioma had low signal intensity on T1-weighted images and high signal intensity on T2-weighted images (Fig. 6). Signal heterogeneity was greater on T2- than on T1-weighted images. MR demonstrated involvement of the mandibular and maxillary divisions in one case (Fig. 5). One meningioma had low signal intensity on both T1- and T2-weighted images owing to extensive calcification demonstrated by CT.

Discussion

The normal trigeminal nerve exits the anterolateral pons and courses anteriorly through the prepontine cistern to enter Meckel's cave. Meckel's cave is a dural invagination along

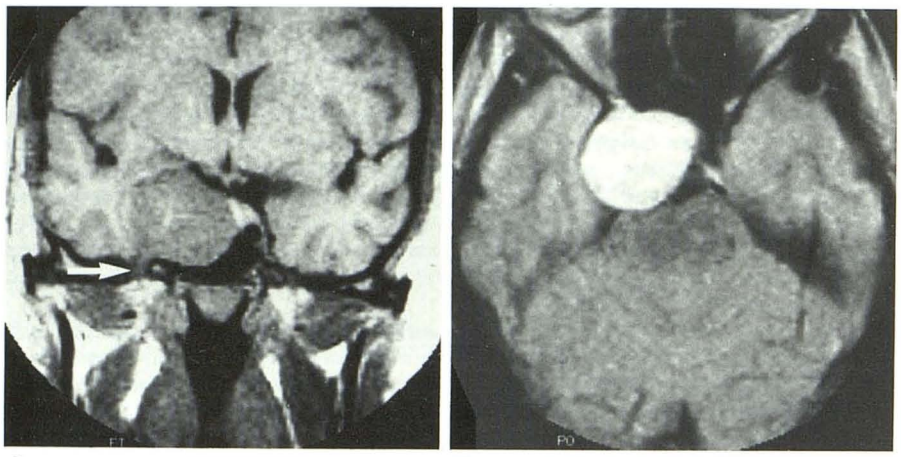


Fig. 1.—*A* and *B*, Case 1. Trigeminal schwannoma of right gasserian ganglion with smooth margins, relatively low signal intensity on T1-weighted image (*A*, 550/26), and high homogeneous signal intensity on T2-weighted image (*B*, 2000/80). Note involvement of mandibular division (*arrow*) in *A*.

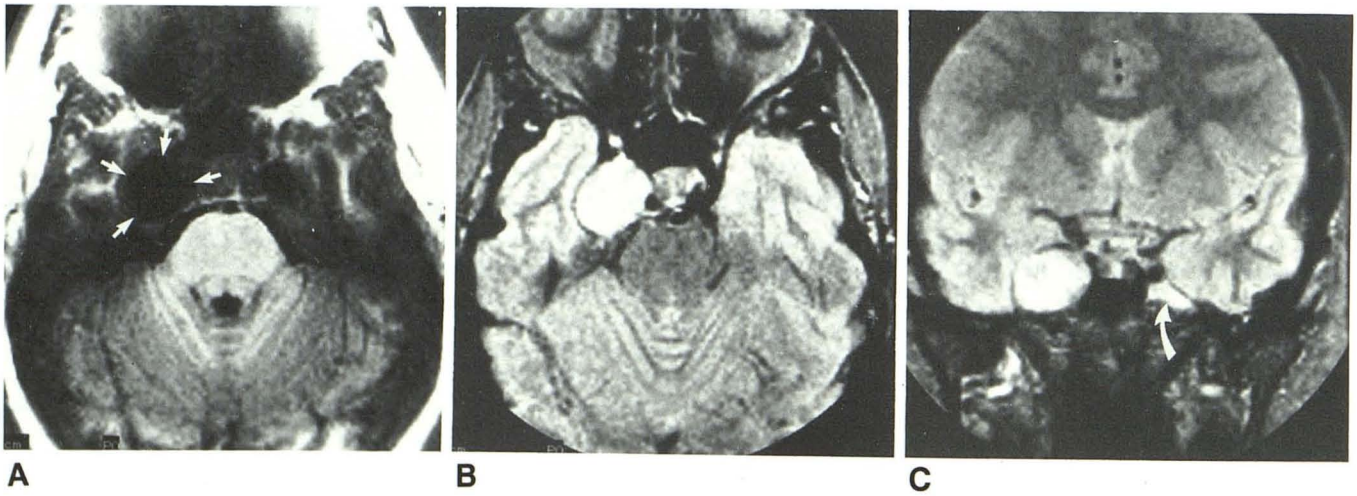


Fig. 2.—*A–C*, Case 2. Trigeminal schwannoma of right gasserian ganglion with smooth margins, relatively low signal intensity (*arrows*) on T1-weighted image (*A*, 2100/600/40), and high heterogeneous signal intensity on T2-weighted image (*B*, 2300/80); *C*, 1650/120. Note normal Meckel's cave (*curved arrow*) on left in *C*.

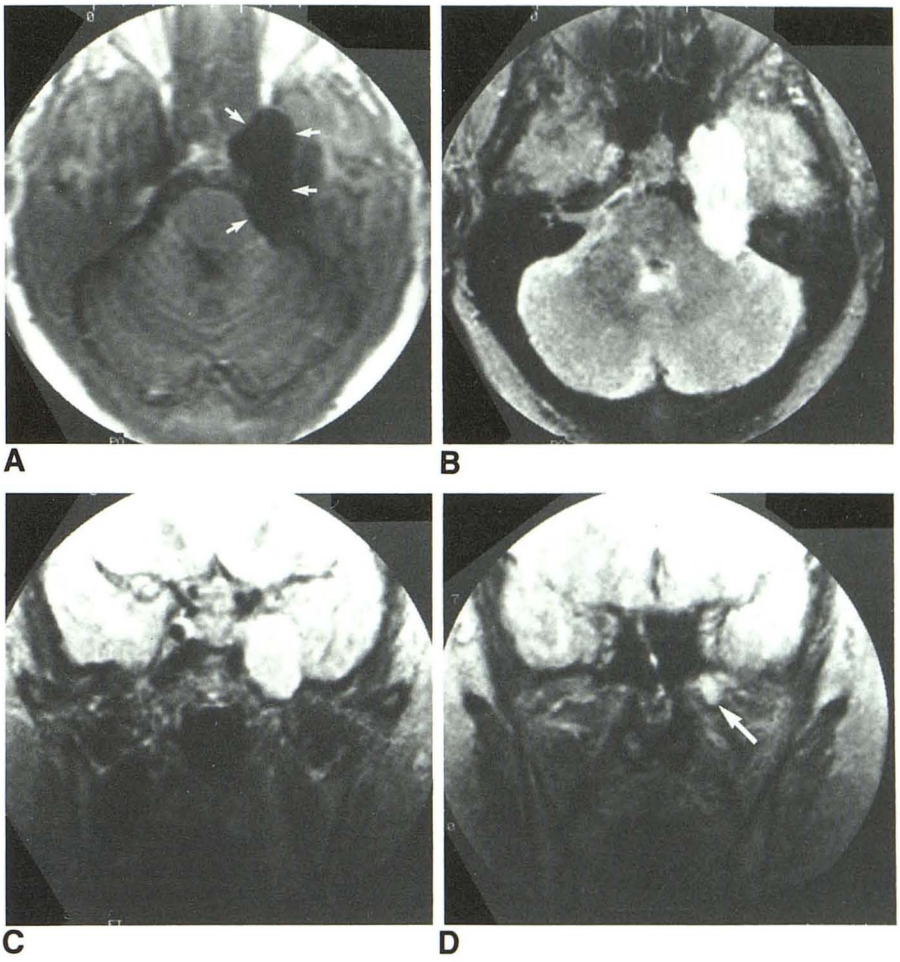


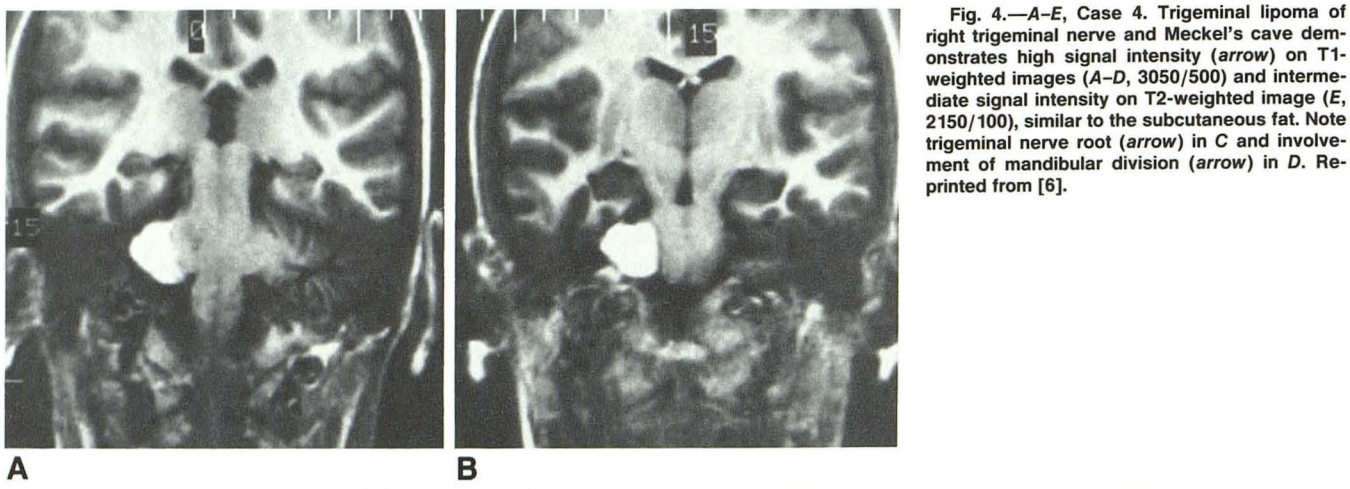
Fig. 3.—*A–D*, Case 3. Trigeminal epidermoid of left trigeminal nerve and Meckel's cave with low signal intensity (*arrows*) on axial T1-weighted image (*A*, 2050/600/40) and moderately high heterogeneous signal on axial T2-weighted image (*B*, 2300/80). Involvement of mandibular division is demonstrated as extension below the floor of the skull in the coronal T2-weighted image (*C*). Involvement of maxillary division (V2) (*arrow*) is shown in *D*, which is 1 cm more anterior than *C*. Note lobulated margins and minimal mass effect.

the medial aspect of the middle cranial fossa that is in continuity with the prepontine cistern via the porus trigeminus. The gasserian ganglion is located anteriorly in Meckel's cave and branches into three divisions. The ophthalmic division (V1) courses anteriorly through the lateral wall of the cavernous sinus and then through the superior orbital fissure. The maxillary division (V2) proceeds anteriorly through the foramen rotundum where it enters the superior aspect of the pterygopalatine fossa. The mandibular division (V3) proceeds inferiorly through the foramen ovale. The trigeminal nerve is primarily sensory to the face except for the motor root, which does not enter the ganglion and joins the mandibular division below the foramen ovale. The motor root innervates the medial and lateral pterygoids, temporalis, masseter, tensor tympani, tensor palatine, mylohyoid, and anterior belly of the digastric muscles. The CT and MR appearance of the normal trigeminal nerve and Meckel's cave has been described [4, 5, 7].

Trigeminal schwannomas are relatively rare, with only 183 reported cases by Lesoin et al. in 1986 [8]. Three major types can be distinguished on the basis of their origin in the preganglionic posterior fossa portion, gasserian ganglion, or postganglionic branches [8]. Both our cases involved the gasserian ganglion (which is the most common location) and had smooth margins and prolonged T1 and T2 relaxation times (Figs. 1 and 2). This is in agreement with the findings of Gentry et al. [9] for five trigeminal schwannomas.

Epidermoid tumors probably arise embryologically from incomplete cleavage of neural ectoderm from cutaneous ectoderm with inclusion epiblasts in the neural groove at the time of closure (3–5 weeks gestation) [10]. These tumors grow by desquamation of epithelial cells that break down into keratin and cholesterol within the tumor capsule. The soft pliable cholesterol and keratin produced by this process allow for slow growth.

All epidermoids we imaged had low signal intensity on T1-weighted images, high intensity on T2-weighted images, and lobulated margins conforming to the preexistent space with minimal mass effect. Although epidermoids contain cholesterol, they have low signal on T1-weighted images and do not demonstrate increased signal as seen in some craniopharyngiomas [11]. This difference in signal may be secondary to the varying physiologic state of cholesterol, which is solid in epidermoids and liquid in craniopharyngiomas [12, 13].



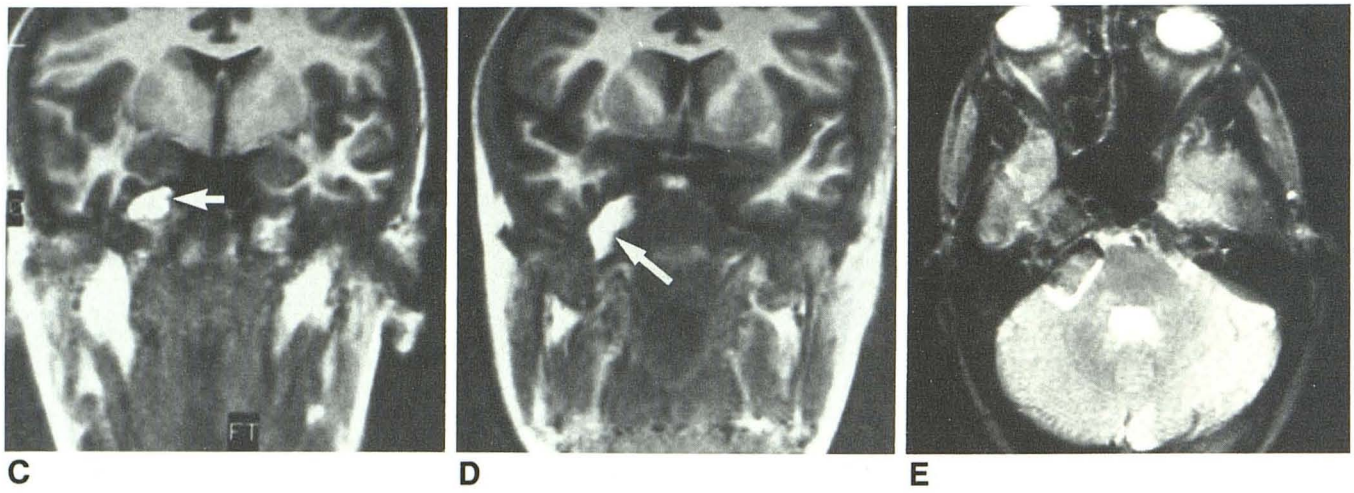


Fig. 4.—*A–E*, Case 4. Trigeminal lipoma of right trigeminal nerve and Meckel's cave demonstrates high signal intensity (*arrow*) on T1-weighted images (*A–D*, 3050/500) and intermediate signal intensity on T2-weighted image (*E*, 2150/100), similar to the subcutaneous fat. Note trigeminal nerve root (*arrow*) in *C* and involvement of mandibular division (*arrow*) in *D*. Reprinted from [6].

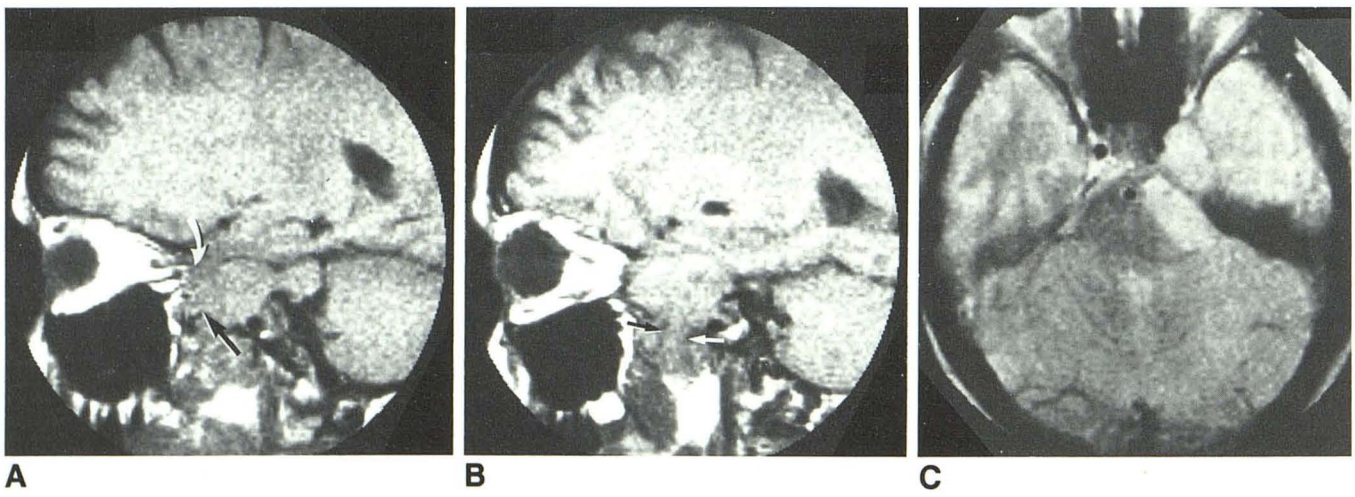


Fig. 5.—*A–C*, Case 5. Trigeminal meningioma of left trigeminal nerve and Meckel's cave demonstrates isointensity with surrounding brain on both T1- (*A* and *B*, 550/26) and T2-weighted (*C*, 2000/80) images. Note ophthalmic (*curved arrow*) and maxillary (*straight arrow*) divisions in *A* and mandibular division (*arrows*) in *B*.

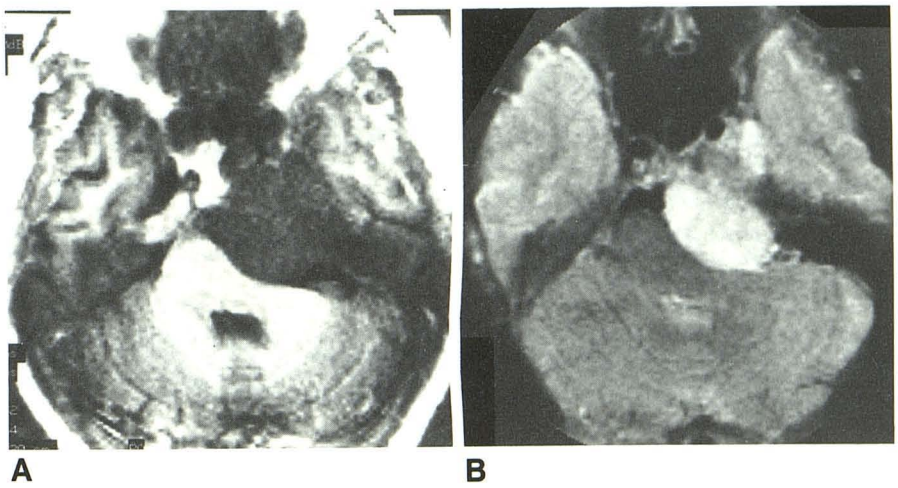


Fig. 6.—*A* and *B*, Case 6. Meningioma of left trigeminal nerve demonstrates atypical signal characteristics with low signal intensity on T1-weighted image (*A*, 2050/500) and high signal intensity on T2-weighted image (*B*, 2300/80).

Trigeminal lipoma is a rare lesion with a tissue-specific MR signal intensity. Preoperative identification is important because the lipoma intimately involves and infiltrates the nerve fascicles, making complete resection difficult [14, 15]. MR clearly delineates the extent of tumor involvement, which is also crucial for preoperative planning (Fig. 4).

Meningiomas are usually relatively isointense with surrounding normal brain parenchyma on both T1- and T2-weighted images [9, 15]. Three of our five meningioma cases were isointense (Fig. 5); the fourth case had low signal intensity on T1-weighted images and high signal intensity on T2-weighted images (Fig. 6); and the fifth had low signal intensity on both T1- and T2-weighted images due to heavy calcification demonstrated on CT. Signal intensity was homogeneous on T1-weighted images with slight heterogeneity on T2-weighted images. This is in agreement with the findings of Zimmerman et al. [15] and Gentry et al. [9]. We did not visualize the hypointense rim, which was reported in 66% of cases by Zimmerman et al. The reason is not clear, but it could be related to location, since most of the tumors reported by Zimmerman et al. were supratentorial. MR clearly displayed the extent of tumor involvement, especially on T1-weighted images (Fig. 5).

In spite of the small number of cases studied in our series, interesting observations about the symptoms, location, and pathology were noted. Three of the four patients with lipid-containing tumors (two epidermoids and one lipoma) had minimal symptoms that did not relate to the trigeminal nerve. These may be attributed to the soft nature of the tumors. On the other hand, most of the nonlipid tumors (both neuromas and four of the five meningiomas) had symptoms related to the trigeminal nerve. The only meningioma without trigeminal nerve symptoms was located at the trigeminal root in the posterior fossa with symptoms of diplopia and dizziness. All patients with symptoms of diplopia had sixth nerve palsy, possibly due to the proximity of the sixth nerve to the trigeminal nerve. One patient with symptoms of diplopia also had third and fourth nerve palsies. All the patients with nonlipid tumors (seven) had either trigeminal neuralgia or diplopia; three of the seven had both symptoms.

Tumors that involve the trigeminal nerve and Meckel's cave can be classified as extrinsic or intrinsic lesions [4]. Most extrinsic lesions are the result of a direct invasion from a lesion in the adjacent bone, and therefore usually have an associated abnormal bony change and are most commonly from metastasis. The intrinsic lesions can be further classified as primary or secondary tumors [4]. Secondary tumors include retrograde extension of nasopharyngeal tumors, seeding via CSF into the cerebellopontine angle or into Meckel's cave through the porus trigeminus, and hematogenous metastasis directly into the trigeminal nerve or Meckel's cave. Seeding into Meckel's cave or trigeminal root via CSF has not been reported. Hematogenous spread directly into the trigeminal nerve and ganglia is extremely rare. Retrograde extension of nasopharyngeal tumor is usually a late manifestation, and abnormal radiographic findings in the nasopharynx area as well as the clinical history should suggest the diagnosis. Primary tumors usually do not cause bone destruction, but they may expand Meckel's cave and displace the adjacent bony structure when a tumor is large enough. Therefore, a diagnosis of primary tumors of the trigeminal nerve and Meckel's cave should be strongly considered in patients presenting with symptoms of trigeminal neuralgia or diplopia and absence of bone destruction.

In conclusion, MR is helpful in the differential diagnosis of primary tumors of the trigeminal nerve and Meckel's cave and in determining the extent of tumor involvement for preoperative planning.

REFERENCES

1. DeBenedittis G, Bernasconi V, Ettorre G. Tumors of the fifth cranial nerve. *Acta Neurochir (Wien)* **1977**;38:37–64
2. Schigano G, Olivecrona H. Neurinomas at the gasserian ganglion and trigeminal root. *J Neurosurg* **1960**;17:306–322
3. Levinthal R, Bentson JR. Detection of small trigeminal neurinomas. *J*

Neurosurg **1976**;45:568–575
4. Kapila A, Chakeres D, Blanco E. The Meckel cave: computed tomographic study. Part I: normal anatomy; Part II: pathology. *Radiology* **1984**;152:425–433
5. Chui M, Tucker W, Hudson A, Bayer N. High resolution CT of Meckel's cave. *Neuroradiology* **1985**;27:403–409
6. Yuh WTC, Barloon TJ, Jacoby CG. Case report: trigeminal nerve lipoma: MR findings. *J Comput Assist Tomogr* **1987**;11:518–521
7. Daniels DL, Pech P, Pojunas KW, Kilgore DP, Williams AL, Haughton VM. Trigeminal nerve: anatomic correlation with MR imaging. *Radiology* **1986**;159:577–583
8. Lesoin F, Rousseaux M, Villette L, et al. Neuromas of the trigeminal nerve. *Acta Neurochir (Wien)* **1986**;82:118–122
9. Gentry LR, Jacoby CG, Turski PA, Houston LW, Strother CM, Sackett JF. Cerebellopontine angle-petromastoid mass lesions: comparative study of diagnosis with MR imaging and CT. *Radiology* **1987**;162:513–520
10. Burger PC, Vogel FS. *Surgical pathology of the central nervous system and its coverings*. New York: Wiley, **1982**:117–123
11. Pusey E, Kortman KE, Flannigan BD, Tsuruda J, Bradley WG. MR of craniopharyngiomas: tumor delineation and characterization. *AJR* **1987**;8:439–444
12. Yuh WTC, Barloon TJ, Jacoby CG, Schultz DH. MR of fourth-ventricular epidermoid tumors. *AJNR* **1988**;9:794–796
13. Wong WS, Tsuruda JS, Kortman K, Bradley WG Jr. *Practical MRI: a case study approach*. Rockville, MD: Aspen Publishers, **1987**:136, 167
14. Christensen WN, Long DM, Epstein JI. Cerebellopontine angle lipoma. *Hum Pathol* **1986**;17:739–743
15. Zimmerman RD, Fleming CA, Saint-Louis LA, Lee BCP, Manning JJ, Deck MDF. Magnetic resonance imaging of meningiomas. *AJNR* **1985**;6:149–157