Meningeal melanocytoma: magnetic resonance imaging characteristics and pathological features

Case report

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A case of meningeal melanocytoma at the foramen magnum is reported in a 62-year-old man. Magnetic resonance (MR) imaging revealed characteristic signal patterns: homogeneous high intensity on the T1-weighted image and low intensity on the T2-weighted image. Light microscopy showed a histological appearance similar to that of melanotic meningioma. The ultrastructural features of the neoplastic cells were compatible with those of melanocytes, but they contained no features of arachnoidal cells. Immunohistochemical bromodeoxyuridine study revealed low proliferative activity among the neoplastic cells. The MR appearance and pathological features in this rare case of meningeal melanocytoma are demonstrated and discussed.

Key Words • meningeal melanocytoma • melanotic meningioma • magnetic resonance imaging

Meningeal melanocytoma is a rare tumor that is still confused with melanotic meningioma. In this report, we describe a case of meningeal melanocytoma diagnosed by magnetic resonance (MR) imaging. Details of the pathological studies are presented to further characterize the lesion.

Case Report

This 62-year-old man presented in January, 1990, with loss of consciousness and gait disturbance. Frequent episodes of loss of consciousness had occurred during the year before admission. There was no history of any type of skin tumor.

Examination. The neurological examination was normal except for a mildly ataxic gait. Computerized tomography (CT) revealed a dura-based isodense to high-density mass with homogeneous contrast enhancement in the mid-suboccipital region (Fig. 1). Magnetic resonance imaging was performed using a 0.5-tesla scanner with a slice thickness of 10 mm; T1- and T2-weighted images were obtained by a spin-echo technique (TR 500 msec, TE 30 msec for the short TR/TE image and TR 2000 msec, TE 120 msec for the long TR/TE image). Gadolinium diethylenetriamine pentaacetate acid contrast enhancement was used for the T1-weighted image. A lesion, appearing as a homogeneous high-intensity mass on the T1-weighted image and a low-intensity mass on the T2-weighted image, was seen at the posterior edge of the foramen magnum (Fig. 2). Gadolinium contrast enhancement was homogeneous (Fig. 2 lower right). Left vertebral and external carotid angiography showed no tumor stain.

Operation. Suboccipital craniectomy, C-1 laminectomy, and total removal of the tumor were performed in an en bloc fashion. Macroscopically, a black-and-tan tumor was attached to the dura mater at the C-1 level, compressing the dorsal medulla oblongata without ex-
tension into the brain stem. No cranial nerve was involved. A few areas of pigmentation were scattered over the meninges. The patient had an uneventful postoperative course, and repeat CT did not show any residual tumor. The patient remains alive and well 1½ years after surgery without evidence of recurrence.

Pathological Examination. The tissue was prepared for light microscopy and stained with hematoxylin and eosin, Perl's Prussian iron, reticulin, and Fontana-Masson melanin stains. Immunoperoxidase staining was performed using polyclonal antibody to S-100 protein and monoclonal antibodies to epithelial membrane antigen and vimentin. Bromodeoxyuridine (BUdR) staining was performed on ethanol-fixed, paraffin-embedded tissue. All immunohistochemical stains were prepared with the avidin-biotin complex technique. The stains were applied with 3,3'-diaminobenzidine tetrahydrochloride or aminomethyl carbazol to differentiate brown melanins and were counterstained with hematoxylin or methyl green. The positive controls consisted of a known schwannoma for S-100 protein and a known meningioma for epithelial membrane antigen and vimentin. Negative controls substituted nonimmune rabbit or mouse serum for the primary antibodies. The in situ BUdR method was applied according to the technique of Hoshino, et al. Small tissue fragments were deparaffinized, refixed in 2.5% buffered glutaraldehyde, and processed for electron microscopy in the usual manner.

Microscopically, the tumor was composed of cells with relatively well-defined cytoplasm, vesicular nuclei, and prominent nucleoli (Fig. 3). There were numerous brown-pigmented granules that were not responsive to iron stain; these were identified as melanin by Fontana-Masson stain. The reticulin stain was positive only in the vicinity of the perivascular spaces. Cellular whorls were seen frequently, although psammoma bodies were not. Anaplastic features, such as mitotic figures, necrosis, and pleomorphism, were not observed. Neither recent nor old hemorrhage was present.

Immunohistochemical staining for vimentin revealed diffusely strong cytoplasmic staining of tumor cells (Fig. 4 upper left). Some tumor cells were also positive for S-100 protein (Fig. 4 upper right). The tumor cells, however, were not immunoreactive with epithelial membrane antigen. Bromodeoxyuridine-labeled cells were rare, suggesting low proliferative activity (Fig. 4 lower).

Electron microscopy demonstrated tumor cells with large nuclei, prominent nucleoli, abundant cytoplasm, and dendritic cytoplasmic processes (Fig. 5 left). There was no basal lamina around the cytoplasmic membrane. Cellular junctions, such as punctate adhesion and desmosome-like junction, were scattered only in limited areas (Fig. 5 right). Almost all tumor cells contained large melanosomes of varying stages of maturity (Fig. 5 right).

Discussion

Melanotic meningeal tumors in the central nervous system include primary or metastatic melanomas, melanotic schwannoma, melanotic neuroectodermal tumor, and meningeal nevus. In this patient, the absence of histologically anaplastic features and the low proliferative activity in BUdR labeling exclude the diagnosis of melanoma. Furthermore, neither light microscopic, im-

Fig. 2. Magnetic resonance images. T1-weighted (left pair), T2-weighted (upper right), and contrast-enhanced T1-weighted (lower right). There is a homogeneous high-intensity mass on the T1-weighted images and a low-intensity mass on the T2-weighted image at the posterior edge of the foramen magnum. The gadolinium contrast enhancement is homogeneous.

Fig. 3. Photomicrograph of the tumor. Clusters of tumor cells show numerous whorls and multiple areas of pigmentation. H & E. X 135.
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munohistochemical, nor electron microscopic features suggest a melanotic neuroectodermal tumor. The histological features in this case are most consistent with those of meningeal melanocytoma.

**Historical Review**

The entity of meningeal melanocytoma was first proposed by Limas and Tio in 1972. They reported a subdural tumor at the foramen magnum with a histology similar to melanotic meningioma, and demonstrated melanin production in neoplastic cells with characteristic polar processes, a zonula adherens type of cellular junction, and a long-spacing collagen in the interstitium by electron microscopy. They concluded that the tumor originated from a melanocyte rather than a meningothelial cell and suggested the diagnostic
term "meningeal melanocytoma" was more appropriate than "melanotic meningioma." Subsequently, only seven cases of meningeal melanocytomas, including this case, have been reported. \(^1,14,17,20,31,33\) All investigators have stressed that meningeal melanocytoma is a different entity from melanotic meningioma on the basis of its ultrastructural features: 1) desmosome and interdigitating processes are not present in meningeal melanocytoma, but are characteristic of meningioma; and 2) a similarity exists between meningeal melanocytoma and the cells of extracranial blue nevi and leptomeningeal melanocyte. \(^8\)

Several investigators have suggested that some reported melanotic meningiomas may have been misdiagnosed, but this is controversial. To our knowledge, 11 cases diagnosed as melanotic meningiomas have been reported. \(^1,3,4,15,16,19,23-25,27,32\) Ten cases were diagnosed by light microscopy alone and antedated the introduction of the term "meningeal melanocytoma" by Limas and Tio. \(^20\) One case reported by Lesoin, et al. \(^19\) was investigated by electron microscopy. These authors found features characteristic of meningioma. Kepe et al. \(^8\) described melanotic meningiomas and the capacity for melanin production by arachnoidal cells. Thus, the very existence of melanotic meningioma remains open to question. Precise pathological studies of future cases are needed.

**Magnetic Resonance Characteristics**

To our knowledge, the MR characteristics of meningeal melanocytoma have not previously been reported in detail, although those of intracranial malignant melanoma have. \(^2,3,4,36\) Winston, et al. \(^36\) diagnosed a meningeal melanocytoma at the left cerebellopontine angle using only T₁-weighted MR imaging to localize the lesion; however, they did not describe its MR features. In our case, the tumor exhibited homogeneous high intensity on the T₁-weighted image and low intensity on the T₂-weighted image. This signal pattern is unique and opposite to that usually seen with intracranial tumors, which appear isointense or hypointense on the T₁-weighted image and hyperintense on the T₂-weighted image. Stable free radicals, such as indole semiquinones and semiquinonimines within melanin, have been identified by electron spin-resonance studies. \(^28\) These free radicals are paramagnetic and responsible for decreasing the T₁ and T₂ relaxation times. Intracranial malignant melanoma has similar signal patterns; \(^2,3,4,36\) however, Woodruff, et al. \(^36\) have stressed that hemorrhage in malignant melanoma may have a greater influence on the MR appearance than does melanin, showing heterogeneous signal intensity. Most malignant melanomas contain some hemorrhage, \(^11\) therefore melanoma varies in appearance, depending on the degree of hemorrhage. Atlas, et al. \(^2\) have reported that nonhemorrhagic amelanotic melanoma appears isointense or mildly hypointense on the T₁-weighted MR image and isointense or mildly hyperintense on the T₂-weighted image. In addition, they suggested that the MR appearance of melanoma was not uniform, but depended on the degree of melanization. Thus, in this case, the homogeneous MR appearance with decreased T₁ and T₂ relaxation times, histologically diffuse melanization, and lack of hemorrhage are important considerations in establishing the diagnosis of meningeal melanocytoma.

**Histological Considerations**

Fitzpatrick, et al., \(^4\) have classified melanosomes into four stages of maturity: 1) those containing small vesicles; 2) those containing filamentous collections (premelanosome); 3) those containing some partially electron-dense granules; and 4) those containing uniformly electron-dense granules (mature melanosome). In meningeal melanocytoma, varying stages of melanosome maturity have been reported. \(^5,14,17,20,31,33\) Most cases contained compact melanosomes without pleomorphism or structural derangements, suggesting a benign character. The basal lamina formation around neoplastic cells varies, but usually is not well developed. It is well developed by schwannoma. Thus, it may be important to differentiate this lesion from schwannoma.

Only two immunohistochemical studies of a meningeal melanocytoma have been reported, and both showed the presence of S-100 protein and the absence of epithelial membrane antigen in the tumor cells. \(^17,35\) One case was also immunoreactive for vimentin. \(^17\) The tumor cells in the present case were also immunoreactive for S-100 and vimentin, but not for epithelial membrane antigen. S-100 immunoreactivity has been recognized in meningioma, melanoma, schwannoma, and various neuroectodermal tumors. \(^22,38,39\) Schwannoma usually presents with stronger immunoreactivity for S-100 than meningioma. \(^26\) Epithelial membrane antigen immunoreactivity has been identified in meningioma, ependymoma, and some neuroectodermal tumors. \(^22,29\) but has not been found in melanoma or schwannoma. \(^22,29\) Vimentin immunoreactivity has limited value in the differential diagnosis and indicates that a cytoskeleton exists in the tumor cells. \(^9,18\) Based on this immunohistochemical study, S-100 and vimentin positivity without epithelial membrane antigen staining only suggests that the diagnosis of meningioma can be ruled out. Although in situ BUdR studies have been reported in many kinds of brain tumors, \(^12\) they have not previously been reported for meningeal melanocytoma. In situ BUdR staining in this case revealed low proliferative activity.

**Prognosis**

The prognosis is quite good in most cases of meningeal melanocytoma. \(^5,14,17,20,31,33\) However, local recurrence may be seen, as reported by Winston, et al. \(^35\) possibly more often than with meningioma. Among seven localized meningeal melanocytomas with a definite diagnosis by electron microscopy, three tumors recurred within 6 months to 3 years after the initial surgery. \(^5,31,35\) Two of these cases recurred 2 to 3 years.
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after partial or subtotal resection, and the last recurred 6 months after total resection. The case reported by Winston, et al., may have had some malignant potential, given its early recurrence in spite of total removal. Although all these patients underwent irradiation, the efficacy of that treatment was unclear. Thus, it is important to evaluate the proliferative activity in this rare neoplasm to determine the best treatment. Based on the findings in this case, complete removal is likely to be the most important determinant of outcome.

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