Case report

Neuroradiological findings of atypical meningiomas

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Abstract

Neuroradiological findings of atypical meningiomas were retrospectively reviewed in 8 patients to clarify their characteristics. Partial or complete disappearance of the peritumoral band was seen in a majority of tumors. More than half of the tumors exhibited heterogeneous density or intensity, heterogeneous contrast enhancement, lack of dural tail sign, and a relatively large perifocal edema. The tumors sometimes showed early venous filling on angiography that is not seen in benign lesions. CT, MRI, and angiographic findings gave useful information for the possible diagnosis of the atypical meningiomas before surgery.

Keywords: Meningioma; Atypical; CT; MRI; Angiography

Most meningiomas are benign and classified as grade I according to World Health Organization (WHO) standards [1]. However, subtypes such as atypical, clear cell, chordoid, and malignant meningiomas display less favorable clinical outcomes and are classified as grades II and III [2–5]. Atypical meningiomas account for between 4.7 and 7.2% of all meningiomas [1]. Malignant meningiomas are less common, comprising between 1.0 and 2.8% [1]. Malignant and atypical meningiomas are more prone to recurrence and rapid growth [2]. The distinction between benign and atypical or malignant meningioma represents important surgical information, because surgical and treatment planning as well as prognostication will depend on those pathologic types. However, previous studies investigating such distinctions have not necessarily been reliable. No previous reports have investigated radiological findings of a series of atypical meningiomas. The present study attempted to retrospectively elucidate radiological characteristics of atypical meningiomas, as information useful before surgery.

1. Materials and methods

Seventy-one cases of meningioma were treated surgically in our hospital between January 1994 and December 2002.

Eight cases (11.3%) were histologically identified as atypical meningioma. The patients comprised 3 males and 5 females, ranging in age from 39 to 78 years (mean, 62.7 years). Neurological symptoms such as headache, loss of consciousness, and numbness of the extremities were reported. Duration of symptoms ranged from 1 month to 16 years, with a mean of 4 years 11.4 months. Three cases represented recurrent disease subsequent to resection of benign meningothelial meningiomas. Computed tomography (CT) was performed before and after contrast administration in five cases. Magnetic resonance imaging (MRI) including pre- and postcontrast T1-weighted imaging using spin-echo (SE) sequences and T2-weighted imaging using fast spin-echo (FSE) sequences was performed in seven cases. Angiography using intraarterial digital subtraction angiography was performed in seven cases. On CT, attenuation of the tumor compared to normal gray matter, presence of calcification, pattern of contrast enhancement, and extent of surrounding edema were analyzed. On MRI, signal intensity of the tumor compared to normal gray matter, pattern of contrast enhancement, characteristics of tumor margin, and extent of surrounding edema were analyzed. Extent of edema was divided into three grades: –, not seen; +, smaller than the tumor; and 2+, larger than the tumor. For characteristics of the tumor margin, the CSF interface between the tumor and the brain surface, the 'peritumoral band', shows a hypointense rim.
on T1W and a hyperintense rim on T2W. Presence of the peritumoral band was evaluated. Presence of the dural tail sign [6] with thickened enhancing dura extending from the tumor on postcontrast T1W was also assessed. Angiographic features such as presence of pial supply, tumor staining, and early appearance of draining veins were reviewed.

2. Results

Findings for all patients are summarized in Table. Two tumors were located in the falx, two in the convexity, three in the parasellar region, and one of en plaque meningioma. Tumor size ranged from 25.0 to 85.0 mm in maximum diameter (mean, 51.4 mm). Of the five cases in which CT

Fig. 1. A 67-year-old male with atypical meningioma in the left parasellar region. CT (a) shows a tumor (arrows) with heterogeneous attenuation and calcification. MRI shows a heterogeneous intensity of the tumor (arrows) in both T1-weighted (T1W) (b) and T2-weighted images (T2W) (c). Postcontrast axial T1W (d) heterogeneously enhanced tumor (arrows), and coronal T1W (e) depicts tumor invasion into the cavernous sinus (arrow). Histology (f) (hematoxylin-eosin, × 200) demonstrates loss of architecture, increased cellularity and mitotic activity.
was utilized, tumor attenuation appeared heterogeneous in two (Fig. 1), although homogeneous hyperdensity was observed in three. Calcification was seen in one tumor (Fig. 1). Three tumors homogeneously enhanced to the same degree as blood vessels in postcontrast CT, and two were heterogeneously enhanced. Bony changes such as erosion and hyperostosis were not seen in any tumors. On T1W MRI, tumors were homogeneously isointense in two cases and hypointense in one. One tumor appeared inhomogeneously hypointense. Three tumors displayed heterogeneous signal intensity with hypo-, iso- and hyperintensity (Figs. 1 and 2). On T2W MRI, tumors were homogeneously hyperintense in two and isointense in one. One tumor appeared inhomogeneously hyperintense (Fig. 2). Heterogeneous intensity was seen in three cases. Perifocal edema was (+) in one tumor, (2 +) in four, and (−) in two. Peritumoral band was complete in one tumor. On postcontrast T1W, all tumors were enhanced after administration of contrast material, with heterogeneous enhancement in four (Figs. 1 and 2) and homogeneous enhancement in three. Two tumors enhanced to the same degree as blood vessels. Five of the seven cases displayed edema larger than the tumor. No perifocal edema was seen in two cases. Although, a peritumoral band was only completely present in one case, it was partially apparent in some other tumors. Postcontrast T1W showed a dural tail sign in three of the seven tumors. Angiography revealed pial supply in four cases and tumor staining in all seven. A typical sun-burst appearance was seen in only one case.

Two of the seven cases displayed early appearing of the draining vein (Figs. 2 and 3, Table 1).

3. Discussion

The radiological diagnosis of meningioma is not difficult in the majority of cases. CT and MRI play important roles in the diagnosis of meningioma. Typically, meningiomas are sharply demarcated and hyperdense on CT. On MRI, the tumor is iso- or hypointense on non-contrast T1-W, and iso- or hyperintense on T2-W. Homogeneous enhancement is observed after contrast administration. Unusual radiological findings are present in about 15% of all meningiomas and can include cystic, necrotic, or fatty changes [7]. Cystic components, which can be partially necrotic, were seen in four of the present cases. Fatty change was not seen. Only three of our cases radiologically displayed findings similar to benign meningioma. The other five tumors demonstrated non-homogeneous CT density or MRI intensity, in addition to heterogeneous contrast enhancement. Dural tail sign was seen in only one of these five tumors. Calcification was also found in only one of the present series. A previous report considered the absence of calcification in malignant meningiomas [8]. This may well be associated with increased growth rate. In the present series, excluding malignant meningioma, no hypointense and only one isointense tumor on T2W might be due to absence of calcification. The peritumoral band represents the border between the tumor...
and the brain surface, and demonstrates the extraaxial nature of the tumor [7]. A complete peritumoral band was seen in only one tumor. Partial or complete disappearance of the peritumoral band was seen in other tumors. Although, histological proof was not obtained, this finding is attributable to tumor invasion of the pia mater [9]. The amount of edema surrounding meningioma varies in the literature, but some reports [10,11] have found no correlation between edema and histological type. However, amount of edema was relatively large in more than half of the tumors in the present series. Statistical analysis could not be performed due to the small number of patients in the present study.

Conventional angiography is invasive, but provides useful information such as location of feeding arteries and draining veins, and degree of tumor vascularity. An angiographic finding of early appearance of the draining

Fig. 2. A 78-year-old female with atypical meningioma in the right frontal lobe. The tumor appears heterogeneous in precontrast T1W (a) (arrows), and heterogeneously enhanced in postcontrast T1W (b). Angiography reveals tumor staining and early appearing of the draining vein (c) (arrow). Histology (hematoxylin-eosin, × 200) (d) demonstrates sheetlike growth and an increased cellularity of tumor cells.
vein, suggesting the presence of arterio-venous shunting, is often seen in malignant tumors in various organs. This angiographic finding, seen in two cases in the present series, has never been described in previous descriptions of atypical meningioma. This finding must reliably differentiate malignant or atypical meningiomas from benign ones. However, differentiating atypical from malignant meningiomas is difficult. Servo et al. [8] stated that atypical or anaplastic meningioma could not be angiographically differentiated from benign, but some malignant meningiomas were rather poorly vascularized and tumor staining was weak. It is difficult to objectively evaluate the degree of vascularization and tumor staining, but all tumors in the present series displayed almost the same degree of tumor staining as typical benign meningioma.

Recently, the effectiveness of diffusion-weighted imaging (DWI) in differentiating malignant or highly atypical from benign meningiomas has been reported [12]. In that report, apparent diffusion coefficient (ADC) values were low in malignant or atypical meningioma, but sample size was small. ADC could be effective in differentiating malignant or atypical from benign meningiomas, because ADC reflects degree of cellularity and amount of extracellular space in various tumors other than meningioma. DWI was not performed in the present series due to the retrospective study. The utility of DWI should be further studied.

Fig. 3. A 39-year-old male with atypical meningioma in the left parasellar region. Postcontrast CT shows an enhanced tumor in the left parasellar region (a) (arrows). Angiography demonstrates intense staining of the tumor with early appearance of a draining vein (b) (arrows). Histology (hematoxylin-eosin, $\times$ 200) (c) demonstrates sheeting, nuclear atypia and increased cellularity of tumor cells.
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<th>Case</th>
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F, female; M, male; homo, homogeneous; hetero., heterogeneous density on CT, or heterogeneous intensity on MRI; inhomog., inhomogeneous; np, not performed; CE, contrast enhancement; CA, calcification; T1W, T1-weighted imaging; T2W, T2-weighted imaging; 1 + , contrast enhancement of tumor is less than that of blood vessels; 2 + , contrast enhancement of tumor is equal to that of blood vessels; –, negative; +, positive; iso., isointense; hypo., hypodense or hypointense; hyper., hyperdense or hyperintense; angio., angiography.
The present study showed that partial or complete disappearance of the peritumoral band was seen in a majority of tumors. More than half of the tumors exhibited lack of dural tail sign and a relatively large amount of perifocal edema. The tumors sometimes showed early venous filling on angiography that was not seen in benign lesions. CT, MRI, and angiographic findings gave useful information for the possible diagnosis of the atypical meningiomas before surgery. Predicting histologic nature meningiomas would aid in surgical and treatment planning, because recurrence rate and prognosis in atypical meningiomas are different from those in benign meningiomas. If a meningioma radiologically has the above characteristics before surgery, surgeons may need to prepare to remove it completely as possible as they can.

References


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