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Pictorial review

Meningioma mimics: five key imaging features to differentiate them from meningiomas

C.J. Starr*, S. Cha

Department of Radiology and Biomedical Imaging, University of California San Francisco, CA, USA

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There are a wide variety of intracranial mass lesions, both benign and malignant, which can closely mimic meningioma on imaging. We present five characteristic imaging features that can alert the radiologist to consider other differential diagnoses. Of the five imaging characteristics that were rarely seen in meningiomas, but common and specific for meningioma mimics, absence of dural tail is the most common (83.7%). Homogeneous T2 hyperintensity or T2 hypointensity are seen in nearly half of meningioma mimics and osseous destruction and leptomeningeal extension are present in 40.5% and 21.6% of meningioma mimics, respectively. The distinction between meningioma and its mimics is important because a large portion of the meningioma mimics requires substantially different clinical and surgical management.

Introduction

Meningiomas are the most common intracranial neoplasms and the most common extra-axial mass representing up to 30% of all adult intracranial neoplasms. The vast majority of meningiomas (70–90%) are histologically benign, World Health Organization (WHO) grade I tumours. Pathologically they arise from arachnoid meningothelial cap cells and are of two basic morphologies: expansile mass with wide dural attachment, or "*en plaque*" pattern of growth in a sheet-like pattern along the dura. They occur along the broad dural surface with most common locations being the falcine, parafalcine, cerebello-pontine angle, and planum sphenoidale[1–4]; however, meningiomas that occur in unusual locations or have abnormal morphologies are diagnostically challenging.[5]

The vast majority of extra-axial, dural-based masses are meningiomas and their imaging diagnosis is usually straightforward and accurate; however, there are several intra-axial and extra-axial masses that can mimic meningiomas on imaging and pose a diagnostic challenge. Several of these lesions can be more aggressive and are rarer than meningiomas. Conversely, making the distinction between meningioma and its mimics is important because both the clinical management and prognosis can differ significantly.

The imaging appearance of typical meningiomas is well recognised. They are usually homogeneously enhancing dural-based masses with or without a dural tail of enhancement and show similar signal intensity to the adjacent brain on T1- and T2-wieghted imaging on magnetic resonance imaging (MRI). The adjacent calvarium may be normal, sclerotic, or lytic. Computed tomography (CT) best shows the osseous involvement of meningiomas, of which hyperostosis is most characteristic[2–4,6]; however, to date, little exists on the imaging features of lesions that mimic meningiomas. It is incumbent upon the radiologist to be able to accurately distinguish meningioma from their mimics as the vast majority of meningiomas are benign

* Guarantor and correspondent: C. J. Starr, Department of Radiology and Biomedical Imaging, University of California San Francisco, 505 Parnassus Avenue, L352, San Francisco, CA 94143-0628, USA. Tel.: +1 859 229 7125; fax: +1 415 353 8593.
E-mail address: christopher.starr@ucsf.edu (C.J. Starr).

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tumours, whereas several mimics can be more aggressive and potentially malignant.

Five imaging features to distinguish meningioma mimics

The present study was approved by the institutional review board. From 1999 to 2015, 37 patients were identified who had undergone resection or brain biopsy of brain lesions where meningiomas were considered likely in the initial differential diagnoses, but a different diagnosis was found at histopathology. Five imaging characteristics (Fig. 1) that were rarely seen in meningiomas, but common and specific for meningioma mimics were found; these were (1) homogeneous T2 hypointensity of tumour, (2) homogeneous T2 hyperintensity of tumour, (3) osseous destruction adjacent to the mass, (4) leptomeningeal or pial extension of tumour, and (5) absence of a dural tail of enhancement. These five imaging features are described in this review.

In the present series (Table 1), haemangiopericytomas were found in six patients, lymphomas were found in six patients, schwannomas were found in four patients, solitary fibrous tumours (SFTs) were found in four patients, chondrosarcomas were found in four patients, metastases were found in two patients, plasmacytomas were found in two patients, and chordomas were found in two patients. In addition, one case each of pleomorphic xanthoastrocytoma, gliosarcoma, haemangioblastoma, giant cell tumour, dural haemangioma, coccidioidomycosis, and astroblastoma was also observed in the present series (Table 1). With the exception of coccidioidomycosis, these pathological entities display at least one of the five imaging characteristics, with many displaying several of the five imaging signs (Table 1).

Marked T2 hypointensity

Marked and profound intratumoural T2 hypointensity is a feature that is typically not seen in meningiomas, as this generally indicates hypercellularity, large areas of calcification, or significant fibrous tissues. Of the 37 meningioma mimics, there were 16 (43%) patients with lesions with T2 hypointensity. Of these 16 cases, 4/16 (25%) were chondrosarcoma, 3/16 (18.8%) were haemangiopericytoma, 2/16 (12.5%) were central nervous system (CNS) lymphoma, 2/16 (12.5%) were SFT, and 1/16 (6.3%) was a chordoma.

Chondrosarcomas arise from remnant cells in the meninges; thus, these tumours can occur in similar locations to meningiomas, complicating interpretation.[7,8] An enhancing mass at the cerebello-pontine angle, especially without a CT correlate, can be a great mimic for meningioma (Fig. 2); however, areas of marked T2 hypointensity due to large areas of calcification should raise the radiologist's level of suspicion (Fig. 2). This feature is not generally seen in meningioma.

It is important to note that some meningiomas do calcify, but the patterns of calcification seen in meningiomas are generally diffuse and punctate, which are difficult to appreciate on MRI, but easily seen on CT.[1,3,6,9] Large areas of calcification and marked T2 hypointensity seen in the mimics, such as chondrosarcomas, are generally not seen in meningiomas.

Similarly, SFTs can also have significant areas of marked T2 hypointensity due to large portions of fibrous tissue (Fig. 3). SFT is a benign mesenchymal tumour that can occur anywhere in the body. Although a rare entity intracranially, it is a great mimic of meningioma as it is dural-based, avidly enhancing, and occurs in similar locations to meningiomas.[10,11]

Fibrous meningioma, a subtype of typical meningioma, contains fibrous tissues and elements, but is rarely described as T2 hypointense and has a significantly smaller component of T2 hypointensity compared to a tumour such as SFT, where the majority of the tumour is replaced by fibrous tissue.[10–13]

Conversely, CNS lymphoma is another tumour type where marked T2 hypointensity can occur due to its hypercellularity. This recognition is extremely important as gross total resection, which is the standard of care for meningiomas, is not considered such for CNS lymphoma.

Marked T2 hyperintensity

Marked T2 hyperintensity is a feature that is also not typically seen in meningiomas. It reflects significant water content, a feature that is very unusual for meningiomas

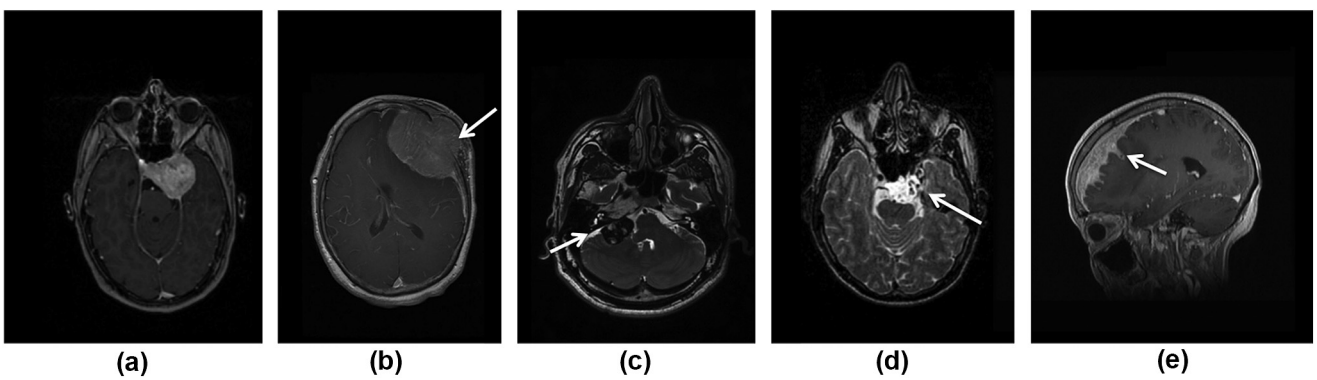

Figure 1 Five imaging signs of meningioma mimics: (a) lack of dural tail, (b) osseous destruction (arrow), (c) marked T2 hypointensity (arrow), (d) marked T2 hyperintensity (arrow), and (e) leptomeningeal extension (arrow).

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