Osteomas of the Skull: Comparison of Magnetic Resonance Imaging and Histological Findings

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Abstract

Magnetic resonance (MR) images of five patients with osteomas of the skull and six patients with other primary skull tumors were reviewed. All osteomas appeared as low-intensity areas on T1-weighted images. T2-weighted images showed homogeneous low-intensity areas in two dense osteomas, a high-intensity area in one spongy osteoma, and mixed intensity areas in two mixed spongy and dense osteomas, respectively. The signal intensities of osteomas on T2-weighted MR images correlated well with the histological findings. Other skull tumors showed no specific MR imaging appearance.

Key words: magnetic resonance imaging, osteoma, pathology, skull

Introduction

Primary tumors of the skull are relatively rare and demonstrate various histological types. The radiological diagnosis of skull tumor is generally based on roentgenography or computed tomography (CT) which can clearly show calcification, ossification, cortical destruction, or periosteal reaction. The use of magnetic resonance (MR) imaging in the examination of primary skull tumors has not been established except for skull base tumors, but MR imaging can evaluate invasion or compression of the brain parenchyma, dura mater, cerebral arteries or sinuses, bone marrow, and other soft tissues.

We evaluated the MR imaging findings in five patients with osteoma of the skull and six patients with primary skull tumor of other histology, to correlate MR imaging findings with the surgical pathology.

Materials and Methods

The MR images of five patients with osteoma (Case 1 previously reported) and six patients with other types of primary tumor (2 eosinophilic granuloma, 2 chordoma, 1 chondrosarcoma, 1 osteoblastoma) of the skull were reviewed. The patients were aged from 1 to 70 years old. There were four males and seven females. The histology of all the tumors was verified by examination of surgical specimens. MR imaging was performed with either a G-10 (0.15 T; Hitachi Co., Tokyo) or a MRT50A (0.5 T; Toshiba Co., Tokyo). Axial T1-weighted inversion recovery images (1400/400/30 msec) or fast echo images (300/14 msec) and T2-weighted spin echo (SE) images (1200/60 or 3000/120 msec) were used. Some selected patients were imaged with gadolinium enhancement. All patients were also evaluated by skull roentgenography and CT.

Results

Table 1 summarizes the neuroimaging appearances and histology of the patients. A spongy osteoma (Case 1) appeared as a radiolucent lesion on both the CT scan and roentgenogram and a homogeneous high-intensity lesion on the T2-weighted MR image (Fig. 1). Two dense osteomas (Cases 4 and 5) appeared as radiopaque areas on both CT scans and roentgenograms and as a homogeneous low-intensity area on the T2-weighted MR images (Fig. 2). The other two osteomas (Cases 2 and 3) consisted of mixed high- and low-intensity portions on the MR...
The examination of the surgical specimens showed that the high-intensity areas on T2-weighted images corresponded with fibrous spongy osteoma (Fig. 4) and the low-intensity areas on T2-weighted images corresponded with dense compact osteoma (Fig. 5). One case of spongy osteoma was enhanced by gadolinium infusion. The histology of this spongy osteoma showed no malignant potential.

Other six skull tumors generally appeared as low-intensity areas on T1-weighted MR images and high-intensity areas on T2-weighted MR images. Two chordomas appeared as heterogeneous low-intensity areas on T1-weighted MR images and heterogeneous high-intensity areas on T2-weighted MR images. The tumors were markedly enhanced by intravenous injection of gadolinium. The two chordomas appeared radiopaque on roentgenograms and radiolucent lesions on CT scans. Two eosinophilic granulomas, one chondrosarcoma, and one osteoblastoma appeared as homogeneous low-intensity areas on T1-weighted MR images and homogeneous high-intensity areas on T2-weighted MR images. The two eosinophilic granulomas appeared as radiolucent areas on both roentgenograms and CT scans. The chondrosarcoma appeared as a radiolucent area on roentgenograms and a radiopaque area on CT scans. The osteoblastoma appeared as a radiopaque area on

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**Table 1 Neuroimaging appearance of various types of skull tumor**

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age</th>
<th>Sex</th>
<th>CT/roentgenography</th>
<th>MR imaging T1-weighted</th>
<th>MR imaging T2-weighted</th>
<th>Histology</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6</td>
<td>M</td>
<td>radiolucent/radiolucent</td>
<td>low</td>
<td>homogeneous high</td>
<td>spongy osteoma</td>
</tr>
<tr>
<td>2</td>
<td>25</td>
<td>F</td>
<td>radiopaque/radiopaque</td>
<td>low</td>
<td>mixed low and high</td>
<td>dense/spongy osteoma</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>M</td>
<td>radiopaque/radiopaque</td>
<td>low</td>
<td>mixed high and low</td>
<td>spongy/dense osteoma</td>
</tr>
<tr>
<td>4</td>
<td>13</td>
<td>F</td>
<td>radiopaque/radiopaque</td>
<td>low</td>
<td>homogeneous low</td>
<td>dense osteoma</td>
</tr>
<tr>
<td>5</td>
<td>70</td>
<td>F</td>
<td>radiopaque/radiopaque</td>
<td>low</td>
<td>homogeneous low</td>
<td>dense osteoma</td>
</tr>
<tr>
<td>6</td>
<td>57</td>
<td>M</td>
<td>radiolucent/radiolucent</td>
<td>low</td>
<td>heterogeneous high</td>
<td>chordoma</td>
</tr>
<tr>
<td>7</td>
<td>64</td>
<td>F</td>
<td>radiolucent/radiolucent</td>
<td>low</td>
<td>heterogeneous high</td>
<td>chordoma</td>
</tr>
<tr>
<td>8</td>
<td>36</td>
<td>F</td>
<td>radiolucent/radiolucent</td>
<td>low</td>
<td>homogeneous high</td>
<td>eosinophilic granuloma</td>
</tr>
<tr>
<td>9</td>
<td>51</td>
<td>M</td>
<td>radiolucent/radiolucent</td>
<td>low</td>
<td>homogeneous high</td>
<td>eosinophilic granuloma</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
<td>F</td>
<td>radiopaque/radiopaque</td>
<td>—</td>
<td>homogeneous high</td>
<td>chondrosarcoma</td>
</tr>
<tr>
<td>11</td>
<td>34</td>
<td>F</td>
<td>radiolucent/radiopaque</td>
<td>low</td>
<td>homogeneous high</td>
<td>osteoblastoma</td>
</tr>
</tbody>
</table>

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Fig. 1 Case 1. Axial T2-weighted MR image (SE 1200/60 msec) showing a left parietal skull osteoma as a high-intensity area. Reproduced from Shibata et al., Radiolucent osteoma of the skull: Case report, in: Neurosurgery 29: 776-778, 1991, with permission.

Fig. 2 Case 4. Axial T2-weighted MR image (SE 3000/120 msec) showing a left retroauricular skull osteoma as a low-intensity area.

Fig. 3 Case 3. Axial T1-weighted MR image (SE 1200/60 msec) showing a left occipital skull tumor as a low-intensity area at the periphery and a high-intensity area at the center.

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roentgenograms and a radiolucent area on CT scans.

**Discussion**

Our study found that the MR imaging appearance of osteomas correlated well with the histological findings. Radiolucent spongy osteoma appeared as a high-intensity area on T2-weighted images, and radiopaque dense osteomas as low-intensity areas on T2-weighted images. Osteomas of mixed histological type appeared as mixed intensity areas.

Dense compact bone appears as signal void on MR images. A small component of interposed fibrous tissue in an osteoma causes a low-signal intensity to appear on the T2-weighted image. A larger amount of fibrous tissue gives a high-signal intensity on the T2-weighted image. Stiglbauer et al. also reported that lymphoma of bone appeared as an inhomogeneous high-intensity lesion on the T2-weighted MR image, due to the high content of the fibrous tissue.

MR imaging is reported to be of limited usefulness in the histological diagnosis of bone tumors, although some workers have found indications on MR images. Zimmer et al. discussed the presence of poorly defined heterogeneous areas within bone tumor which may suggest malignancy. Erleman et al. reported that T1-weighted images with gadolinium enhancement improved the differentiation of necrotic and viable areas, and dynamic gadolinium studies provided information about the malignant potential of the tumor. We found faint enhancement with gadolinium in one case of osteoma, but this was associated with a small component of connective tissue. Our present study found no clear indications of histology by neuroradiological imaging for tumors other than osteoma. MR imaging can indicate the presence of osteoma and other skull tumors containing fibrous connective tissue.

**References**

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