MR Imaging Features of Extraspinal Plasmacytoma of Bone

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Purpose: To describe the MR imaging features of extraspinal plasmacytoma of the bone.

Materials and Methods: MR images of 10 lesions in 10 patients (3 men, 7 women; age range, 49–69 years) with extraspinal plasmacytoma of the bone were retrospectively reviewed. The bones involved included the pelvic bone (n = 7), humerus (n = 1), tibia (n = 1), and clavicle (n = 1). Signal intensity, contrast enhancement pattern, cortical bone abnormality, and surrounding bone marrow edema were analyzed.

Results: Compared to a muscle signal, the T1-weighted MR images showed either homogeneous high (n = 9) or iso (n = 1) signal intensity. The gadolinium-enhanced T1-weighted images showed homogeneous enhancement (n = 9), with only one huge plasmacytoma that has a central nonenhancing area. Cortical thinning and expansion was seen in all the lesions, while cortical penetration was apparent in 5 lesions. Also, in 5 lesions, serrated endosteal erosions were demonstrated. In all cases, perilesional bone marrow edema was not observed.

Conclusion: At MR imaging, extraspinal plasmacytoma of the bone has a characteristic homogeneous high signal intensity on a T1-weighted image. Other remarkable MR features include bone expansion with or without focal cortical penetration and serrated endosteal erosion.

Index words: Plasmacytoma
Magnetic resonance [MR]
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Plasmacytomas, otherwise known as solitary myelomas, are malignant neoplasms arising from a single clone of plasma cells. They are commonly found in the axial skeleton; especially in the spine, pelvis, and skull and are characterized as expansile osteolytic bone lesions on radiography [1].

The MR imaging findings of plasmacytoma or multiple myeloma located in the spine has been well described, but nonspecifically (2, 3). Plasmacytomas usually present as a marrow-replacing process with variable signal intensity on T1-weighted images and high signal intensity on T2-weighted images (1–4). Therefore, it is often indistinguishable from other marrow-replacing processes such as lymphoma or metastasis.

For extraspinal lesions, the MR imaging features of plasmacytoma were rarely reported and, to our knowl-
edge, most of the reported literature was limited to single case reports (5–7). The purpose of this study was to describe the MR imaging findings of extraspinal plasmacytoma of the bone.

**Materials and Methods**

We searched the pathological and radiological records of all patients who were diagnosed with plasmacytoma at our institution from January 2000 to December 2008. From these, we chose the patients with a lesion in the extremities or pelvic bone and who underwent MR imaging. Finally, 10 patients (3 men, 7 women; mean age, 60 years; age range, 49–69 years) with pathologically proven extraspinal plasmacytoma of the bone were selected for this study. The bones involved included the pelvic bone \( n = 7 \), humerus \( n = 1 \), tibia \( n = 1 \), and clavicle \( n = 1 \).

The MRI systems and pulse sequences varied, but all MR imaging was performed using 1.0-T or 1.5-T machines. The sequences consisted of T1-weighted images,
T2-weighted images, and gadolinium-enhanced T1-weighted images with or without fat suppression. Moreover, the imaging planes included axial and at least one longitudinal plane in all the patients.

An experienced musculoskeletal radiologist retrospectively reviewed the MR images for characteristic morphologic features including signal intensity on T1- and T2-weighted images, gadolinium-enhancement patterns, cortical change of the lesion, presence of perilesional bone marrow edema (surrounding bone marrow edema of low signal intensity on T1-weighted images and high signal intensity on T2-weighted images), and surrounding soft tissue edema (soft tissue abnormality of high signal intensity on T2-weighted images and/or soft tissue enhancement on gadolinium enhanced T1-weighted images).

The signal intensity of plasmacytoma was qualitatively compared with that of muscle on T1-weighted images and we observed a low, iso, or high signal intensity. Moreover, the cortical change, cortical thinning, expansion, penetration, or serrated endosteal erosion were analyzed and recorded. Cortical penetration was defined as a focal cortical discontinuity, whereas serrated endosteal erosion was defined as the saw tooth-like appearance of endosteal erosion.

**Results**

The MR imaging findings of 10 lesions are summarized in Table 1. All 10 lesions showed high signal intensity on T2-weighted MR images, and either homogeneous high \( n = 9 \) or iso \( n = 1 \) signal intensity on T1-weighted MR images compared with muscle signal intensity (Figs. 1–3). All the lesions had homogeneous enhancement on the gadolinium-enhanced T1-weighted images (Fig. 1D, 3B) except for one huge plasmacytoma, which appeared to have a central nonenhancing necrotic area.

The MR imaging showed cortical thinning and expansion in all the lesions (Figs. 1–3). Among them, cortical penetration was apparent in 5 of the 10 patients (50%) (Figs. 2, 3). Endosteal erosion with a serrated appear-

| Table 1. Summary of MR Imaging Findings of Extraspinal Plasmacytoma \( (n = 10) \) |
|---------------------------------|---------------------------------|
| **Signal intensity on T1-weighted images** | High \( n = 9 \), Iso \( n = 1 \) |
| **Signal intensity on T2-weighted images** | High \( n = 10 \) |
| **Gadolinium enhancement** | Homogeneous enhancement \( n = 9 \) |
| **Cortical changes** | Nonenhancing central portion \( n = 1 \) |
| **Thinning and expansion** \( n = 10 \) |
| **Penetration** \( n = 5 \) |
| **Serrated endosteal erosion** \( n = 5 \) |
| **Surrounding bone marrow edema** | None |

Fig. 2. A 54-year-old male with plasmacytoma in the left clavicle
A. An axial T1-weighted image shows an expansile mass [arrows] with homogeneous high signal intensity in the left distal clavicle. B. An oblique sagittal T2-weighted image shows expansile bone lesion with focal cortical penetrations [arrows] in the left clavicle.
ance was demonstrated in 5 lesions (50%) (Fig. 1). Moreover, one of the 10 lesions had perilesional bone marrow edema and the 5 lesions with cortical penetration revealed accompanying soft tissue edema.

Discussion

In our study, most cases of extraspinal plasmacytoma of the bone demonstrated relatively high signal intensity on T1-weighted images compared with muscle signal intensity. Solitary plasmacytoma of the bone was known to have a similar signal intensity to muscle on T1-weighted images and spinal multiple myeloma is of similar or higher signal intensity to muscle signal intensity (2, 3). The difference in signal intensity between our study and previous studies could be attributed to improved tissue contrast of the MR imaging. This high signal intensity on T1-weighted images was found in some reports about primary lymphoma of the bone as well as osseous metastasis from renal cell carcinoma and was considered to have likely been attributed high cellularity and hypervascularity (8-10). We believe that plasmacytoma has the high signal intensity on T1-weighted images for the same reason.

Another MR imaging feature of extraspinal plasmacytoma was cortical expansion with or without focal cortical penetration. These cortical changes may suggest an intermediated aggressiveness tumor, which grows neither too slowly nor too rapidly. A periosteal reaction and surrounding soft tissue edema were observed in 5 patients, however we could hardly determine whether they were part of the tumor’s natural processes or the result of a pathologic fracture. Even more, it was difficult to distinguish a pathologic fracture from cortical penetration in the 5 patients with cortical disruption. Because of these features we were not able to definitively identify soft tissue edema or enhancement around the plasmacytomas.

One of the remarkable MR imaging features of plasmacytoma was the serrated endosteal erosion. This appearance resembles the undermining osteoclastic resorption of cortical bone in renal osteodystrophy, leading to a highly irregular endosteal surface and spongiosation of the cortical bone [11]. A destructive bone lesion in plasmacytomas generally begins in the medullary cavity, moves on to erode the cancellous bone, and finally, progressively destroys the cortical bone. The bone resorption results from the secretion of certain cytokines (e.g., IL-1β, tumor necrosis factor, IL-6) by myeloma cells [12]. We postulate that the serrated endosteal erosion in plasmacytoma is caused by the local effect of these substances, which in turn facilitate osteoclast-mediated bone resorption [13]. We also assume that this appearance is associated with the intracortical canal system, especially Volkman’s canals.

Major et al. [14] proposed that the ‘mini brain’ appearance is a characteristic MR imaging features of plasmacytoma in the spine. They suggested that the thickened cortical struts are a secondary compensatory reponse of cortex to a combination of bony destruction. Recently, Subhas et al. [7] reported the ‘mini brain’ appearance of plasmacytoma in the proximal femur as a first report outside of the spine. In our series, however, we could not identify the characteristic ‘mini brain’ sign of plasmacytoma in the proximal femur.

Fig. 3. A 76-year-old female with plasmacytoma in the right ischium. (A) An axial T1-weighted image shows an expansile mass with homogeneous high signal intensity (arrow) in the right ischium. (B) An axial gadolinium-enhanced fat-suppressed image shows homogeneous enhancement of the lesion and surrounding soft tissue enhancement (arrows) at the focal cortical penetration regions.
macytoma in the extraspinal lesions.

Extraspinal plasmacytoma did not show perilesional bone marrow edema in this study. Tumorigenic bone marrow edema is secondary to direct capillary trauma from trabecular destruction, with the release of intravascular fluid and associated hemorrhage (15). Another report proposed that peritumoral edema was caused by chemical mediators and is significantly correlated with prostaglandin levels of primary bone tumor (16). The absence of perilesional bone marrow edema in extraspinal plasmacytoma is supposed to be attributable to the less aggressive nature of the tumor and absent or little prostaglandin production. This characteristic could be another differential feature which excludes other benign or malignant bone tumors showing perilesional bone marrow edema.

In summary, high signal intensity on T1-wighted images, expansile osteolytic lesions, with or without focal cortical penetration, and serrated endosteal erosion, are the common MR findings of extraspinal plasmacytoma of the bone and does not accompany surrounding bone marrow edema. These findings can be helpful to differentiate plasmacytomas from other tumors in the extraspinal skeleton.

References


척추 외 골에서 발생한 형질세포종의 자기공명소견

유미혜 ∙ 홍성환 ∙ 최자영 ∙ 명재성 ∙ 김수진 ∙ 최정아 ∙ 강홍식

목적: 이 연구에서는 척추 외 골에 발생한 형질세포종의 자기공명영상 소견을 알아보고자 하였다.

대상과 방법: 척추를 제외한 사지골이나 골반뼈에 발생한 형질세포종으로 진단된 환자 10명(남녀비 = 3:7, 49-69세)을 대상으로 하여 자기공명영상 소견을 후향적으로 분석하였다. 병변의 위치는 골반뼈(n=7), 상완골(n=1), 경골(n=1), 그리고 쇄골(n=1)이었다. 자기공명영상에서 병변의 신호강도, 조영증강 유형, 피절골의 이상, 그리고 골수부종 동반 여부 등을 분석하였다.

결과: 근육의 신호강도와 비교하였을 때, T1 강조영상에서 높거나(n=9) 또는 동일하고(n=1) 균질한 신호강도를 보였다. 조영증강 후 T1 강조영상에서는 9개의 병변에서 균질한 조영증강을 보였고, 1개의 병변에서 내부에 조영증강되지 않는 피질굴이 있었다. 모든 병변에서 피질굴이 약아졌고 피질굴의 팽창을 보였으며 5개(50%)의 병변에서는 부분적으로 피질굴을 통과 나가는 모양을 보였다. 이와 함께 톱니바퀴 모양의 골내막 미란을 5개(50%)의 병변에서 볼 수 있었다. 모든 병변에서 병변 주변의 골수부종은 보이지 않았다.

결론: 자기공명영상에서 척추 외 골의 형질세포종은 T1 강조영상에서 특징적인 균질한 고 신호강도를 보이며, 골피질 관통이나 톱니바퀴 모양의 골내막 미란을 동반하는 괴생성 병변으로 나타나는 경우가 많다.