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MR Imaging Features of Solitary Plasmacytoma of the Spine

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OBJECTIVE To evaluate the MR imaging features of solitary plasmacytomas of the spine.
METHODS The MR images of 7 patients with histologically proven solitary plasmacytomas of the spine were reviewed.
RESULTS All tumors showed predominantly iso- to hypointensity relative to muscle on T1-weighted MR images and intermediate signal intensity between muscle and fat on T2-weighted images. Curvilinear low signal intensity structures were seen within the lesions on T1 and T2-weighted images in five tumors. Moderate to strong enhancement was seen in all 6 tumors that underwent contrast enhanced MR examination. All tumors showed areas of high signal intensity on T2-weighted images and heterogeneous enhancement, except the 2 largest tumors without pathologic fracture in the sacrum. Intervertebral discs were preserved in all tumors.
CONCLUSION The MR imaging features that suggest plasmacytoma of the spine include predominant intermediate signal intensity on T2-weighted images, curvilinear low signal intensity structures, moderate to strong enhancement, relatively homogeneous appearance if there are no pathologic fracture and preservation of the intervertebral discs.

KEY WORDS: magnetic resonance imaging, spine, plasmacytoma.

Introduction

Solitary plasmacytoma of bone is a local primary bone tumor consisting of malignant plasma cells without systemic involvement[1]. It is rare and responds well to local radiation therapy[2]. Any bone can be involved, but more than half of solitary osseous plasmacytomas are localized in the spine[2]. There are relatively few reports of MRI characteristics of solitary plasmacytoma of spine (SPP), which are limited to case reports and studies of small number of cases[3-8]. The purpose of this study was to determine the MR imaging (MRI) features of this unusual lesion.

Patients and Methods

Patients

The medical records and MRI studies of 7 patients (5 men, 2 women; age range 34-73 years, mean 51.1 years) with SPP from 2001 to 2008 were reviewed with the approval of the institutional Research Ethics Board. SPP was diagnosed using the following criteria: (a) biopsy-

proven plasmacytoma of the spine, (b) bone marrow biopsy with plasma cells comprising less than 10% of the cellular population, and (c) absence of other bone lesions based on skeletal survey[3,4].

Imaging examination

MRI was performed using a1.5T or 3.0T scanner (Magnetom Vision or Magnetom TrioTim, Siemens Medical System, Erlangen, Bavaria, Germany) with a receive-only circularly polarized spine coil. Sequences included various combinations of sagittal, axial and coronal spin-echo T1-weighted images (T1WIs) (400-650/8-20 ms) and turbo spin-echo T2-weighted images (T2WIs) with and without fat saturation (TR/TE: 2,500-4,000/65-110 ms). Matrix was 192-640 × 192-640, field of view 240-350 mm, slice thickness 3-7 mm, number of averages 1-2. Gadopentetate dimeglumine (Beilu, Beijing, China) was intravenously administered at a dose of 0.1 mmol/kg body weight in 6 patients. Radiographs were available in 5 patients.

The tumor location, size, signal intensity (SI) and density, internal architecture, margin, contrast enhancement, pathological fracture, invasion of intervertebral discs, and formation of soft tissue mass were evaluated by 2 musculoskeletal radiologists for consensus.

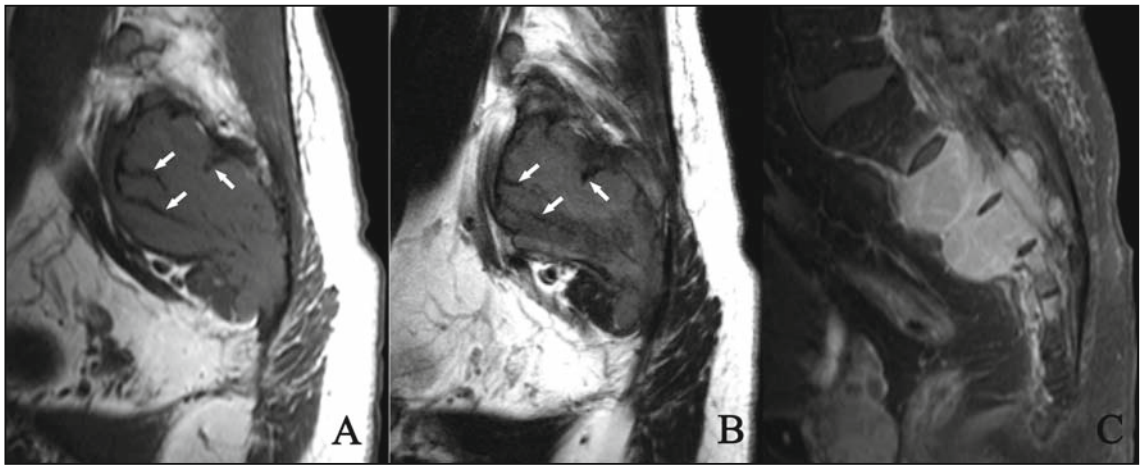

Fig.1. Plasmacytoma in the sacrum of a 47 year-old man. (A) Sagittal T1WI and (B) sagittal T2WI show a lesion in the sacrum with predominant isointensity relative to muscle on T1WI and intermediate SI between those of muscle and fat on T2WI. There are curvilinear lower SI structures (arrows) within the lesion on both T1WI and T2WI. (C) Sagittal T1WI after administration of contrast shows diffuse and relatively homogeneous enhancement of the lesion and preservation of intervertebral discs.

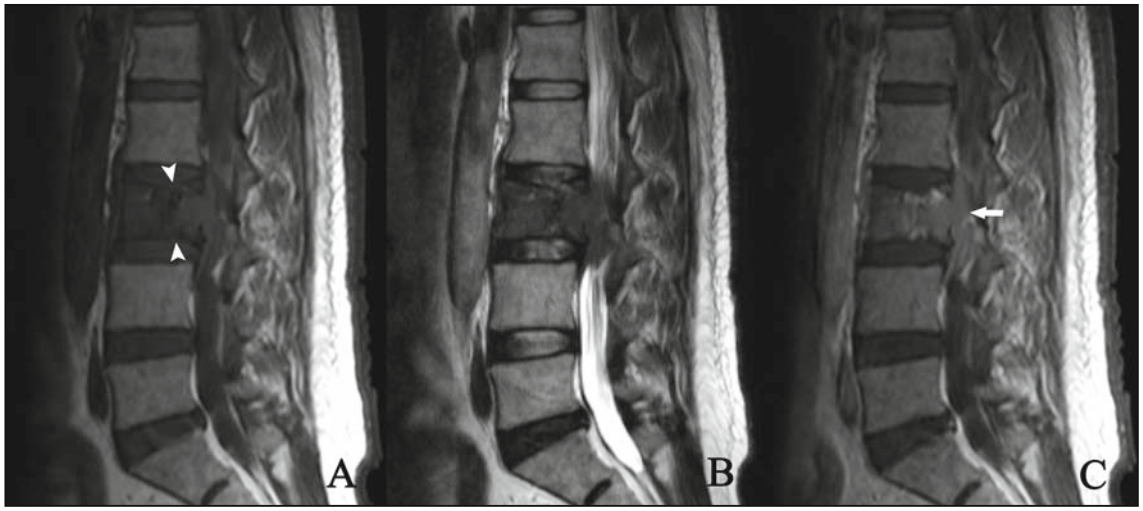

Fig.2. Plasmacytoma in L3 vertebral body of a 45 year-old man. (A) Sagittal T1WI shows a lesion in L3 vertebral body, which is predominantly iso- and hypo- intense to muscle with small focus of hyperintensity. There are focal fractures at the superior and inferior end plate (arrowheads). (B) Sagittal T2WI shows that intermediate SI predominates in the lesion with foci of hyperintensity adjacent to end plate fractures. Intervertebral discs are preserved. (C) Sagittal T1WI after administration of contrast shows heterogeneous enhancement and formation of soft tissue mass (arrow).

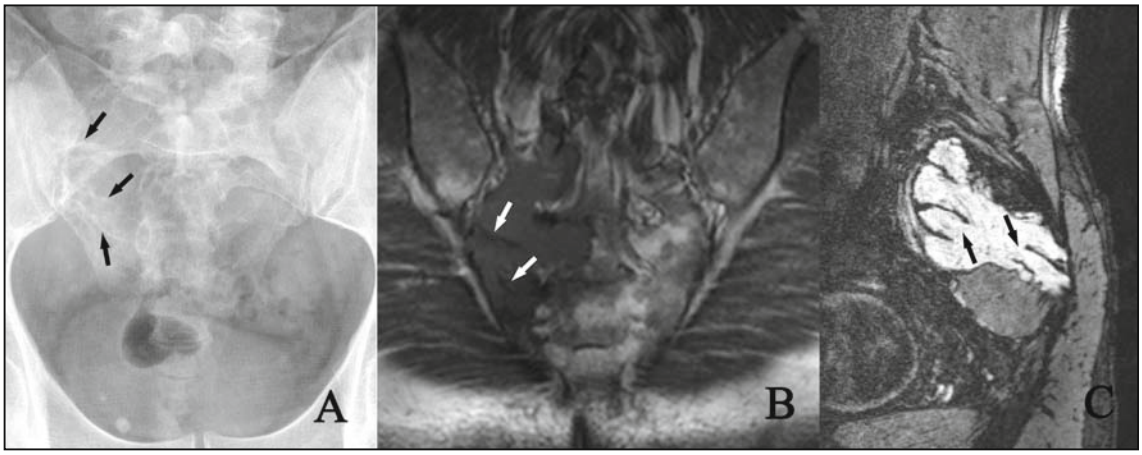

Fig.3. Plasmacytoma in the sacrum of a 53 year-old man. (A) Anterior-posterior radiograph shows a lytic lesion of the sacrum with curvilinear internal high density structures (arrows). (B) Coronal T1WI and (C) sagittal fat-saturated T2WI demonstrate curvilinear lower SI structures (arrows) within the lesion.

Results

Location and size

Three tumors were in the thoracic spine, 1 in the lumbar spine, and 3 in the sacrum. The maximum measured diameter ranged from 3.9 to 9.8 cm (mean, 5.8 cm). The tumors in the sacrum showed a larger size than the other tumors.

MRI findings

All tumors showed predominantly iso- to hypointensity compared with muscle on T1WIs (Figs.1A, 2A, 3B). Their predominant SI on T2WIs was intermediate between those of muscle and fat. But they all had areas of high SI (similar to or higher than that of fat) on T2WIs (Fig.2B), except the 2 largest tumors in the sacrum (Fig.1B). Two tumors showed focal areas of high SI on T1WIs and T2WIs with and without fat saturation (Figs.2A-B). Five tumors showed curvilinear low SI structures on T1WIs and T2WIs, and 2 of them were in the sacrum (Figs.1A-B, 3B-C). Moderate to strong enhancement was seen in all 6 tumors that underwent contrast enhanced MRI. The 2 largest tumors in the sacrum showed relatively homogeneous enhancement (Fig.1C), and the other 4 tumors heterogeneous enhancement (Fig.2C).

All tumors showed varying degrees of vertebral compression and focal end-plate fractures (Figs. 2A-C), except the 2 largest tumors in the sacrum. Formation of soft tissue mass (Fig. 2C) and preservation of intervertebral discs were noted in all tumors (Figs. 1C, 2A-C).

Radiographic findings

On radiographs, all 5 tumors were lytic with absence of periosteal new bone formation. Two showed partially sclerotic margin，and 3 showed internal curvilinear high density structures (Fig.3A), which matched the curvilinear low SI structures on MRI.

Discussion

Demographic features and common locations of SPP

Solitary plasmacytoma of bone is localized in presentation, but may progress into multiple myeloma [2,9,10]. It occurs most frequently in patients in their 60s', but occasionally in young adults or even adolescents[3,6,11]. There is a male dominance with a ratio of male:femail at 2:1-3:1[3]. It has predisposition for the red marrow of the axial skeleton. Thoracic vertebrae are the most common site, followed by lumbar, sacral, and cervical vertebrae[2]. In current study, the tumors in the sacrum are more than those in the lumbar vertebrae, but equal to those in the thoracic vertebrae in number.

MRI features of SPP

SPP usually affects the vertebral body[1,5], though SPP centered in posterior elements of spine has been also reported[8,11]. Soft tissue mass is not rare for SPP and can compress the spinal cord [1,8,11]. Involvement of the intervertebral disc is rare, even for the large sacral plasmacytoma involving 2o or more vertebrae of sacrum [4,5,8]. Vertebral compression and focal endplate fracture are common for SPP above the sacrum[3,5,6]. Periosteal new bone formation is seldom seen in SPP[12].

Kosaka et al.[4] reported 3 sacral plasmacytomas that showed intermediate SI between muscle and bone marrow on T2WIs and demonstrated homogeneous and intense enhancement. The intermediate SI on T2WIs

was considered the results from the high cellularity of SPP. In current study, the 2 largest plasmacytomas in the sacrum without pathologic fracture showed the same findings. All other lesions showed pathologic fracture, high SI besides predominant intermediate SI on T2WIs and heterogeneous enhancement. Two of them also showed high SI on non-enhanced T1WIs. In reviewing the studies and case reports of SPP which mentioned the presence or absence of fracture of involved vertebral body or showed the fracture of vertebral body by images[3,5,6,8], we found that all lesions with high SI on T2WIs had fractures of vertebral body, though not vice versa. We therefore speculate that the high SI on T2WIs and T1WIs and heterogeneous enhancement of SPP may be the reflection of changes induced by pathologic fracture, such as hemorrhage and edema.

Major et al.[7], in a series of 10 patients with SPP, reported the curvilinear low SI structures partially extending through the vertebral body and resembling sulci of brain on all imaging sequences, which are likely caused by thickened cortical struts or trabeculae. They consider this as appearance characteristic for SPP and termed it "mini brain" appearance. Shah et al.[5] reported the same finding in 4 of 6 SPP cases. In present study, 5 tumors showed the curvilinear low SI structures and 2 of them were in the sacrum. To the best of our knowledge, this is the first report of this imaging feature of plasmacytoma in the sacrum. In addition, these low SI structures on MRI were visible as high density areas on radiograph in 3 cases, which demonstrated their osseous nature.

Differential diagnosis of SPP

Hemangioma is reported to have thickening of the remaining trabeculae. But they often have vertical orientation and produce corduroy appearance on radiograph instead of mini brain appearance on MR imaging[7,11]. In addition, hemangioma often shows high SI on non-enhanced T1WIs and T2WIs, which is related to the amount of adipocytes or vessels and interstitial edema, respectively[13].

Giant cell tumor (GCT) of the spine may also mimic SPP. But patient with GCT tend to be younger than those with SPP. Moreover, 90% of spinal GCTs occur in the sacrum[14], and they often show heterogeneous appearance on MR image due to the presence of cystic or necrotic areas and foci of hemorrhage[1,15] .

Spinal metastasis also commonly occurs in elder patients and needs to be differentiated from SPP. However, spinal metastasis usually shows high SI on T2WIs without curvilinear low signal intensity structures[4,6]. In addition, the history of primary tumor and presence of multiple lesions will also support the diagnosis of metastasis.

In conclusion, the typical MRI features of SPP include predominant intermediate SI on T2WIs, curvilinear low SI structures, moderate to strong enhancement, relatively homogeneous appearance if there are no pathologic fracture and preservation of the intervertebral discs. Recognition of these MRI features is helpful in the early establishment of correct diagnosis for SPP.

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