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Characteristics of primary giant cell tumor in soft tissue on magnetic resonance imaging: A case report

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Abstract

BACKGROUND

Primary soft tissue giant cell tumor (GCT-ST) is rare and has relatively low malignant potential. Most reports are pathological and clinical studies, while imaging studies have only been reported in cases of adjacent bone or with atypical cystic degeneration. With regard to the findings on magnetic resonance imaging (MRI) or ultrasonography, superficial masses can be further identified based on facial edema, skin thickening, skin contact, internal hemorrhage or necrosis and lobulation of the mass. Unlike deep-seated masses, MRI features do not always provide an accurate diagnosis for benign and malignant patients with superficial soft-tissue lesions. Thus, the application of diffusion-weighted imaging (DWI) to evaluate superficial soft tissue tumors is necessary.

CASE SUMMARY

A 36-year-old woman who had a suspected malignant tumor in the upper limb on ultrasound and computed tomography is reported. The signal intensity of the suspected tumor was heterogeneous on plain MRI; nodular and heterogeneous enhancement was observed in the tumor with irregular shapes and blurred margins on dynamic contrast-enhanced MRI. The lesion on DWI was hyperintense with a higher mean apparent diffusion coefficient (ADC) value. Finally, a GCT-ST was confirmed by pathology. This case suggests that GCT-ST should be distinguished as a benign soft tissue mass from giant cell-rich soft tissue neoplasms or malignant tumors.

competing interests.

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CONCLUSION

The MRI features of the superficial GCT-ST in the upper limb included heterogeneous signal intensity within the lesion on T2-weighted image (T2WI) and T1-weighted fat-saturation spoiled gradient recalled echo (T1 FSPGR), nodular enhancement with blurred margins, irregular shapes, and a slow-increased enhancement. DWI could be used to differentiate a benign soft tissue mass from a malignant mass by the mean ADC value and provide more radiologic-pathologic information for the diagnosis of GCT-ST. Comprehensive imaging of primary GCT-ST could help complete tumor resection, and in turn likely prolong survival after surgery.

Key Words: Soft tissue giant cell tumor; Magnetic resonance imaging; Diffusion-weighted imaging; Case report

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Core Tip: The comprehensive magnetic resonance imaging (MRI) features of primary superficial soft tissue giant cell tumor (GCT-ST) in the upper limb were reported in our case. The manifestations of MRI included heterogeneous signal intensity within the lesion on T2-weighted image and T1-weighted fat-saturation spoiled gradient recalled echo, nodular enhancement with blurred margins, irregular shapes, and a slow-increased enhancement. Diffusion-weighted imaging could be used in the differential diagnosis by the mean apparent diffusion coefficient value and provide more radiologic-pathologic information for the diagnosis of GCT-ST.

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INTRODUCTION

Primary giant cell tumor of soft tissue (GCT-ST) is rare and usually located in superficial and deep soft tissues, and has relatively low malignant potential[1]. Histologically, GCT-ST lesions bear a close resemblance to their bony counterparts, giant cell tumor of bone. Most existing reports are pathological and clinical studies, while imaging studies have only been reported in cases of adjacent bone or with atypical cystic degeneration[2-11]. With regard to the findings on magnetic resonance imaging (MRI) or ultrasonography, superficial masses in the soft tissue can be further identified based on facial edema, skin thickening, skin contact, internal hemorrhage or necrosis and lobulation of the mass[12-15].

Unlike patients with deep-seated masses, size (*i.e.*, 50 mm in diameter) is not an important factor in superficial soft-tissue lesions. However, MRI features do not always provide an accurate diagnosis for benign and malignant soft tissue lesions. The application of diffusion-weighted imaging (DWI) to differentiate benign from malignant soft tissue tumors is necessary. So far, only one case was reported on the juxtacortical mass of GCT-ST lesions using intravoxel incoherent motion (IVIM) DWI [2]. Moreover, qualitative and quantitative data from conventional MRI can improve the diagnosis of benign and malignant soft-tissue masses[11]. Therefore, the aims of the current study were to report the case of GCT-ST in the upper limb using comprehensive medical imaging examinations especially quantitative DWI and to present a literature review on the topic.

CASE PRESENTATION

Chief complaints

A 36-year-old woman was admitted to our hospital with swelling, skin redness and pain in the upper limb that persisted for 6 mo without a prior history of trauma.

History of present illness

The patient underwent ultrasound (US) and a computed tomography (CT) scan. The US revealed a blurred large solid mass in the deltoid muscle. Plain CT showed a hypodense mass in the superficial deltoid muscle extending to the intermuscular space (Figure 1A, white arrow) with axillary lymphadenopathy (Figure 1A, orange arrow), while contrast-enhanced CT revealed a slightly heterogeneous enhancement of the mass with blurred margins (Figure 1B, white arrow). There was no evidence of calcification or mineralization in the mass, and the adjacent structures were all normal.

Physical examination

A clinical examination revealed that the 6.0 cm x 4.0 cm mass was tender without discharge or drainage sinus.

Imaging examinations

MRI: MRI was performed using a 1.5T whole-body MR scanner (Signa, Excite, HDxt, General Electric Healthcare, Milwaukee, WI, USA). The MRI protocols were as follows (Table 1): (1) Conventional MR scan sequences included coronal or axial T2-weighted fast spin-echo (FSE) images, T1-weighted fat-saturation spoiled gradient recalled echo (T1 FSPGR) images; (2) Axial T1 3D FSPGR liver acquisition with volume acceleration (LAVA) sequence (total 4 phases, repetition time/echo time (TR/TE) = 6.0 ms/3.0 ms, FA = 12°, slice thickness/slice spacing = 5.0 mm/2.5 mm, acquisition time = 23 s/one phase) was performed after an injection of 0.1 mmol/kg gadolinium using an antecubital vein power injector at a rate of 2.0 mL/s followed by 20 mL saline; the first acquisition started 25 s after contrast agent injection; and (3) DWI (b = 500 s/mm²) with TR/TE of 4700 ms/69 ms, slice thickness/slice spacing of 6.0 mm/1.5 mm, a field of view (FOV) of 280 mm x 252 mm and matrix size of 256 × 256 were used; DWI was performed before contrast injection.

MRI analysis: All MR images were transferred to a GE workstation (Advantage Windows 4.5; General Electric, Madison, WI, USA) for image processing and were interpreted by two radiologists with more than five years of diagnostic experience. Only the consensus of any diagnosis between the two readers was used for the final MRI analysis. The following lesion characteristics were recorded: (1) Signal intensity on T2WI and T1 FSPGR; (2) Morphology and maximum lesion size on dynamic contrast-enhanced MRI (DCE-MRI); (3) Time-intensity curve (TIC) obtained from DCE-MRI; and (4) Apparent diffusion coefficient (ADC) value obtained from DWI.

On morphological MR images, the manifestations of the mass were obvious. The maximum lesion size was 6.0 cm. Compared to muscle signal intensity, the lesion showed hyper-intensity on T2WI without fat saturation (Figure 2A, white arrow), and heterogeneous hypo-intensity to iso-intensity on T1 FSPGR (Figure 2B, white arrow). On DCE-MRI, the solid mass showed multiple nodular enhancements with irregular shapes and blurred margins (Figure 2C). Furthermore, internal enhancement was heterogeneous. The TIC showed slow increased type (Figure 2D). On DWI (b = 500 s/mm²), the lesion was hyperintense with a higher mean ADC value of 2.19×10^{-3} mm²/s (Figure 2E, ROI 3) than surrounding normal soft tissue (1.03×10^{-3} mm²/s) (Figure 2F, ROI 2).

FINAL DIAGNOSIS

The resected specimen revealed that the tumor invaded the peripheral muscles. Consequently, complete surgical excision of the mass was performed. Pathological examination indicated that many multinucleated giant cells were scattered and surrounded by spindle cells, suggesting a GCT-ST. The giant and spindle cells had slight cellular atypia. In addition, spindle cells exhibited brisk mitotic activity. The tumors invaded the neighboring muscles. The obtained samples showed a slow-growing entity.

Table 1 Magnetic resonance imaging protocols in this case

Scan sequence	TR (ms)	TE (ms)	FOV (mm)	Thickness (mm)	Gap (mm)	Flip angles	NEX	Matrix (mm)
T1 FSPGR	235	3.2	280 × 224	6.0	1.5	80°	3	256 × 192
T2WI	3940	87	260 × 208	5.0	1.0	90°	3	320 × 192
DWI	4700	69	280 × 252	6.0	1.5	90°	4	128 × 128
LAVA	5.8	3.1	280 × 224	5.0	-2.5	12°	1	224 × 160

T1FSPGR: T1-weighted fat-saturation spoiled gradient recalled echo; T2WI: T2-weighted image; DWI: Diffusion-weighted imaging; LAVA: Liver acquisition with volume acceleration; FOV: Field of view.



Figure 1 A 36-year-old woman was admitted to our hospital with swelling, skin redness and pain in the upper limb that persisted for 6 months without a prior history of trauma. A: Plain computed tomography (CT) imaging shows an irregular hypodense mass in the superficial deltoid muscle extending to the intermuscular space (white arrow) with axillary lymphadenopathy (orange arrow); B: Contrast CT (venous phase) reveals a slightly persistent inhomogeneous enhancement of the mass with a blurred margin (white arrow).

Tumor interstitial hemorrhage was obvious and rich in hemosiderin-containing cells (Figure 3A-D). Immunohistochemically, the giant cells were strongly positive for CD68, no staining of myoglobin, myogenin, MyoD1, desmin, CD34, S-100, CK, and EMA were found in the tumor (Figure 3E, F). The patient was finally diagnosed with giant cell tumors based on clinical, histologic and immunohistochemical (IHC) findings.

TREATMENT

Complete surgical excision of the mass was performed.

OUTCOME AND FOLLOW-UP

No metastasis or recurrence was found in this case on 1-year MRI follow-up.

DISCUSSION

The diagnosis of GCT-ST based on preoperative US and CT can be challenging due to non-specific manifestations and difficulty in defining tumor extent. In our study, we used conventional MRI and DWI to investigate a case of GCT-ST in the upper limb. The lesion abnormalities were limited to soft tissues without obvious calcification or bone erosion as frequently observed at the periphery of GCT-ST tumors[2-7]. In addition, the lesion on MRI presented with a solid mass and blurry upper and lower

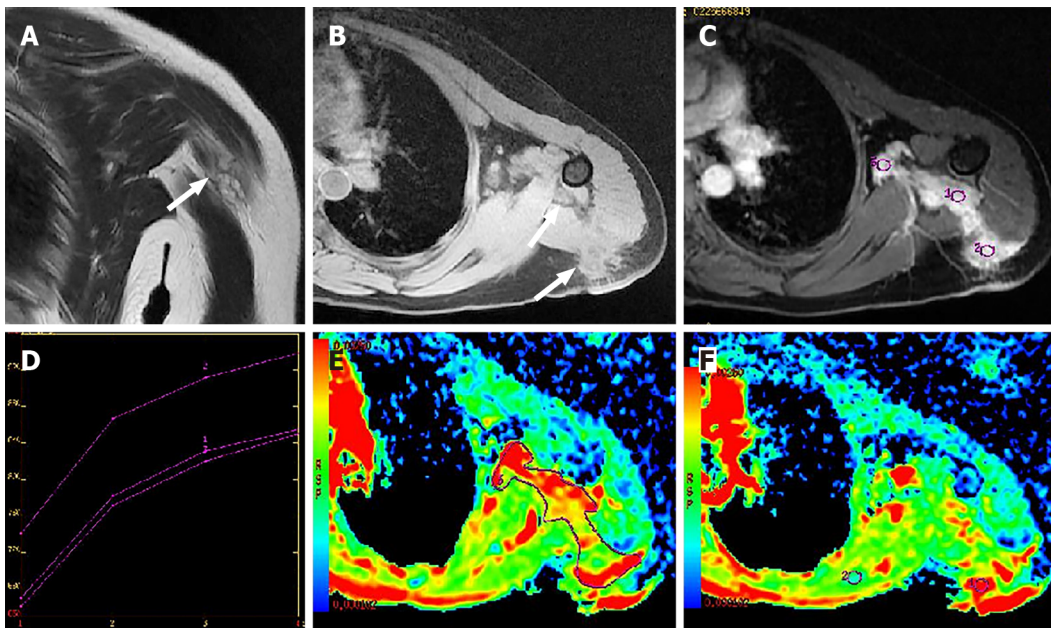


Figure 2 On morphological magnetic resonance images. Iso- to hyper-intensity of the mass (white arrow) on the coronal T2-weighted without fat saturation image (A) and hypo- to iso-intensity (white arrow) on the axial T1 FSPGR (pre-contrast enhancement) (B) are shown compared to signal intensity. Axial T1 3D FSPGR LAVA sequence shows multiple nodular enhancements with irregular shapes and blurred margins (ROI1, 2, 3) (C). TIC of the mass presents as a slow-increased trend (D). The lesion on DWI was hyperintense with a higher mean ADC value of $2.19 \times 10^{-3} \text{ mm}^2/\text{s}$ (E, ROI 3) than surrounding normal soft tissues ($1.03 \times 10^{-3} \text{ mm}^2/\text{s}$) (F, ROI2).

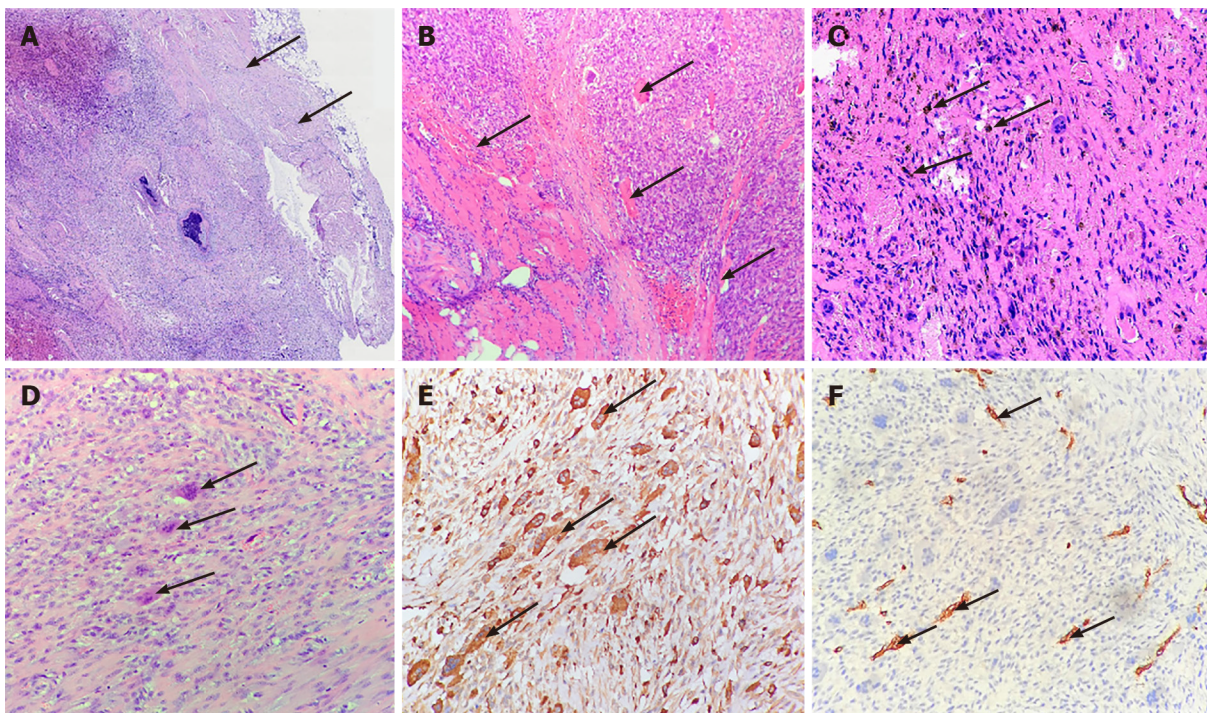


Figure 3 Pathological features of the tumor. A: The relatively clear boundary (arrows) of the tumor; B: The tumor had invaded neighboring muscles (arrows) on one side; C: Hemosiderin-containing cells (arrows) indicated the tumor with interstitial hemorrhage; D: The tumor had many multinucleated giant cells (arrows) surrounded by spindle cells; E: Multinuclear cells showed strongly positive CD68 (arrows); F: The tumor cells showed negative CD34 but were reactive to vascular endothelial cells (arrows) in the stroma.

boundaries. There was slight hyper-intensity on T2WI, indicating that the tumor invaded the neighboring muscles. Thus, our results suggested that MRI-DWI can be useful in identifying soft-tissue masses with no malignant potential. In our study, the lesion showed a non-homogeneous hypo-intensity to iso-intensity on T1WI and hyper-intensity on T2WI. Consistent with previous reports, MR images of bone GCT may

suggest the presence of solid components with hypo-intensity to iso-intensity on T1WI and T2WI, caused by hemosiderin deposition or high collagen content[3,4]. On contrast-enhanced images, unlike malignant soft tissue tumors or GCT-ST tumors with diffuse cystic components located in the subcutaneous tissue[8-11], the solid region of the lesion was slowly enhanced like hypervascular tissue, in line with IHC performance such as in bone GCT and the findings in other benign soft tissue tumors [2-4].

In the present study, the lesion was significantly large (maximum lesion size was 6.0 cm) and located in the superficial areas of the extremity or trunk. This type of lesion is commonly observed in GCT-ST, but it can also be found in the deep soft tissues of the head, neck, and retroperitoneum region[2-10]. Unlike deep-seated masses, size (*i.e.*, 5 cm in diameter) is not an essential indicative factor of malignancy for superficial masses[12]. To determine the benign characteristics of GCT-ST on MRI, we attempted to evaluate the feasibility of DWI.

DWI is used to differentiate benign from malignant soft tissue lesions based on ADC values as quantitative DWI is useful for differentiating between malignant and benign superficial masses[12-14]. Typically, if the ADC value is higher than the threshold of $1.0 \times 10^{-3} \text{ mm}^2/\text{s}$, the superficial soft-tissue mass is considered to be benign[12]. In this study, DW images were acquired with a b value of 500 s/mm^2 and the mean ADC value of solid GCT-ST lesions was $2.19 \times 10^{-3} \text{ mm}^2/\text{s}$, which was higher than the surrounding healthy tissue and its threshold. The reason for an overlap between the ADC values in benign and malignant tumors might be the heterogeneous nature of soft-tissue tumors such as intratumoral water content that increases diffusion, mucinous contents and intratumoral necrosis[12,13]. We speculated that high ADC values of the solid GCT-ST were consistent with tumor histology as intensely enhanced solid masses with no detectable macroscopic necrotic or myxoid predominant areas despite tumor interstitial hemorrhage were observed. Future studies with a higher sample size are needed to further confirm that a high ADC value is a characteristic of GCT-ST.

Clinically, primary GCT-ST mainly affects young to middle-aged adults[4-11,16]. Here, our patient was a young woman who had an ill-circumscribed multinodular mass covered by a fleshy red-brown surface and pain in the upper limb. Although the lesion in the upper limb had axillary lymphadenopathy and infiltrated adjacent anatomical structures, including neurovascular bundles, the lesion was unilateral and identified as a benign GCT-ST.

A noncalcified or unossified soft-tissue mass with low signal on T2WI is usually fibrous with little cellularity. As the observed mass with solid components in our study was not a bone lesion, giant cell tumors of tendon sheath (GCT-TS) and giant cell-rich forms of nodular fasciitis (NF) were included in the differential diagnosis. A GCT-TS is generally located near joint spaces, while a cystic lesion and metaplastic bone formation are absent, and calcification or ossification are very rare. GCT-TS always shows hyper-intensity on contrast-enhanced images[17,18]. NF is usually located in the subcutaneous tissue and shows hyper-intensity on T2WI caused by fluid-filled mucoid spaces. NF on MR images is more variable. Differential diagnosis of these giant cell-rich soft tissue neoplasms is important as clinical behavior, prognosis, and treatment can significantly differ[15-22].

CONCLUSION

Our case suggested that the MRI features of superficial GCT-STs in the upper limb, including heterogeneous signal intensity within the lesion on T2WI and T1 FSPGR, nodular enhancement with blurred margins, irregular shapes, and a slow enhancement of TIC on DCE-MRI. In addition, DWI could be used to differentiate a benign soft tissue mass from the malignant one by the mean ADC value, thus providing more radiologic-pathologic information for the diagnosis of GCT-ST. Comprehensive imaging of primary GCT-ST can aid in complete tumor resection, which in turn might promote long-term survival after surgery. However, these findings need to be confirmed using more samples.

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