Giant cell tumor of the tendon sheath: Magnetic resonance imaging findings in 38 patients

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Abstract. The present study aimed to investigate the value of magnetic resonance imaging (MRI) in the diagnosis of giant cell tumor of the tendon sheath (GCTTS), including localized (L-) and diffuse (D-) types. A total of 38 patients with GCTTS, including 31 with L-GCTTS and 7 with D-GCTTS, diagnosed by surgery and pathology, were retrospectively analyzed. All patients underwent MRI examination. Of the 31 patients with L-GCTTS, the tumors were located in the hand and wrist (18 patients), the ankle and foot (10 cases), the knee joint (2 cases) and the temporomandibular joint (1 case). All 31 lesions were either located in relation to a tendon or were partially/completely enveloping it and all were well marginated. With respect to the 7 D-GCTTS patients, the tumors were located in the ankle and foot (6 cases) or the hand and wrist (1 cases). All 7 lesions presented as an aggressive soft tissue mass infiltrating the tendon sheath and adipose tissue around the joint. The characteristic internal signal of GCTTS, including L-GCTTS and D-GCTTS, was demonstrated by MRI examination. MRI is currently the optimal modality for preoperative assessment of tumor size, extent and invasion of adjacent joint and tenosynovial space.

Introduction

Giant cell tumor of the tendon sheath (GCTTS) is a type of benign soft tissue tumor that was first described by Chassaignac in 1852 (1). GCTTS is also termed tenosynovial giant cell tumor, pigmented nodular tenosynovitis, xanthogranuloma, benign synovioma and fibrous xanthoma of synovium. The World Health Organization distinguishes between two types of giant cell lesions originating from the tendon and the synovium (2). GCTTS can be classified as localized (L-) or diffuse (D-) type. L-GCTTS primarily occurs in the tendon sheaths of the hand and foot and exhibits clear boundaries, whereas D-GCTTS occurs in large joints with a more aggressive growth pattern and associated high recurrence rate (2). As magnetic resonance imaging (MRI) can be used to characterize and estimate the extent of soft tissue tumors, this imaging technique is currently the method of choice for the diagnosis of GCTTS (3). Certain studies have investigated the use of MRI for the diagnosis of L-GCTTS (3-5). However, few studies have exclusively clarified the characteristic MRI features of L-GCTTS and D-GCTTS. Therefore, the present study aimed to document the MRI and clinical features of L-GCTTS and D-GCTTS by conducting a retrospective MRI and clinical review of 38 patients that received a diagnosis of GCTTS via surgery or biopsy, consisting of 31 patients with L-GCTTS and 7 with D-GCTTS.

Materials and methods

Patients. The present study retrospectively reviewed the MR images of 38 patients with GCTTS, who were treated and histologically diagnosed at The Second Affiliated Hospital of Zhejiang University School of Medicine (Hangzhou, China) between January 2011 and January 2015. An institutional review board exemption and a waiver for the requirement of written informed consent were obtained, facilitating the present study. All the patients underwent surgical excision. The follow-up length of the patients ranged between 6 and 60 months.

MR examination. MRI was performed using a 3.0T GE Signa MRI scanner (GE Healthcare Life Sciences, Chalfont, UK). The scan parameters were as follows: the time when 63% of the longitudinal magnetization has recovered (T1)-weighted fast spin echo sequence [repetition time/echo time (TR/TE), 500/10 msec; slice thickness, 5.0 mm; field of view, 380-520 mm; matrix scan, 256x256]; and T2 weighted turbo-spin echo sequence (TR/TE, 3000/75 msec; slice thickness, 3.0 mm; field of view, 300-380 mm; matrix scan, 256x256).

Between 0.1 and 0.2 mmol/kg gadolinium-diethylene triamine pentaacetic acid (Magnevist, Bayer AG, Leverkusen, Germany), a contrast agent, was administered intravenously to the patients undergoing contrast-enhanced MRI.

MRI analysis. A total of 2 independent radiologists, who were aware of the diagnosis of GCTTS but were blind to the

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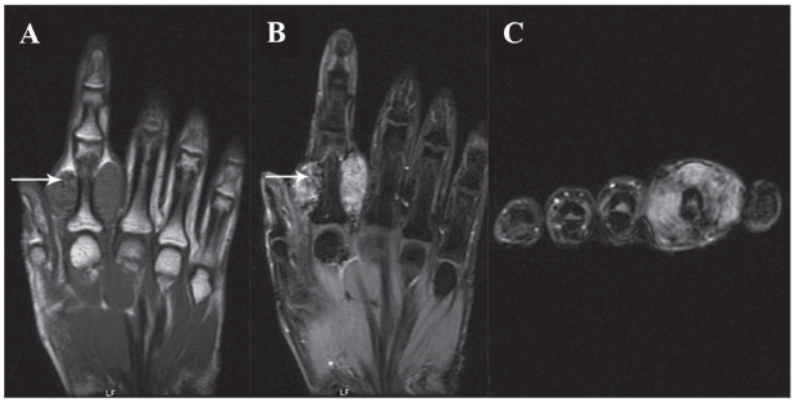

Figure 1. L-GCTTS of an index finger. (A) A T1WI, showing that the signal intensities of the tumor were isointense. Small, scattered foci of hypointensity are able to be observed within the tumor (arrow). (B) A T2WI, showing that the signal intensities of the tumor were hyperintense. Small, scattered foci of hypointensity may be observed within the tumor (arrow). (C) On the contrast-enhanced T1WI, heterogeneous enhancement was present. L-GCTTS, localized giant cell tumor of tendon sheath; WI, weighted image.

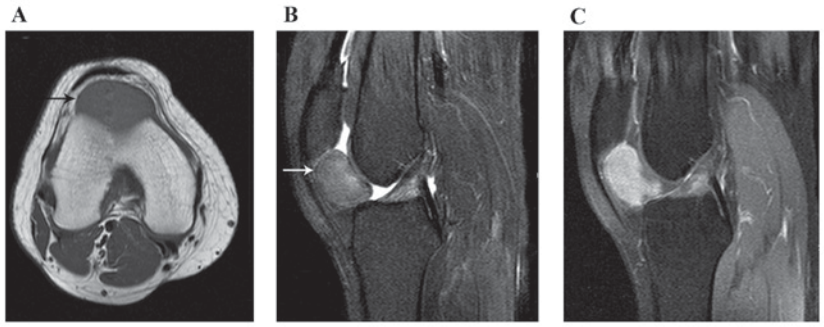

Figure 2. L-GCTTS of a knee joint. (A) A T1WI, showing that the signal intensities of the tumor were isointense. A hypointense capsule is able to be observed (arrow). (B) A T2WI, showing that the signal intensities of the tumor were hyperintense. A hypointense capsule can be observed (arrow). (C) On the contrast-enhanced T1WI, homogeneous enhancement was present. L-GCTTS, localized giant cell tumor of tendon sheath; WI, weighted image.

surgical findings, inspected the MRI features of the tumors. A discussion between the readers would occur subsequent to a disagreement in order to reach a consensus. The readers evaluated the following items: margination, signal intensity, signal inhomogeneity, enhancement, tumor extent and the involvement of adjacent tissues.

Results

Clinical data. The GCTTS group included 12 males and 26 females with a mean age of 40 years and a range between 16 and 82 years. In total, 38 patients consisting of 31 with L-GCTTS and 7 with D-GCTTS were studied. The L-GCTTS group included 10 males and 21 females with a mean age of 37 years and a range between 16 and 65 years. Of the 31 patients with L-GCTTS, 18 of the tumors were located in the hand and wrist, 10 in the ankle and foot, 2 in the knee joint and 1 in the temporomandibular joint. In total, 8 patients had a history of trauma directly prior to the appearance of the mass. The mean duration of symptoms prior to diagnosis was 3 years, with a range between 1 month and 7 years. A total of 27 patients exhibited painless soft tissue masses and 4 presented with slight pain. The masses were solitary, solid and well-defined lesions with good or poor mobility. Tumor size ranged between 0.8 and 3.2 cm with a mean size of 3.4±1.4 cm. All patients underwent local tumor excision. In total, 3 patients developed recurrence subsequent to surgical excision resulting in a recurrence rate of 10%.

The D-GCTTS group included 2 males and 5 females with a mean age of 57 years and a range between 36 and 82 years. Of the 7 patients with D-GCTTS, 6 of the tumors were located in the ankle and foot and 1 was in the hand and wrist. A total of 2 patients had experienced a trauma directly preceding the appearance of the mass. The mean duration of symptoms prior to diagnosis in the D-GCTTS group was 1.5 years, with a range between 1 month and 2 years. Of the 7 patients, 3 exhibited a painless soft tissue mass and 4 presented with varying degrees of pain. Tumor size ranged between 1.4 and 8.5 cm with a mean size of 5.8±1.9 cm. All patients underwent surgical excision. In total, 4 patients developed recurrence subsequent to surgical excision, resulting in a recurrence rate of 57.1%.

MRI findings. All 31 patients with L-GCTTS were examined using MRI and 14/31 patients received contrast medium-enhanced MRI scanning with a fat suppression sequence. All 31 lesions were located in association with or partially/completely enveloping a tendon and were well marginated. On the T1-weighted image (WI), the signal intensities of the L-GCTTS were almost isointense in 26 patients (Figs. 1 and 2) and were slightly hypointense in 5 patients. On

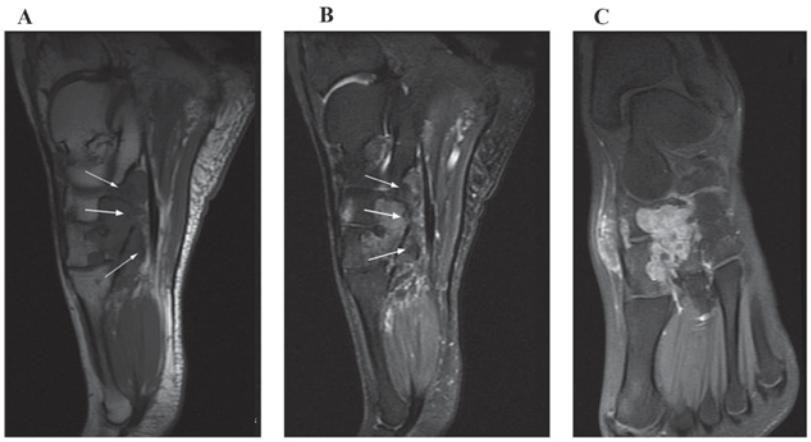

Figure 3. D-GCTTS of the foot. (A) A T1WI, showing that the signal intensities of the tumor were isointense. Numerous scattered foci of hypointensity may be observed within the tumor (arrow). The lesions are accompanied by adjacent tarsal bone destruction. (B) A T2WI, showing that the signal intensities exhibited a heterogeneously mixed signal of hyperintensity with hypointense areas (arrow). (C) On contrast-enhanced T1WI, marked heterogeneous enhancement was present. D-GCTTS, diffuse giant cell tumor of tendon sheath; WI, weighted image.

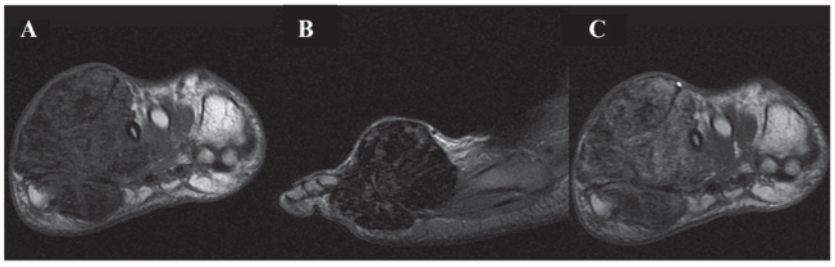

Figure 4. D-GCTTS of a foot. (A) A T1WI, showing that the signal intensities of the D-GCTTS were hypo intense. The lesion is accompanied by adjacent metatarsal bone destruction. (B) A T2WI, showing that the signal intensities were hypointense. (C) On the contrast-enhanced T1WI, intermediate heterogeneous enhancement was present. D-GCTTS, diffuse giant cell tumor of tendon sheath; WI, weighted image.

the T2WI, the signal intensities were hyperintense in 27 patients (Figs. 1 and 2) and isointense in 4 patients. Small scattered foci (Fig. 1) and/or capsules (Fig. 2) of hypointensity were observed in all 31 lesions on T1WIs and T2WIs. On the contrast-enhanced T1WI, heterogeneous enhancement was present in 10/14 patients (Fig. 1) and homogeneous enhancement in 4 patients (Fig. 2).

All 7 patients with D-GCTTS were examined using MRI and 5/7 patients received contrast medium-enhanced MRI scanning with a fat suppression sequence. All 7 lesions presented as an aggressive soft tissue mass infiltrating the tendon sheath and adipose tissue around the affected joint. In addition, all 7 lesions were accompanied by adjacent bone destruction. On the T1WI, the signal intensities of the D-GCTTS were almost isointense in 6 cases (Fig. 3) and were almost hypointense in 1 case (Fig. 4). On the T2WI, the signal intensities were heterogeneously mixed, with hyperintensity with hypointense areas in 4 cases (Fig. 3), almost hyperintensive levels in 2 cases and almost hypointensive levels in 1 case (Fig. 4). On contrast-enhanced T1WIs, marked heterogeneous enhancement was present in 4/5 cases (Fig. 3) and intermediate heterogeneous enhancement was present in 1 case (Fig. 4).

Discussion

GCTTS frequently presents as a firm, slow-growing, multilobular, non-tender mass located adjacent to the tendon sheath synovium. The tumor usually affects individuals aged 30-50 years and females exhibit slight predominance (6,7). GCTTS occurs in two different clinical presentations: L-GCTTS on fingers and toes and D-GCTTS that primarily occurs around large joints. The etiology of D-GCTTS remains to be established, and was previously termed extra-articular pigmented villonodular synovitis (PVNS) as it shares similar histological characteristics with PVNS (8). L-GCTTS is the second most common tumor of the hand following ganglion cysts (9). L-GCTTS primarily occurs in hands (10), feet and knees (11-13) whereas D-GCTTS occurs in large load-bearing joints including knees, hips, ankles, shoulders and elbows (14). Consistent with previous studies (6,7), GCTTS mainly affected females and young adults (mean age=41 years) in the present study. In addition, the present study demonstrated that L-GCTTS primarily affected young adults (mean age=37 years), whereas D-GCTTS was more frequently identified in elderly patients (mean age=57 years). Consistent with previous studies (10-13), the L-GCTTS tumors in the present study were mainly located in the hands and feet. However, it may be noted that L-GCTTS of the knee and temporomandibular joint were rare in the present study. The difference between the present study and a previous study (14) was that D-GCTTS tumors were primarily located in ankle and foot (6 of 7 cases) in the present study. The slight differences between the present study and the previous study, with respect

to the locations of D-GCTTS, may be attributed to the small sample size of the present study.

L-GCTTS typically exhibits small, scattered foci of low signal on T1WIs and T2WIs due to the presence of hemosiderin (15). The lesion may also be characterized by a low signal intensity capsule as a result of fibrosis or hemosiderin deposition. L-GCTTS is well delineated and lobulated with an incomplete fibrous capsule; however, the tumor may exhibit variability in signal intensity on MR images. De Beuckeleer *et al* (4) observed that the majority of signal intensities of L-GCTTS were isointense to the signal intensities of muscle on T1WI and T2WI. Jelinek *et al* (16) investigated the MRI features of 9 L-GCTTS. All 9 lesions were hypointense on the T1WI. On the T2WI, the signal intensities were equal to skeletal muscle in 2 patients, lower in 3 patients, slightly higher in 2 patients and more heterogeneous in 2 patients. Kitagawa *et al* (5) described the MRI features of 25 cases of L-GCTTS. The signal intensities of L-GCTTS that the authors observed were isointense to that of skeletal muscle or hyperintense on the T1WI; on the T2WI, the majority of signal intensities were hyperintense; and L-GCTTS enhanced following gadolinium administration. De Beuckeleer *et al* (4) identified that 10/13 cases of L-GCTTS exhibited highly homogeneous enhancement due to the presence of numerous proliferative capillaries in the collagenous stroma. Kitagawa *et al* (5) observed that 13/18 lesions were not homogeneously enhanced whereas 5 lesions exhibited homogeneous enhancement. In the present study involving 31 patients with L-GCTTS, on the T1WI the signal intensities of L-GCTTS were isointense in 26 patients and hypointense in 5 patients. On the T2WI, the signal intensities were hyperintense in 27 patients and isointense in 4 patients. On contrast-enhanced T1WI, the majority of signal intensities were heterogeneously enhanced. These findings were consistent with the findings of Kitagawa *et al* (5).

D-GCTTS is less well-defined than L-GCTTS and generally develops outside the joint, growing in a multinodular manner that is more irregular than that of L-GCTTS (17). MRI often reveals equal or higher signals than muscle on T1WI, whereas the features on T2WI vary and may be characterized by hypointense, isointense or hyperintense signals (18). Low signal intensity on the T1WI and T2WI is an indication of the hemosiderin content typical for this type of tumor (19). The findings of the present study with respect to D-GCTTS were consistent with the findings of the aforementioned studies. Additionally, the present study observed that D-GCTTS is heterogeneous with larger areas of hypointensity on T1WI and T2WI compared with L-GCTTS, and has enhanced heterogeneity on contrast-enhanced T1WIs compared with L-GCTTS. In the present study, the tumors exhibited predominantly low signal intensities on T1WI and T2WI. The present study speculates that D-GCTTS possesses more hemosiderin deposits, which reduce the T2-relaxation time due to a magnetic susceptibility effect, compared with L-GCTTS. In the present study, heterogeneous enhancement was present in all the contrast-enhanced cases, but the association between MR and histological findings was not evaluated.

In conclusion, L-GCTTS typically presents as a well-defined mass eccentrically located in association with or partially/completely enveloping a tendon. D-GCTTS is less well-defined and more aggressive than L-GCTTS, growing in a multinodular manner that is more irregular than that of L-GCTTS. GCTTS typically exhibits a low signal on T1WIs and T2WIs due to the presence of hemosiderin. D-GCTTS is more heterogeneous with larger areas of hypointensity on T1WI and T2WI, with enhanced heterogeneity on contrast-enhanced T1WI compared with L-GCTTS. The present study demonstrates that the characteristic internal signals of GCTTS, including L-GCTTS and D-GCTTS, are demonstrated clearly by MRI examination. MRI is currently the optimal modality for preoperative assessment of tumor size, extent and invasion of adjacent joint and tenosynovial space.

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