Localized Giant Cell Tumors of the Flexor Tendon Sheath of the Finger: An Analysis of Twenty Five Patients

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Abstract

Aim: The aims of this retrospective study were to evaluate localized giant cell tumors of the tendon sheath (GCTTS) with Magnetic Resonance (MR) imaging findings and to review the epidemiological features of the disease. We also evaluated the literature regarding GCTTS and performed an analysis of the available information. Material and Method: We retrospectively reviewed the MR images of 25 histologically proven cases of GCTTS of the finger during the period between 2012-2014. In addition, a retrospective analysis of the patients’ records was carried out, and age, gender, site and size of lesion, recurrence, and MRI findings were reviewed. Results: The patients were predominantly female (n = 16) and had a mean age of 51.9 ± 12.8 years. Nine patients were male with a mean age of 45.1 ± 13.4 years. The size of the tumors ranged from 6 mm to 30 mm, with a mean size of 15.3 ± 6.6 mm. Tumors were present on the right hand in 15 patients and on the left hand in 10 patients. Among women, 11 tumors were located on the right hand and 5 were found on the left. In men, 4 of the tumors were located on the right hand and 5 were on the left. The most frequent digit on which tumors were found was the index finger, accounting for 40% of cases (n=10). The most frequent location was the index finger for both women (n=6) and men (n=4). All of the lesions were described as well-circumscribed, encapsulated, lobulated, or multilobulated solitary masses with MR imaging. Signal intensity on T1 weighted images (WI) was equal to that of skeletal muscle in 23 cases. In two cases, signal intensity tended to be between those of skeletal muscle and fat in all of the cases. All of the lesions showed mild to moderate contrast enhancement when compared with precontrast images. There was no statistically significant differences between male and female patients in terms of age, tumor side, involved digit, and highest tumor size. But, tumor volume was slightly larger in female patients compared with male patients (p= 0.083). Discussion: MR imaging is very valuable in the diagnosis of GCTTS because of characteristic internal signal intensity. Also, axial and sagittal images are useful for evaluating the degree of extension around the phalanx, and invasion into the joint and tenosynovial space prior to surgery. These factors can influence the surgical approach.

Keywords
Giant Cell Tumor of Tendon Sheath; Finger; MR Imaging; Surgery; X-Ray
Introduction
A giant cell tumor of the tendon sheath (GCTTS) is a benign proliferative disorder of the synovium that may affect the tendon sheaths, joints, and bursae [1]. It is the second most common benign soft tissue tumor of the hand after the ganglion cyst [2]. The tumor affects digits more often than large joints (53.33%) [3]. It can also be seen in other parts of the body including the ankle, wrist, elbow, toes, knees, hips, and spine [4]. It is more frequently seen in women, especially those between the ages of 30 to 40 years. The etiology is still unknown, but it is thought to be associated with trauma [1]. These lesions are characterized by slow-growing, smooth, painless, and usually asymptomatic. However, secondary nerve compression, joint degeneration, and bone involvement can occur.

Magnetic Resonance (MR) imaging is useful for the diagnosis because it demonstrates the characteristic features of the tumor. These include low signal intensity equal to or slightly higher than the signal intensity of skeletal muscle on T1 and T2 weighted images (WI) [5,6]. In this study, we evaluated 25 cases of histologically proven GCTTS in the finger with MR imaging findings and also reviewed its epidemiological features. In addition, we assessed the literature regarding GCTTS and performed an analysis of the available information.

Material and Method
This study was approved by the Institutional Review Board of the Samsun Education and Research hospital. We retrospectively reviewed the MR images of 25 histopathologically proven cases of GCTTS of the finger during the period from 2012-2014. A retrospective analysis of the patients’ records was carried out with respect to age, gender, location, dimension of lesion, and recurrence. MR imaging findings were evaluated by the same radiologist (ATS). Also, neurovascular and flexor tendon involvement were evaluated with MR and compared with pathology reports.

MR imaging was performed on the 25 cases of GCTTS with a 1.5-T system (Signa HDX 1.5 T; GE Medical Systems, Milwaukee, WI, USA). The fields of view varied from 7.5 to 20 cm. The slice thickness varied from 2 to 4 mm and the slice gap varied from 0 to 2.7 cm. Matrices of 256x128-256 were used. Axial and either sagittal or coronal images, or both, were obtained for all lesions. In each patient, T1-weighted spin-echo images [pulse sequences: 300-600/11-30 (TR/TE)], T2-weighted spin-echo images [puls sequences: 2000-2700/80-90 (TR/TE)] or fast spin-echo images [pulse sequences: 2000-4000/80-120 (TR/TE)] were obtained. Gadolinium-enhanced images and the fat suppression technique were applied for all patients. Each lesion was assessed with regard to its location, size, extension, signal-intensity characteristics, and pattern of contrast enhancement.

Also, the signal intensity of the lesions was compared with that of normal skeletal muscle and subcutaneous tissue on T1 and T2-weighted sequences. Contrast enhancement patterns of the lesions were evaluated by comparison with the pre-contrast images. Finally, bony erosion, calcification, and cystic changes were evaluated by the same radiologist using plain film x-rays. Surgical management was performed with complete resection of all lesions and there were no complications. The resected specimens were examined by a staff pathologist. All of the lesions were confirmed to be localized GCTTS.

Statistical Analyses
Data were summarized as mean ± standard deviation and median (minimum-maximum) for continuous variables and frequencies (percentiles) for categorical variables. The Mann Whitney U test was used for independent group comparisons, depending on the distributional properties of the data. The Chi-square test was used when the data were sparse. A p value <0.05 was considered to be statistically significant.

Results
All of the 25 cases were new patients presenting with primary tumors. The age of the patients ranged from 28 to 75 years, with a mean age of 49.5±13.2 years. GCTTS was found most often in the fourth and fifth decades of life (24%). By gender, 16 patients were female and 9 were male, yielding a female to male ratio of 1.7/1. The mean age was 51.9±12.8 years for females and 45.1±13.4 years for males. The size of the tumors ranged from 6 mm to 30 mm, with a mean size of 15.3±6.8 mm. The volume of the tumors ranged from 0.15 cm3 to 15 cm3, with a mean volume of 2.6±3.69 cm3. All of the lesions were solitary and located adjacent to the flexor tendon sheath. Most of the patients presented with a slow growing, painless mass in the hand.

The following is a description of the location of the GCTTS:
Tumors were present on the right hand in 15 patients and on the left hand in 10 patients. In women, 11 tumors were located on the right hand while 5 were on the left hand. In men, 4 of the tumors were located on the right hand and 5 were on the left hand. The digits involved were the thumb (n=5), index (n=10), middle (n=5), ring (n=5), and little fingers (n=2) (Table 1). In women, the affected digits were the thumb (n=3), index (n=6), middle (n=2), ring (n=3), and little fingers (n=2). In men, the affected digits were the thumb (n=2), index (n=4), middle (n=1), and ring fingers (n=2). None of the tumors in men were located on the little finger. Overall, the most frequent location of the tumors was the index finger in 40% of patients (n=10). The most frequent location of the tumor was the index finger.
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(n=6) in women and men (n=4). There were no statistically significant differences between male and female patients in terms of age, tumor side, involved digit, and tumor size. The tumor volume was slightly larger in female patients compared with male patients (2.97 ± 3.94 cm³ versus 1.96 ± 3.31 cm³; p= 0.083) (Table 1).

All of the patients presented with slow growing, painless, palpable masses in the volar aspect of the fingers. In all cases, physical examination revealed a hard, painless, well-circumscribed, fixed, subcutaneous mass lesion. The overlying skin and neurological examination of the extremity was normal in all cases. All of the lesions were described as well-circumscribed, encapsulated, lobulated, or multilobulated solitary masses with MR imaging. Signal intensity on T1WIs was equal to that of skeletal muscle in 23 cases (Figure 1a,b,c). In two cases, signal intensity was slightly higher (Figure 2). On T2WIs, the signal intensities tended to be between those of skeletal muscle and fat in all of the cases. Most of the lesions showed non-homogeneous signal intensities, including foci of low-signal intensities, that might be associated with hemosiderin deposits on T2WIs. All of the lesions showed high signal intensity on fat-saturated T2WI and short tau inversion recovery (STIR) sequences (Figure 3a,b). All of the lesions showed mild to moderate contrast enhancement when compared with precontrast images (Figure 4a,b). All of the lesions were not obviously in contact with the tendon sheath and the joint on MR imaging. All patients underwent conventional radiological examinations of the affected finger. There were no abnormalities such as bone erosion, impression, calcification, or cystic changes on the X-rays. Similarly, involvement of the bone adjacent to the lesion was not detected by MR imaging.

All of the lesions were managed by surgical excision of the tumor under local anesthesia. Macroscopically, each of the lesions was described as a well-circumscribed, yellow-brownish, lobulated, or multilobulated mass. Only one particularly large lesion was found to be attached to the flexor tendon sheath during the surgery. Its size was 30x15x15 mm. Synovial cell hyperplasia, histiocytes, multinucleated giant cell accumulation, hemosiderin-laden macrophages, and collagen strands were observed during microscopic examination of all lesions (Figure 5). There was no evidence of necrosis or mitotic figure 6. A 32 year-old woman presenting with a painless soft tissue mass on the volar aspect of the proximal phalanx of the right thumb. A coronal T1-weighted spin echo (SE) Magnetic Resonance (MR) image (TR/TE=450/22) shows a homogenous, well-defined, rounded-shaped, soft tissue mass with signal intensity equal to that of muscle(A). An axial T2-weighted SE MR image (TR/TE=2600/80) reveals a slightly hyperintense mass lesion adjacent to the flexor hallucis tendon. There was no invasion of the flexor hallucis tendon with MR imaging findings, which was supported by the histopathologic findings(B). A coronal SE short tau inversion recovery (STIR) image (TR/TE=3000/60) shows a hyperintense mass lesion without any signal changes on the phalanx(C).

figure 7. A 75 year-old woman presenting with a soft tissue mass along the volar aspect of the middle phalanx of the right ring finger due to a giant cell tumor of the tendon sheath (GCTTS). The Axial T1-weighted SE MR image (TR/TE=600/15) shows a slightly hyperintense soft tissue mass (white arrow) adjacent to the flexor digitorum tendon (yellow arrow).

Figure 1. A 32 year-old woman presenting with a painless soft tissue mass on the volar aspect of the right thumb. A coronal T1-weighted SE MR image (TR/TE=450/22) shows a homogenous, well-defined, rounded-shaped, soft tissue mass with signal intensity equal to that of muscle(A). An axial T2-weighted SE MR image (TR/TE=2600/80) reveals a slightly hyperintense mass lesion adjacent to the flexor hallucis tendon. There was no invasion of the flexor hallucis tendon with MR imaging findings, which was supported by the histopathologic findings(B). A coronal SE short tau inversion recovery (STIR) image (TR/TE=3000/60) shows a hyperintense mass lesion without any signal changes on the phalanx(C).
activity in any of the tumors. There was no recurrence in any of the patients. In three cases, however, the boundaries of the lesion were found to be positive during microscopic examination. One of them was located at the middle phalanx of the left index finger near the flexor tendon sheath. Its size was 2.5x2x2 mm. Microscopic examination revealed that the mitotic activity varied from 10-15. Another lesion was seen in the subcutaneous tissue near the proximal phalanx of the right thumb in a 32 year-old woman. The lesion was located near the flexor tendon sheath and there was no invasion. In addition, there was no increased mitotic activity or loss of capsule integrity in the lesion. The third patient was a 59 year-old man with a GCTTS in the distal phalanx of the ring finger in the right hand. There was no increased mitotic activity or loss of capsule integrity in the lesion in this case as well.

Discussion

There are different forms of GCTTS, including the localized form (also known as tenosynovitis), the intra-articular form (also known as localized nodular synovitis), and the diffuse form (also known as extra-articular pigmented villonodular synovitis). The localized form is the most common and is mostly seen in the hand and wrist, especially on the volar aspect. More specifically, the volar aspect of the first three fingers is the most common site in the hand. Most patients present with a painless, palpable, slow-growing soft tissue mass in the third through fifth decades of life. In rare cases, distal numbness and mild disability can be seen in some patients [2, 6]. GCTTS most commonly involves a single joint with multiple joint involvement seen in less than 1% of cases [7]. In the literature, GCTTS is more common in women than men, with a range from 1.5:1 to 2:1. In our study, the female to male ratio was 1.7:1. Consistent with our study, Darwish et al observe a slight predominance of the right hand [4]. Some authors report that the most frequent tumor location is the index finger [6, 8, 9]. Darwish et al, however, report that the most common location of the tumor is the thumb [4]. In our study, the most common digit was the index finger and the second most common was the thumb and ring finger. Most lesions were on the right hand in women but on the left hand in men. In women and men, lesions were seen most often on the index finger, followed by the thumb and ring finger. Also, none of the tumors in men were on the little finger.

In the literature, some studies show that lesions are most common on the dorsal aspect of the hand, while other studies identify the volar aspect as most common [10-13]. In our study, all lesions were located on the volar aspect of the hand and were located adjacent to the flexor tendon sheath. There was no marked invasion of the flexor tendon sheath or extension into the joint space based on MR imaging. Half of all cases were shown to consist only of a soft tissue mass and 15-20% were seen to consist of a soft tissue mass with bone erosion in the radiographs. Cystic changes in the adjacent bone tissue, degenerative changes in adjacent joints, periosteal reaction, and calcification were seen in radiographs in about 17% of cases. Darwish et al detected cortical compression by GCTTS in 5 patients with diameters ranging from 0.5 cm to 2 cm based on radiography [1]. Hamdi et al reported 3 of 27 patients having cortical bone impression of the phalanx by radiography [6]. Grazia et al detected 3 of 64 (4.7%) cases with bone erosion associated with GCTTS by radiography [2]. In our study, none of the patients were shown to have bone changes based on radiographs or abnormal signal intensity on MR imaging. Localized GCTTS were usually described as well-defined, encapsulated, eccentric mass lesions. They were mostly close to the tendon sheath or partially/fully surrounding the tendon sheath. MR imaging can reflect the histological characterization of the GCTTS. Hemosiderin-laden tissue is shortened in the T1 and T2 relaxation times by paramagnetic effect, and results in low to intermediate signal intensity in T1- and T2-weighted spinecho sequences. This effect is exaggerated due to increased magnetic susceptibilities on gradient echo sequences and results in areas of very low signal intensity and blooming artifact [1]. Abundant collagen proliferation typically leads to low signal intensity as well. After the administration of intravenous gadolinium, lesions typically show moderate enhancement. Hemosiderin deposits are seen as tiny areas with low signal intensity on all sequences and post-contrast images [1]. In our cases, most of the lesions were described as isointense to muscle on T1WI and isoointense or slightly hyperintense to muscle on T2WI, with higher signal intensity on fat-suppressed T2WI and STIR images. MR imaging is the most important modality for detecting tumor size, extent, neighboring tenosynovial area of insertion, and extension prior to surgical management [1]. Soft tissue tumors and tumor-like lesions should be considered in the differential diagnosis of GCTTS. Among them, particular consideration should be given to ganglion cysts, hemangiomas, nerve sheath tumors, synovial sarcomas, and foreign body granuloma. These are easily distinguished from GCTTS because they demonstrate high signal intensity in T2WI. However, sarcomas and desmoid tumors demonstrate intermediate signal intensity, depending on high collagen content, and are prone to cause confusion in the differential diagnosis [1]. Although surgery is most often curative, recurrence rates of 7-44% are reported in the literature [1]. The most important approach to prevent the recurrence of GCTTS is to perform complete surgical excision. But, sometimes it is very difficult, because GCTTS often extends into the surrounding structures, particularly neurovascular structures. As a result, a high recurrence rate has been observed in some studies [4]. The tumor must be dissected gently to avoid unwanted complications such as numbness, joint stiffness, painful scars, and skin necrosis. Also, the entire lesion must be removed without allowing any remaining abnormal tissue that could lead to a recurrence. High recurrence rates may result from incomplete excision of the lesion, proximity of the arthritic joint, proximity to the interphalangeal joint of the finger, and bony invasion by the tumor [4]. But, Lowyck et al did not support this theory, asserting that there is no significant correlation between recurrence and pressure erosion or degenerative joint disease with respect to the location at the distal interphalangeal joint [14]. Intraosseous invasion of GCTTS is uncommon in the hand, but it may be associated with high recurrence rates [15]. Therefore, intraosseous invasion is not to be confused with bony erosion. This is despite claims by some authors who suggest that recurrence is consistent with cellularity and mitotic activity, capsular involve-
ment, and incomplete excision of the lesion [4, 16]. In our study, recurrence after complete excision was not observed in any of the 25 cases. However, we note that positive surgical margins were found in 3 cases. Follow-up with imaging and clinical findings was recommended to these patients. Abnormal bony signal intensity or intraosseous invasion was not observed in the three patients who had microscopically positive margins. However, mitotic activity varying from 10-15 was found in one of the patients during microscopic examination. Complete primary tumor resection is the standard of care. Postoperative adjuvant radiation therapy has been recommended to prevent recurrences for high risk lesions. Using magnifying glasses or microscopy during the operation has the potential to reduce the recurrence rate. Ikeda et al reported only one recurrence in 18 patients after microscopic excision [17].

Microscopically, GCTTS consist of fibroblasts, macrophages, foam cells, and hemosiderin pigment [9]. Macroscopically, GCTTS are observed as well-circumscribed, encapsulated, yellow-brownish, lobulated, or multilobulated masses ranging in size from 0.5 to 5 cm in diameter, with an average size of 1.1 cm [1]. Capsule formation is typical around the mature, localized tumor. A diffuse form of the tumor does not include the capsule formation and extends along the tendon sheath [6]. There is no reported mitotic activity in the literature. The basic question the pathologist first attempts to answer is whether the lesion is neoplastic or non-neoplastic. A large number of immunohistochemical studies are carried out for the purpose of making this distinction.

In conclusion, GCTTS are slow-growing, benign masses of the tendon sheath that are frequently seen in the hand. The accepted treatment modality is complete surgical resection. MR imaging of the extremity is the best method for evaluating the surrounding structures before planning the definitive resection. Axial and sagittal MR images are very useful for evaluating these structures. The exact dimensions of the lesion, the degree of extension around the phalanx, the involvement of the joint, and the tenosynovial space should be evaluated carefully to provide the surgeon with additional information that can assist in planning the surgical approach.

Competing interests
The authors declare that they have no competing interests.

References

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