Orthopaedic Case of the Month

A 51-year-old Man with a Painless Wrist Mass

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History and Physical Examination

A 51-year-old right-hand dominant man was evaluated for an enlarging, painless left wrist mass of 2 months duration. The patient reported no recent injury or antecedent trauma and denied any local neurologic symptoms, fevers, chills, or changes in weight.

Physical examination revealed a nontender, 3 × 2-cm firm, mobile mass overlying the volar aspect of the left distal ulna. There was no rash or other identifiable overlying skin changes, and the lesion did not transilluminate. The patient had normal strength and ROM, and sensation to light touch was intact in all three nerve distributions. There was a negative Tinel's sign and the mass was nonpulsatile with a normal vascular examination.

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AP and lateral views of the left wrist (Fig. 1) and MRI of the wrist (Fig. 2) were obtained.

Based on the history, physical examination, and imaging studies, what is the differential diagnosis at this point?

Imaging Interpretation

AP (Fig. 1A) and lateral (Fig. 1B) radiographs showed a 3-cm solitary soft tissue mass volar to the distal ulna. The mass contained multiple amorphous eccentric mineralization. There was no associated periosteal reaction, extrinsic osseous erosion, or cystic change in the adjacent bone. MRI (Fig. 2) showed the mass was located dorsal to the flexor carpi ulnaris and medial to the flexor digitorum tendons. The mass abutted the distal volar ulna and the volar radioulnar joint capsule without communication with the radioulnar joint. The mass was of intermediate to low signal intensity on T1-weighted (Fig. 2A), fat-saturation proton density (Fig. 2B), short tau inversion recovery (STIR) (Fig. 2C), and gradient echo (Fig. 2D) sequences. The low signal intensity areas in the mass are best seen on the gradient echo sequence. Areas of mineralization and hemosiderin deposition are most apparent on gradient echo sequences owing to magnetic susceptibility, or “blooming artifact,” which is delineated by white arrows in Fig. 2D [4]. There was moderate enhancement of the lesion after intravenous gadolinium contrast administration (Fig. 2E).

Differential Diagnosis

Synovial sarcoma
Epithelioid sarcoma

Fig. 1A–B (A) AP and (B) lateral radiographs show an ovoid-shaped soft tissue mass volar to the distal ulna. The mass contains amorphous calcifications without underlying periosteal reaction or changes in the adjacent osseous structures.

Extraskelatal osteosarcoma

Giant cell tumor of tendon sheath

Fibroma of the tendon sheath

A biopsy using a TEMNO® needle (Cardinal Health, Dublin, OH, USA) was performed and sent for histopathologic and microbiologic analyses.

Based on the history, physical examination, laboratory studies, imaging studies, and histologic picture, what is the diagnosis and how should the patient be treated?

Histology Interpretation

On microscopic examination, the tumor was composed mostly of broad dense collagen bundles with a few inflammatory cells and round cells scattered throughout. Areas of acellular, dense eosinophilic material (Fig. 3) indicating broad bands of collagen were mineralized (and responsible for the opacification seen on radiographs). On more careful examination, the tumor contained foci of multinucleated giant cells (Fig. 4), inflammatory cells, round synovial-like cells, xanthoma cells (foamy macrophages), and siderophages with hemosiderin pigment (Fig. 5).

Diagnosis

Giant cell tumor of the tendon sheath (GCTTS).

Discussion and Treatment

GCTTS was diagnosed based on the history of a painless slowly growing wrist mass, combined with distinctive radiologic and histologic findings. Plain radiographs showed a soft tissue mass without associated periosteal

reaction or bone erosion. MRI showed a well-defined mass with homogeneous enhancement after administration of contrast. The mass was intimately associated with the flexor carpi ulnaris muscle and tendon. Finally, histologic analysis revealed that the mass was composed of a proliferation of round synovial-like cells accompanied by a variable number of multinucleated giant cells, inflammatory cells, siderophages, and xanthoma cells (foamy macrophages).

Malignant tumors with a propensity to mineralize, such as synovial sarcoma, epithelioid sarcoma, and extraskelatal osteosarcoma, also must be considered in the differential diagnosis. A synovial sarcoma can be composed of epithelial and mesenchymal elements (biphasic) or just mesenchymal ones (monophasic). It classically presents as a painless, enlarging mass found in a periarticular location. Mineralization is seen on plain radiographs in 30% of patients with synovial sarcoma [2]. MRI often shows a heterogeneous appearance, with low signal intensity on T1-weighted images, high signal intensity on T2-weighted images, and contrast enhancement [1]. Unlike GCTTS, approximately 44% of synovial sarcomas have foci of hemorrhage observed on MR images, but both entities frequently are found in close proximity to a joint [9]. Epithelioid sarcoma is another malignant lesion that should be considered in the differential diagnosis. An epithelioid sarcoma characteristically is a slowly growing neoplasm, most often involving the upper extremities [1]. As such, it initially may be misdiagnosed as a benign process. Once referred to as a large-cell sarcoma of the tendon sheath, epithelioid sarcoma has a tendency to extend regionally along the tendon sheaths, and frequently recurs locally after excision [24]. On plain film, it presents as a soft tissue mass adjacent to a bony structure, occasionally producing periosteal new bone as it invades and elevates the periosteum [14]. Bone invasion, combined with a prominent hemorrhagic component on MRI [23], distinguishes epithelioid

Fig. 2A–E (A) Axial T1 weighted, (B) axial proton density fat saturation, and (C) coronal STIR images show a discrete volar mass (black arrows) primarily of intermediate and low signal intensity on all imaging sequences. (D) A coronal gradient echo image shows increased conspicuity of low signal intensity areas of calcification and hemosiderin owing to magnetic susceptibility, or blooming artifact (white arrows). (E) An axial T1-weighted fat-saturation post-gadolinium contrast axial image shows moderate enhancement of the mass.

sarcoma from GCTTS. Extraskeletal osteosarcoma also may present radiographically with areas of mineralization. In contrast to conventional osteosarcoma and juxtacortical osteosarcoma, extraskeletal osteosarcoma arises in the soft tissue and is not attached to bone or periosteum [12]. Unlike GCTTS, the most common site of presentation is the lower extremity, with a high incidence in patients older than 50 years [4]. The diagnosis of this rare tumor is confirmed histologically by the production of osteoid, which sometimes is accompanied by cartilage [2]. Fibroma of the tendon sheath is a neoplasm composed of tightly packed spindle cells suspended in a collagen stroma, and it presents as a slow-growing nodule that is attached to a tendon [4]. The majority of these lesions are found in the extremities, particularly in the upper limb. Although

fibromas of the tendon sheath have a clinical presentation and many imaging characteristics that are similar to those of GCTTS, they show little or no contrast enhancement on MRI [6]. Furthermore, they differ microscopically, with scarce or absent multinucleated giant cells, and no associated xanthoma cells or siderophages.

GCTTS was likely first described in 1852 by the French physician Charles Marie Edouard Chassaignac, who referred to it as “cancer of the tendon sheath” [3]. In 1941, Jaffe et al. [8] suggested that the synovial lining of the tendon sheath, joint, and bursa represents one anatomic unit and as a result, that GCTTS, pigmented villonodular synovitis (PVNS), and the rare pigmented villonodular bursitis exemplify different manifestations of the same disease, respectively. In their classic work, they promulgated the concept that the underlying

Fig. 3 In the center of the photograph is a broad band of mineralized collagen with a distinct border. The collagen is slightly more eosinophilic than the surrounding collagen and it is acellular (Stain, hematoxylin and eosin; original magnification, $\times 400$).

Fig. 4 Microscopic examination revealed that the tumor contained foci of multinucleated giant cells (black arrows), which are present in the center of the field (Stain, hematoxylin and eosin; original magnification, $\times 400$).

disease process of this family of lesions is an inflammatory one [8]. However, a more recent investigation identified the clinicopathologic features of GCTTS, such as the nodular growth pattern and propensity for recurrence after incomplete excision, and suggested that it is a neoplastic proliferation of synovial histiocytes and fibroblasts [19]. Although some uncertainty remains concerning its histogenesis, karyotypic abnormalities isolated in GCTTS cells have largely been accepted as evidence of a neoplastic phenomenon [20].

GCTTS is the second most common soft tissue neoplasm of the hand, surpassed in incidence only by ganglion cysts [10, 13, 16, 18, 26]. It is a benign proliferative lesion of synovial origin that occurs most commonly in the hand

Fig. 5 On further examination, brown hemosiderin pigment and siderophages are seen in the tumor (Stain, hematoxylin and eosin, original magnification, $\times 400$).

and fingers [18], typically throughout the third through fifth decades of life [10], and it shows a slight female preponderance [10, 13, 18]. Left untreated, the lesion may undergo a rapid increase in size, cause pain with movement, or impair normal function [22].

Although radiographic features such as a soft tissue shadow and pressure erosion of adjacent bone have been well documented in the literature [7, 10, 16–18, 25, 26], associated mineralization is an uncommon finding. In outlining the spectrum of radiologic manifestations of GCTTS, Karasick and Karasick [10] reported that features such as mineralization, periosteal reaction, and intraosseous invasion are atypical and only found in a minority of cases. Their series contained only one case of GCTTS that had amorphous periarticular mineralization. When encountered, a soft tissue mass that exhibits intralesional mineralization on plain radiographs should be evaluated further with MRI, which is the preferred modality to determine the composition of a lesion and its anatomic relationship to surrounding structures [14, 21]. This relationship reportedly influences the risk of recurrence [27]. As a result, it is an invaluable tool in preoperative planning. On MRI, GCTTS presents as a lobulated mass that is hypointense or isointense to skeletal muscle on T1-weighted images, while varying from hypointense to hyperintense on T2-weighted sequences [11, 16, 17, 26]. The decreased signal intensity is attributable to the paramagnetic effect exerted by hemosiderin, which causes a blooming artifact on the gradient echo sequences [17, 26]. GCTTS typically shows moderate to marked contrast enhancement after administration of gadolinium owing to the presence of numerous proliferative capillaries located in the collagenous stroma [5, 16]. Other specific MRI features that are useful in differentiating GCTTS from malignant diagnoses, such as extraskeletal osteosarcoma

and synovial sarcoma, include the appearance of a well-circumscribed, lobulated mass that is usually in close approximation to a nearby tendon. Moreover, the lesion does not show focal invasion and destruction of adjacent structures, such as neurovascular bundles and physes, or distant metastases.

The histopathologic understanding of this fibrohistiocytic tumor was advanced in 1959 by Phalen et al. [18], who examined 56 cases of GCTTS and determined the lesions are composed of variable proportions of round or polygonal histiocyte-like cells, multinucleated giant cells, hemosiderin-laden cells (siderophages), and foam cells. They suggested multinucleated giant cells of the osteoclast type and hemosiderin pigment (intracellular and extracellular) were a constant feature, whereas the presence of macrophages and foam cells was variable.

The treatment of GCTTS is careful surgical excision. Common reasons for removal include cosmetic concern, loss of function, and symptoms of neuropathy secondary to nerve compression. Although complete surgical excision is ideal, the surgeon must balance aggressive excision, which may result in increased morbidity, with less aggressive excision, which may result in recurrence. According to one report, recurrence rates for GCTTS may be as much as 40% [27]. Overexpression of specific tyrosine kinase receptors reportedly occurs on the surface of GCTTS stromal cells [15]. Although further investigation is needed to elucidate the precise role of these receptors in the pathophysiology of synovial proliferation, this finding has sparked interest in the possible role of tyrosine kinase inhibitors as a treatment for GCTTS.

Clinical history and characteristic imaging will frequently allow the physician to diagnose GCTTS with a fair amount of reassurance. However, in our patient, the atypical radiographic presentation of GCTTS as a soft tissue mass with mineralization prompted the need for a biopsy to ascertain a diagnosis. Given the wide differential of a mineralizing soft tissue mass, investigation with MRI can be useful in further characterizing the mass, differentiating it from malignant lesions, assisting with preoperative planning, and identifying the extent of tumor involvement of adjacent structures. Although associated mineralization is a rare radiographic feature, it does occur and therefore GCTTS should be included in the differential diagnosis of a mineralizing soft tissue mass. Although far less common in the distal upper extremity than a benign tumor, a high index of suspicion for a soft tissue sarcoma should be maintained throughout the preoperative assessment to avoid unplanned excisions.

Our patient elected to undergo complete surgical resection. In the intervening year of followup, the patient has had no complications, with pain-free and full return of wrist and hand function, and no clinical evidence of recurrence.

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