Ultrasound of soft tissue tumors and pseudotumors

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Purpose

Superficial soft-tissue masses are common in clinical practice. The sonographic findings of superficial soft-tissue masses are nonspecific, nevertheless, sonography can be an important diagnostic tool and can help achieve a diagnosis or limit a differential diagnosis. We review the technical aspects of soft-tissue ultrasound and the sonographic findings of the most common superficial soft-tissue masses.

Methods and Materials

Soft-tissue lesions are frequently encountered by radiologist in every clinical practice. Characterization of these soft-tissue remains problematic. In an important subset of cases, characteristic clinical and imaging features can help to narrow the differential diagnosis. Sonography plays an important role in the diagnosis of superficial soft-tissue masses because sonography can be performed on patient rapidly, is a readily available, inexpensive, and noninvasive modality. The primary disadvantage of sonography is relative operator dependence.

For sonographic evaluation of superficial soft-tissue masses, linear array transducer with multifrequencies of (7-14 MHZ) are often used. Either the transducer is placed directly on the skin or a silicon stand-off pad is placed between the transducer and the skin to get ideal contact with the surface.

Superficial soft-tissue masses may be classified in one of the following general diagnostic categories: Pseudotumour, benign tumors and malignant tumors.

The article is based on our experience with superficial soft-tissue masses, as an overview with emphases on lesions that are more common or relatively more common in our every clinical practice: pseudotumour and benign tumors.

Results

Pseudotumour.

1.1 Peri-articular cystic structure: synovial cyst, ganglion cyst, tenosynovitis.

Synovial cyst: Occasionally, out-pouches from joints are seen on ultrasound as fluid filled structures adjacent to a joint. Such synovial cyst recesses are particularly common around the knee. (Baker’s cyst). Characteristically, the Baker or popliteal cyst has a
narrow neck arising from the posterior joint between the semimembranosus tendon and medial head of gastrocnemius (Fig.1).

Ganglion cyst: They are mucin filled cystic structures and lined with a fibrous capsule. They may arise from tendon sheath, joint capsules, bursae or ligaments. On ultrasound they appear as well-defined anechoic or complex lesion, which may contain septa. The sonographic appearance of ganglia depends on their size and chronicity (Figs. 2, 3, 4 and 5).

Tenosynovitis can present as a mass if significant synovium hypertrophy, fluid accumulation, or thickening of the retinacula is present. Sonography shows the tendons surrounded by an anechoic fluid collection (Figure 6) or by a hypoechoic hypertrophied synovium. Old lesions are echogenic and show internal thick septa (Fig. 7).

Rheumatoid arthritis is characterized by proliferative, hypervascularized synovitis, resulting in bone erosion, cartilage damage and joint destruction. Proliferative synovitis, also called pannus, is the earliest pathologic abnormality in rheumatoid arthritis, and it is secondarily responsible for bone and cartilage damage. (Figs. 8, 9, 10 and 11).

1.2 Serous effusion Morel-Lavallée.

Is defined as a hemolymphatic collection-mass located between hypodermis and the aponeurotic planes. At clinical examination is a soft tissue injury after tangential trauma, consisting of a closed internal degloving of the subcutaneous tissue creating a collection filled by bloody serous liquid. (Fig. 12)

1.3 Haematoma.

They appear as fluid collections that can display a fluid-fluid level because of the hematocrit effect. (Figs. 13 and 14).

1.4 Skin Appendage Lesions.

These lesions originate in the epidermis and dermis. The most common of these is the epidermal cyst. This simple epithelial cyst is lined with epidermal-like cells that keratinize. Sonography imaging features are not specific. At US, the epidermal cyst appears as a circumscribed oval hypoechoic mass, often in association with a hair follicle. (Figs. 15, 16, 17, 18, 19 and 20)

1.5 Foreign Bodies Granulomas.

Following penetrating injury or surgical procedures, a granulomatous response may form pseudotumours. The visibility of foreign bodies will vary with composition. Ultrasound is fairly reliable at demonstrating foreign bodies. Sonographic findings of an echogenic structure with a surrounding hypoechoic mass, representing granulation tissue, are typical. (Fig. 21)
1.6 Endometriosis.

Endometriosis is defined as functioning endometrial tissue outside the uterine cavity. In most cases, is located within the pelvis. Endometrial implants, however, have been reported in many unusual sites outside the pelvis including the abdominal wall. A peculiar appearance is as a discrete mass near surgical or procedural scars, such as cesarean delivery or hysterectomy. (Fig.22).

The sonographic finding of a solid mass in the abdominal wall is not pathognomonic for endometriosis, but if located close to a cesarean section scar it should be of prime consideration in the differential diagnosis. A wide spectrum of disorders presenting as a mass in the abdominal wall should be considered in the imaging differential diagnosis include sarcoma, desmoid tumor, lymphoma, metastasis, suture granuloma or hematoma.

1.7 Others.

We expose a case of cystic lesions at the subcutaneous tissue of the leg, in a 32 year-old woman. The pathology revealed it was fatty tissue with fatty necrosis and cystification (fig. 23).

Benign Tumors

2.1 Lipomas and other lipomatous lesions.

Lipomas are the most common soft-tissue tumor and contain tissue histologically identical to adipose fat. Lipoma derived predominantly from primitive mesenchyme is mainly located in the subcutaneous fat and is composed of mature adipose tissue. Lipoma present as soft, painless mass. Sonography shows well circumscribed mass with no internal flow signal on Color Doppler. The more common lipomas have a high echogenicity with a typically striated, feathery appearance (Fig. 24). Additional mesenchymal elements are occasionally apparent; may be seen include bone and cartilage (Fig.25 and 26)

2.2 Fibroblastic / Myofibroblastic Tumors

2.2.1 Myositis Ossificans.

Is a benign ossifying soft -tissue mass that occurs in muscle, following trauma. (Fig. 27 and 28)

2.2.2 Fibromatoses.

The fibromatoses are a diverse group of soft-tissue lesion that occur at different ages and anatomic locations and have common histopathologic features. Their biologic behavior is intermediate in aggressiveness between benign fibrous lesion and fibrosarcoma. There is a strong tendency toward local recurrence; however, these lesions never
metastasize. The fibromatoses are divided into two groups: superficial (fascial) and deep (musculoaponeurotic).

The superficial group includes palmar fibromatosis (Dupuytren disease), plantar fibromatosis (Ledderhose disease), juvenile aponeurotic fibroma and infantile digital fibromatosis.

The deep fibromatoses are larger than superficial and may grow rapidly. They are more aggressive and likely arise from the deep fascia about muscle and aponeurotic tissue. The most common types of deep fibromatoses are infantile myofibromatosis, fibromatosis colli, desmoid tumor and aggressive infantile fibromatosis.

**Plantar Fibromatosis (Ledderhose disease):** Occurs most frequently between the ages of 30 and 50 years, with bilateral involvement seen in 20%-50% of cases. Concomitant palmar fibromatosis is seen in 10%-65% of patients. These lesions develop most commonly in the medial aspect of the plantar aponeurosis. (Figs. 29, 30 and 31)

**Palmar Fibromatosis (Dupuytren disease):** Is the most common type of fibromatosis, with a prevalence of 1%-2% in the general population. Bilateral involvement is seen in 42%-60% of cases. These lesions are three to four times more common in men. The clinical presentation is subcutaneous nodules on the palmar surface which progress slowly to fibrous cords. Sonography shows nodules as hypoechoic fusiform thickening of the palmar aponeurosis (Fig. 32). Dynamic examination performed during finger movements allows detection of adherences to the flexor tendons. The fourth and fifth rays are most commonly affected. Surgery has a high rate of recurrence (30%-40%).

2.2.3 **Desmoid tumor.**

Desmoid tumors arise from fascial and musculoaponeurotic structure. Desmoid tumors of the abdominal wall are the most common. (Fig. 33). Desmoid tumors are locally aggressive tumors, with invasion of contiguous structure and a strong tendency toward recurrence. Metastases, however, are not seen. Desmoid tumors pathogenesis is unknown but there are some factors involve as: pregnancy, birth control pills, scars, surgery, Gardner syndrome...

2.2.4 **Elastofibroma dorsi.**

Elastofibroma dorsi is a benign soft-tissue tumor. (Figs. 34 and 35) The tumor had a reported prevalence of 2% in patients who were undergoing chest CT. These tumors are now known to be much more common in the elderly population, most frequently in older women.

Elastofibroma dorsi is classically found in the infrascapular regions, deep to the serratus anterior and latissimus dorsi musculature. Other uncommon locations are: adjacent to the ischial tuberosity, adjacent to the olecranon, within the thoracic wall or deltoid muscle. Bilateral masses have been seen in 10%-66% of cases.
Elastofibroma dorsi is composed of fibrous tissue with internal fatty streaks. At histologic analysis, it is composed of eosinophilic collagen bundles; groupings of mature adipocyte cells; and linear, globular, and stellate elastic fibers. The poorly defined margins of the mass demonstrated with multiple imaging modalities are consistent with the lack of a capsule seen at gross pathologic examination.

At clinical examination, elastofibroma dorsi is often asymptomatic and incidentally found soft-tissue tumor at CT in a classic infrascapular location. Sometimes may cause moderate pain.

2.3 Fibrohistiocytic tumors:

Giant Cell Tumor of the Tendons Sheath (GCTTS): Occurs most frequently between the ages of 30 and 50 years old. GCTT is the most common soft-tissue tumor of the hand. Ganglia are the most common masses of the hand. GCTT mainly affects the volar aspect of the distal fingers. It presents clinically as an indolent, slowly growing nodular firm mass. Sonography shows non-homogeneous, hypoechoic, well-delineated solid mass in close contact with the tendon. Sometimes, US can detect erosions on the adjacent cortex bone. Color Doppler sonography detects variable internal flow signals. (Figs. 36, 37, 38 and 39).

Pigmented villonodular synovitis (PVNS) is the intraarticular form of giant cell tumor of the tendon sheath (Figs. 40 and 41)

2.4 Smooth muscle tumor: Angioleiomioma.

Is a rare benign smooth-muscle tumor. The most common presentation is a single subcutaneous painful nodule. On sonography, vascular leiomyoma shows hypoechogenicity, homogeneous and well-defined margins. On color Doppler sonography vascular density is moderate or high.

2.5 Glomus tumor.

They are usually solitary and can be found under the fingernails. These tumors tend to have a bluish discoloration, they are often painful and the pain is reproduces when the lesion is placed in cold water. At the time of diagnosis, most patients are between 20 and 40 years of age. The prevalence of glomus tumors is about equal in men and women but particularly subungual lesion, are more common in females than males. (Fig.42)

At US, a glomus tumor usually manifests as a nonspecific, solid, hypoechoic mass beneath the nail, possibly with associated erosion of the underlying phalangeal bone. The high-velocity flow in intratumoral shunt vessels causes this lesion to be hypervascular at color Doppler imaging.

2.6 Vascular tumors.
Hemangiomas: Is the most common type of angiomatous lesion. This lesion shows variable heterogeneous echogenicity depending on the different components that constitute it. (Fig. 43) Vascular channels in this lesion can show increase inner flow on color Doppler: arteriovenous hemangiomas shows high flow and venous Hemangiomas shows low flow. Sometimes there are hyperechoic foci with posterior shadowing representing phleboliths. (Fig.44)

2.7 Neurogenic tumors.

Schwannomas and neurofibromas are benign peripheral nerve sheath tumors. On sonography neurogenic tumors usually presents as a small, hypoechochogenic, spindle-shape connected to a peripheral nerve. Other typical findings of large tumors are calcifications, internal degenerative cystic foci or bleeding. (Figs. 45 and 46) In some cases it is possible to demonstrate the continuity of the neurogenic tumor with the nerve at the junction between the nerve and the tumor, an important finding for the diagnosis.

Morton neuromas are not true neoplasms; rather, they are masses composed of interdigital perineural fibrosis and nerve degeneration. Morton neuroma occurs between the second and third intermetatarsal space. Morton neuroma is more common in women. (Fig. 47).

Malignant tumors

Soft-tissue malignancies are relatively uncommon, in comparison with the large number of benign lesions that may be seen in the superficial tissue. Evaluation of a soft-tissue mass begins with the clinical history and physical examination. Clinical information regarding rapid growth, masses that are fixes to surrounding tissues is more suggestive of malignancy. Imaging findings such as: > 5 cm, irregular borders, poli lobulated shape, cystic-necrosis internal changes, irregular vascularity are suggestive of malignancy. (Figs. 48, 49, 50 and 51).

Images for this section:
**Fig. 1:** US image shows a Baker’s cyst in the popliteal fossa. Anechoic structure with internal echoes (rupture of a popliteal cyst).

**Fig. 2:** Chronic ganglion cyst: US images show a solid appearance.
**Fig. 3:** Wrist ganglion cyst: US image shows a hypo-anechoic polylobulated lesion with internal echoes.

**Fig. 4:** Ganglion.US scan of unilocular, anechoic cysts located near of the third flexor tendon.
**Fig. 5:** US image of wrist ganglia with internal thick septa.

**Fig. 6:** Longitudinal US scan shows anechoic accumulation within the tendon sheath.
Fig. 7: Longitudinal and transverse US scan. Tenosynovitis Achilles tendon.

Fig. 8: A 57 year-old woman with rheumatoid arthritis and soft-tissue mass in elbow. Transverse color Doppler sonogram of elbow reveals proliferative synovitis (pannus). High signal color Doppler imaging indicates hyperemia.
Fig. 9: A 57 year-old woman with rheumatoid arthritis and soft-tissue mass in elbow. MR images shows the rheumatoid pannus responsible for ulnar bone erosion.
Fig. 10: A 62 year-old woman with rheumatoid arthritis and soft-tissue mass in right shoulder.
**Fig. 11:** A 62 year-old woman with rheumatoid arthritis and soft-tissue mass in right shoulder. US images shows subacromial bursa of the right shoulder distended and filled of echogenic material. (bursitis)
Fig. 12: Morel-Lavallée lesion after motor vehicle crash. Sonogram reveals large anechoic mass between subcutaneous fat and aponeurotic planes.
Fig. 13: US images shows post-traumatic haematoma in the myotendinous junction.
Fig. 14: US images shows post-traumatic haematoma within the muscle.
Fig. 15: Different ultrasound appearance of epidermal cyst. Sonogram shows well-defined, cystic with a solid pole and internal echoes.
**Fig. 19:** Different ultrasound appearance of epidermal cyst. US shows homogeneous mass with no flow.
Fig. 17: Different ultrasound appearance of epidermal cyst. Color-Doppler US, shows an ovoid mass, solid appearance. No flow.
Fig. 18: Different ultrasound appearance of epidermal cyst. Lobulated shape and hypoechogenic mass.
**Fig. 16:** Different ultrasound appearance of epidermal cyst. Well-defined cystic lesion with multiple internal echoes.
Fig. 20: Different ultrasound appearance of epidermal cyst. Well-defined mass localized between epidermis and dermis.

Fig. 21: Foreign bodies granulomas: A, Echogenic splinter with a surrounding hypoechogenic tissue.
Fig. 22: A 35 year-old woman with abdominal wall endometriosis with cesarean section scar. Transverse sonogram shows hypoechoic solid mass confined to right rectus abdominis sheath.
Fig. 23: Nodular -cystic fat necrosis. We report a case of benign subcutaneous cystic lesions in a 32 year-old woman.

Fig. 24: Lipoma. An ovoid isoechoic lesion with a striped feathered internal structure. There is no flow on color Doppler.
Fig. 25: Partial ossifying lipoma. Scapular left mass. Ultrasonogram shows an ovoid mass localized within the subcutaneous fat tissue, isoechogetic. There is central calcification with posterior shadowing.
**Fig. 26**: Partial ossifying lipoma. Scapular left mass. Coronal CT reveals a mass of homogeneous adipose tissue, capsulated with a central calcification-ossification central pattern.
Fig. 27: Post-traumatic myositis ossificans. Ultrasonogram shows calcification with posterior shadowing within subcutaneous fat tissue.
Fig. 28: Post-traumatic myositis ossificans. Coronal CT study demonstrates a soft-tissue haematoma with typical peripheral ossification.
Fig. 29: Plantar fibromatosis in a 40 year-old man. Ultrasonogram shows a solid, heterogeneous mass in the plantar aponeurosis.

Fig. 30: Plantar fibromatosis in a 40 year-old man. Ultrasonogram, in the same patient, shows another one fusiform shape mass in the plantar aponeurosis.
Fig. 31: Plantar fibromatosis in a 40 year-old man. Sagittal MRI image shows a mass in plantar aponeurosis with signal intensity similar to adjacent muscle.

Fig. 32: Palmar fibromatosis in a 60 year-old man. US images shows hypoechoic mass adjacent to the 5th flexor tendon, which resulted in flexion contracture.
Fig. 33: A 33 year-old woman with abdominal wall mass with cesarean section scar. Transverse sonogram shows hypoechoic solid mass, poorly-defined, confined to subcutaneous abdominal fat. Rectus abdominis muscle is not involved. (Desmoid tumor).
**Fig. 34:** Elastofibroma dorsi. Right subscapular mass in a 60 year-old man. US shows a multilayered pattern of hypoechoic linear areas (fat) intermixed with echogenic fibroelastic tissue.
Fig. 35: Elastofibroma dorsi. Right subscapular mass in a 60 year-old man. CT shows a well-defined soft-tissue mass in the subscapular region with attenuation similar to that of the adjacent muscle. There is no contrast enhancement, no bone destruction and no calcification.

Fig. 36: Giant cell tumor of the tendon sheath in the first finger (37 year-old man). Sonography shows an ovoid, hypoechoic lesion in close contact with the 1º flexor tendon.
Fig. 37: Giant cell tumor of the tendon sheath in the first finger (37 year-old man). Sagittal T2-weighted and T1-weighted MR images show well-defined mass. (GCTT)
Fig. 38: Soft-tissue mass over proximal fourth finger. Sonogram shows solid, homogeneous, hypoechoic mass (GCTT).
**Fig. 39:** Soft-tissue mass over proximal fourth finger. Sonogram shows solid, homogeneous, hypoechoic mass. Spectral Doppler Ultrasound detects variable internal flow signals. (GCTT)

**Fig. 40:** Localized intraarticular PVNS. 33-year-old man. with history of prior resection of PVNS who presented with recurrent mass in ankle. Color Doppler ultrasound and sonogram gray-scale reveals the hypoechoic intraarticular soft-tissue mass (hypertrophic synovial) in the ankle.
**Fig. 41:** Localized intraarticular PVNS. 33-year-old man. with history of prior resection of PVNS who presented with recurrent mass in ankle. Sagittal T1-weighted shows a 1 cm node with intermediate signal intensity, consider adjacent muscle. There are some low signal intensity foci, caused by hemosiderin and recurrence (arrow).
Fig. 42: Glomus tumor in a 55-year-old man with a painful thumb in the knee. Color Doppler US image reveals a focal, solid, hypoechoic mass beneath with vascularity within the tumor.
**Fig. 43:** 15 year-old woman with mass on right wrist. Sonogram shows solid vascularized mass with high flow. Hemangioma.

**Fig. 44:** 14-year-old: Gray-scale sonography and Doppler sonography shows inhomogeneous lesion consisting of larges sinuses seen as tubular anechoic structure with flow inside. Phlebolith (arrow).
**Fig. 45:** Chest wall schwannoma in a 35 year-old man that originated from intercostal nerve. Sonogram shows a hypoechoic structure with oval shape in dorsal chest wall.
Fig. 46: Chest wall schwannoma in a 35 year-old man that originated from intercostal nerve. Axial MR images. Large neurogenic posterior dorsal tumor. Degenerative cystic changes and internal hemorrhage is also seen.
Fig. 47: Morton neuroma in 41 year-old woman with pain at the metatarsal head. Ultrasonogram shows a hypoechoic mass localized between the second and third rays.
Fig. 48: Subcutaneous metastases from lung cancer. Well-circumscribed solid, spherical mass with peripheral vascularity.
Fig. 49: Soft-tissue mass in left soulder. Metastase from renal cell carcinoma in a 42 year-old man. Conventional radiography shows scapular osteolytic lesion.
Fig. 50: Soft-tissue mass in left shoulder. Metastasis from renal cell carcinoma in a 42 year-old man. On color Doppler sonogram, soft-tissue mass has marked vascular flows.
**Fig. 51:** Soft-tissue mass in left shoulder. Metastasis from renal cell carcinoma in a 42 year-old man. Axial CT, Soft-tissue mass and osteolytic changes in scapular bone. Metastasis from renal cell carcinoma.
Conclusion

Sonography is a useful imaging tool in the evaluation of superficial soft-tissue masses. On the basis of clinical presentation and the sonographic findings, selection of additional imaging modalities including CT and MR imaging can be applied.

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