BENIGN LESIONS OF THE SUBCUTANEOUS SOFT TISSUE WITH CALCIFICATIONS. WHICH IS THE ROLE OF ULTRASOUNDS IN DIAGNOSIS?

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Purpose

The calcium is an obstacle for the US examination, due to the difference acoustic impedance with the rest of the tissues which provoke a very reflexive interface that produces an almost complete reflexion of the energy of the beam of ultrasound and therefore an hyperrefringent line with acoustic shadow; although it is unable to assess an adequate evaluation of the central structure it allows the diagnosis of a calcification easily. Moreover, most of these lesions appear as palpable lumps and they frequently are evaluated with US as the first diagnostic tool. Therefore, we should be familiar with their appearance and the most frequent etiologies to guide additional diagnostic evaluation with other image modalities.

We will illustrate the most frequent entities which may appear as subcutaneous nodules with calcification with US, their diagnosis and the radiological correlation.
Methods and Materials

Dermal and subcutaneous soft tissue calcifications may be produced in a wide range of clinical entities. Calcinosis is due to a deposit of calcified hydroxyapatite or classic amorphous phosphate in soft tissue. Calcifications can be divided in four basic types considering the etiopathogenic mechanism.

1- Dystrophic calcifications:

This is the most frequent type of calcification which is characterized by phosphocalcic deposits in previously injured subcutaneous tissue by diverse mechanisms: traumatic, burns, venous insufficiency, radiotherapy, infections, tumors, insect bites and injections. Calcifications in these cases are usually localized being known as circumscribed calcinosis. These calcifications are also produced in some connective tissue diseases, especially in scleroderma and dermatomyositis, but also in SLE and others. This type of calcification is found in different soft tissue tumors, particularly frequent in the pilomatricoma, lipoma and advanced neuroma between others.

2- Metastatic calcifications:

These calcifications occur within the healthy soft tissue in patients with an altered phosphocalcic metabolism. The subcutaneous tissue involvement is not frequent and when it occurs is characterized by hard subcutaneous nodules and plaques, which occasionally are ulcerated with calcaric material extrusion. They are seen more frequently in chronic renal disease, primary and secondary hyperparathyroidism, sarcoidosis, hypervitaminosis and alkali-milk syndrome.

3- Iatrogenic calcifications:

They usually appear in those locations where an invasive procedure has been performed and are related with previous administration of intramuscular drugs, calcium gluconate or solutions with phosphates especially in previous extravasation. They can also appear in post-surgery scars, being particularly frequent in mid laparotomy.

4- Idiopathic calcifications:
These calcifications appear in absence of any cause or metabolic abnormality and their physiopathologic mechanism is unknown. The most representative entity of this group is tumoral calcinosis, nowadays it is referred as a hereditary condition with well defined massive periarticular calcifications, lobulated and non painful which are usually localized in the extensor surfaces of the joints and in the anatomic distribution of the bursae.
Results

1- ISOLATED SUBCUTANEOUS CALCIFICATIONS:

95% of the subcutaneous soft tissue calcifications are dystrophic calcifications. Post - injection gluteal calcifications, post-traumatic and fat necrosis are the most frequent types.

Post-injection calcifications have a typical radiologic appearance. They are well rounded peripheral lineal calcifications with lower density centrally, located in the gluteal region superolaterally (Fig. 1). Ultrasound shows a convex hyperechogenic line with posterior acoustic shadow, which avoid evaluating both the central zone and normal adjacent soft tissue.

Post-traumatic calcifications may appear as small palpable nodules, with a hard consistency, with convex linear appearance in the ultrasound examination, homogeneous, with posterior acoustic shadow with a normal echotexture of the adjacent tissue (Fig.2).

Fat necrosis has different sonographic appearances. They can appear as hyperechogenic, ill-defined areas with an increase in consistency with ultrasound transducer pressure that may have lower echogenicity areas inside. They may also appear as lobulated tumors, similar to fat lobules but with a lower echogenicity, which are surrounded by a variable amount of fluid isolating them from the rest of tissue where they can freely move. Another appearance of fat necrosis is that of relatively hyperechogenic masses with a well defined hypoechoic capsule, with a tendency to calcify (Figs. 3-4).

In connective soft tissue diseases, mostly in scleroderma and CREST syndrome, dermis or subcutaneous soft tissue circumscribed calcifications of the fingers, are frequent. The ultrasound examination can easily identify calcifications and may be used in the surgical map when it is required (Fig. 5).

Sonographically calcifications are visualized as hyperechogenic images with smooth border and lobulated contours and posterior acoustic shadow with the largest diameter horizontally orientated related to the skin and a normal lobular structure of the adjacent subcutaneous soft tissue. Ultrasound cannot distinguish between the etiopathogenic mechanisms, however detects easily size,
morphology and location in depth of the lesion and can diagnose a circumscribed calcification in the skin (Fig. 5).

2.-CALCIFICATIONS WITHIN BENIGN SUBCUTANEOUS TUMORS:

Ultrasound can distinguish easily isolated calcifications and dystrophic calcifications, chondroid or osseous within soft tissue tumors. The most frequent tumors that can calcify are the following ones:

2.1. Pilomatricoma:

It is a benign tumor of dermal origin, from the primitive cells of the cellular matrix of the hair. It represents less than 1% of the subcutaneous tumors. However, it is the most frequent solid subcutaneous tumor in people younger than 20 years. There is a second peak of incidence in 50-65 year-old adults. Generally are small tumors, less than 3 cm, with a slow growth and confined to the subcutaneous tissue. The most frequent location is the face, neck and arms. One of the fundamental characteristic is the presence of a calcification or ossification which is usually centrally located, and can be appreciated in 85% of the cases.

Sonographically they appear as hyperechogenic masses in relation with the muscle, with central calcification or ossification posterior acoustic shadow, rounded, with well-defined margins. The quantity of calcium may vary between isolated hyperechogenic foci to gross deposits of calcium or even complete calcification of the tumor. In most of the cases there is a hypoechoic halo surrounding the tumor. Doppler color or Power Doppler US examinations show a predominant peripheral high vascularization of the tumor (Fig. 6-8).

2.2. Hemangioma:

The term hemangioma includes a varied group of neoplasm of vascular origin, which are characterized by an increment of the number of normal and abnormal vessels. Both hemangiomas, which are real tumors that appear in the childhood that usually revert, and arteriovenous malformations, which show a dysplastic growth of blood vessels without associated cellular proliferation, are included. If considering the hemodynamic behavior, arteriovenous malformations can be divided in those with high and low grade flow. The most frequent tumors of the subcutaneous soft tissue are capillary and cavernous hemangiomas. In ultrasound they appear as subcutaneous soft tissue mass rounded, well-defined, with varied echogenicity, homogeneously hypoechoic or highly heterogeneous. Hemangiomas may be circumscribed with well-defined margins or diffused with interdigitation in the surrounding soft tissue, which difficults its delimitation.
Characteristically, they show a wide vascular signal with high spectral peaks, which helps in the differential diagnosis with other subcutaneous masses. They may have serpiginous structures which are anechoic inside that depending on its flow may fill with Power Doppler signal or respond to compression maneuvers. Low flow arteriovenous malformations are characterized by venous varicosities with a normal arterial component. The spectral examination may demonstrate a slow monophasic or absent flow. It is frequent the presence of phleboliths, as small hyperechogenic and convex linear images with posterior acoustic shadow. (Fig. 9).

2.3. Lipoma:

Lipoma is the most frequent soft tissue tumor. It represents 50% of all soft tissue tumors, with a prevalence of 2.1 per 100 habitants. They usually appear in the 5th-7th decades of life with no male or female predilection. It is not clear if represents a real benign tumor or a focal hyperplasia of adipocytes. They may be superficially located in the subcutaneous soft tissue or deeply, being subcutaneous lipomas extraordinary frequent. They may appear in any location but predominantly in the back, neck, proximal extremities and abdomen. They use to be solitary tumors, but may be multiple in 5-15%, more frequently occurring in males with a family history in 30% of the cases.

The ultrasound presentation is variable and generally diagnostic, with two types of common appearances:

a) Small sized lipomas are usually located in the more superficial subcutaneous soft tissue. They are rounded, homogeneously hyperechogenic, well-defined with no visible capsule and generally avascular. This type of presentation is common in the case of multiple lipomas which are mostly located in the trunk and extensor surfaces of the arms. These lipomas may be spontaneously painful or under transducer pression. In these cases, areas lower echogenicity within the tumor are frequently visualized.

b) The other type of superficial lipomas appears as oval masses, with their largest diameter parallel to the skin, well defined margins and in a hyperechogenic capsule. The global echotexture may be hyperechogenic, isoechoic or hypoechoic related to the surrounding subcutaneous soft tissue, but the most frequent appearance is hyperechogenic. These tumors present linear hyperrefringent septae inside, which are orientated to the largest axis of the tumor. They usually are easy compressed with ultrasound transducer pressure.

Typical lipomas may have necrosis, which produces an heterogeneous image: hypoechoic or hyperechoic areas with posterior acoustic shadow due to dystrophic calcification. However, this is more frequent in deep, large size and
longstanding lipomas. Moreover, considering the different variants of lipoma, calcification is frequently present in chondroid lipomas and phleboliths in angiolipomas (Fig.10).

2.4 Extraskeletal chondroma:

This is a benign cartiliginous tumor, most common in hands and feet (80% in fingers). They usually occur in 30-60 year-old adults. It appears as a subcutaneous nodule with a slow growth and rarely with spontaneous pain.

Plain films usually show irregular, ring or curvilinear calcifications.

On US a soft-tissue tumor with irregular hyperrefringent foci. (Fig.11)

2.5. Other tumors

Dystrophic calcifications may be seen in other soft tissue tumors, mostly longstanding schwannomas and angioleiomyomas.

3.- PSEUDOTUMORAL CALCIFICATIONS:

3.1. Panniculitis ossificans:

Myositis ossificans is a mass formed by heterotopic bone and cartilage, which is typically located in the muscle. The circumscribed type of myositis ossificans is usually secondary to traumatic events, burns or abnormalities of the central nervous system. Plain films show peripheral calcifications with a centripetal pattern of growth, which appear 4-6 weeks after injury. Panniculitis ossificans is a variant that appears in the subcutaneous soft tissue. They are also known as osseous pseudomalignant soft tissue tumors. They occur frequently in adolescents and young adults, and 80% of the cases are located in lower extremities. Ultrasound examination findings may vary depending on the moment of this process, detect peripheral calcification before is shown in plain films and associated inflammatory changes of surrounding tissues (Fig.12).

3.2. Tophi:

Tophi are soft tissue conglomerates of urate crystals, which are preferentially localized in the hands, feet and elbows. Ultrasonographically are depicted as heterogeneous masses with central hypo echoic areas which are surrounded by echogenic tissue. They usually appear as oval masses, which may be in occasions lobulated and avascular. If a deposit of calcium is associated, more echogenic foci
within the mass with or without posterior acoustic shadow or completely calcified masses are visualized being only the surface and the posterior acoustic shadow visible. (Fig.13).

3.3: Inclusion cysts:

This is a cystic lesion which is covered by infundibular or epidermal cells that keratinize. Its origin is usually the traumatic implementation of epidermal cells in the subjacent tissue. It has an heterogeneous content which is formed by keratin and cholesterol granules, but also by epithelial rests and calcium. Generally speaking is named as sebaceous cyst, although this is an inappropriate term, being also named as epidermoid cyst.

Ultrasonographically it appears as a rounded or oval lesion, which is subcutaneously located, immediately beneath the dermis, sometimes with signs of umbilication with the dermis or associated with a hair follicle. The margins are usually sharp and the capsule of the cyst may be identified. The content is heterogeneous and its echotexture is mixed, usually hypoechochogenic, with hyperechogenic foci within the cyst or a clearly heterogeneous echotexture, specially in largest cyst. They usually have posterior acoustic enhancement.

The Power Doppler examination do not show vascularization within the cyst, but artifacts are common due to the heterogeneity of the content with structures of very variable density and the presence of calcium. (Fig. 14). Deposits of peripheral calcium or within the capsule may be shown as hyperechogenic layers.

3.4. Joint and bursal calcifications:

Synovial chondromatosis usually appears in large joints: knees, elbows, hips and shoulders. They are due to the presence of a chondroid metaplasia of the synovial joint with multiple cartilaginous and osteochondroid nodules formation that become loose bodies in the latter stage of the disease with similar size and calcification or ossification in most of them. When this entity occurs in superficial joints clinically may appear with pain and mass. (Fig.15). Chronic bursitis may also present dystrophic calcifications, mostly those which are more susceptible to repetitive microtraumatisms, such as pre-patellar or olecranon bursitis (Fig.16).

3.5. Foreign bodies:

Ultrasound detects both radiopaque and radiolucent foreign bodies, with 90% sensibility and 100% specificity. Foreign bodies are hyperechogenic independently of its composition and may have posterior acoustic shadow, comet artifact or both depending on its composition. In general metallic or glass foreign
bodies present a posterior comet tail artifact and vegetable foreign bodies a posterior acoustic shadow. They may present a surrounding hypoechoic halo which helps to its identification, due to the inflammatory reaction of adjacent tissues, and Power Doppler shows surrounding hyperemia allowing thus to distinguish between phlegmonous tissue and fluid. The differential diagnosis with calcification is usually easy, due to the linear morphology, surrounding inflammatory reaction, clinical history and the presence of posterior artifact. However, in some occasions the small size and absence of inflammatory reaction or a previous traumatic event may difficult the diagnosis. Moreover, in some cases the patient may consult because of a palpable lump, without a clear traumatic event, secondary to the foreign body granuloma formation. The ultrasonographic appearance is a non specific rounded hypoechoic mass with increased vascularization. (Fig. 17 and 18).
Fig. 1. Hip radiography: rounded peripheral lineal calcifications with lower density centrally (red arrows), Same patient B Mode US (white arrows)
Fig. 2. A 20 years male consulted for a non painful lump in the pre-tibial region following a traumatic event 1 year ago. Plain film and US examination show a small calcified mass (arrows).
Fig. 3

Post-traumatic subcutaneous calcification. US examination demonstrates a dense calcification with posterior acoustic shadowing (arrows) and normal surrounding tissues, which was also radiographically visualized.
Fig. 4. Post-traumatic necrosis: US images showing an adipose mass in the anterior aspect of the thigh with faint capsular calcification (arrows).
Fig. 5. Calcinosis cutis in a patient with clinical history of dermatomyositis. Plain film demonstrates soft tissue linear calcifications (arrows). Ultrasound shows their dermal location (calipers and arrows).
Fig. 9 Hemangioma: homogeneous oval shaped soft tissue mass (calipers), with rounded calcifications (arrows).
Fig. 8. Pilomatrixoma: Radiograph showing a small hyperdense mass in the upper thigh with no clear calcification (arrow). US examination demonstrates a calcified mass with posterior acoustic shadowing (calipers), and low peripheral vascularity with Doppler color.
Fig. 7. Pilomatrixoma. A small soft tissue tumor with no evidence of calcium is shown in plain film. US demonstrates a subcutaneous mass of mixed echotexture (arrows) and high peripheral vascularity with Doppler color imaging.
Fig. 6. Pilomatricoma. Plain film showing a small subcutaneous mass with gross calcification. Axial sonogram demonstrates a well-defined mass with peripheral hypoechoic halo (yellow arrowheads), an eccentric dense calcification (white arrow) and dispersed hyperechogenic foci (red arrow).
Fig. 10. Lipomas. a) Typical lipoma with dystrophic calcification (red arrows).
b) Angiomyolipoma: soft tissue mass with heterogeneous echotexture and tiny calcification (arrow).
Fig. 11 Soft tissue enchondroma in the finger. US shows a well-defined subcutaneous mass (calipers) with lumpy calcifications within the tumor (red arrow).
Fig. 12 Paniculitis ossificans in an adolescent with a history of 6 weeks painful lump in the popliteal fossa. Peripheral calcification and abnormal echotexture in the surrounding soft tissue (inflammatory changes, arrows).
Fig. 13

Calcified tophus in the fleshy part of the second finger tip. US shows a mass with wide posterior acoustic shadow (calipers). CT and plain film of the same patient (arrows).
Fig. 14. Inclusion cyst. US images show a rounded soft tissue mass in dermis-hypodermis location with peripheral calcification (arrows).
Fig. 15. Secondary synovial chondromatosis in a patient with rizarthrosis. Plain film shows a faint calcification (white arrow). US demonstrates a calcified loose body (red arrow) and synovial hyperemia with Doppler color (red arrowheads).
Fig. 16. Carpet layer male with chronic symptoms, recurrent inflammatory episodes and a lump in the pre-patellar soft tissue. Plain film with US images correlation showing a heterogenously calcified mass in the prepatellar bursa (calipers and arrows).
Fig. 17. Foreign bodies: A. US images showing a soft tissue vegetable spine foreign body (calipers), with marked inflammatory reaction in the surrounding soft tissue at Doppler color. B. Porcelain material in finger soft tissue (calipers) with no inflammatory reaction on US images.
**Fig. 18.** Foreign body granuloma. US images with plain film correlation. Subcutaneous oval shaped soft tissue mass in plain film (white arrow). Hypoechoic mass with small calcifications within the mass (red arrows) on US image, and mild vascularity with Power Doppler image.
Conclusion

Ultrasound is usually the first diagnostic imaging method to evaluate a palpable soft tissue mass. Calcifications within the mass can render the examination difficult. However, knowledge of ultrasound pattern can suggest a probable diagnosis, reduce the differential diagnosis, help to select additional tests and to avoid unnecessary or invasive procedures.
References
