# 17 Main Concepts on Ultrasonography of Dermatologic Inflammatory Conditions

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## Introduction

Multiple dermatologic inflammatory conditions can benefit from ultrasound support [1–20]. The main objectives of ultrasound are to help the diagnosis and management of diseases. Ultrasound can support the assessment of the degree of severity and activity of these conditions [1, 7, 19–23].

Keys for the ultrasound help are the detection of echogenicity abnormalities and hypervascularity in the cutaneous layers. This would be difficult to assess using other imaging modalities with lower penetration and/or axial spatial resolution.

## Considerations on the Ultrasound Examination Protocol of Inflammatory Conditions

There are different ultrasound examination protocols according to the type of inflammatory condition because it is not the same examining a localized serohematoma as a morphea, psoriasis, or hidradenitis suppurativa.

Of course, the protocol for localized lesions such as post-traumatic serohematoma includes the study of one corporal region. Thus, extended examinations are required in other conditions that commonly present subclinical involvement.

In morphea, the protocol should include the whole clinically affected corporal region, not just the visible cutaneous lesions, as well as the adjacent corporal segments to detect subclinical involvement. For example, the additional study of the scalp in the same axis is relevant in the coup de sabre morphea that affects the frontal region of the face. Suppose we are dealing with a Parry-Romberg morphea that clinically affects one side of the face. In that case, the study should include both sides of the face, the submandibular

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skin, the scalp following the axis of the most affected side, and the salivary glands.

In nail psoriasis, the study should include all the fingernails and/or toenails of both sides. It is not recommended to make a diagnosis of nail psoriasis only by studying one nail. When suspecting psoriatic arthropathy, the study should include the bilateral study of the nails, tendons, joints, and bony margins of the hands and feet. The ultrasound diagnosis of psoriatic arthropathy requires the study of the nails; otherwise, it would be difficult to assess the causality of the arthropathy.

In acne, the recommended protocol includes the whole face and the submandibular regions.

In rosacea, the study should at least include both cheeks and the nose. The study of only the tip of the nose is not recommended.

In hidradenitis suppurativa, the protocol should be bilateral and include all the affected regions. The axillary study includes both axilla and the proximal part of the inner aspect of the arms. The groin study includes both inguinal regions, the pubic region, both sides of the perineo-vulvar region, and the inner aspect of the proximal part of the thighs. In patients with intergluteal involvement, the protocol should also include both gluteal regions. When dealing with intermammary involvement, the protocol includes both inframammary regions. In the study of facial hidradenitis, the study should include the face and both submandibular regions. In the retroauricular form of presentation, the protocol needs a bilateral examination and also includes the infra-auricular regions. In the scalp involvement, the study should include the frontoparietal and occipital regions. In the presence of involvement of the posterior neck, the protocol should also include the occipital region.

## Cutaneous Inflammatory Conditions

### Edema and Lymphedema

Edema is the increase of water in the cutaneous layers, which can be due to inflammation, trauma, and failure of the venous and lymphatic systems to remove this excess [17, 24].

Lymphedema is the increase of lymph in the cutaneous layers due to the failure of the lymphatic system [17, 24, 25].

On ultrasound, the edema generates a diffusely decreased echogenicity of the dermis and increased echogenicity of the hypodermis. Anechoic laminar bands of fluid in between the fatty lobules of the hypodermis are not uncommon in severe stages (Fig. 17.1) [17, 24].

In lymphedema, typically, there is diffuse epidermal, dermal, and hypodermal thickening, sometimes with a bilaminar hyperechoic appearance of the epidermis, decreased echogenicity of the dermis, and increased echogenicity of the hypodermis [17, 24]. Using 70 MHz, dilated lymphatic channels can be identified (Fig. 17.2) [26].

Occasionally, lymphedema shows as a blurry increase of the echogenicity of the hypodermis [17, 24].

Fully or partially compressible anechoic fluid in between the fatty tissue of the hypodermis can be found, and some of them may contain floating echoes [17, 24].

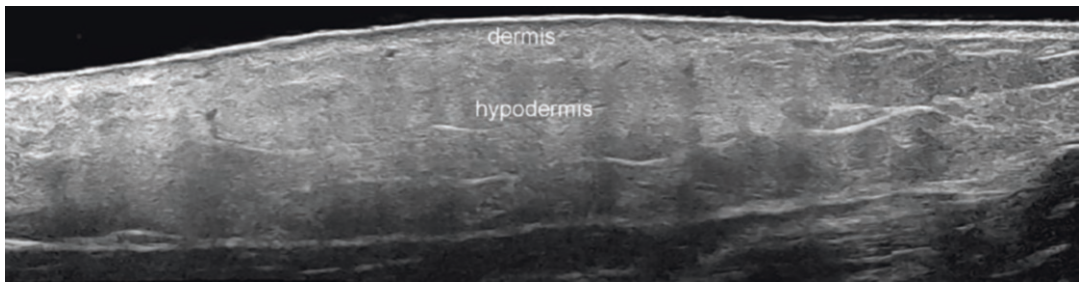


**Fig. 17.1** Edema. Notice the prominent increase of the echogenicity of the hypodermis, besides the slight decreased echogenicity of the upper dermis and epidermal thickening

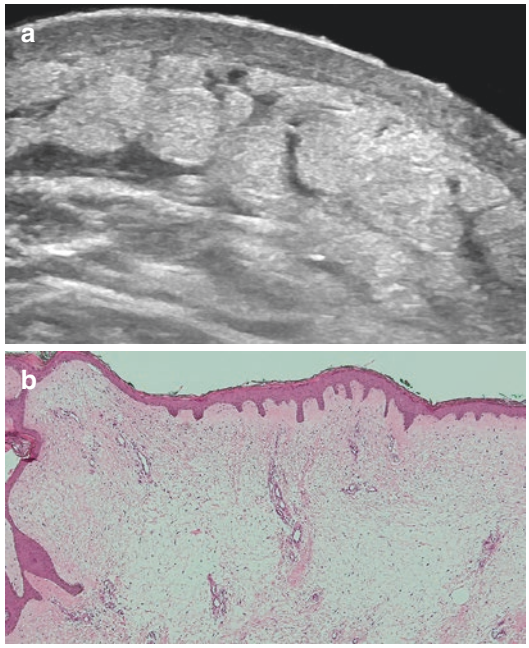


**Fig. 17.2** Lymphedema. (**a**) Grayscale ultrasound. Diffuse thickening of the epidermis, dermis, and hypodermis with decreased dermal echogenicity and increase of the echogenicity of the hypodermis. There is also hypoechoic thickening of the hypodermal septa usually partially compressible. (**b**) Histology (H&E 50x): dermis with marked edema and some dilated vessels

## Seromas, Hematomas, and Serohematomas

Seromas, also called lymphoceles, are localized collections of lymph, and on ultrasound, they appear as anechoic laminar bands or pockets that are usually compressible by the probe. The resolution of seromas is slow and may take months or years [17, 24].

Hematomas are collections of blood in the tissues, and they show as pockets with an oval shape and irregular borders [8]. The echogenicity of hematomas changes according to the phase. In the initial stage, hematomas are anechoic. During the regression period, they show a mixed anechoic-hypoechoic appearance and then turn to hypoechoic due to fibrinous material and scarring [17, 24].

Serohematomas are a mix of seromas and hematomas and are common after trauma.

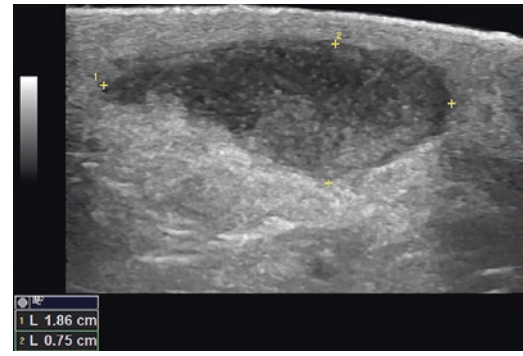


**Fig. 17.3** Serohematoma. Hypoechoic dermal and hypodermal fluid collection (between markers) with echoes. Notice the posterior acoustic reinforcement at the bottom of the collection

These fluid collections present posterior acoustic reinforcement due to their fluid-filled structure.

On color Doppler, these collections are hypovascular, and there are no signs of vascularity in their inner part. A few slow-flow vessels may be found in their periphery (Fig. 17.3) [17, 24].

## Abscesses and Fistulous Tracts

Abscesses are pockets of fluid that become infected. They could appear as multiple small pockets or as a single collection. On ultrasound, they show as anechoic or hypoechoic pockets of fluid that commonly present floating echoes and sometimes septa.

On color Doppler, they usually show hypervascularity in their periphery with slow-flow arterial and venous vessels (Fig. 17.4) [1, 10, 17, 24, 27, 28].

Fistulous tracts are tunnels that communicate the layers of the skin or deeper tissues. On ultrasound, they show as anechoic or hypoechoic bands. In the periphery of old fistulas, it is possible to detect a laminar hypoechoic pattern due to fibrosis and inflammation.

On color Doppler, fistulas are hypovascular and can present slow-flow vessels in their periphery (Fig. 17.5) [17, 24].

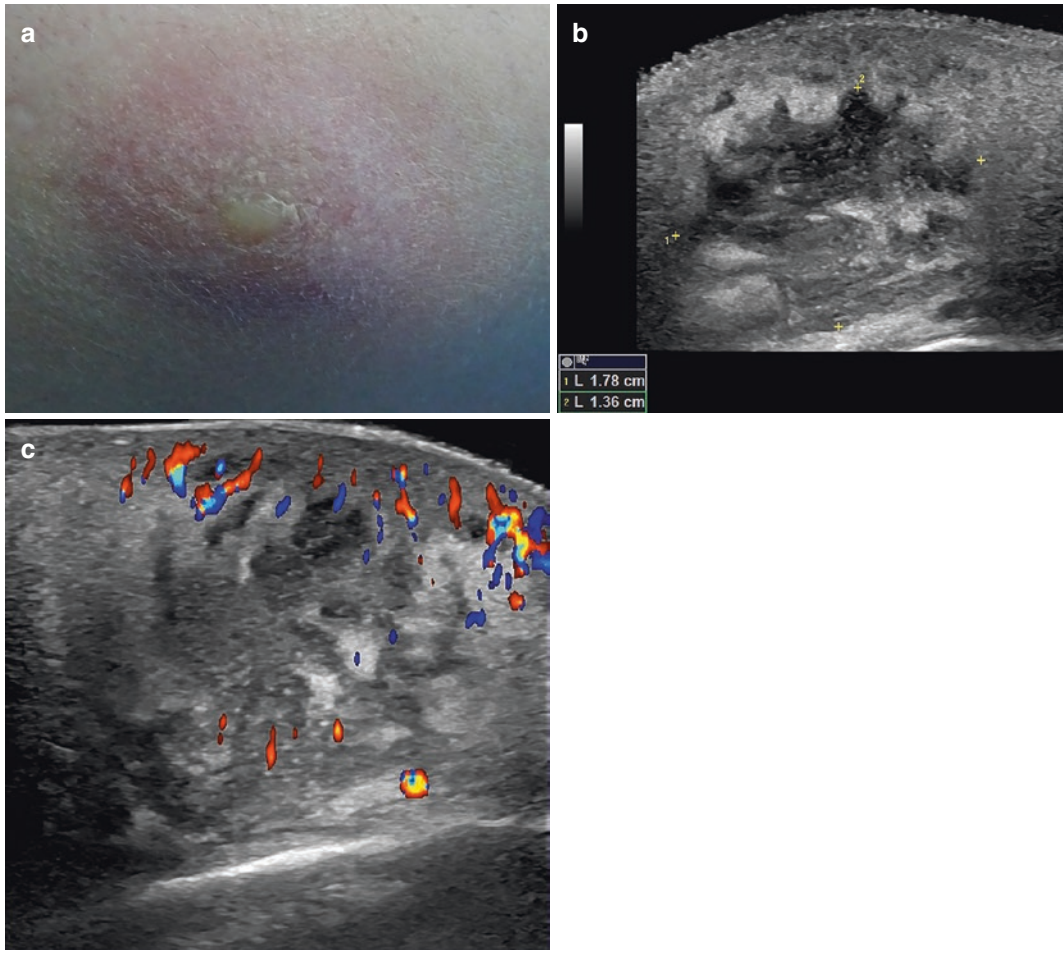


**Fig. 17.4** Abscess. (**a**) Clinical photograph of the right mandible region. (**b**) Ultrasound image (grayscale; transverse view). A 1.78 cm transverse × 1.36 cm depth hypoechoic hypodermal fluid collection (between markers) with prominent echoes. Notice the decreased dermal echogenicity and hyperechogenicity of the surrounding hypodermis. (**c**) Color Doppler ultrasound image demonstrates hypervascularity in the periphery of the collection

### Odontogenic Fistula

This is a periodontal abscess that composes a fistula that drains into the cutaneous layers. Clinically, it can be a simulator of cutaneous diseases.

On ultrasound, a hypoechoic or anechoic band-like structure connects the bony margin of the maxilla or mandible with the skin. In the bony margin, there is usually an erosion. Increased echogenicity of the hypodermis and decreased echogenicity of the dermis are found in the periphery of the fistula.

On color Doppler, there is a variable degree of hypervascularity in the periphery of the fistula and sometimes vascularity within the tract due to the inflammation and granulation tissue (Fig. 17.6) [17, 24, 29, 30].

### Panniculitis

This is the inflammation of the hypodermis or subcutaneous tissue. The causes are multiple, but the main patterns are predominantly lobular, predominantly septal, or mixed [16, 17, 24, 31–34]. Frequently, the panniculitis presents a mixed pattern. On ultrasound, lobular panniculitis shows a diffuse increase of the hypodermal echogenicity

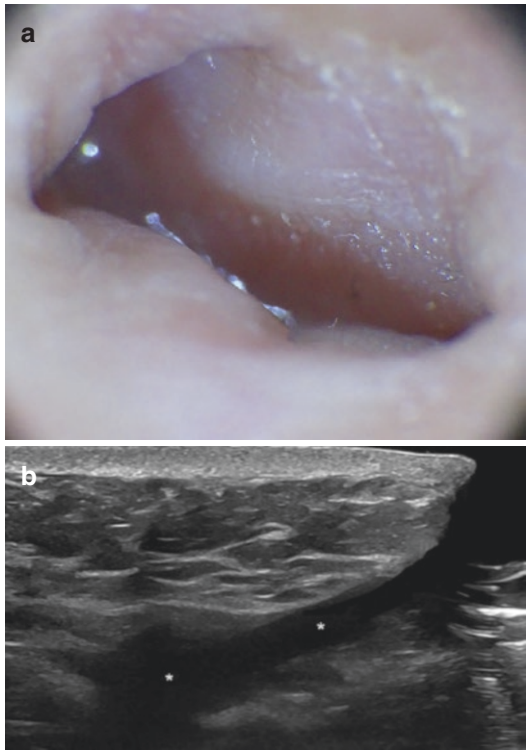


**Fig. 17.5** Fistulous tract. (**a**) Dermoscopic view shows fluid in the umbilical region. (**b**) Ultrasound (longitudinal) shows anechoic dermal and hypodermal tract (*) that corresponds to the fistula

(Fig. 17.7). In septal panniculitis, there is a hypoechoic thickening of the hypodermal septa besides the hyperechogenicity of the hypodermis (Fig. 17.8). In the mixed forms of presentation, there are areas with lobular and septal types.

Ultrasound has been reported to discriminate these forms of presentation, which can orient to the cause [6, 16, 17, 24, 31–35].

## Morphea

The cutaneous form of scleroderma is an autoimmune connective tissue disease that shows inflammatory and atrophic phases. The production of collagen is dysregulated, and there is prominent fibrosis, particularly in the end stages [36, 37].

On ultrasound, the appearance varies according to the phase, and there are criteria for assessing the activity of the disease. In the inflammatory phase, there is decreased echogenicity of the dermis, loss of definition of the dermal-hypodermal border, and increased echogenicity of the hypodermis, and on color Doppler, there is dermal

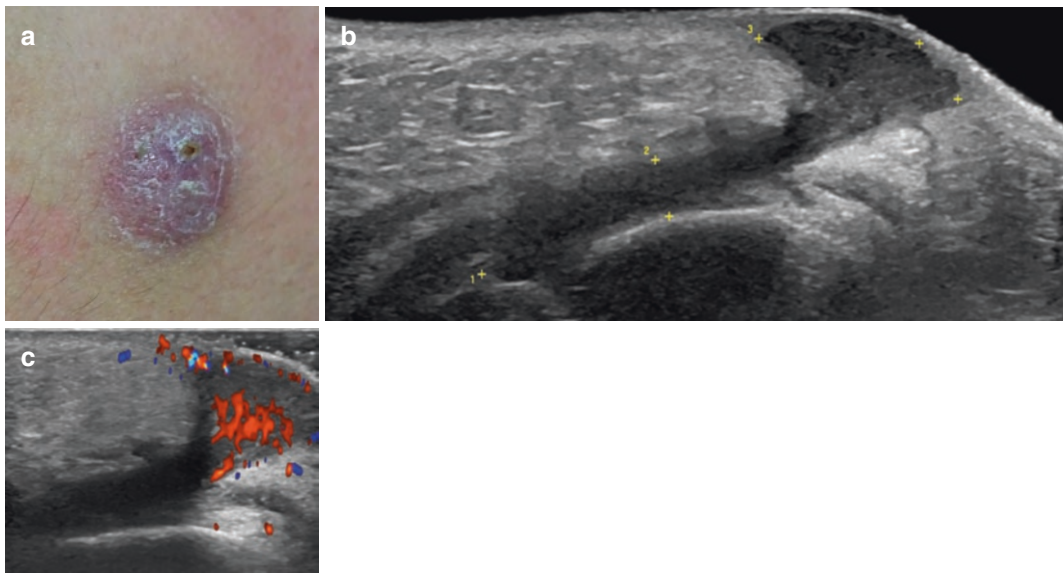


**Fig. 17.6** Odontogenic fistula. (**a**) Clinical image of the lesion in the left mandibular region. Ultrasound images (**b**, grayscale and **c**, color Doppler) present hypoechoic dermal and hypodermal tract (between markers in **b**) that connects the subepidermal region with the bony margin. There is hypervascularity in the periphery and within the tract

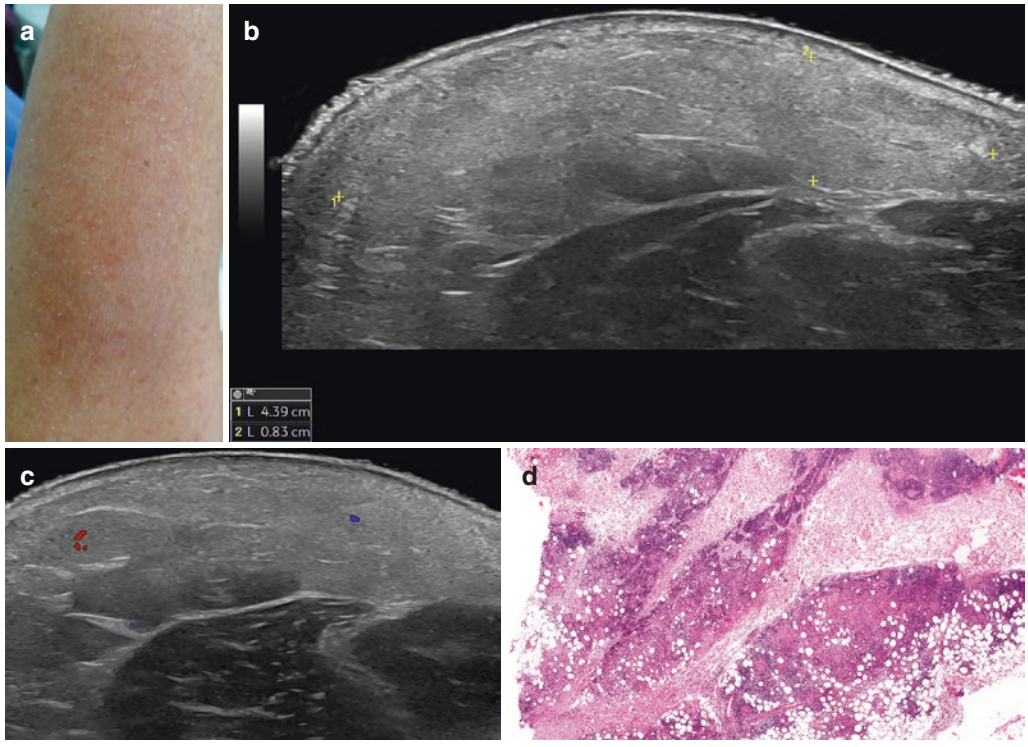


**Fig. 17.7** Predominantly lobular panniculitis. (**a**) Clinical photograph of the left arm. Ultrasound (**b**, grayscale and **c**, color Doppler; transverse views) shows diffuse hyperechogenicity of the hypodermis (between markers in **b**). Secondary mild epidermal thickening and epidermal thickening. On color Doppler, few vessels are detected in the area (in colors). (**d**) Histology. (H&E 25x): low-power view shows a mostly lobular inflammatory infiltrate with some areas of fat necrosis

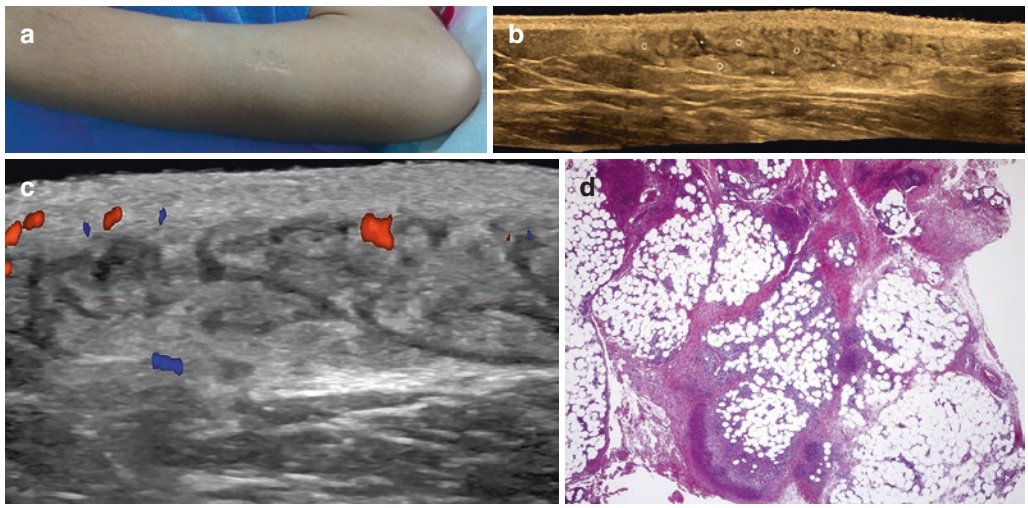


**Fig. 17.8** Predominantly septal panniculitis. (**a**) Clinical image shows erythema in lower part of the left arm. Ultrasound images (**b**, grayscale and **c**, color Doppler) show increased echogenicity of the hypodermis with prominent fatty lobules (o) and hypoechoic thickening of the septa (*). On color Doppler, there is mild dermal and hypodermal hypervascularity. (**d**) Histology H&E (20X): both the septa and the lobules of the hypodermis are involved by inflammatory infiltrates in Behçet's disease panniculitis. The septa are thick with fibrosis and the inflammatory cells; mostly, lymphocytes involve not only the connective tissue but also the vessel wall (panniculitis with vasculitis)

and/or hypodermal hypervascularity with slow-flow vessels [18, 23].

The reported ultrasound criteria for detecting activity which are the most sensitive signs of active inflammation are [18, 23]:

Increased echogenicity of the hypodermis.

Dermal and/or hypodermal hypervascularity.

In atrophic stages, there is a decrease in the dermal and/or hypodermal thickness. Usually, the hypodermal fat decreases and causes a major loss of the volume of the affected segment.

The hypodermal panniculitis commonly starts as diffuse foggy lobular type and then turns to mostly septal with a cobblestone appearance [17, 18, 23, 24].

Ultrasound has been proved to be useful to assess the diameters of scleroderma cutaneous ulcers [38]. Some articles have explored the use of elastography in scleroderma; however, still this technique needs technical development for its use in morphea [9, 18, 22, 23, 35, 38–40].

There is scalloping of the bony margin in some cases, which predominates in the end stages of coup de sabre morphea [17, 24].

Additionally, abnormalities of the echogenicity of the muscles due to myositis and an increase of fluid in joints due to synovitis may be found [17, 24].

Fascial thickening and hypoechogenicity are other features in deep morphea, a form that has been linked to eosinophilic fasciitis [17, 24].

Hyperechoic calcium deposits (calcinosis) in the hypodermis that generate posterior acoustic shadowing are not uncommon in the generalized forms of presentations of morphea (more than two affected corporal segments). These can show as isolated deposits or as large hypodermal plaques [17, 24].

Commonly, the ultrasonographic extent of morphea is larger than the clinically visible lesional areas. Thus, the protocol for examining morphea should include the clinically involved corporal regions and the adjacent anatomical body segments. Therefore, ultrasound examination is not just focused on the macula or hyperpigmented area. This is relevant because the idea is to catch subclinical activity [17, 18, 24].

A recently described ultrasonographic sign suggestive of subclinical activity of morphea is the sun sign. This is the increased echogenicity of the hypodermis that surrounds subcutaneous veins [41].

Importantly, color Doppler ultrasound is a relevant tool to detect activity and monitor the treatment of the disease (Figs. 17.9, 17.10, 17.11, and 17.12) [18, 23, 40].

Morphea can appear after trauma, including plastic surgery procedures such as liposuction. The use of ultrasonography allows us to diagnose and manage early this complication [42].

Not long ago, an ultrasonographic scoring of the activity of morphea was described. This scoring is called US-MAS and can support the management in basal and follow-up examinations (Table 17.1) [43].

## Cutaneous Lupus

This is an autoimmune connective tissue disease that affects several tissues, with the skin being one of them. It can be classified as acute, subacute, or chronic. The cutaneous manifestation can be simultaneous or precede a systemic erythematosus. The chronic form presents different types, such as discoid lupus, lupus erythematosus profundus, chilblain cutaneous lupus (lupus pernio), and lupus tumidus [44, 45].

On ultrasound, the appearance varies according to the phase of the disease. In the active stage, there is thickening and hypoechogenicity of the dermis and increased echogenicity of the hypodermis. The initial involvement of the dermis commonly presents fusiform or plateau shapes. On color Doppler, the degree of dermal and hypodermal vascularity varies according to the activity level and can go from hypervascular to hypovascular, commonly with slow-flow vessels [17, 24, 46]. In chronic forms of presentation such as lupus erythematous profundus, there is a prominent hypodermal alteration. Frequently, in the beginning, lupus profundus presents a predomi-

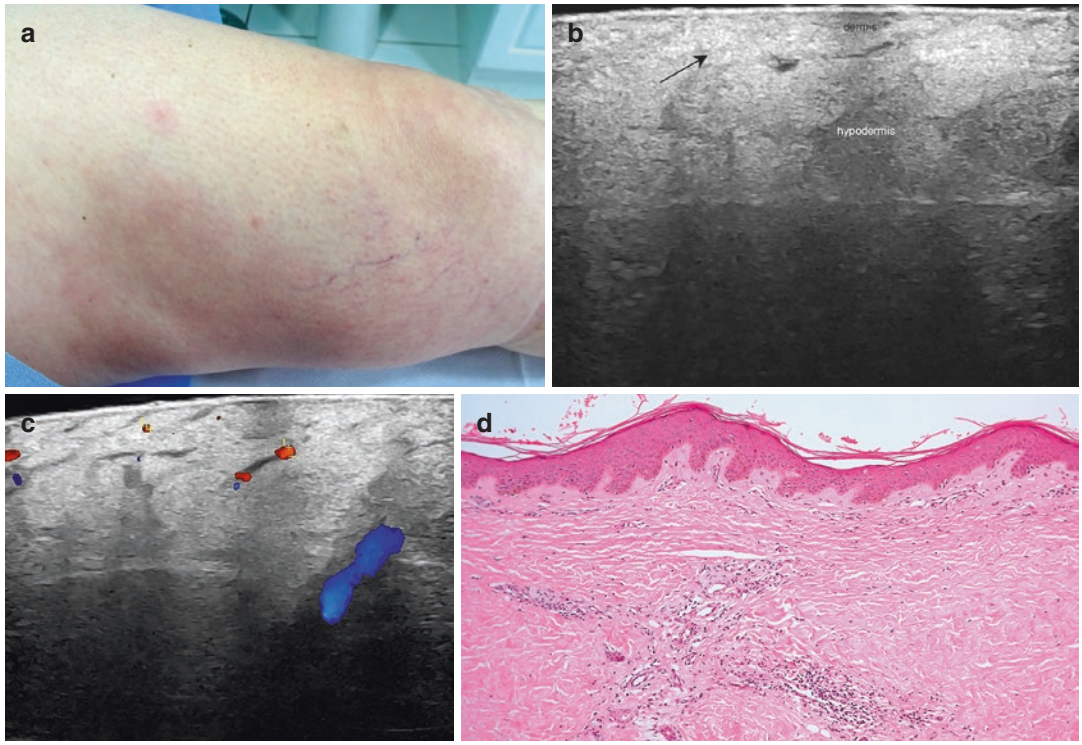


**Fig. 17.9** Morphea in active (inflammatory) phase. (**a**) Clinical photograph shows erythema in the left thigh. Ultrasound (**b**, grayscale; **c**, color Doppler) presents loss of the definition of the dermal-hypodermal border (arrow) with increased echogenicity of the hypodermis. On color Doppler, there is a mild dermal and hypodermal hypervascularity. (**d**) Histology (H&E 100x): epidermis with discrete rete ridge hyperplasia and mild perivascular inflammatory infiltrate

nantly lobular type of panniculitis with a foggy hyperechoic appearance of the hypodermis. In the late stages of inflammation, the pattern can change to mixed panniculitis or a predominantly septal appearance with a cobblestone pattern of the hypodermis (Fig. 17.13) [17, 24].

Importantly, beading and thinning of the arterial lumen due to inflammation may be found, particularly in the fingers. Another essential feature that should be kept in mind is the presence of thrombosis of small arteries, also common in the fingers [17, 24, 47].

In patients with Raynaud, color Doppler ultrasound may monitor the efficacy of the treatment [48].

## Dermatomyositis

This autoimmune connective tissue disease can involve the skin, muscles, and lungs. On ultrasound, there is a hyperechogenicity of the hypodermis predominantly with a lobular foggy appearance. The underlying muscles can show a variable degree of echogenicity abnormalities that go from patchy or partial to full hyperechogenicity [17, 24].

Hyperechoic calcium hypodermal deposits (calcinosis) with posterior acoustic shadowing artifacts may be found in dermatomyositis as isolated or as wide plaques.

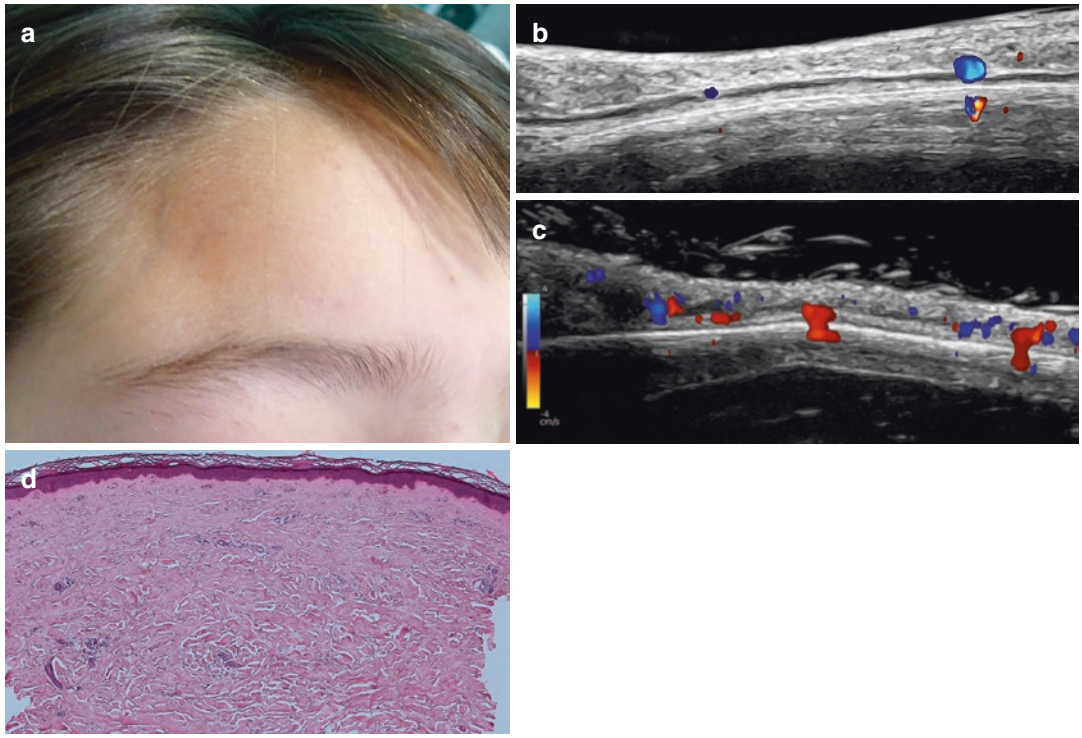


**Fig. 17.10** Morphea in active phase with atrophy. (**a**) Clinical image of patient with coup de sabre morphea in the right frontal region. Color Doppler ultrasound images (**b**, facial frontal region in transverse view; **c**, frontoparietal region, longitudinal view following the same axis). There is dermal and hypodermal atrophy in the frontal facial region with dermal and hypodermal hypervascularity only in the scalp. Therefore, there is inactivity of the morphea in the frontal facial region and activity in the scalp. (**d**) Histology (H&E 50x; frontal facial region): epidermis is atrophic. There is loss of adnexal structures. Collagen bundles are crowded, thickened, and brightly eosinophilic. There is no inflammation

On color Doppler, the degree of hypodermal and muscular vascularity is variable according to the activity of the disease and can go from hypovascular to hypervascular (Fig. 17.14) [17, 24, 49].

## Psoriasis

This autoimmune inflammatory disease affects the skin, nails, tendons, joints, and bony margins [50, 51].

On ultrasound, the signs of cutaneous psoriasis are epidermal thickening and undulation, decreased echogenicity, and hypervascularity of the upper dermis [7, 17, 24, 52–55].

The ultrasound signs of nail psoriasis from early to late phase are thickening of the nail plate, focal hyperechoic deposits in the ventral plate, loss of definition of the ventral plate, and thickening and undulation of the nail plate (dorsal and ventral plates). In the active phase of nail psoriasis, there is hypervascularity of the nail bed with low-flow vessels. The ultrasonographic abnormalities of the skin can also affect the hyponychium and proximal nail fold [15, 17, 24, 53–57].

The tendons can show thickening and hypoechogenicity, and the joints may present anechoic fluid distention. Nail involvement in psoriasis [58] may predict the presence of enthesopathy. The fluid distention is common (but not

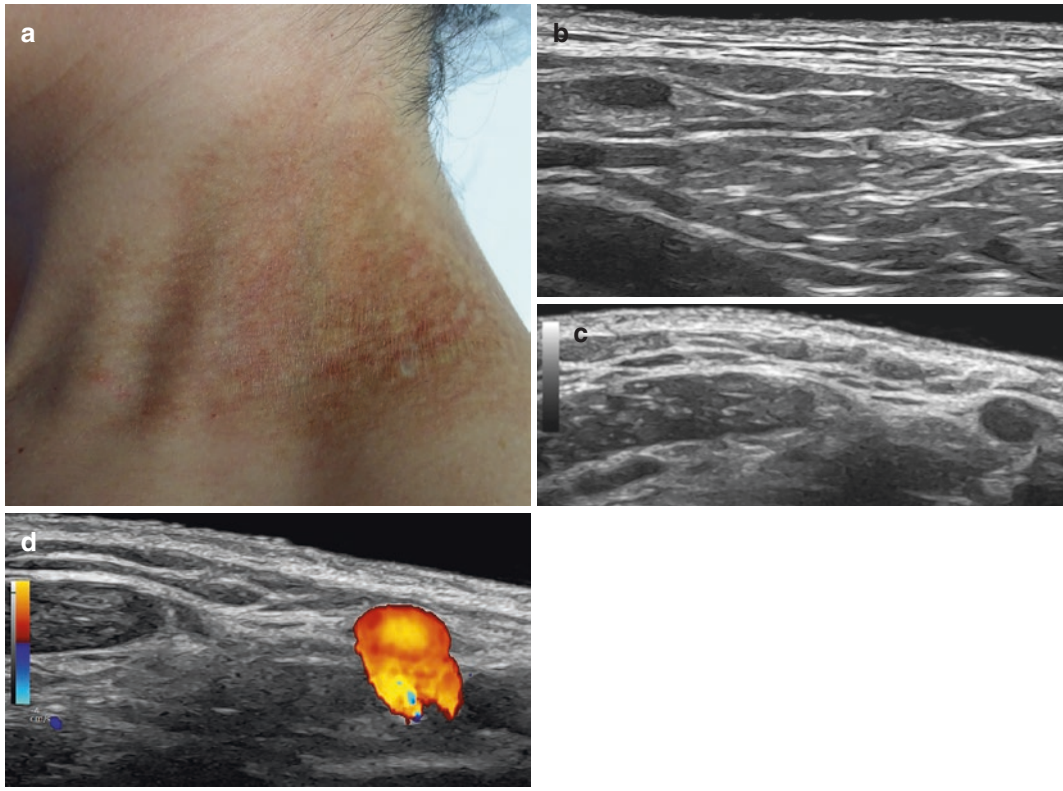


**Fig. 17.11** Morphea in inactive phase. (**a**) Clinical image of lesion located in the left aspect of the neck. Ultrasound images (transverse views; **b** and **c**, grayscale; **d**, color Doppler). Notice the atrophy of the fatty tissue in **b** and **d** with prominent hyperechoic fibrous septa in the hypodermis that predominate in **b**. **a** decreased echogenicity of the dermis is also detected in **b** and **c**. On color Doppler, there is no hypervascularity in the dermis or hypodermis

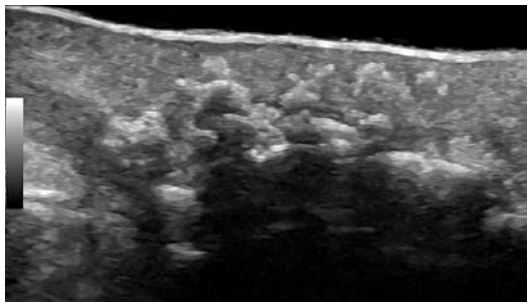

**Fig. 17.12** Calcinosis plaque in morphea. Ultrasound (grayscale) shows multiple and confluent hyperechoic deposits with posterior acoustic shadowing artifact in the dermis and hypodermis

limited) in the radiocarpal joint of the wrist, the metacarpophalangeal joints of the hands, and the suprapatellar recess of the knees [15, 17, 24, 47, 53–57, 59, 60]. It has been reported that there is

**Table 17.1** Ultrasound morphea activity scoring (US-MAS)

| **Variable score** |
|---|
| **Increased subcutaneous echogenicity or loss of dermo-hypodermic limits**[a] |
| 0 = negative |
| +2 = positive |
| **Increase of subcutaneous vascularization** |
| 0 = negative |
| +2 = positive |
| **Type of flow** |
| 0 = no increase in flow |
| +1 = venous or arterial less than 2 cm/sec |
| +2 = arterial greater than 2 cm/sec |
| **Body extension (body segments: Head and neck, trunk, upper limbs, and lower extremities)** |
| +1 = less than 2 body segments affected |
| +2 = 2 or more body segments affected |
| **Variables added in control CDU (compared to previous):** |
| **Increase in size of affected areas** |

**Table 17.1** (continued)

| |
|---|
| +1 = increase in the size of 1 affected area |
| +2 = increase in the size of 2 or more affected areas<br>+2 = extension in the size of the same affected areas or to another segment[b] |
| 2 |
| **Appearance of new affected areas in the same or different body segments** |
| 0 = negative |
| +2 = positive |
| **Decrease in maximum size or number of affected areas** |
| 0 = negative |
| −1 = positive, partially |
| −2 = positive, completely |
| Maximum score 14 points |

[a]In control CDU, this item can be considered as +1 point when echogenicity or vascularization remains altered but has partially improved

[b]In this item, the facial segments such as frontal region, cheeks, nose, lips, and chin were considered as distinct segments. Ref. [43]

a high prevalence of synovitis and enthesopathy in patients with psoriasis without psoriatic arthritis [61].

The bony margins can show erosions, proliferation, and irregularities in the periarticular regions [15, 17, 24, 47, 53–57, 59, 60].

Ultrasound allows to monitor the activity and the performance of the treatment in psoriasis, which is relevant for all the targets of the disease (Figs. 17.15, 17.16, and 17.17) [13, 15, 17, 24, 47, 55–57, 59].

## Acne

This inflammatory cutaneous disease involves the pilosebaceous unit that commonly affects the face of young individuals generating a potent decrease in self-esteem [62, 63].

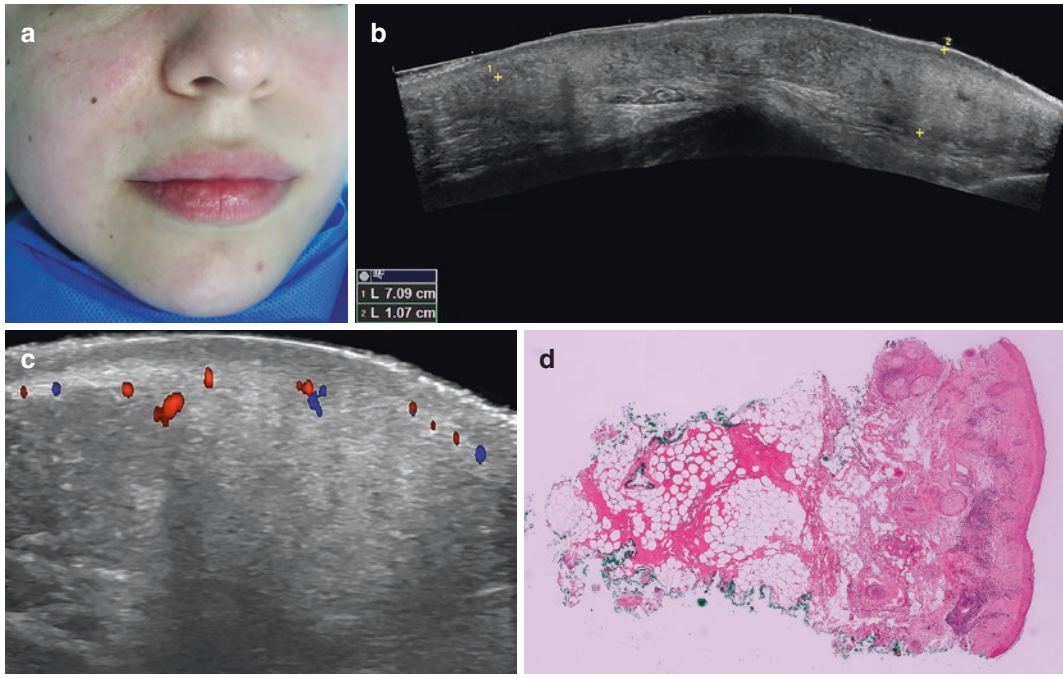


**Fig. 17.13** Cutaneous lupus. (**a**) Clinical image. Ultrasound images (transverse views of right cheek; **b**, grayscale, and **c**, color Doppler) present thickening, decreased dermal echogenicity, hyperechogenicity of the hypodermis with some thickening of the septa in the central part, and hypervascularity in the dermal-hypodermal border (in colors). Histology. (**d**) (H&E 25x): there is epidermal atrophy with vacuolar interface dermatitis and superficial and deep perivascular and periadnexal lymphocytic infiltrate. (**e**) H&E (100X): perivascular infiltrate of lymphocytes and increased interstitial dermal mucin, evidenced as amorphous clear basophilic material separating collagen fibers and adipocytes

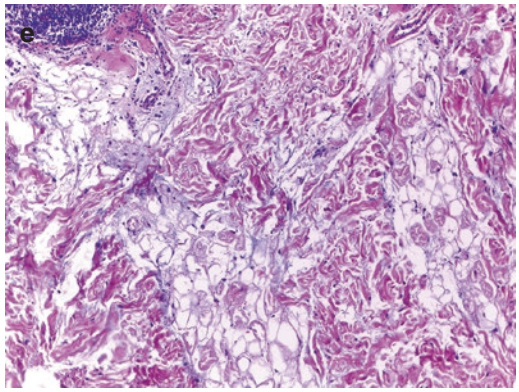


**Fig. 17.13** (continued)

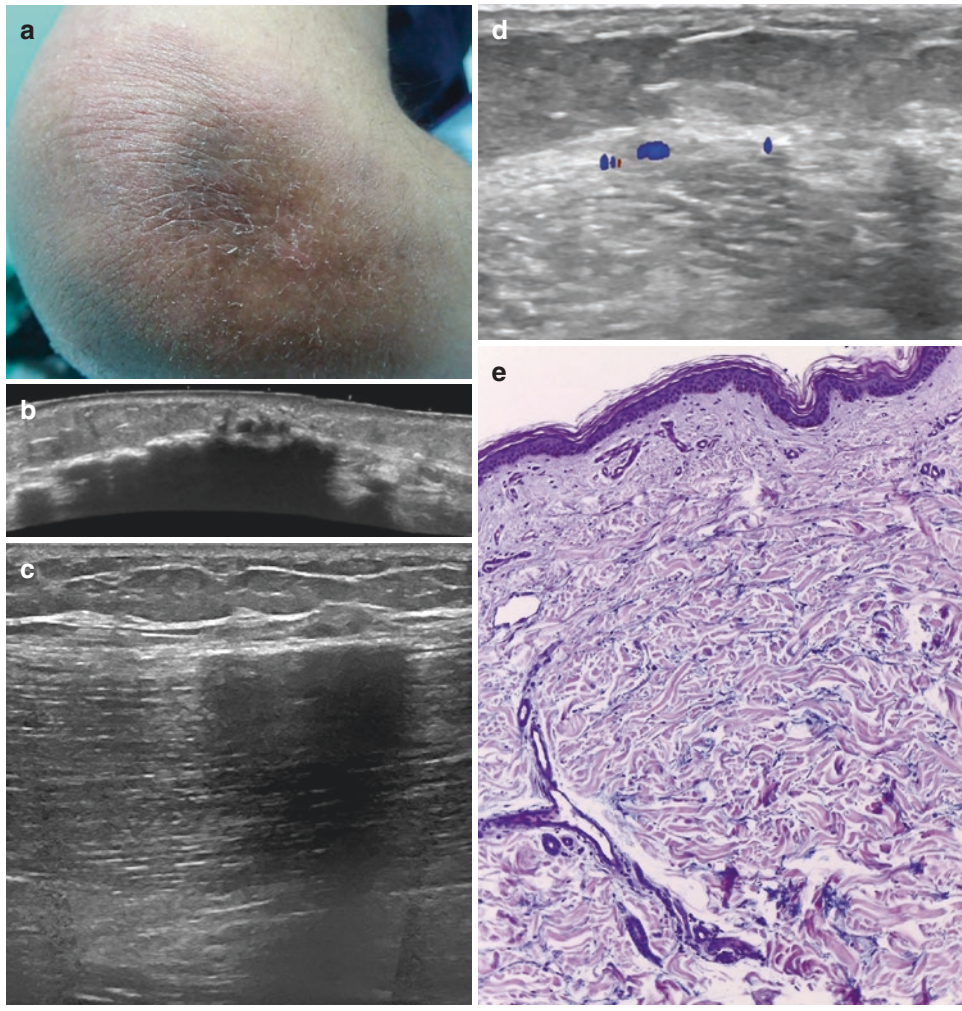


**Fig. 17.14** Dermatomyositis. (**a**) Clinical image. Ultrasound images (posterior aspect of the lower third of the arm; **b** and **c**, grayscale, longitudinal views; **d**, color Doppler, transverse view) present in **b** and **c** hyperechoic plaques of calcium with posterior acoustic shadowing (calcinosis) in the fascial layers that protrude into the hypodermis (**b**). In **d**, a mild hypervascularity is detected in the deep hypodermis and fascial layers. Notice the diffuse increased echogenicity of the underlying muscle (lower third of the triceps). (**e**) Histology. H&E (100X): scant perivascular infiltrate of lymphocytes and increased interstitial dermal mucin evidenced as clear basophilic amorphous material

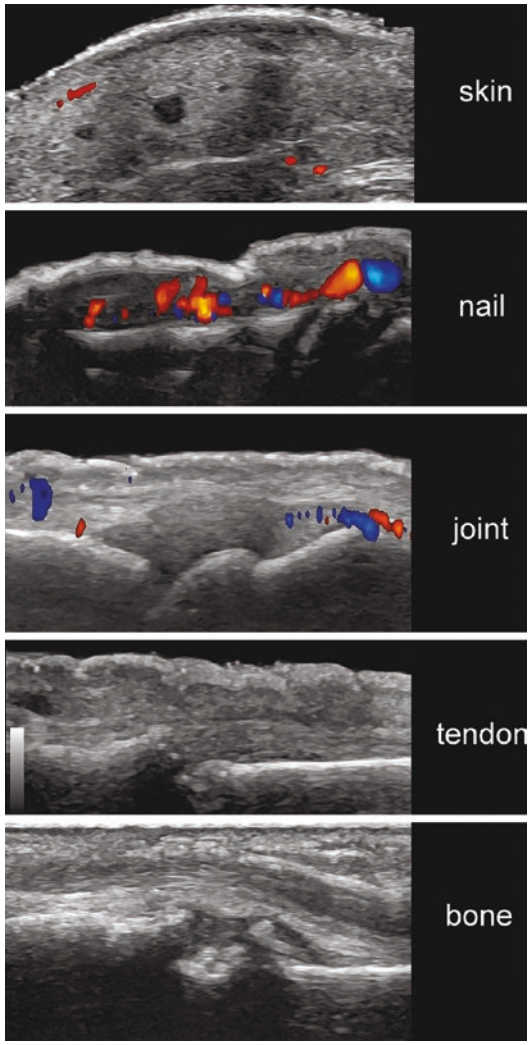


**Fig. 17.15** Psoriasis ultrasound abnormalities in the skin, nail, joint, tendon (enthesis), and bony margin

The primary ultrasonographic lesions are dilation of the hair follicles, focal dermal thickening, decreased echogenicity, oval- or round-shaped dermal and/or hypodermal pseudocystic structures, and band-like hypoechoic fistulous dermal and/or hypodermal tracts [64].

Focal hyperechoic calcium dermal deposits that generate posterior acoustic shadowing artifacts are not uncommon [17, 24, 64].

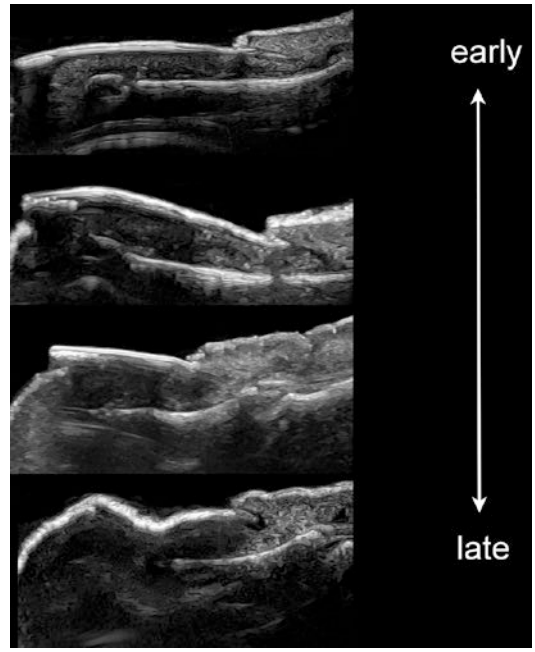


**Fig. 17.16** Psoriasis nail abnormalities from early to late phases

Scarring areas can also be detected in acne and appear as focal hypoechoic zones with epidermal retraction and/or laminar pattern [17, 24, 64].

The severity of the disease can be scored on ultrasound by the SOS-Acne Scoring System (Table 17.2) [64].

On color Doppler, the vascularity is variable according to the degree of activity of the disease.

Thus, ultrasonographically, it is possible to assess the severity and activity of the disease (Figs. 17.18 and 17.19) [64, 65].

## Rosacea

It is a chronic inflammatory facial disease that commonly presents erythema and papules, pustules, cutaneous fibrosis and hyperplasia, and ocular involvement. There are multiple forms of presentation; however, in the most severe forms, there is an enlargement of the tip of the nose

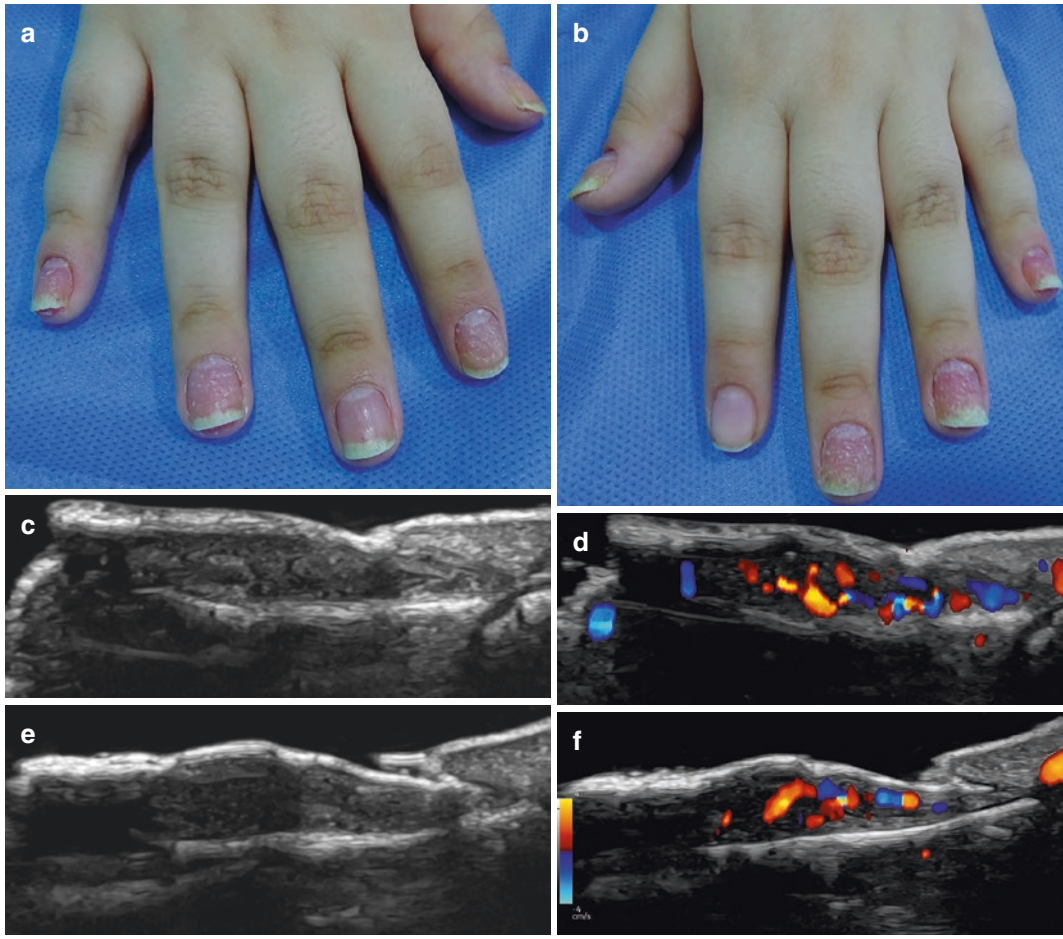


**Fig. 17.17** Nail psoriasis. Clinical images of the right (**a**) and left (**b**) fingernails. Ultrasound images (longitudinal views; right middle finger; **c**, grayscale, **d**, color Doppler; left thumb; **e**, grayscale, and **f**, color Doppler) show increased thickness and decreased echogenicity of the nail bed and thickening of the nail plates with focal hyperechoic deposits in the distal part of the nail plates. Wavy nail plate is detected in **e** and **f**. Hypervascularity of the nail bed is observed in **d** and **f**

**Table 17.2** SOS-acne classification of severity[a]

| Severity | Number of lesions |
|---|---|
| Mild | <5 pseudocysts and without fistulae |
| Moderate | 5–9 pseudocysts and without fistulae |
| Severe | ≥10 pseudocysts and/or fistulae |

[a]Ref. [64]

called rhinophyma and facial edema or lymphedema. The cause of rosacea is still controversial, and it is supposed that there is chronic inflammation, development of granulomas, and sebaceous hyperplasia [66–68].

On ultrasound, there is decreased echogenicity of the dermis and increased echogenicity of the hypodermis and prominent sebaceous glands. On color Doppler, the active phases present dermal and hypodermal hypervascularity with slow-flow vessels (Fig. 17.20). Interestingly, the alar nasal cartilages and the perichondral tissues can also present hypervascularity. Therefore, rosacea may involve subclinically deeper layers, which can explain the failures of topical treatments [3].

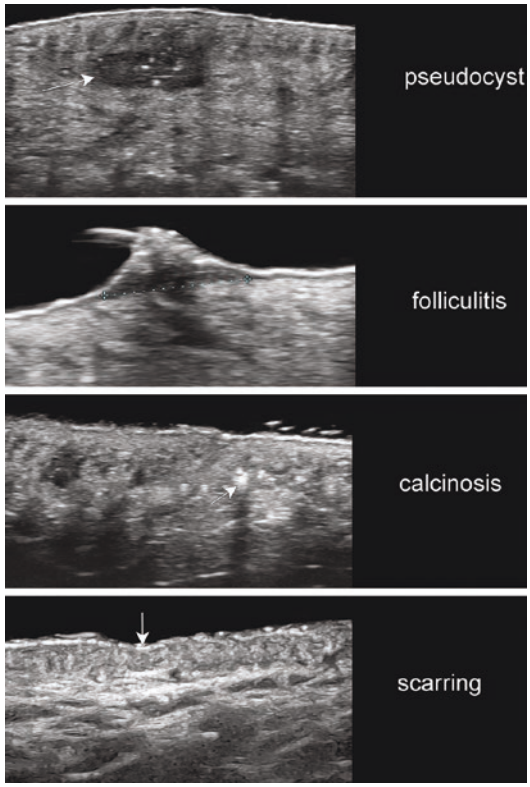


**Fig. 17.18** Common acne lesions on ultrasound (arrows)

## Hidradenitis Suppurativa (HS)

This is a chronic autoimmune disease that affects hair follicles. In the past, it was thought that the cause was the inflammation of the apocrine glands; nevertheless, nowadays, this theory has been demonstrated by multiple publications to be untrue [69].

The most common sites of involvement are the intertriginous areas such as the axillary regions, the perineo-vulvar or perineo-scrotal areas, the perianal regions, the intergluteal regions, the intermammary and inframammary regions, and the scalp. There are also reports on the face and umbilical region involvement [69–72].

Clinically, the most used severity classification is the Hurley system that separates the disease into three stages (Table 17.3) [69–73].

On ultrasound, there are key lesions that conform with ultrasonographic criteria for diagnosing HS, and these are: [19, 74–76]

Thickening and hypoechogenicity of the dermis.

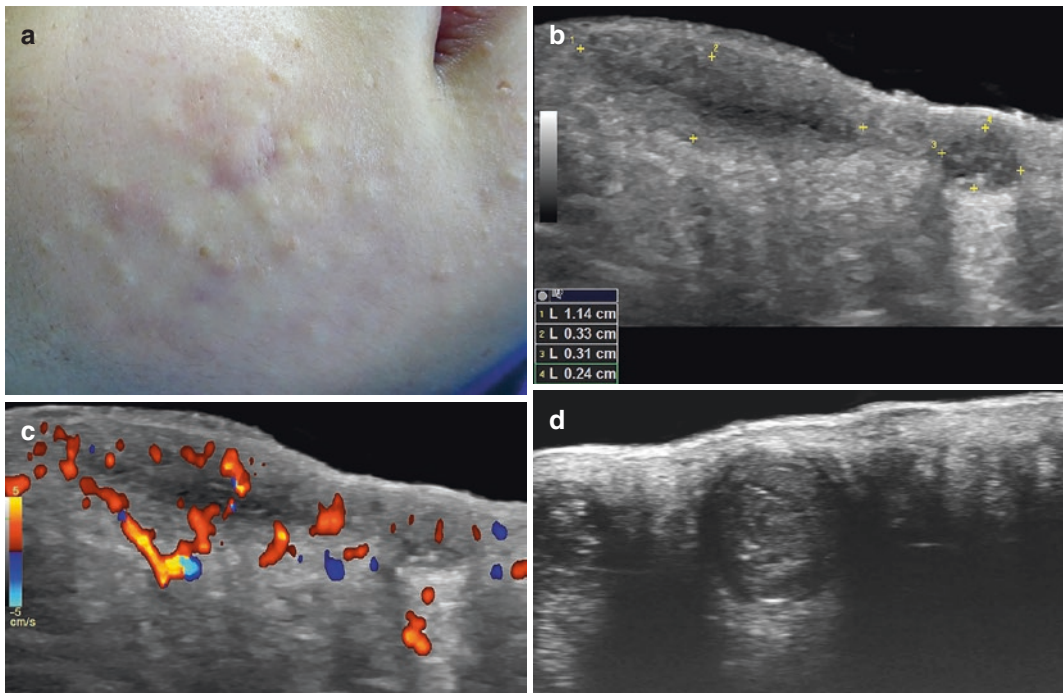


**Fig. 17.19** Acne. (**a**) Clinical photograph. Ultrasound images (grayscale; **b** at 18 MHz and **d** at 70 MHz; **c**, color Doppler) show dermal pseudocysts (between markers in **b**) with increased vascularity in their periphery (**c**). Notice the posterior acoustic reinforcement artifact at the bottom of the pseudocysts in the ultrasound images

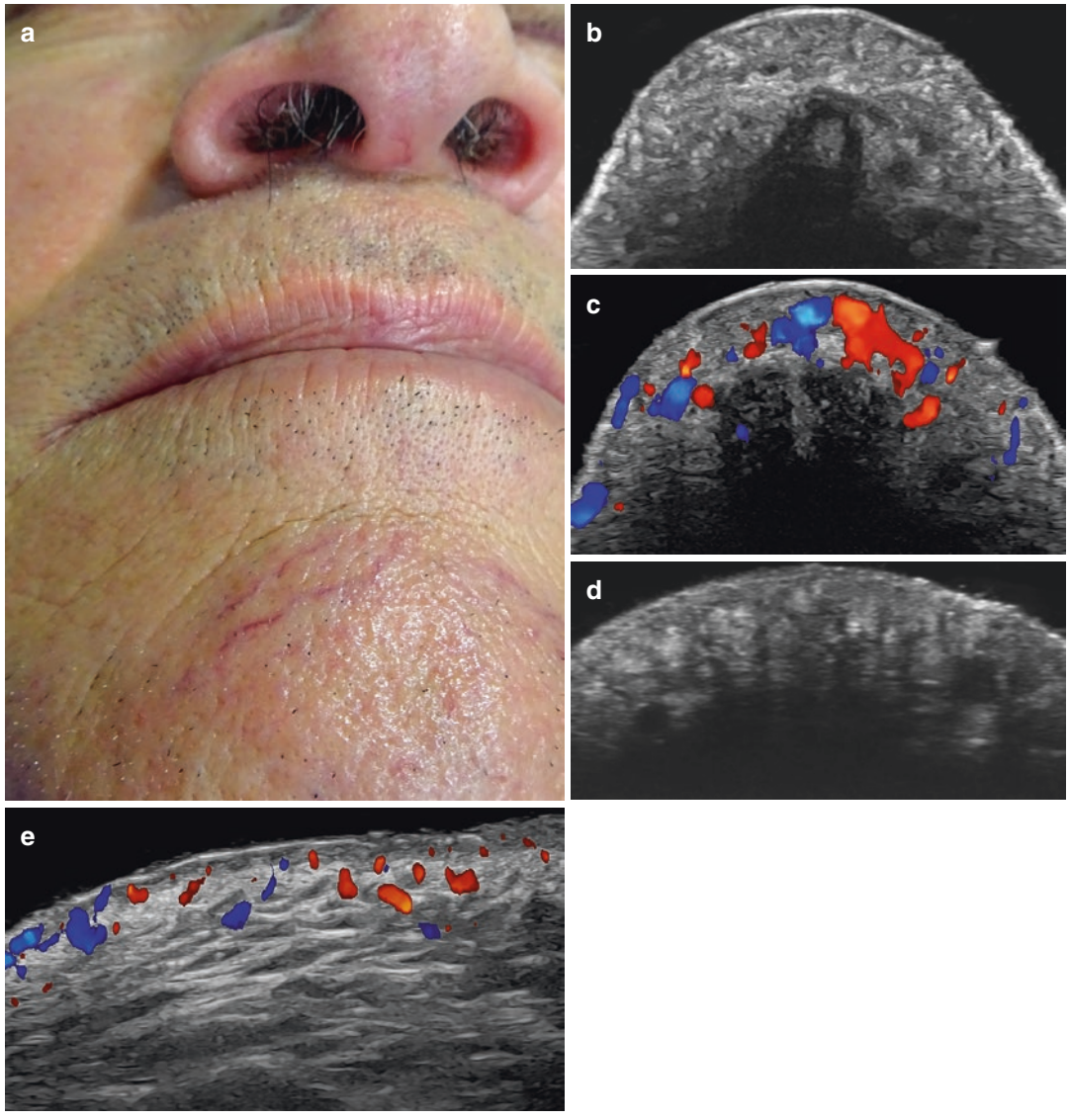


**Fig. 17.20** Rosacea. (**a**) Clinical image. Ultrasound images (transverse views nasal region; (**b**, **c**) and (**e**) at 18 MHz; (**d**) at 70 MHz; (**c**) and (**e**), color Doppler; (**f**) right cheek) show dermal thickening and hypoechogenicity with prominent sebaceous glands (**d**) in the nasal region. Dermal hypervascularity is detected at the nasal tip and the right cheek. Additionally, there is decreased echogenicity of the dermis in the right cheek (**e**)

**Table 17.3** Hurley staging system of hidradenitis suppurativa[a]

| | |
|---|---|
| **Stage I** | Single or multiple abscess formation without fistulas and scarring |
| **Stage II** | Recurrent single or multiples abscesses widely separated with limited fistulas and scarring |
| **Stage III** | Diffuse or near-diffuse involvement of multiple interconnected tracts and abscesses across an entire area |

[a]Adapted from Ref. [73]

Dilation of the hair follicles.

Pseudocysts (i.e., saclike anechoic or hypoechoic dermal and/or hypodermal structures that measure <1 cm).

Fluid collection (i.e., saclike anechoic or hypoechoic dermal and/or hypodermal structures that measure ≥1 cm).

**Table 17.4** Grade types of HS fistulous tracts (tunnels) according to grading of fibrosis and edema[a]

| |
|---|
| 1. Low fibrotic scarring (grades 0–1) with high or low edema (grades 0–2) |
| 2. High fibrotic scarring (grade 2) with low edema (grades 0–1) |
| 3. High fibrotic scarring (grade 2) with high edema (grade 2) |

[a]Adapted from Ref. [77]

**Table 17.5** Grading of fibrosis and edema of HS fistulas (tunnels)[a]

| **Grading of fibrosis** |
|---|
| 0 absent |
| 1 thin peripheral hypoechoic band (intermittent or continuous) with a fibrillar pattern |
| 2 thick and continuous peripheral hypoechoic band with a fibrillar pattern that invades the lumen of the tract and produces a hypoechoic "halo" sign in transverse view (intermittent or continuous) |
| **Grading of edema** |
| 0 absent |
| 1 diffuse increase of the echogenicity of the hypodermis |
| 2 prominent hyperechoic hypodermal fatty lobules, with anechoic fluid between the fatty lobules |

[a]Adapted from Ref. [77]

Tunnels or fistulous tracts (i.e., band-like anechoic or hypoechoic dermal and/or hypodermal structures).

The tunnels (fistulas) can be classified according to the degree of edema and fibrosis in three types (Tables 17.4 and 17.5). The types of tunnels II and III are associated with communicating and complex tracts [17, 74, 75, 77, 78]. Furthermore, tunnels can be classified according to their layer of involvement. Certainly, subcutaneous (hypodermal) tunnels present a higher severity of the disease in comparison with only dermal locations. Hyperechoic bilaminar, and sometimes trilaminar, structures that correspond to retained fragments of hair tracts, and hyperechoic bands suggestive of thick pieces of keratin can be detected within the pseudocysts, fluid collections and tunnels [78, 79, 80].

Lymph nodes are rarely enlarged in HS, which makes sense given their autoimmune and noninfectious nature [81, 82].

The presence of ultrasonographic alterations and hypervascularity usually correlates well with the pain referred by the HS patients [20, 83].

**Table 17.6** Sonographic scoring of hidradenitis suppurativa (SOS-HS)*

| Stage | Sonographic signs |
|---|---|
| **Stage I** | Single fluid collection and/or dermal changes affecting a single body segment (either one side or bilateral), without fistulous tracts |
| **Stage II** | Two to four fluid collections and/or a single fistulous tract with dermal changes, affecting up to two body segments (either one side or bilateral) |
| **Stage III** | Five or more fluid collections and/or two or more fistulous tracts with dermal changes and/or involvement of three or more body segments (either one side or bilateral) |

[a]Adapted from Ref. [19]

At 70 MHz, it is possible to detect early signs of HS, which include the dilation and curved shape of hair follicles, the ballooning of hair follicles, and the donor sign (i.e., ballooned hair follicle within a fluid collection or tunnel). There are early signs that are linked to severity, such as the bridge sign (i.e., hypoechoic bands that connect two or more follicular ostia) and the sword sign (i.e., a hyperechoic fragment of hair protruding out of the ballooned hair follicle). Additionally, the presence of multifragmented-type keratin within the dilated hair follicles has been linked to the development of fluid collections, and the presence of a cylindric type of keratin within the dilated hair follicles is associated with the development of tunnels [80, 84].

The most used ultrasonographic scoring of severity is called SOS-HS and is displayed in Table 17.6 [19, 76]. Usually, there is a discordance between the clinical and ultrasonographic scorings due to the underestimation of severity by the clinical evaluation, which has been reported by several groups of researchers around the globe [19, 76, 85–90]. Ultrasound evaluations present a higher inter-rater and intra-rater agreement in comparison with the clinical examinations [19, 76, 85–89].

Dissecting cellulitis of the scalp and pilonidal cysts present similar ultrasonographic morphology with HS, which is indicative of sharing a common pathophysiology. In fact, pilonidal cysts have been suggested a localized form of presentation of HS [4, 91].

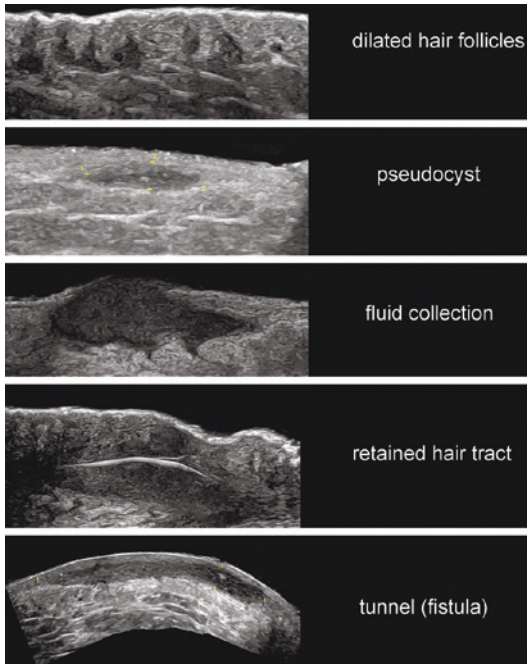


**Fig. 17.21** Hidradenitis suppurativa key ultrasound lesions

The activity of HS can be tracked on ultrasound with the use of color or power Doppler, which has been reported as a reliable biomarker of the degree of activity of the disease [17, 19, 74, 76, 92–96].

The ultrasound scoring of severity has been reported to present higher inter-rater and intra-rater correlations than a clinical scoring in a multicentric study [88]. Moreover, the use of ultrasound in HS can modify the management of adults and children in 83% and 92%, respectively [19, 76].

It is relevant to use standardized ultrasound reports in HS that allow to monitor the patients and perform research properly. So far, there have been examples of these reports in the literature [97].

Thus, ultrasound also allows the monitoring of the treatment of HS, which to date has been reported for several systemic drugs [97–101]. In addition, ultrasound can support the guiding of percutaneous treatments [102–104]. So far, ultrasound has been the first imaging modality for studying HS, and it has been suggested as a standard of care in these cases (Figs. 17.21, 17.22, 17.23, 17.24, 17.25, and 17.26) [16, 19, 20, 74, 76, 83, 88, 93, 94, 105–110].

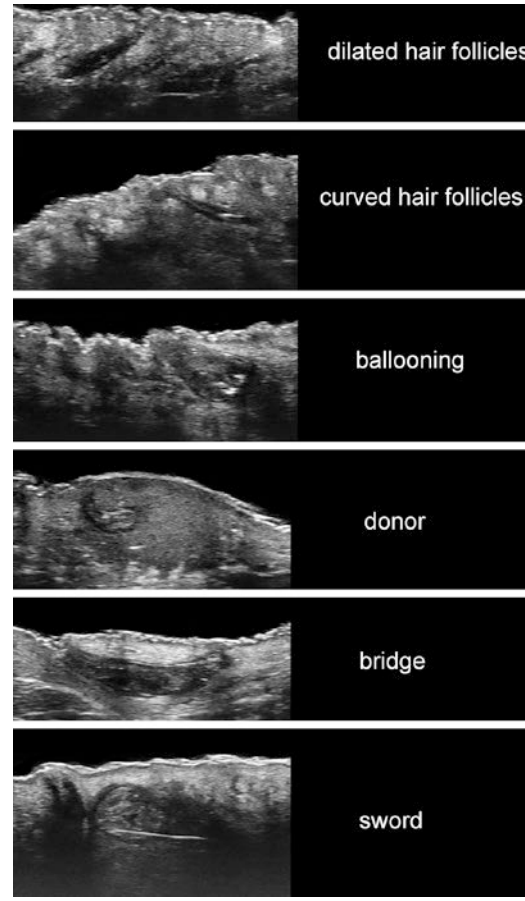


**Fig. 17.22** Hidradenitis suppurativa early signs at 70 MHz

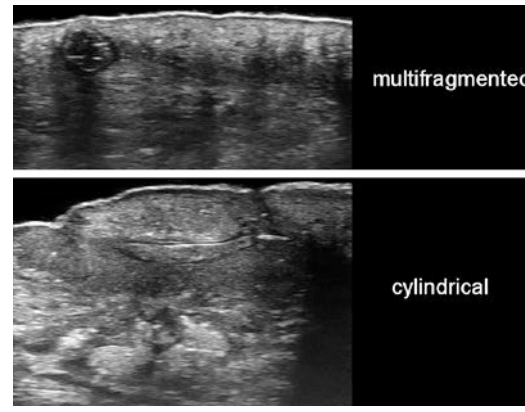


**Fig. 17.23** Keratin fragmentation types in hidradenitis suppurativa

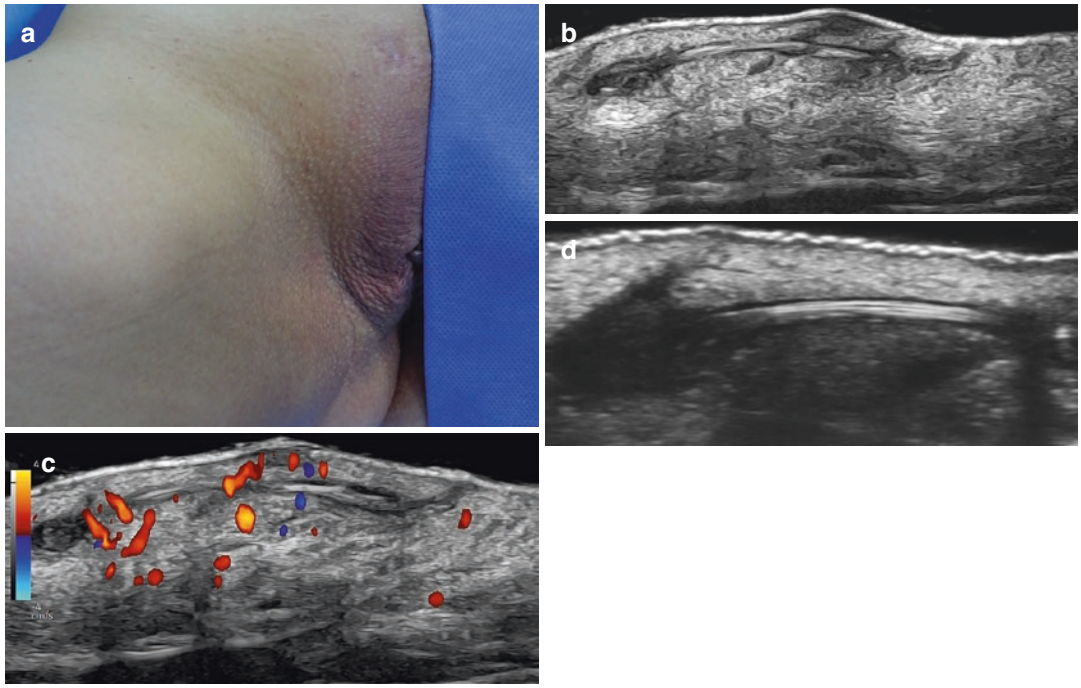


**Fig. 17.24** Hidradenitis suppurativa SOS-HS I. (**a**) Clinical image. Ultrasound images (grayscale; **b** at 18 MHz and **d** at 70 MHz; **c**, color Doppler at 18 MHz; longitudinal view) show dermal pseudocyst with retained thick fragment of hair tract. On color Doppler, there is hypervascularity in the periphery of the pseudocyst

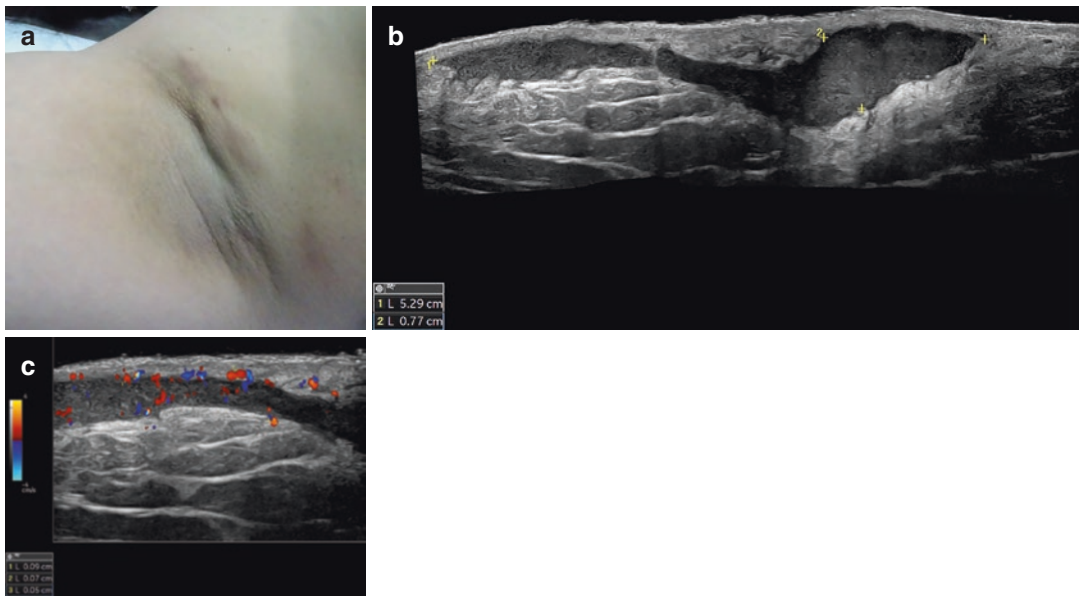


**Fig. 17.25** Hidradenitis suppurativa SOS-HS II. (**a**) Clinical photograph. Ultrasound images (**b**, grayscale; **c**, color Doppler; longitudinal view of right axillary region) show dermal and hypodermal tunnel (fistula; marked between markers) type I (without fibrosis). On color Doppler, there is hypervascularity in the periphery and within the tunnel

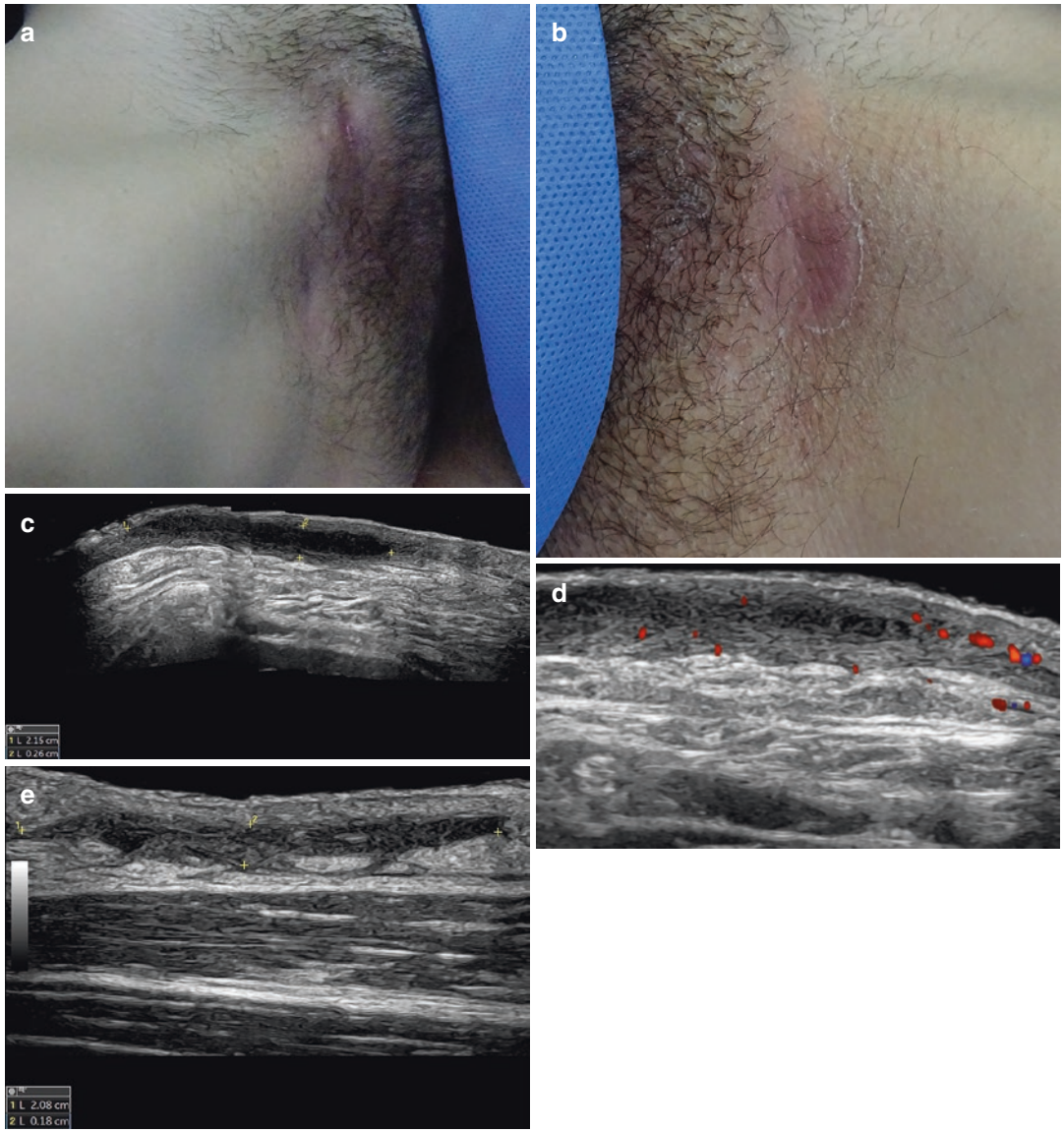


**Fig. 17.26** Hidradenitis suppurativa SOS-HS III. **a** and **b** Clinical photographs. Ultrasound images (grayscale; **d**, color Doppler; **c** and **d**, right perineal region and thigh; **e**, left perineal region and thigh) demonstrate two hypoechoic dermal tunnels (fistulas) one per side. The tunnel located on the right side (**d**) is type II (with fibrosis and low degree of edema), and the tunnel located on the left side (**e**) is type I (without fibrosis)

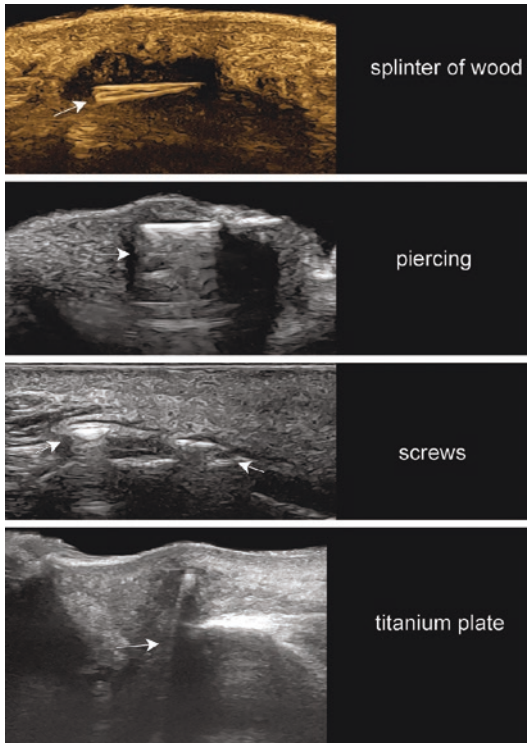


**Fig. 17.27** Ultrasound patterns of foreign bodies

## Foreign Bodies

These exogenous materials can be divided into organic (i.e., derived from living structures) and synthetic (i.e., inert structures).

There is a wide field of organic materials such as splinters of wood, thorns of roses, and coral fragments. Examples of synthetic materials are metal and glass.

On ultrasound, these fragments appear as hyperechoic linear structures commonly surrounded by hypoechoic inflammatory and/or granulomatous tissue. The main ultrasonographic difference between organic and synthetic materials is the reverberance artifact that is more frequently seen in synthetic materials (Fig. 17.27).

On color Doppler, it is possible to detect a variable degree of hypervascularity in the periphery of the foreign body [2, 17, 24, 111].

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