Tumours and tumour-like lesions of the skin: ultrasonographic investigation.

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Learning objectives

Our purpose is to classify tumours and tumour-like lesions of the skin into distinct categories for educational purposes and present educational images of high-resolution ultrasound (HRUS) of cutaneous tumours and tumour-like conditions. Given the increasing use and widespread availability of modern ultrasonographic systems with high-frequency transducers, radiologists should be familiar with this technique and cutaneous lesions findings.
Background

Cutaneous lesions include a wide range of benign and malignant lesions whose appropriate treatment requires accurate and timely diagnosis. Clinical examination and biopsy represent the cornerstone of diagnosis. Nevertheless, the introduction of high-frequency and very high-frequency transducers allowed investigation of cutaneous lesions with HRUS.

B-mode technique accurately visualizes skin anatomy, providing information about a lesion's location, size, echotexture and margins. Sensitive colour, power Doppler technique and elastography complete the ultrasound (US) investigation.
Findings and procedure details

We performed skin HRUS using a 5-13 MHz linear array transducer. Higher penetration 3.8-7.5 MHz transducers were used to examine deeper structures. Adequate quantity of gel was applied to increase the transducer’s distance from a superficial lesion, thus improving spatial resolution by positioning the lesion at the transducer focus level.

Lesions were classified based on their echotexture in as (Fig. 1 on page 14):

1. Cystic including: abscess, haematoma, epidermoid cyst, trichilemmal cyst, inflammatory cyst, pilonidal cyst and digital mucus cyst.

2. Solid including: seborrheic keratosis, acquired melanocytic nevi, pilomatricoma, lipoma, fat necrosis, leiomyoma cutis, angioleiomyoma, glomus tumour, soft fibroma, neurofibromatosis, lymphoma, non-melanoma malignancies, malignant melanoma and metastases.


4. Vascular including: solitary and multiple vascular malformations.

5. Associated with foreign bodies consisting of wood, metal and glass.

Some of the afore-mentioned lesions may be either solitary or multiple (Fig. 1 on page 14).

I. CYSTIC LESIONS

Subcutaneous abscess

Subcutaneous abscesses typically appear as relatively rounded anechoic, hypoechoic or mixed echogenicity fluid collections with irregular or lobulated margins. An abscess’ margins may be well demarcated or poorly-defined. Greyscale US appearance of an abscess largely depends on the abscess’ location, age and content. The abscess’ content may rarely appear hyperechoic or isoechoic to the surrounding inflamed tissues (Fig. 2 on page 14). Internal echoes caused by debris or bubbles of gas associated with "dirty shadowing" or reverberation artifact may be found inside the abscess. Other imaging findings of abscesses include internal septations, posterior acoustic enhancement and hyperechogenicity of the surrounding tissues. If pressure is applied to the US transducer,
movement of the cavity's content may be visualized. Colour Doppler technique usually demonstrates hyperaemia of the abscess' wall and surrounding tissues [1].

**Subcutaneous haematoma**

The subcutaneous layer of the skin is always involved in cases of traumatic injury of the skin. This type of trauma will result in a subcutaneous haematoma formation. This type of haematoma is situated in the deeper layers of hypodermis and appears on imaging as an anechoic or hypoechoic fluid collection, occasionally containing fluid-fluid levels (Fig. 3 on page 15). US is a valuable tool to accurately evaluate the lesion's extent (Fig. 4 on page 16) and exclude the presence of other organs injuries (e.g. Muscles or tendons injuries). Moreover, US follow-up is easy and can successfully monitor the haematoma's resolution. [2]

**Epidermal cyst**

US findings of epidermal cysts depend on their developmental stage. Small cysts appear anechoic or hypoechoic and with well-defined borders. Parts of the cysts may appear hyperechoic due to the presence of calcium deposits. Furthermore, epidermal cysts may demonstrate an echotexture similar to testicular parenchyma; a sign referred to as "pseudotestis pattern" (Fig. 5 on page 16). Larger cysts may sometimes be multilocular or show a heterogeneous hyper- and hypo-echoic or onion-like appearance with layers of alternating echogenicity, caused by deposits of keratin (Fig. 6 on page 17). When complicated by inflammation, these cysts are usually larger and hyperechoic while the surrounding hypodermis appears hyperechoic due to oedema, especially if the cyst is ruptured. The reaction of the surrounding tissue to a ruptured epidermal cyst is explained by the spread of keratin, which causes a reaction similar to that triggered by foreign body impaction. Another characteristic finding of epidermal cysts is the posterior acoustic enhancement. Ruptured epidermal cysts have usually irregular or lobulated margins. Colour and power Doppler imaging demonstrates increased blood flow signals particularly in inflamed or ruptured cysts. These signals may be either of low flow arterial type or venous type [3, 4].

The term "sebaceous cyst" is a misnomer frequently used to describe epidermoid cysts, although this is not accurate based on the different origin of sebaceous and epidermal cysts. Sebaceous cysts are less common and arise from secreting glands of the skin. These cysts' margins are well-demarcated and mild posterior acoustic enhancement may be seen. Internal echoes can be found due to the presence of crystals (Fig. 7 on page 18). In general these cysts appear anechoic but may occasionally contain calcifications or ossified parts [5].
Trichilemmal cyst

US diagnosis of trichilemmal cysts is rather easy as they appear rounded, ovoid or multilocular anechoic or hypoechoic lesions with internal echoes caused by debris (Fig. 8 on page 18). Trichilemmal cysts are situated in the epidermis and subcutaneous tissue and may occasionally show a target-like appearance with a hypoechoic periphery and a hyperechoic central part. The hyperechoic central part corresponds to solid hair, calcium deposits or both. When complicated by inflammation (Fig. 9 on page 18), these cysts show blood flow signals of low flow at their periphery [3,6].

Pilonidal cysts

Pilonidal cysts are usually located in the intergluteal cleft and appear on US as ovoid hypoechoic pseudo-cysts situated in the dermis and hypodermis. Internal hyperechoic linear echoes may be found, representing hair fragments (Fig. 10 on page 19). This type of cyst is usually associated with hypoechoic fistulous tracts. Colour or power Doppler technique usually demonstrates increased vascularity at the periphery of the cyst [3,7].

Digital cysts

These lesions are classified into myxoid (digital mucus cysts) and ganglionic. They represent false cystic lesions since they are mucous tumours of the phalangophalangeal joints (Fig. 11 on page 19), usually situated near the nails. They appear as smooth, well-demarcated, solid lesions pigmented with the colour of skin. These lesions are created by excessive production of hyaluronic acid from fibroblasts and represents a form of focal mucinosis.

II. MIXED ECHOGENICITY LESIONS

Hidradenoma

Hidradenoma is a tumour usually appearing solid on B-mode technique. However, in some cases, they may appear as mixed echogenicity lesions containing cystic parts, with the latter resulting from degeneration of tumour's cells (Fig. 12 on page 20). Hidradenomas are situated in dermis under the stratum basale or basal layer, leaving the epidermis intact. When increasing in size, hidradenomas tend to extend towards the subcutaneous layer. Colour or power Doppler imaging identifies significant internal vascularity [8, 9, 10].
Multilocular lymphangioma

Multilocular lymphangiomas tend to enlarge quickly and displace nearby structures. The cyst's content appears completely anechoic but may become echogenic when these lesions are complicated by infection, hemorrhage or if they contain fat (Fig. 13 on page 20). The most characteristic finding of multilocular lymphangiomas is their multilocular cystic nature with the presence of internal septations of varying thickness along with potential communications between different cysts (Fig. 13 on page 20, Fig. 14 on page 21). In some cases, echogenic solid parts may be found within the lesions, along with their multilocular cystic part, creating a mixed echogenicity pattern. These solid parts are characterized by a heterogeneous increased echogenicity. Multilocular lymphangiomas are characterized by a lobulated and ill-defined margin, large size and low or now vascularity on colour Doppler imaging. Blood flow signals tend to follow the course of internal septations [12, 13].

III. SOLID LESIONS

Seborrheic keratosis

Seborrheic keratosis appears on US as flattened, hypoechoic, well-demarcated lesions which show a "pasted on" appearance (Fig. 15 on page 22). They are situated beneath the epidermal "entry echo" and may be seen compressing the underlying dermis. Colour Doppler technique typically reveals no blood flow signals on this type of lesions. It is reported that the high attenuation of the echo beam, a prominent entry echo and their irregular surface can be used to differentiate seborrheic keratosis from melanoma or other types of benign nevi [13, 14].

Melanocytic nevi

The term "nevi" is used to describe slightly elevated "plaque-like" skin pigmented lesions, which may be characterized by an irregular contour. When consisting of melanocytes, they are referred to as melanocytic nevi. They actually represent benign neoplasms created by the proliferation of melanocytes. The diagnosis of these nevi relies mainly on clinical examination. When examined with US though, these nevi appear as hypoechoic and well-defined lesions of varying thickness, which may be situated either on the dermo-epidermal junction, or within the dermis (Fig. 16 on page 22). It is important to have in mind that when melanocytic nevi are to be examined with US, transducers with frequency higher than 13 MHZ should be used. The main point to be addressed by US is the monitoring for potential malignant transformation. When these nevi undergo malignant
transformation, they tend to penetrate deeper layers of the skin and increase in depth. This type of growth can readily be evaluated by means of US [14, 15].

Pilomatrixoma

Pilomatrixoma or pilomatricoma is a benign skin tumour which originates from the hair follicle matrix. It is also known as calcifying epithelioma of Malherbe. From a histological point of view, these tumours usually show a fibrous pseudocapsule, calcifications and keratin debris. Pilomatrixomas appear on US as hypoechoic lesions with a hyperechoic central part representing calcification. This combination of peripheral hypoechoic part with the hyperechoic central part creates a target-like appearance (Fig. 17 on page 22). The identification of calcifications is considered quite pathognomonic as 80% of pilomatrixomas are calcified. These calcifications may vary in shape and size, they may be solitary or multiple, diffuse or confluent and are evident both on US and radiographies. In rarer cases, pilomatrixomas may be completely calcified and cause acoustic shadowing. Cystic pilomatrixomas are another type of this tumour which appears anechoic with a small eccentric solid hypoechoic nodule containing fine echoes. Septations connecting the nodule with the thick hypoechoic lesion’s wall may be seen. These nodules may appear hypo- or hyper- vascular on colour Doppler technique. The vascularity may be either peripheral or internal in half of the cases. As a consequence, hypervascular pilomatrixomas appear on US similar to haemangiomas. When complicated by inflammation, pilomatrixomas become more heterogeneous [14, 16].

Fat necrosis

Fat necrosis is usually affecting breast adipose tissue, while it is a condition poorly described for other anatomic locations. It is usually caused by trauma and is associated with a series of medical conditions. US appearance of fat necrosis in breast varies from cystic areas to solid masses causing distortion of the surrounding tissues. The US appearance of fat necrosis in site outside the breast is not well documented. It usually appears as hypoechoic areas encapsulated by a hyperechoic border and situated within the otherwise hypoechoic normal subcutaneous fat, while loss of surrounding tissue uniformity may be seen (Fig. 18 on page 23) [17].

Lipomas

Lipomas represent the most frequently encountered soft-tissue neoplasm as they account for approximately half of all soft-tissue tumors in large published series. It is not entirely clear whether lipomas are actually benign neoplasms or rather local hyperplasias of fat cells. Subcutaneous lipomas are usually situated in the upper back,
neck, proximal extremities and abdominal region. Less than 2% of lipomas are situated in the deeper layers of the skin. Lipomas typically present as mobile, palpable, solitary soft-tissue masses, usually causing no symptoms. Clinical examination is accurate in diagnosing a lipoma in up to 85% of cases. Imaging may be used to confidently exclude other diagnoses and evaluate the lesion's size and location; information valuable for surgical planning. On US, lipomas generally appear as hyperechoic well-demarcated ovoid lesions. However, some lipomas may appear iso- or hypo-echoic compared to the nearby subcutaneous adipose tissue containing echogenic septations, parallel to the epidermis (Fig. 19 on page 24). The level of internal echogenicity varies depending on the lesion's composition in water, fat or other nonlipomatous components. Up to 15% of patients may present with more than one lipoma (Fig. 20 on page 24). Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) may also be used for the evaluation of lipomas, especially if the latter are situated in deeper layers of the skin or if other differential diagnoses cannot be fully excluded with US [18].

**Leiomyoma cutis**

The term "leiomyoma" describes a soft tissue neoplasm originating from smooth muscle cells which may be encountered wherever smooth muscle cells are present. Beyond their typical location in the uterus, leiomyomas may affect the skin, justifying the term "leiomyoma cutis". On US, these rare tumours appear solid, ovoid and show a heterogeneous echostructure (Fig. 21 on page 25). A peripheral capsule with increased vascularity may be visualized on power Doppler technique. Occasionally, fine calcifications and internal septations or increased vascularity may be seen within the mass [19, 20].

**Angioleiomyoma**

Angioleiomyoma is a very rare benign neoplasm accounting for 5% of all benign soft tissue tumours. It arises from the smooth muscle cells of the blood vessels and usually affects patients between the third and fifth decade of life. As many other soft tissue tumours, it presents as a palpable mass which causes pain in 60% of patients. One characteristic clinical findings of this type of neoplasms is that the swelling increases in size with physical activity of the involved part, particularly the hand. US demonstrated angioleiomyomas as well-defined homogeneous solid lesions. Colour Doppler technique shows intratumoural vascularity which on pulse wave interrogation may demonstrate high or low resistance blood flow, consistent with the presence of muscular arteries (Fig. 22 on page 26). MRI may also be used to evaluate these neoplasms which appear heterogeneous with hyperintense and isointense parts on T2-weighted images [21, 22].

**Glomus tumors or glomangiomas**
Glomangiomas are benign neoplasms of vascular origin, which typically affect distal extremities (Fig. 23 on page 26). They appear on US (with high-frequency transducers) as small, solid, ovoid, well-demarcated and homogeneously hypoechoic or anechoic lesions. On colour Doppler technique, glomangiomas appear hypervascular, with increased blood flow signals [12].

**Soft fibroma**

Soft fibromas (acrochordon, fibroma pedulans, skin tag) are common benign rounded fibrous neoplasms pigmented with the same colour as skin. They may be found as multiple small lesions measuring 1 -2 mm and affecting usually the neck and the axillary cavity. Alternatively, they may occur as multiple lesions measuring 2 to 5 mm. Finally, there is a third type of soft fibromas consisting of solitary pedunculated masses measuring up to 1 cm. Because of their pedunculated shape, these tumours require high-frequency transducers and a large quantity of gel in order to be adequately visualized with US. They appear as isoechoic subcutaneous lesions which may occasionally demonstrate internal hypoechoic areas due to the presence of adipose tissue (Fig. 24 on page 27).

**Neurofibroma**

Neurofibromas are benign nerve sheath tumors which appear on US as rounded or elongated, well-circumscribed, hypoechoic lesions (Fig. 25 on page 28). These tumours are typically situated within a nerve and parallel to its long axis. These tumours appear with no increased internal blood flow signals on colour Doppler technique. If complicated by malignant transformation, neurofibromas appear more heterogeneous and with ill-defined borders. These tumours are strongly associated with neurofibromatosis type 1 [15, 23].

**IV. VASCULAR LESIONS**

**Hemangiomas / Infantile hemangiomas**

Hemangiomas account for approximately 7% of all benign soft-tissue neoplasms, while they are considered the most commonly found vascular soft-tissue abnormalities. Infantile hemangiomas are usually small or even absent at birth. Over the next months however, they are characterized by a proliferative stage, when they show rapid growth lasting up to several months. This rapid growth phase is followed by a stationary period and then a phase of involution. This characteristic natural course differentiates infantile hemangiomas from other types of vascular malformations which are always present at
birth and tend to increase in size in proportion to growth and never involute. Ultrasound findings of infantile hemangiomas depend on the lesion’s stage. During the growth stage, they appear as solid ill-defined hypoechoic lesions (rarely hyperechoic or heterogeneous) with increased vascularity (Fig. 26 on page 28). Multiple "snake-like" enlarged blood vessels may be found within the subcutaneous tissue. On the last stage, these lesions appear hypoechoic or partially hyperechoic and avascular. Areas of lipodystrophy may be found in the surrounding subcutaneous tissue of involuting hemangiomas. A hemangioma’s size varies from 1 to 18 cm. Internal echoes may occasionally be found representing small phleboliths. On pulse-wave Doppler interrogation both arterial and venous waveforms may be found. Arterial peak systolic velocities may be as high as 28.4±5 cm/sec while venous average peak venous velocities are 11.3±1.3 cm/sec. The solid appearance of hemangiomas on US can be used to differentiate them from arteriovenous malformations and venous dysplasias. Flow velocities observed in hemangiomas are generally lower than those of arteriovenous communications [24, 25].

Vascular malformations

Vascular malformations can be classified as lymphatic, capillary, venous, arterio-venous or mixed malformations, according to histologic findings. Moreover, based on the flow hemodynamics observed within the malformation, they can be characterized as high- or low- flow malformations [24].

Venous vascular dysplasias are characterized by low flow, are easily compressible and appear as either hyperechoic areas situated in the subcutaneous tissues or as hypoechoic areas located in the dermis and possibly subcutaneous tissues (Fig. 27 on page 29). These lesions may show a heterogeneous echostructure and may occasionally contain phleboliths with acoustic shadow. Real-time examination of these lesions with colour Doppler imaging reveals monophasic waveforms of low velocities. Flow velocities below 2 cm/s are usually difficult to visualize with colour Doppler technique. On the contrary, high-flow malformations show prominent blood flow signals [26].

V. MALIGNANT TUMOURS

Lymphoma

Nodular lymphoma appears on US as hypoechoic solid confluent nodules with ill-defined margins. Colour Doppler technique reveals the presence of increased vascularity within these nodules in active stages of disease (Fig. 28 on page 29). There may be normally-branching blood vessels perpendicular to the skin layers [27, 28].
Non-melanocytic malignancies

Non-melanocytic malignancies include basal cell and squamous cell carcinomas (Fig. 29 on page 30). Basal cell carcinoma appears on US as a hypoechoic, well-demarcated lesion with variable shapes as flat, hourglass, butterfly, or bulging. Basal cell carcinoma lesions may sometimes appear asymmetric, lobulated or with irregular margins. Intense echogenic reflections may occasionally be identified within the lesion. The presence of these fine reflections can be used to differentiate these lesions from melanoma, which doesn't show such reflections [29, 30]. Colour Doppler imaging usually demonstrates variable degrees of vascularity, from hypovascular to hypervascular within the lesion or in the surrounding tissues. Two artifacts are considered characteristic for this type of lesions: the "angles at the bottom" artifact which is caused by the severe inflammation with dilated blood vessels and confluences of giant cells creating an angle-shaped hypoechoic band at the innermost part of the lesion. The second artifact is termed "blurry tumour" and is usually visible at the nose tip, caused by the hyperplasia of sebaceous glands. This hyperplasia results in a blurry appearance of the lesion whose margins appear ill-defined. In these cases, the lesions appear almost isoechoic to the surrounding tissues. US is valuable in detecting early recurrence, particularly in patients with incomplete surgical resection or in patients treated with radiotherapy or cryosurgery [14, 30].

Squamous cell carcinoma appears on US was a hypoechoic heterogeneous lesion, which may be either regular and well-demarcated or with irregular margins. There are no hyperechoic spots within the lesion. Beyond infiltrating the skin layers, these lesions tend to extend towards deeper layers, infiltrating muscles and cartilage structures, especially in locations with thin skin like the ears or the nose. In such cases, the deeper margin of the lesion appears irregular. Colour Doppler imaging shows increased vascularity of the lesion with low velocity blood flow signals situated within the lesion or at its periphery [15]. Accurate measurement of the lesion's depth may be impossible in cases with hyperkeratosis of the epidermis causing complete reflection of the ultrasound beam [31].

Melanomas appear on greyscale US as hypoechoic, fusiform, well-demarcated lesions. Colour Doppler imaging reveals increased vascularity within the lesion, consistent with its malignant metastatic nature. The presence of neovascularization constitutes a prognostic factor related to the occurrence of metastases, similarly to Breslow index [32, 33].

**Cutaneous metastases**

Metastases of the skin appear on US as nodules located in the subcutaneous tissues which may be well-demarcated and homogeneously hypoechoic. Cutaneous metastases
usually appear hypervascular on colour Doppler imaging, containing multiple peripheral or centrally located blood vessels (Fig. 30 on page 31) [28].

VI. FOREIGN BODIES

Foreign body impaction is a clinical condition which is usually treated with surgical exploration of superficial trauma. Nevertheless, imaging is sometimes necessary in order to identify the presence of small foreign bodies in cases with unclear history or to exclude the presence of remnants after surgical exploration. Imaging usually starts with plain radiographies. However, radiographies will only detect radiopaque foreign bodies. US is thus valuable for the evaluation of radiolucent objects which normally reflect the ultrasound beam. Given that the ultrasound beam is normally completely reflected by the foreign body, it is evident that US will only visualize the object’s surface near to the transducer, while the rest of the objet will be hidden by acoustic shadowing or comet-tail artifact [34, 35].

US appearance of foreign bodies depends on their composition (wooden, plastic, glass or metallic). As a general rule, foreign bodies will appear on US as hyperechoic or heavily reflecting surfaces (Fig. 31 on page 31 Fig. 32 on page 32 Fig. 33 on page 33 Fig. 34 on page 34). The level of echogenicity is proportional to the acoustic impedance at the interface between the foreign body and surrounding tissues. The foreign body is usually followed by posterior acoustic shadowing or comet tail artifact, depending on the foreign body’s surface characteristics and material. Smooth and wide foreign bodies will create a “dirty shadow” appearance or comet tail artifact. The latter is usually found in heavily reflecting foreign bodies like metallic, glass or small stones. If the metallic foreign bodies or glass fragments are not entirely perpendicular to the ultrasound beam, they may not cause these characteristic artifacts at all. Foreign bodies with small diameter or irregular surface are expected to create more clear acoustic shadow.
**Fig. 1:** Classification of tumours and tumour-like lesions of the skin. Red colour represents lesions appearing hypervascular on colour Doppler imaging. Purple colour represents calcified lesions.

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**Fig. 2:** Subcutaneous abscess with cutaneous fistula formation. An 11-year-old boy presented with cutaneous fistula opening in his leg. Panoramic longitudinal view (A) demonstrating a hypoechoic and ill-defined lesion surrounded by hyperechogenic subcutaneous fat, consistent with oedema. Composite power Doppler image (B) showing the anechoic part of the lesion, with irregular margins and containing debris.

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**Fig. 3:** US findings of a post-injection haematoma of the skin in a 39-year-old patient. B-mode image (A) and power Doppler image (B) showing irregular anechoic and avascular areas situated in the subcutaneous tissue. Note the posterior acoustic enhancement.

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**Fig. 4:** US findings of a subcutaneous haematoma in a child presenting after handlebar injury. On clinical examination there was extensive bruising. Panoramic US image showing post-traumatic cellulitis, an early-stage subcutaneous haematoma containing serous fluid, thrombus and internal septations.

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Fig. 5: US findings in a 51-year-old patient with a histologically-confirmed epidermoid cyst of the right little finger. B-mode (A) and power Doppler image (B) showing a "solid appearing" lesion with the "pseudotestis pattern" of echogenicity. Note the absence of posterior acoustic enhancement because of the presence of the juxtapositioned phalange, causing acoustic shadow. No internal vascularity is seen on power Doppler imaging.

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Fig. 6: A 45-year-old man with an epidermal cyst in the anterior surface of the thigh. There is a 1.5 cm well-defined ovoid lesion which is heterogeneous, half hypo-echoic and half hyper-echoic resembling to testicular parenchyma. Colour Doppler image (A) revealed no significant blood flow signals. However, power Doppler imaging (B) demonstrated peripheral increased blood flow signals. Histology after surgical resection showed an epidermal cyst with keratin.

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Fig. 7: Composite B-mode image showing two juxtapositioned cystic lesions. The larger (left) is anechoic with posterior acoustic enhancement and contains fine internal echoes. Note is made of mural calcifications with posterior acoustic enhancement. The smaller cyst (right) appears with larger calcifications with posterior acoustic shadow.

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Fig. 8: US findings of a trichilemmal cyst. A 60-year-old man with a palpable lump on his scalp. B-mode image (A) showing an anechoic, well-demarcated ovoid lesion with posterior acoustic enhancement and is situated in the hypodermis of the occipital region. Note the fine internal linear echoes corresponding to hair. Power Doppler image (B) showing blood flow signals at the lesion's periphery.

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**Fig. 9:** A 6-year-old girl with an inflammatory cyst of the scalp. B-mode image (A) showing a 37x20 mm cyst situated at the occipital region. Note is made of fine internal echoes caused by debris and linear echoes caused by hair. Power Doppler imaging (B) revealed increased blood flow signals at the lesion's periphery, consistent with inflammation.

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**Fig. 10:** US findings in a 20-year-old patient working as a computer technician and diagnosed with a pilonidal cyst in the intergluteal cleft. Longitudinal B-mode image (A) demonstrating an elongated hypoechoic lesion containing hyperechoic lines corresponding to hair fragments (arrow in A). The lesion is situated in the dermis and hypodermis. Power Doppler image (B) showing increased blood flow signals (arrow in B) at the periphery of the sinus.

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Fig. 11: US findings in a 24-year-old patient working as a tailor and diagnosed with a digital cyst. Axial (A) and longitudinal (B) B-mode images showing a hypoechoic lesion situated in the dorsal surface of proximal phalangophalangeal junction of the middle finger. The lesion is found right under the epidermis.

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Fig. 12: A forearm hidradenoma in a 64-year-old patient. B-mode image (A) showing a well-demarcated mixed echogenicity lesion, consisting partly of solid and partly of cystic parts. The lesion was situated in dermis and extended to hypodermis. Colour Doppler image (B) identified internal vascularity.

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**Fig. 13:** US findings in a 2-year-old girl with multilocular lymphangioma in the right inguinofemoral region. B-mode (A) and power Doppler (B) image showing a two-chamber cystic lesion. The one part of the cystic lesion appears hyperechoic, while the other anechoic. Note is made of a small solid part with vascularity. On surgery, the hyperechoic compartment was found containing blood clots while the anechoic compartment was filled with serous fluid.

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**Fig. 14:** A 2-year-old boy with multilocular lymphangioma of the neck. There is a mixed echogenicity lesion containing multiple anechoic or hypoechoic cysts of varying size, separated by septations. Colour Doppler images (A, B) showing multiple cystic spaces separated by septa and solid parts. Compression of the lesion with the probe caused fluid displacement within the lesion's cystic parts resulting in opposite direction jets (arrows, blue colour representing flow towards left and red colour representing flow towards right). Note was made of fluid-fluid levels within cysts with echogenic content. Mild vascularity is seen within the lesion's solid parts.

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**Fig. 15:** US findings in a case of seborrheic keratosis. B-mode image (A) showing a superficial, well-defined, heterogeneous lesion of low echogenicity situated just under the "entry echo of epidermis". The lesion can be seen compressing the underlying dermis. Power Doppler image (B) showing that the lesion is avascular.

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**Fig. 16:** US findings of melanocytic nevi. B-mode (A) and power Doppler (B) images of a melanocytic nevi. There is a hypoechoic, relatively homogeneous lesions situated in the dermis. The lesion measures 4.3 mm in width and 1.8 mm in height. There is no evidence of penetration of the deeper layers of skin (A). No significant vascularity is seen on Power Doppler technique (B).

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Fig. 17: US findings of two pilomatrixomas in the same patient. The patient presented with a 6.2 mm lesion situated on an eyebrow (A, B) and a second (C, D) measuring 5.1x2.6 mm on his neck. These lesions were surgically removed and proved to be pilomatrixomas on histology. Power Doppler examination (B, D) reveals mild internal vascularity of the lesion.

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Fig. 18: US findings in a case of fat necrosis of the neck. Transverse (A) and longitudinal (B) power Doppler images show a well-circumscribed hypoechoic nodule situated within the subcutaneous fat layer, superficial to the thyroid gland. This area is seen containing hypoechoic parts surrounded by hyperechoic tissue. Note the posterior acoustic enhancement.

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Fig. 19: US images showing the diverse echogenicity of lipomas. A well-demarcated hyperechoic lipoma (A) is seen on the thigh. B-mode image showing an isoechoic lipoma (B) situated on the thigh. Note the deformation of the underlying fascia and the similar echogenicity of the lesion with the surrounding subcutaneous tissue. Composite B-mode image of a subcutaneous hypoechoic lipoma situated on the dorsal region (C). Note a flattened, well-demarcated lesion hypoechoic compared to the adjacent tissue. There are some internal hyperechoic lines parallel to the lesion’s longitudinal axis and epidermis. Histology after surgical resection showed a lipoma.

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**Fig. 20:** Panoramic B-mode image showing multiple hyperechoic (at least 4) subcutaneous masses with different sizes in the same plane.

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**Fig. 21:** Ultrasonographic findings of a leiomyoma cutis. B-mode (A) and colour Doppler (B) image showing an ovoid, well-demarcated and hypoechoic solid mass situated in the subcutaneous adipose tissue. Note is made of increased internal vascularity.
**Fig. 22:** A 38-year-old woman presenting with a palpable mass of the right thumb, proved to be an angioleiomyoma. B-mode image (A) showing a 17x10 mm heterogeneous lesion with a hypoechoic and a hyperechoic part, showing well-defined borders, consistent with a benign entity. The lesion was situated on the subcutaneous tissue and was freely mobile, causing skin elevation. Colour Doppler image (B) showing increased and homogeneous internal vascularity within the lesion.

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Fig. 23: Ultrasonographic findings of glomangioma. B-mode image using a 9 MHz transducer showed a hypoechoic ovoid subcutaneous lesion measuring 13x6x10 mm situated on the knee.

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Fig. 24: US findings of a 35-year-old man with a soft fibroma of the dorsal surface of the elbow. B-mode (A) image showing an exophytic pedunculated skin lesion covered
by epidermis. The lesion appears heterogeneous with a hyperechoic and a hypoechoic part due to the presence of both loose connective tissue and ectopic adipose tissue respectively. On colour Doppler imaging (B), there are some blood vessels visualized within the fibrous part of the tumour.

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**Fig. 25:** US findings of a neurofibroma in a 75-year-old male patient with multiple neurofibromatosis. There were multiple neurofibromas on the patient's face, neck and upper extremities. The examined neurofibroma appears exophytic, well-circumscribed, anechoic, avascular on power Doppler and situated on the epidermis.

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**Fig. 26:** An infantile hemangioma in a proliferative phase on a 7-month-old infant. B-mode image (A) shows an ill-defined heterogeneous lesion situated in dermis and hypodermis. There is a mixed echostructure with prominent hypoechoic areas, corresponding to growing areas while the hyperechoic areas correspond to the involuting ones. On Power Doppler imaging (B), there is increased internal vascularity of the lesion with multiple "snake-like" blood vessels.

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**Fig. 27:** US findings in a 12-year-old girl with extensive venous dysplasia on the posterior surface of the thigh. Panoramic B-mode image (A) showing the "snake-like" course of a vein. Colour Doppler image (B) showing blood flow within the anechoic lesions representing dilated veins.

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**Fig. 28:** US findings in a 12-year-old child with enlarged cervical lymph nodes, proved to be a lymphoma. B-mode image (A) showing two hypoechoic enlarged solitary cervical lymph nodes. Power Doppler images (B and C) showing increased vascularity of the enlarged cervical lymph nodes. Pulse wave Doppler interrogation showing a high-resistance flow waveform (D).

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**Fig. 29:** US findings of a non-melanocytic carcinoma in a 74-year-old female patient. The 1.3 cm reddish lesion appeared two months ago, was situated near the left parotid region and was painful under the pressure of the transducer. B-mode image (A) showing the
lesion anechoic with irregular deep margins due to infiltration. Note the acoustic shadow due to the presence of intense echogenic reflections. Power Doppler image (B) showing increased vascularity within the lesion.

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Fig. 30: US findings in a 68-year-old patient with skin metastases from melanoma. There are distant metastases to the thigh and tibia from a surgically removed malignant melanoma of the ipsilateral inguinal region. B-mode image (A) showing the 18.9 mm metastasis which is situated in the subcutaneous tissue. The lesion is markedly hypoechoic with slightly irregular margins and shows increased vascularity on power Doppler imaging (B).

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**Fig. 31:** US findings of a thin wooden stick impaction. US image three days after the impaction shows the soft-tissue oedema of the distal phalange of the fourth finger.

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**Fig. 32:** A 11-year-old child with needle impaction in his foot 11 days ago. X-ray (A) showing the radiopaque foreign body. B-mode US (B) showing the exact needle's location and depth.

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Fig. 33: US findings of mortar shell metallic fragments. The soldier was injured 30 years earlier but there was still evidence of foreign bodies impacted in his posterior surface of neck.

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Fig. 34: A 49-year-old patient with a glass fragment impacted in his gastrocnemius. Composite B-mode image showing the 10x4 cm fragment which was impacted four days earlier. Note the presence of haematoma surrounding the foreign body and the presence of comet-tail shadow posterior to the foreign body.

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Conclusion

HRUS is valuable as it provides accurate anatomic and morphologic information regarding cutaneous lesions, detecting findings suspicious for malignancy. There is a significant overlapping between the ultrasonographic findings of different pathologies. For example, cystic lesions may appear solid (i.e. epidermoid cyst), while lesions of the same type may occasionally show different echogenicity (i.e. lipomas). Moreover, benign lesions may be misclassified as malignant while malignant lesions may mimic benign entities. Even though this field of ultrasound is so complicated, there are specific distinctive findings, which the radiologist should be aware of. These distinctive features (regarding shape, echotexture, size and vascularity), along with meticulous localization of the lesion's tissue of origin (dermatologic or non-dermatologic), patient's history and other laboratory or imaging findings from other modalities will allow for an accurate diagnosis.
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