EFSUMB Course Book, 2nd Edition

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Dermatologic Ultrasound

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Ultrasonography of normal skin and appendages (hair and nails)

The skin covers all our human body, but its function goes further than being just a physical barrier. It is necessary to know exactly the dermatologic structures and its ultrasound features. The skin is composed by three anatomically distinct layers: epidermis, dermis and hypodermis or subcutaneous tissue. There are anatomical regional variations of these strata depending on the location (face, trunk, palm or sole). Besides the skin there are the skin appendages, especially the nail and the hair for ultrasound purposes. And finally there are other structures (glands, vessels, nerves) that we will have to take into account in our ultrasound examinations. Maybe the best way to classify skin disease is according to the skin structure affected: epidermis, dermis, subcutaneous fat, hair or nails. We will need a high frequency linear transducer (> 12 MHz) and Doppler for a suitable skin ultrasound study.

Epidermis

It is the external layer of the skin and it is composed mainly of keratinocytes. In turn, we may differentiate five strata: the basal layer, the spinosum stratum, the granulous layer, the stratum lucidum (only in palm and soles) and the most superficial stratum, the stratum corneum, a cornified external membrane that is mainly formed of keratin. It is the thinnest layer, 0,04 mm (eyelid)-1,6 mm (sole).

On ultrasound examination we will find a single hyperechogenic band, except in areas where is specially thick like palms and soles, where we will identify a bilaminar hyperechoic structure [(1)]. As the epidermis has no vessels or vascular structures, there is no blood flow in color Doppler. Melanocytes and melanin are not well identified by ultrasound, neither Langerhans nor Merkel cells.

Dermis

Dermis is the middle layer of the skin. It is composed mainly of connective tissue, collagen and elastic fibers, within them are embedded the hair follicles and the sebaceous, appocrine and eccrine glands; as well as blood vessels, lymphatics, nerves and the arrector pili muscle. It is 15-40 times thicker than epidermis, being the back the most width.

Dermis we may be divided in two compartments: the papillary dermis and the reticular dermis.

1. Papillary dermis is the most near to the epidermis (between them we found the dermoepidermal junction). It is characterized by many digitiform dermal projections that ascend towards the epidermis (dermal papillae). Lax collagen bundles and elastic fibers are disposed perpendicularly.
2. Reticular dermis goes from the papillary dermis to the subcutaneous fat. We find dense collagen bundles parallel to the skin surface with a network of elastic fibers.

On ultrasound examination there will be a thin moderate hypoechoic homogeneous band just below the epidermis (the papillary dermis), and a thicker more hyperechoic slightly heterogeneous band beneath the latter (the reticular dermis). Intermingled in the reticular dermis we may identify hair follicles.

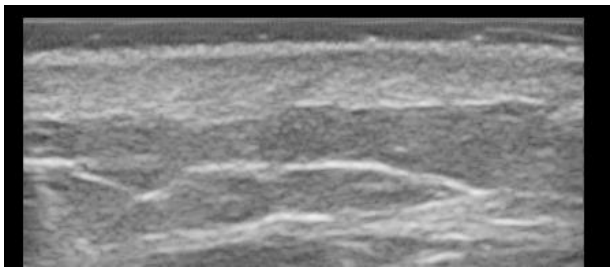
Normal dermis will show no blood flow or minimal in color Doppler studies. What we are going to see varying amounts of small-size blood vessels depending on the anatomical region.

Subcutaneous tissue

It is the deepest layer of the skin. There are two main structures in the hypodermis: lobules and septa. Lobules are composed of adipocytes distributed like irregular rectangular boxes separated by thin bands, the septa, formed mainly by collagen fibers, small and medium-sized blood vessels and lymphatics.

On ultrasound examination we will observe a usually thick homogeneous hypoechoic band with inserted hyperechoic lines. With color Doppler we will appreciate the blood vessels, with a low-flow pattern.

Figure 1 Normal skin of the arm sonography. From top to bottom: hyperechoic linear band (Epidermis), slighltly thin hipoechoic band (papillary dermis), thick hyperechoic structure (reticular dermis) wide hypoechoic layer with linear hyperechoic lines/septa (subcutaneous fat).



Hair unit

Humans have hair in all the body surface, except palms, soles and mucous membranes. There are three types of hair: vellus, sebaceous and terminal. Its life cycle has three stages: anagen (growing phase, the longest), catagen (involution) telogen (resting phase). They are composed of a cuticle (outer layer), cortex (middle layer, hard keratin) and medulla (inner layer, soft keratin).

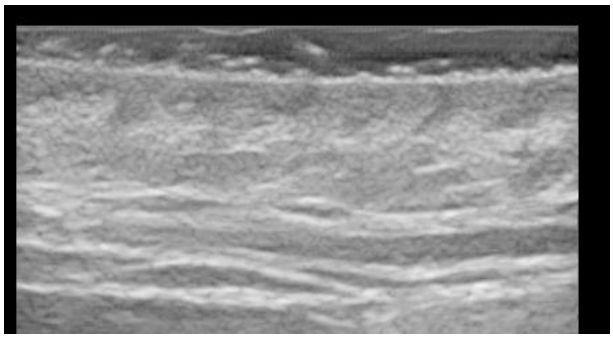
We have to differentiate between:

1. hair shaft (with a extracutaneous portion and a intracutaneous portion inside the follicle) and
2. hair follicle (all of it is intracutaneous). Terminal hair follicle is thick, entering to reticular dermis and subcutaneous fat, especially if they are in anagenic phase; while vellus hair follicle is very thin.

On ultrasound studies we will see hair shafts as an extracutaneous hyperechoic linear structures parallel to each other with a oblique orientation over the surface of the epidermis. With a high resolution probe we will be able to differentiate an inner hypoechoic band in terminal hairs, the medulla, what it gives a trillaminar appearance to the hair shaft. In the other hand the follicles are hypoechoic bands dermal structures with a tendency of be wider at the bottom, also parallel to each other with a oblique orientation, so it is very

important not to put the transducer in a longitudinal way. Follicles in superficial dermis usually correspond to telegenic phase and deeper follicles to anagenic phase.

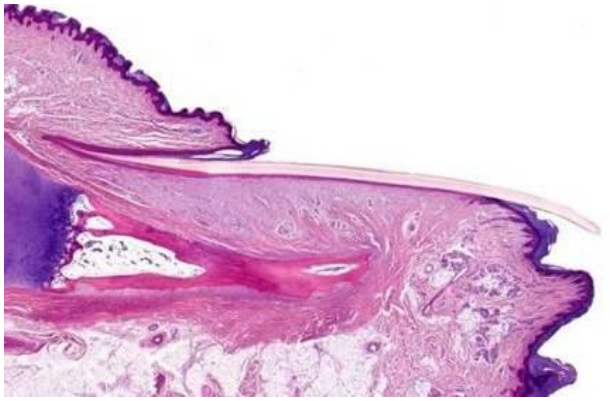
Figure 2 Terminal follicles in the face sonography. Oblique hypoechoic shadows slightly globular in the dermis.



Nail unit

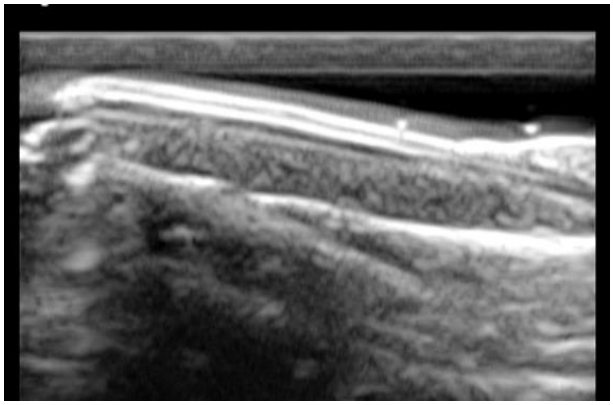
The nail is composed of many structures: 1) the nail plate or lamina, in the surface, keratinized, with three layers: ventral plate, interplate space, dorsal plate; 2) the nail bed, just beneath the nail plate, contains connective tissue with collagen fibers, a capillary network and glomus bodies 3) the ungueal matrix or germinal layer located in the proximal area of the nail bed; and 4) the periungueal folds: distal, proximal and lateral. We should underline the importance of the nail unit and its relation with adjacent structures; the distal phalanx and the extensor/flexor tendon insertion.

Figure 3 Nail unit, longitudinal histological features. From top to bottom: nail fold, nail plate, nail bed, distal phalanx. Courtesy of Dr. Luis Requena.



Ultrasound enables us to differentiate each structure. Nail plate linear is characterized by a slightly convex multilaminar band: two well defined homogeneous parallel hyperechoic lines (dorsal and ventral) and a hypoechoic space between them. Nail bed is seen as a thick homogeneous hypoechoic area below and attached to the nail plate. There are many capillaries, so a low-flow pattern with Doppler is frequently observed. Nail matrix is an ill-defined slightly hyperechoic area in the proximal area of the nail bed.

Figure 4 Nail unit sonography. See a billaminar hyperechoic nail plate with a hypoechoic interplate space, a hypoechoic band underneath that corresponds to nail bed, and the distal phalanx at the bottom



Other Skin Appendages

Skin appendages as sebaceous and apocrine glands (part of the hair unit); and eccrine glands are not identified by ultrasound.