Skin and Subcutaneous Tissue

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2.1 Histologic Considerations

From the histologic point of view, the skin varies in thickness from 1.5 to 4.0 mm and is composed of a superficial layer and a deep layer – the epidermis and the dermis, respectively (Fig. 2.1a). The epidermis is made of stratified epithelium, and can be divided into two main layers: the superficial stratum corneum, which is made of closely packed flattened dead cells, and the deep germinative zone (consisting of the stratum basale, stratum spinosum and stratum granulosum). In regions that are not subject to pressure, the epidermis is thin and hairy, whereas in areas undergoing attrition and local shocks (i.e., palms of the hands and soles of the feet), the skin is hairless and may thicken to an even greater extent as a result of a hypertrophied stratum corneum. Deep to the epidermis, the dermis is a thick layer containing large amounts of collagen and a rich network of vessels, lymphatics and nerve endings. It can be divided into a deep reticular layer, which is composed of bulky connective tissue, and a superficial papillary layer, which interdigitates with the base of the epidermis and provides an important mechanical and metabolic support to the overlying epidermis. Additional structures housed within the dermis are sebaceous and sweat glands, hair follicles and erector pili muscles.

Deep to the dermis, the subcutaneous tissue lies between the skin and the fascia (Fig. 2.1a). It acts as a gliding plane between these structures, thus protecting deeper areas from acute and chronic trauma; it also stores fat and participates in temperature control. The subcutaneous tissue is formed by a network of connective tissue septa and fat lobules. The overall size and extent of these septa vary at different sites of the body: they may be tiny in “loose” skin or compact when the skin is firmly attached to the underlying fascia. In normal conditions, the thickness of the subcutaneous tissue varies greatly depending on the amount of fat contained within. In some areas of the body, such as the dorsal aspect of the hand, the fat is sparse, while in other regions, such as the thighs and the buttocks, it is abundant. The amount and distribution of subcutaneous fat is also related to the individual body habitus, sex and the meteorologic environment. Discrete vessels, lymphatics, sensory nerve endings and hair follicles are contained in the subcutaneous tissue.

In areas where moving structures are tightly apposed, superficial “attritional” bursae separate the skin from the underlying tissues, and especially from the bone. These bursae are synovial-lined sacs tethered by dermis and periosteum. In the fingers and toes, the nails include the nail plate, the nail folds, the epidermis, the germinative matrix and the

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Fig. 2.1a–c. Normal skin and subcutaneous tissue. a Photograph of a cadaveric cross-section of the anterior thigh demonstrates a superficial layer reflecting the epidermis and dermis (black arrow), an intermediate thick layer representing fat contained in the subcutaneous tissue (double arrow) and a deep thin layer, located just superficial to the quadriceps muscle, due to the juxtaposed superficial and deep fascia (white arrow). b Corresponding transverse 17–5 MHz US image obtained in a healthy subject demonstrates the three tissue layers shown in a: the epidermis and dermis (black arrow) are homogeneously hyperechoic; the subcutaneous tissue (double arrow) includes a hypoechoic background reflecting fat lobules (asterisks) and hyperechoic strands (arrowheads) due to connective septa; the apposed superficial and quadriceps fasciae appear hyperechoic (white arrow). c Schematic drawing shows the normal architecture of the superficial tissues. From surface downward, note the epidermis and dermis (1, 2); the subcutaneous tissue (3) containing fat lobules (asterisks) separated by connective tissue strands (arrowheads); the superficial and deep (muscle) fascia (4-5); and the muscles (6).

The nail plate is similar to the stratum corneum of the skin. The proximal nail plate and the lateral folds overlie its sides. The undersurface of the nail plate is lined by squamous epithelium, which is continuous with that of the proximal nail fold and thickens at the nail root to form the germinative matrix.

2.2 Normal US Findings

US of the skin is almost exclusively performed by dermatologists, who make use of dedicated equipment with ultra-high-frequency transducers working at 20–100 MHz. Although the in-plane resolution of these transducer is as high as <50 μm, the depth of field is markedly limited at such high frequencies, and is reported to be 1 mm or less (Erickson 1997). Therefore, these transducers are not suitable for a combined evaluation of the subcutaneous tissue in its full thickness. At 20 MHz, the echogenic dermis can be distinguished from the hypoechoic subcutaneous fat and pilosebaceous units are recognizable (Fornage et al. 1993). The thick epidermis of the palm and sole can be recognized as well. In sites covered by thin hairy skin, the epidermis can be appreciated as an individual structure by means of 40 MHz frequency transducers. In aged skin, a subepidermal low-echogenic band is often appreciated as a result of increased water content. Normal skin thickness ranges have been established with US at different body sites (Fornage and Deshayes, 1986; Fornage et al. 1993). Further details on the US examination of the skin are beyond the scope of this chapter.

An adequate assessment of the subcutaneous tissue can be efficiently performed by means of “less specialized” high-resolution transducers characterized by the same frequency range (5–15 MHz) appropriate for other musculoskeletal examinations. The type and frequency of the selected transducer vary depending on the region of the body to be examined. For the thin subcutaneous tissue of the dorsum of the hand and wrist, linear-array transducers working at a center frequency >7.5–10 MHz are the most appropriate. Superficial focusing capabilities and a thin