

Magnetic Resonance Imaging of Skin Using Short and Ultrashort Echo Time Pulse Sequences

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Introduction

Magnetic resonance imaging of the skin has been a topic of considerable interest to the magnetic resonance (MR) community for many years (1,2). In spite of technical advances including the use of high temperature superconducting coils (3,4) and advanced pulse sequences, as well as in vitro studies at field strengths up to 21T (5), clinical use of the technique remains relatively limited. Many of the components of the skin of interest have short T2s (6) and this has resulted in a lack of signal from structures of interest using conventional pulse sequences. In this study we have used short and ultrashort TE pulse sequences in tissue samples, cadavers and human subjects and focused on the demonstration of relatively short T2 tissue components in the skin.

Materials and methods

Studies have been performed in thin and thick skin samples, intact cadavers and human subjects. All studies were performed on a 3T MR system (GE Healthcare, Milwaukee) using planar copper surface coils of 2-5 cm diameter operating at room temperature. Pulse sequences include 3D ultrashort TE (UTE), spoiled gradient echo, and conventional spin echo. Fields of view ranged from 1-5 cm with matrix sizes 320x320 to 512x512 and slice thicknesses of 30 to 200 μ m. Scan times varied from 15 to 270 minutes.

Results

We observed as distinct entities the stratum corneum, the stratum lucidum (Fig.1), the stratum papillare and stratum reticulare as well as details of the hypodermis including its fiber structure (Figs.2,3). Hair follicles have been observed, including sebaceous glands and the roots of hair follicles (Fig.4). Arrector pili muscles were observed (Fig.2). Both exocrine and apocrine glands were readily seen. Nails showed detectable signal with UTE sequences. Blood vessels were readily apparent in the dermis and hypodermis. Magic angle effects are seen in fibers of the stratum papillare and stratum reticulare.

Discussion

Many of the tissues of interest in the skin have short T2s and these are generally well visualized with short and ultrashort TE pulse sequences. These include structures that have not previously been reported with MRI such as the stratum lucidum, arrector pili muscles and fiber structure of the dermis and subdermis. There are particular advantages in the use of imaging planes parallel to the skin surface combined with thin slices. These allowed direct visualization of ordered structure with high signal to noise ratios in areas of the skin in close proximity to surface coils.

References

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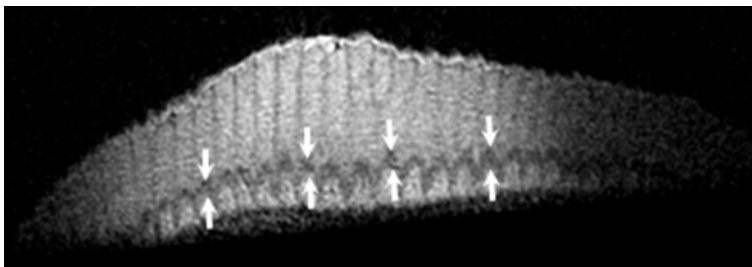


Fig. 1. Thick skin perpendicular to surface (above) with epidermis above and stratum spinosum below. The stratum lucidum is seen as a low signal band (arrows).

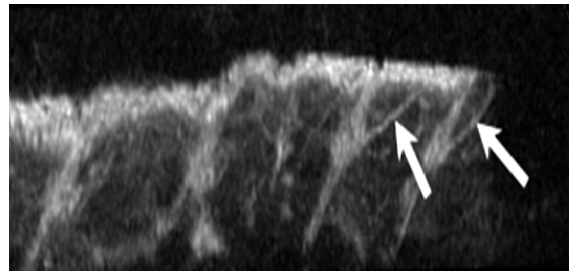


Fig. 2. Thin skin perpendicular to surface. Arrector pili muscles are shown (arrows).

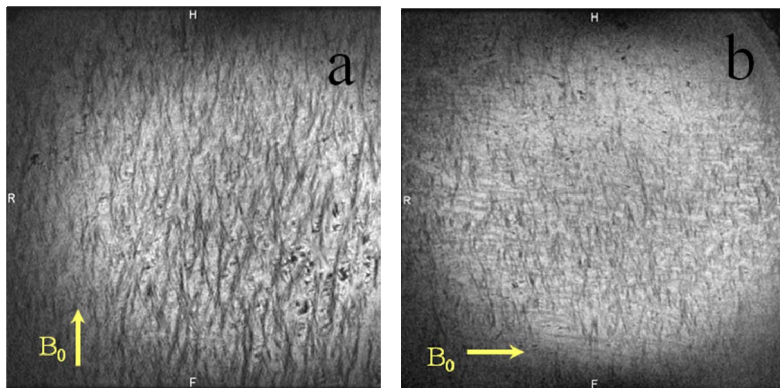


Fig. 3a,b. Thick skin parallel to surface. Stratum reticulare with B_0 parallel to majority of fibers (a) and perpendicular in (b). Many of the fibers are low signal in (a) and nearly isointense in (b).

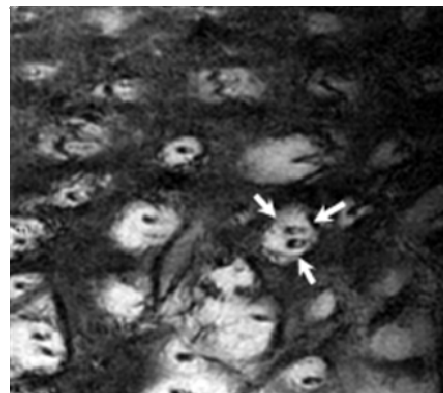


Fig. 4. Thin skin parallel to surface showing hair follicles. Roots have high signal (arrows) and hair cortex has a low signal. The hair medulla has a high signal within the cortex.