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High-frequency Ultrasound Scan for Non-invasive Cross-sectional Imaging of Psoriasis

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Seventeen patients with psoriasis vulgaris were studied by high-frequency (20 MHz) ultrasound imaging. An echo-lucent band located at the dermo–epidermal junction was characteristic. The band represents the combination of acanthotic epidermal thickening and inflammation. Thus, with ultrasound the site within the skin where primary events take place can be studied and followed non-invasively, i.e. with no known disturbance and influence on the course of the disease. ***Key words: Activity; Echo-lucent band.***

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High-frequency ultrasound technique for the examination of skin was introduced in the early eighties. In 1984, a study with a prototype 15 MHz scanner showed that the thickness of psoriasis plaques was increased by 55% as a mean, with a larger increase of thickness on extremities as compared to truncal skin (1). The same year, a cross-sectional ultrasound image of a psoriasis plaque was presented and ultrasound B-mode scanning of psoriasis introduced (2). In 1985, another case of ultrasound B-mode scanning of psoriasis was presented, and in this case an echo-lucent band can be seen corresponding to the acanthotic area (3). However, it was Querleux et al. who in 1987 described an echo-lucent band corresponding to the acanthotic area as a more common feature in psoriasis (4). They suggested that the band represented both acanthosis and inflammation in the outer dermis. Their scanner was a prototype scanner, which to the best of our knowledge has no facility for adjustment of the amplification in depth. The echogeneity of a tissue and the recognition of echographic bands depend on the gain profile and the technical specifications of the equipment.

Recently, ultrasound A-mode measurement of the thickness of psoriasis plaques was used to rank the therapeutic effects of corticosteroids applied under hydrocolloid occlusive dressing, and compared to other bioengineering methods (5). With super-potent corticosteroids psoriasis was cleared clinically in 1 week, and the skin thickness returned to normal, while colorimetry still indicated some redness.

The purpose of the present study was further to evaluate and confirm the presence of an echo-lucent band in psoriasis by the use of a commercially available 20 MHz ultrasound scanner with an adjustable gain function and other technical facilities, which serve to validate the findings. This scanner was originally developed as a prototype in our laboratory.

MATERIAL AND METHODS

Seventeen patients with a diagnosis of psoriasis vulgaris were included in the study, after informed consent. Seven males and 10 females participated. Their mean age was 50.2 years (14–73 years). A plaque of one of the upper extremities, the trunk and one of the lower extremities was studied in each case, if present, to average regional differences. The mean duration of plaques studied was 10.6 months (1–66 months). Furthermore, 2 cases of pustular psoriasis were examined. The Dermascan C® (Cortex Technology Aps, Hadsund, Denmark) was used for the study (5, 6). The scanner has facilities both for A-mode, B-mode, C-mode and M-mode scanning. The transducer is focused, with a centre frequency of 20 MHz. In the present study we used the C-mode facility and obtained a number of parallel cross-sectional images through the different skin layers. Images were shown on a colour screen. Polaroid pictures of the screen were taken (Fig. 1). By the use of the inbuilt facilities, A-mode lines were selected in each image on these sites, which were assessed as being representative.

The selection of amplification is important in imaging. We used the gain adjustment on live image method previously described (6). Initially the normal skin of the same body region was scanned. The gain was adjusted on the live picture so that the whole dermis was filled up with echoes in a uniform pattern throughout the papillar and reticular dermis. Then the plaque of the same region was studied by the use of the same gain profile, adjusted to meet with skin and anatomical side of that particular volunteer. Turning to another region the gain was reset. Scales might create shadows. The total thickness as measured from the epidermal surface to the interface between reticular dermis and subcutaneous fat was measured, the epidermal thickness from the surface to the interface echo between epidermis and dermis was measured, and finally the echo-lucent band was measured, i.e. from the internal interface of the epidermis to deeper parts of the dermis with a normal echogeneity. In 3 patients punch biopsies were taken for the purpose of comparison and stained with hematoxylin-eosin.

Correlations were expressed as the Spearman correlation coefficient.

RESULTS

A total of 44 definite plaques with redness, some scaling and thickening clinically were examined. An echo-lucent band was found in 42 of the plaques, i.e. only 2 plaques showed no band. The mean thickness of the echo-lucent band was 0.493 mm (SD 0.211 mm). In psoriasis plaques the mean thickness of the epidermis/entrance echo was 0.116 mm (SD 0.039 mm), and the mean total thickness of plaques (from skin surface to interface between dermis and subcutaneous fat) was 2.244 mm (SD 0.768 mm).

The epidermis/entrance echo thickness of regional and uninvolved skin was 0.113 mm (SD 0.029 mm), and the mean total skin thickness was 1.562 mm (SD 0.478 mm). Calculation of mean thickening of plaques versus regional control was 0.682 mm (SD 0.597 mm).

The mean surface area of plaques studied was 9.51 cm^2 (SD 13.95 cm^2). Histological examination of three samples of the present material with thickness measurement of the sections

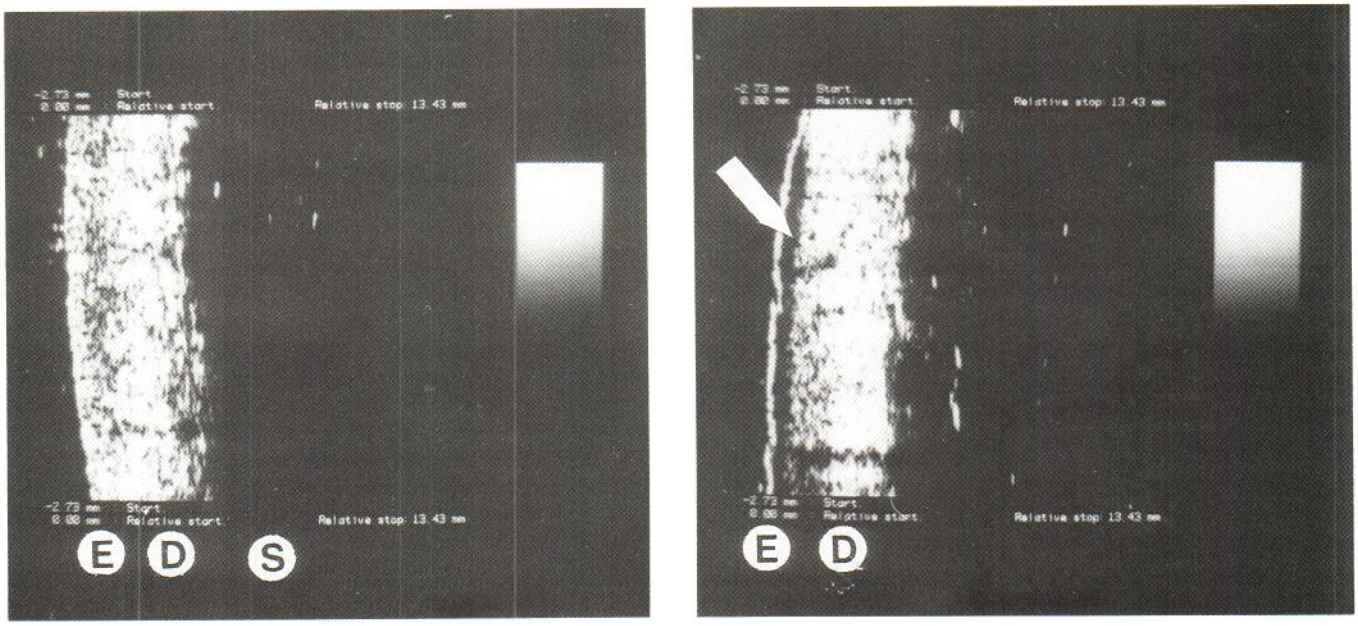

Fig. 1. Ultrasound cross-sectional image of unaffected regional skin (left) and a psoriasis plaque (right) with an echo-lucent band (*arrow*) in the outer skin corresponding to the epidermo–dermal junction and the papillar dermis. *E* = epidermis/entrance echo. *D* = dermis. *S* = subcutaneous fat.

are shown in Table I, which includes ultrasound measurement of the same plaques. Ultrasound examination of 3 patients with pustular psoriasis showed changes essentially similar to findings in psoriasis vulgaris, including a subepidermal echo-lucent area; however, this was not a continuous band but confined to spots with pustules.

Analyses of correlation of variables in this material of selected psoriasis plaques showed coefficients of correlation between echo-lucent band and total thickness of the plaques = 0.379, between the thickening (difference total thickness psoriasis plaques minus control skin) = 0.394, and between plaque area and echo-lucent band = −0.231.

DISCUSSION

The present study confirms that an echo-lucent band is common in fully developed psoriasis plaques. Our findings indicate that anatomically the band was located in the papillar dermis corresponding to the elongated rete papillae, where cellular infiltraiton is also present. This was also evident in the three cases, where ultrasound was compared with histology. In a quantitative study of the histopathology of psoriasis objectively measured by histology Chapman & Ross found the thickness of psoriatic epidermis close to our observations based on ultrasound (7). Thus, there is circumstantial evidence that the echo-lucent band seen by ultrasound represents the combination of elongated rete papillae and inflammation, in the papillar dermis.

Formation of an echo-lucent band in the papillar dermis was previously observed in different dermatological disorders with inflammatory activity (6). Such diseases include allergic and irritant patch-test reactions and contact dermatitis (8, 9). The echo-lucent band may be very prominent in atopic dermatitis, corresponding to the lichenifications (10). Examples of echo-lucent band formation due to disorganisation of the fibrillar network are scleroderma, prurigo nodules, keloids and neurofibromatosis of Recklinghausen.

It was not the purpose of the present study to follow the echo-lucent band of psoriasis in relation to the spontaneous course of the disease or to therapy. We only included fully developed plaques, which may explain why we found no significant correlation between echo-lucent band and thickening. However, we have the impression that the thickness of the band is related to the activity of the disease and disappears relatively early when the therapy is efficient. A number of hypotheses about the etiology of psoriasis have been suggested. Different authors agree that the events which determine the development and spontaneous course of psoriasis take place in the epidermo–dermal area including the outer

Table I. *Histology compared with ultrasound examination of the same plaques*

The outer epidermis was measured from the outer skin surface to the top of the dermal papillae, and the rete layer represented the rete ridge/dermal papillae layer. By ultrasound measurement a velocity of 1580 m/s was used. By ultrasound the epidermis corresponded to the outer epidermis by histology, and the echo-lucent band was roughly 50% thicker than the rete layer by histology.

		Case 1	Case 2	Case 3	Mean
Histology					
Epidermis, outer layer	mm	0.16	0.09	0.12	0.12
Epidermis, rete layer	mm	0.44	0.31	0.33	0.38
Ultrasound					
Epidermis echoes	mm	0.10	0.10	0.10	0.10
Echo-lucent band	mm	0.68	0.57	0.36	0.54
Full-thickness of skin	mm	1.97	2.10	1.58	1.88

dermis, i.e. corresponding to the echo-lucent band. We find it of interest that it is now possible, non-invasively, to study and follow primary events in psoriasis by the use of high-frequency ultrasound imaging.

Seidenari & DiNardo recently described how echographic bands of the dermis can be quantified using an image analysis system connected to the Dermascan C® (8, 9). They also conducted experiments demonstrating that ultrasound image analysis is useful for the assessment of psoriasis and stages of healing as well (11).

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