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Skin Thickness in Patients with Osteoporosis and Controls Quantified by Ultrasound A Scan

Key Words
Osteoporosis
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Abstract
In order to study a possible association between skin thickness and osteoporosis, we measured skin thickness by A mode ultrasound scanning in 20 females with osteoporosis and 20 age- and sex-matched controls. Bone mineral content (BMC) of the lumbar spine and the forearm was measured by dual-photon absorptiometry. BMC of the lumbar spine was significantly reduced in the osteoporotic group as compared to controls ($p < 0.002$). No difference in skin thickness was found between osteoporotic patients and controls. A statistically significant correlation between skin thickness on the forearm and BMC of the forearm was found ($p < 0.02$), but was opposed by a lack of correlation between skin thickness and BMC of the lumbar spine. We found a correlation between skin thickness and body weight ($p < 0.002$), which to our knowledge had not been reported earlier.

In the literature patients with osteoporosis are described as persons with a kyphotic spine, decreased height and a wrinkled, thin, atrophic skin [1]. An association between transparent skin, recorded by infrared photography, and osteoporosis has been described, and the prevalence of osteoporosis in women with transparent skin was reported to be significantly higher than in women with opaque skin [2]. It has been suggested that the atrophy seen in bone matrix in osteoporosis could be due to a more widespread atrophy, also involving the connective tissue of the skin [1].

This study was undertaken to examine whether an association between skin thickness and osteoporosis exists. By use of one-dimensional ultrasound, skin thickness in osteoporotic women and controls was quantified and compared.

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Table 1. Demographic data in the groups investigated

	Osteoporosis		Controls	
Age, years	73	(71, 77)	74	(68, 77)
Height, cm	156	(146, 160)	162	(159, 165)
Weight, kg	57.8	(51.0, 65.9)	64.2	(57.7, 73.9)
BMI, kg/m^2	24.5	(21.4, 27.4)	24.1	(21.4, 28.0)
BMC forearm, arbitrary units[1]	24.15	(20.95, 28.70)	29.10	(23.70, 32.60)
BMC spine, g HA	23.99	(21.62, 26.94)	30.36	(25.52, 34.65)
Age at menopause, years	47	(45, 50)	49	(46, 51)

Results are given as medians, lower and upper quartiles are given in parentheses. HA = Hydroxyapatite.

[1] One arbitrary unit corresponds to 0.07 g of hydroxyapatite.

Materials and Methods

Twenty Caucasian females with osteoporosis (i.e., low bone mass and at least one spontaneous fracture in the spine), aged 62–80 years, participated in the study. The subjects were recruited from Sundby Hospital, Medical Department, Copenhagen. The criterion for osteoporosis was the presence of at least one atraumatic fracture in the spine and radiographically confirmed demineralization of vertebrae. Twenty age-matched Caucasian females served as controls. These subjects were also recruited from Sundby Hospital, Copenhagen, and were characterized as subjects without any fractures in the spine (all radiographically checked), but all had an earlier bone fracture of the arm or the leg on a traumatic basis. Patients were excluded if they had secondary causes of osteoporosis, such as hypo- or hyperparathyroidism, Paget's disease of bone, renal osteodystrophy, or if they had been or were on a steroid therapy. None of the participants had medical conditions or medications with a known influence on skin thickness. Informed consent was obtained from all participants, and the study was approved by the local ethical committee.

Bone mineral content (BMC) of the lumbar spine was measured by dual-photon absorptiometry (^{153}Gd, BMC-LAB 22a, Novo Diagnostic Systems, Denmark) over the second, third and fourth lumbar vertebrae, and expressed as the total BMC in grams of hydroxyapatite [3]. The coefficient of variation in osteoporotic patients is 4–5% [4].

Regional BMC of the distal nondominant forearm was measured by single-photon absorptiometry (^{125}I, Novo GT, Novo Diagnostic Systems, Denmark) [5]. BMC was expressed in arbitrary units (one arbitrary unit corresponding to approximately 0.03 g of hydroxyapatite). The coefficient of variation in osteoporotic patients is 3–4% [3].

Table 2. Skin thickness measured at back of hand (BH), extensor side of forearm (EF), flexor side of forearm (FF) and extensor side of upper arm (EU) in the groups investigated

	Skin thickness, mm	
	osteoporosis	controls
BH	0.60 (0.55, 0.65)	0.59 (0.54, 0.71)
EF	0.84 (0.75, 0.91)	0.87 (0.78, 0.94)
FF	0.79 (0.70, 0.84)	0.79 (0.73, 0.87)
EU	0.84 (0.78, 0.90)	0.85 (0.80, 0.92)

Results are given as medians, lower and upper quartiles are given in parentheses.

The skin thickness (epidermis and dermis together) was quantified with a 20-MHz ultrasound A scan (Dermascan A®) [6–8]. The value was expressed in millimeters and was calculated from the sound velocity in the tissue, known to be approximately 1,580 m/s in skin [8, 9]. All measurements of skin thickness were performed on the right arm on the following locations: back of hand, forearm flexor side, forearm extensor side and upper arm extensor side. All recordings were performed by the same investigator. All measurements were expressed as the average value of three recordings.

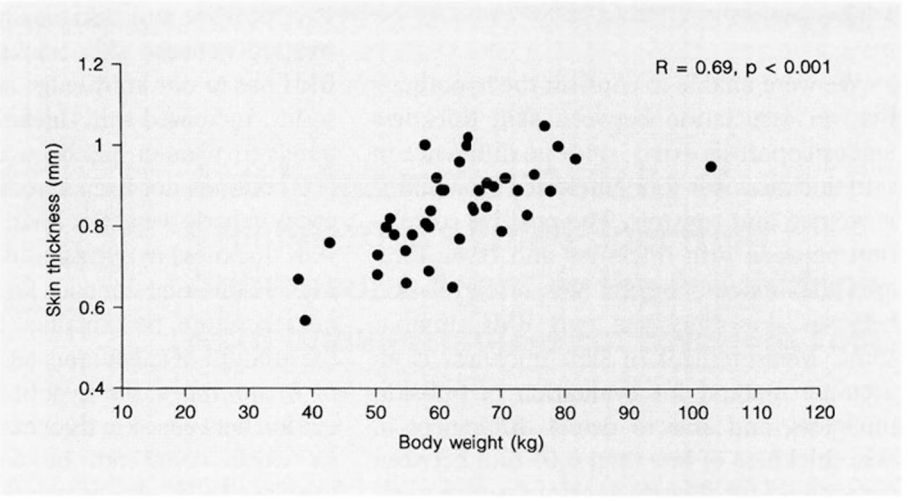

Fig. 1. Correlation between skin thickness on the flexor side of the forearm and body weight.

Statistics

Wilcoxon's test for unpaired samples was used for comparig median values. Reproducibility of the skin thickness measurements was calculated on the basis of the SD of three measurements from all patients as:

$$SD_{repro} = \sqrt{\frac{1}{n} \Sigma SD^2}$$

Spearman's rank correlation analysis was used for correlation studies. All p values were two-tailed.

The number of participants was calculated on the basis of SD on measurements being 0.03, and the type 1 and 2 error estimated as 5% each, and the present number of participants ensured that a difference in skin thickness of 0.04 mm between the groups would not be overlooked.

Results

In table 1 values for age, height, weight, body mass index (BMI), BMC forearm, BMC lumbar spine and age at the menopause are given for osteoporotic patients and controls. A significant difference between the groups was found for BMC in the lumbar spine only, this being statistically significantly lower in the osteoporotic group ($p < 0.002$). Skin thickness measurements for osteoporotic patients and controls are demonstrated in table 2. No statistically significant difference in skin thickness between the groups was found in any of the measured locations ($p > 0.05$).

We found a statistically significant positive correlation between skin thickness measured on the forearm (both flexor and extensor side) and BMC forearm ($p < 0.02$, $R = 0.39$ and $p < 0.01$, $R = 0.41$, respectively). No significant correlation between skin thickness measured on the upper arm or the back of the hand and BMC forearm was found. No significant correlation was found between BMC lumbar spine and skin thickness at any locations ($p > 0.05$). A statistically significant positive correlation was found between skin thickness (measured on all locations) and body weight ($p < 0.002$; $R = 0.49$; fig. 1). Also skin thickness and BMI were significantly correlated according to all four measuring locations ($p < 0.009$; $R = 0.53$).

Discussion

We were unable to confirm the hypothesis that an association between skin thickness and osteoporosis exists, since no difference in skin thickness was found between osteoporotic women and controls. The positive correlation between skin thickness and BMC forearm was opposed by the lack of correlation between skin thickness and BMC lumbar spine. Measurement of skin thickness is an accurate method for evaluation of full-skin thickness, and able to detect differences in skin thickness of less than 0.05 mm between the groups [10]. The diagnosis of osteoporosis in the patient group was made by radiographically confirmed atraumatic vertebral crush fractures. This was not found in the control group, which was also radiographically examined. Additionally, a statistically significant difference in BMC lumbar spine between the groups was demonstrated.

A positive and statistically significant correlation between skin thickness and weight/BMI has to our knowledge not been reported so far. Increased skin thickness in men compared to women has been described earlier [11], but has not been associated with differences in body weight or BMI. Measurement of skin thickness by ultrasound A scan does not include the subcutaneous fat; the finding cannot, therefore, be explained by differences in the amount of subcutaneous fat.

In summary, the hypothesis that an association between skin thickness and osteoporosis exists could not be confirmed in the present study. An association between low body weight and thin skin was demonstrated, and as osteoporotics are often of low body weight [12], this may very well explain the clinical impression of the thin-skinned osteoporotic patient.

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