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Cutaneous Thickness-Age and Gender Influence: Review of Ultrasound Measurements

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INTRODUCTION

Skin thickness can vary widely among individuals as a result of a person's gender, age, and location. In order to measure skin thickness, a variety of tools have been used. Scanning electron microscopy and light microscopy have been used to measure thickness of skin in vitro [1]. To measure the thickness of the skin in vivo, a skin caliper instrument can be used, however, it is less commonly used today as it is not a precise measurement [2]. A method that has been shown to be a reliable direct measure of unmodified skin is ultrasound scanning, a non- invasive method for in vivo measurement of epidermal and dermal thickness [3]. There are two types of ultrasonography including A and B mode, as well as different frequencies that can be used. The dermis and hypodermis is measured well with 20MHz ultrasound, but the epidermis is much thinner indicating that HFUS up to 100MHz should be used to better visualize the epidermis [4]. The purpose of this review is to understand the factors that influence skin thickness and echo density.

Factors Influencing Skin Thickness and Echo Density

Skin thickness and echo density can be influenced by factors such as increasing age, gender, and particular sites of the body. Evidence suggests that skin thickness is typically higher in males than females, opposite of echo density, which is typically higher in women [1,5-7]. Gender, however, has not been shown to play a significant role in epidermal entrance echo thickness [1]. Although age was not reported to affect echo density [1], age is a significant factor in skin thickness. Thickness of the dermis is more often thinner in the aging population [1,5,6,8-10].

To gain a better understanding of these influencing factors, this review will focus on the study "The influence of gender and age on the thickness and echo-density of skin", while also reviewing other articles in the literature that analyze skin measurements. Firooz et al. used high frequency ultrasonography (HFUS) to assess influencing factors such as gender, age, and location on skin to further determine how these variables affect skin thickness and echo density of skin [1]. Epidermal entrance echo thickness, dermal thickness, and echo density of dermis was measured in 30 individuals, 17 female and 13 male. With the use of B mode HFUS at 22 and 50MHz ultrasonic probes, five anatomic locations were measured, and healthy participants were placed into groups based on age. The age range was 24- 61 years old; the young skin group consisted of subjects less than 35 years old and the old skin group consisted of subjects over 35 years old. Subjects were not included in the study if they met any of the following exclusion criteria: any skin disorders, application of corticosteroid drugs, BMI >30, chronic systemic diseases, instant sun exposure in previous 3 months and/or hard physical activity.

The five skin locations measured included the cheek, neck, palm, dorsum of the foot, and sole. The study was done in winter to avoid exposure to sun in subjects over the previous 3 months due to the fact that sun exposed areas have less decrease in skin thickness compared to protected areas [11].

Firooz et al. found that dermal thickness was higher in males compared to females, showing statistical significance on the neck and dorsum of foot. Shuster et al. also showed thickness of dermis in all ages was higher in men than women in the forearm [5]. Furthermore, a 25 MHz A mode ultrasonography used to measure the ventral forearm of 54 men and 64 women between ages 0-90+ years of age concluded that in all ages, the skin thickness of men was higher than women's skin thickness ($p<0.001$).[6]Because different sites of the body were measured and different tools were used, the studies suggest that there is strong evidence that men have a thicker dermis than women overall.

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Epidermal entrance echo thickness was also measured with the use of B mode HFUS indicating that it is higher in men than women; however, it did not reach statistical significance in any site [1]. Echo thickness was almost equal in men and women in the dorsum of the foot. All the information regarding epidermal entrance echo thickness is based on the findings of Firooz et al. There is limited amount of information on epidermal entrance echo thickness due to the fact that it may not be commonly measured.

Lastly, echo density of dermis was found to be higher in females on all sites, showing significance on the neck only [1]. Similar to epidermal entrance echo thickness, the echo density on the dorsum of the foot was almost equal in men and women. When comparing age groups, however, there was no significant difference in echo density.

Supporting these findings, Seidenari et al. concluded that echo density of dermis was higher in women than men using a 20MHz B-mode scanner [7]. Skin thickness and echo density of dermis was analyzed on six sites of 48 individuals divided into two groups each with 27 subjects, from 27-31 years of age and over 60 years of age respectively. This same study also concluded that skin thickness on the forehead, cheek, volar forearm, dorsal forearm, and upper abdomen was higher in males compared to females [7].

Different locations on the body also influence skin measurements. Taking the overall mean of all the sites measured, Firooz et al. reported that the palm had the thickest dermis, the sole had the highest epidermal entrance echo, and the neck showed the highest echo density of dermis [1]. This may be a result of different sites receiving more sun exposure than others or an individual's amount of activity.

Comparison between the two age groups found that epidermal entrance echo thickness and thickness of dermis in the young age group was higher than the old age group [1]. Epidermal entrance echo thickness decreased with age on the palm, cheek, and dorsum of the foot, however, it was only significantly higher in young adults on the dorsum of the foot. It remained constant on the neck and sole. Thickness of the dermis was statistically higher in young adults in the sole [1].

It was also shown that skin thickness decreased with age. Branchet et al. concluded that in both men and women, epidermal thickness decreased with age after analyzing the skin of 34 women and 30 men between 20- 80 years of age. The study showed that skin thickness in men decreased 7.2% per decade, which was more significant, than in women with a 5.7% decrease per decade [8]. Other studies suggested that age related thinning of the skin was more prominent in women [6,9]. Thinning of the skin can begin as early as the third and fourth decade of life. [8,9]Shuster et al. found that skin thickness in females was shown to be constant until the age of 40, and then began decreasing with age ($p<0.001$). With increasing age, the skin thickness of men gradually decreased ($<p<0.001$) [5].

Using 25MHz B- mode ultrasound, images were obtained from 142 women with 10-20 subjects in each decade of lie from 0-90 years old. De Rigal et al. showed that the skin on the volar forearm of women mostly thinned after the eighth decade ($p<0.05$), without showing significant variations between the first and seventh decade of life ($p<0.001$) [10]. However, Escoffier et al. showed that subjects under 15 years old had thinner skin, but their skin thickness actually increased between 0 and 20-30 years ($p<0.013$) with no variation between 15-65 years of age. Skin thickness was significantly thinner in subjects after 65 years of age [6]. Slight differences in findings between De Rigal et al. and Escoffier et al. could be associated to the use of B mode and A mode devices respectively.

Other studies found no significant difference between age groups. Using 25MHz ultrasound and confocal microscopy, dermis thickness on the back of the arm was measured in females, 16 women 18-25 years old and 18 women 62-69 years old. The thickness of the living epidermis was lower in aged subjects; however, there was no significant difference between the young group (15 ± 3 um) and aged group (17 ± 3um) [12]. Sauerman et al. also found no correlation between whole skin thickness and age with the use of confocal microscopy [13].

The images from HUFS include the epidermal entrance echo, dermal layer, and echogenic subcutaneous tissue. The echogenicity of the epidermis is affected by the content of keratin, collagen in the dermis, and fat lobules in the subcutaneous tissue [14]. Some studies suggest that echogenicity increases with age [15], while others report echogenicity of the dermis decreases with age [16-19]. These differences in results might be explained by the changes that occur with aging such as decreased elasticity of the skin that may affect dermal echogenicity as well as skin thickness [20,21].

CONCLUSION

Epidermal and dermal thickness varies depending on many factors such as gender, location, and sun exposure. [22] This could attribute to the varied results in the literature. Environmental factors as well as hormonal status among individuals should also be taken into consideration. Body sites and population could also account for other differences between studies. It was noted that high frequency ultrasonography is an accurate tool for skin thickness measurements, density, and echogenicity of the dermis. In addition to analyzing larger sample sizes and standardizing conditions, the use of ultrasonography for skin measurements could be a beneficial tool for future research.

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