

Variations in Facial Skin Thickness and Echogenicity with Site and Age

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The characteristic pattern of reflectivity of facial skin, as evaluated by ultrasound, has not previously been described quantitatively. The aim of this study was to evaluate site- and age-dependent variations in skin thickness and echogenicity of facial skin. A total of 40 women, in different age groups, were studied at 12 different facial skin sites. Echographic images were recorded with a 20 MHz B-Scanner and processed by dedicated software. Skin thickness measurements showed significantly higher values on the lower part of the face, whereas skin echogenicity was higher on the upper part of the face. In elderly subjects, an increase in facial skin thickness and overall echogenicity was observed compared with the younger subjects at all assessed skin areas, except the infraorbital regions. Moreover, modifications of skin echogenicity according to age, consisting in the appearance of a subepidermal band and an enhancement of the lower dermis' reflectivity, were observable at most facial skin sites. Key words: face; skin thickness; skin echogenicity; 20 MHz B-scanner; ageing; ultrasound.

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INTRODUCTION

The skin ageing process is influenced by a wide variety of factors. Age-related alterations of the skin, known as chron-ageing, are modulated by genetic, behavioural, catabolic, endocrine and gravitational factors. Moreover, chronic exposure to sunlight induces a multitude of clinically important degenerative changes in the various compartments of the skin (so-called photo-ageing), introducing great inter-individual and site-to-site variations in the ageing process (1).

At different facial skin sites, values characterizing roughness and wrinkling of the skin increase with age (2). Variations in parameters of skin elasticity suggest quantitative and qualitative changes in elastic fibres with ageing (3), whereas no age-related impairment of skin barrier function, as assessed by transepidermal water loss, is observable (4).

The B-scan imaging method has been used to correlate the age-dependent degree of elastosis to modifications in skin thickness and reflectivity (5). A sub-epidermal hypoechogenic band, appearing as a relatively homogeneous, echolucent structure, located immediately below the entry echo, has been described in the skin of elderly subjects on the volar and dorsal aspects of the forearm (5). Site to site variations in skin echogenicity related to ageing were reported using image analysis procedures on 20 MHz B-scan recordings (6). Whereas a decrease in mean echoamplitude values was

observed on forearm skin in elderly subjects, forehead and cheek skin showed an enhanced dermal echogenicity.

So far, little attention has been paid to site and age-related variations of facial skin assessable by ultrasound. The aim of this study was to evaluate the echographic aspect of facial skin in young subjects at different sites and the modifications of skin thickness and echogenicity which intervene in elderly people.

MATERIALS AND METHODS

The study was carried out on 40 healthy Caucasian women, 20 of whom were aged 25–30 years, and 20 aged 60–90 years. None of the subjects had been affected by skin disease or skin tumours. The subjects were asked to avoid using any skincare products for 2 days before testing.

A total of 12 facial skin sites were studied: central forehead, lateral left and lateral right forehead, nose, infraorbital left and right regions, left and right cheeks, upper left and upper right lips, and lower lip and chin.

Echographic evaluations were carried out by a 20 MHz B-Scanner (Dermascan C, Cortex Technology, Denmark), which produces images representing a cross-section of the skin. Dermascan C is provided with a 20 MHz transducer, which enables the high definition study of tissues close to the body surface. A water-based gel (Cogel, Comederal, Italy) was employed as coupling medium between the transducer and the skin surface. After acquisition, the echographic images were processed by an image analysis program (Dermavision 2D, Cortex, Denmark), based on segmentation procedures, enabling a numerical description of the images. The instrument, the standardization procedures and recording conditions have already been described in detail elsewhere (7). For evaluation of the images, 4 amplitude intervals were used. The first, ranging from 0 to 30, marks the hypoechogenic parts of the tissue; the 30–100 and 100–200 intervals mark the tissue reflecting with intermediate amplitude values; the last, ranging from 201 to 255, highlights hyper-reflecting parts of the skin coinciding with the epidermis and the deep dermis. Images undergoing image analysis were recorded with a standard gain curve at 22 dB (8). Because of the poor echogenicity of skin sites on the lower part of the face, images were also recorded using a gain curve at a higher level, evidencing the dermis-hypodermis boundary both for skin thickness assessment and for outlining the region of interest during the image analysis procedure. Absolute values referring to the extension of homogeneous amplitude areas of a given image, expressed in number of pixels, were divided by skin thickness values of the corresponding image (relative pixel values), in order to exclude variations related to differences in skin thickness. Measurements were repeated twice at each skin site in each volunteer and the mean of the 2 values was employed for statistical calculation.

Statistics

Means and standard deviations were calculated. The Mann–Whitney test for independent samples, as implemented in the SPSS statistical package (release 7.0, 1995; SPSS Inc., Chicago, IL, USA), was used to evaluate the differences between values referring to different skin areas in young and elderly subjects. A *p* value < 0.05 was considered significant.

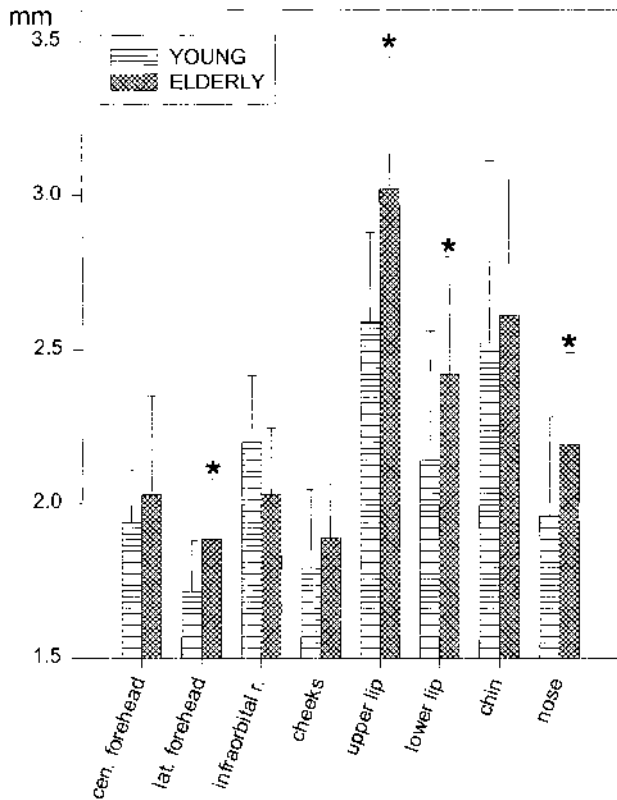


Fig. 1. Skin thickness at different facial skin sites (mean±SD) in young and in elderly subjects. Values referring to the lateral forehead, infraorbital region, cheeks and the upper lips represent mean values of 2 measurements taken on the left and right side of the face. *Significance of difference vs. young adults. Cen.=central; lat.=lateral; r.=region.

RESULTS

Skin thickness

Skin thickness is significantly higher on the upper and lower lips, chin, and infraorbital regions than on central forehead, lateral forehead and cheeks (Fig. 1). In elderly subjects, we observed an increase in facial skin thickness on the forehead, cheeks, lips, chin and nose, and a thinning on the infraorbital regions, compared with younger subjects. The increase in skin thickness values was statistically significant on the lateral regions of the forehead, the upper and lower lips and the nose.

Skin echogenicity

Facial skin reflects ultrasound far less than other skin sites (6). On some facial skin areas reflectivity of the dermis is so low that it does not enable the delineation of the dermis-hypodermis boundary. Skin echogenicity was higher on the upper part of the face (forehead, infraorbital regions and cheeks) than the lower part (lips and chin), as shown by the decrease in hyporeflecting echoes (Fig. 2) and the increase in 30–100 and 100–200 pixel values (Figs. 3 and 4). Whereas on forearm skin images of elderly subjects, the hypoechogenic subepidermal band is highly distinguishable (5, 6, 9), at facial skin sites a clear distinction of the image into 2 areas (1 echo-poor and the other echo-rich) is not always possible.

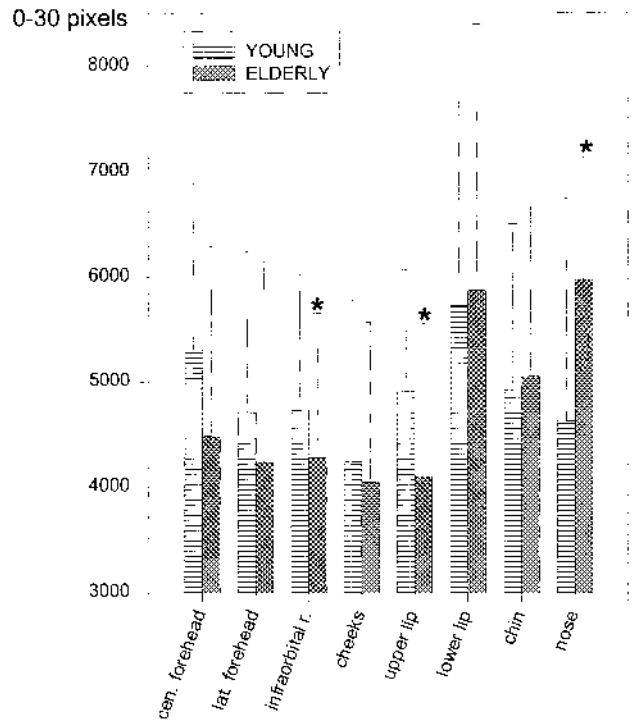


Fig. 2. Image analysis on echographic pictures. Variations with age of the extension of areas reflecting within the 0–30 interval in the dermis (mean±SD). Values referring to the lateral forehead, infraorbital region, cheeks and the upper lips represent mean values of measurements taken on the left and right side of the face. *Significance of difference vs. young adults. Cen.=central; lat.=lateral; r.=region.

Observation of the images referring to the upper and middle part of the face (forehead, infraorbital region, cheek and upper lip) revealed a subepidermal hypoechogenic band on the central forehead in 14 out of 20 elderly subjects, on the lateral forehead in 8 out of 20, on the infraorbital regions in 16 out of 20, on the cheeks in 14 out of 20 and on the upper lips in all 20 cases (Fig. 5). In elderly subjects an increase in values referring to extension of intermediate and high amplitude areas (30–100, 100–200 and 201–255 amplitudes) and a decrease in the extension of hyporeflecting areas were observable (Figs. 2, 3 and 4). Differences were significant at the infraorbital region (for the 0–30 band), the cheek (for the 100–200 band) and the upper lip (for all intervals).

The lower lip and chin showed the lowest reflectivity with small hyper-reflecting areas (100–200 and 201–255 intervals), especially in the younger subjects. On images referring to the lower lip significant differences with respect to the younger subjects were observed for the 30–100 and the 100–200 intervals, whereas on the chin differences were observed for the 100–200 band alone (Figs. 3 and 4). A subepidermal hypoechogenic band was observed on the lower lip in 10 out of 20 elderly subjects and on the chin in 14 out of 20.

Echographic images of nose skin present a peculiar aspect: the lower part, corresponding to the skin covering the cartilage, appears poorly echogenic both in the younger subjects and in the elderly subjects, while the upper part, representing the skin over the bone, shows a hypoechogenic sub-epidermal area, which is particularly pronounced in the

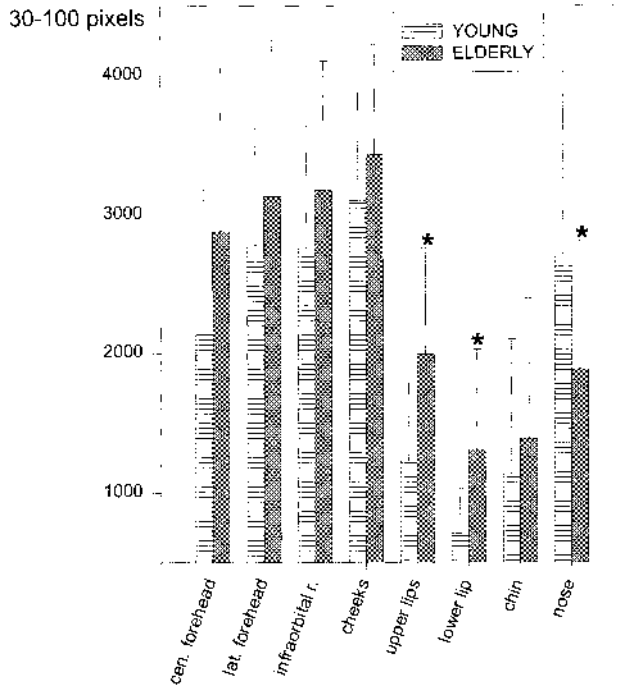


Fig. 3. Image analysis on echographic pictures. Variations with age of the extension of areas reflecting within the 30–100 interval in the dermis (mean ± SD). Values referring to the lateral forehead, infra-orbital region, cheeks and the upper lips represent mean values of measurements taken on the left and right side of the face. *Significance of difference vs. young adults. Cen.=central; lat.=lateral; r.=region.

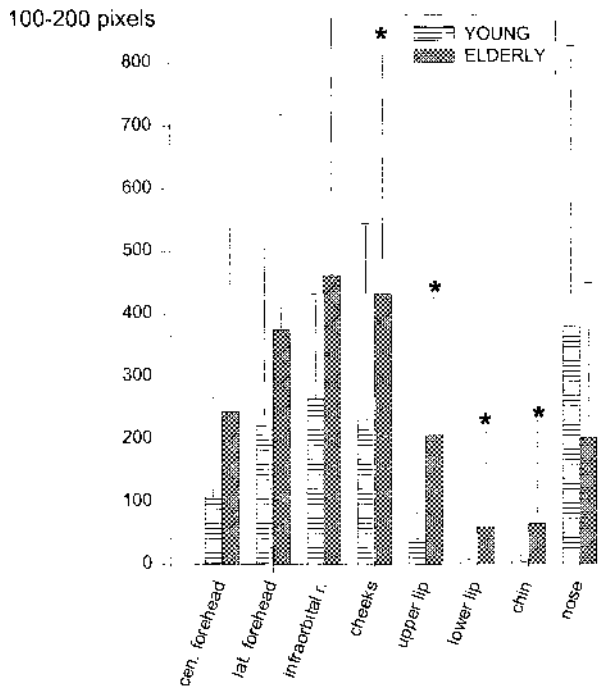


Fig. 4. Image analysis on echographic pictures. Variations with age of the extension of areas reflecting within the 100–200 interval in the dermis (mean ± SD). Values referring to the lateral forehead, infraorbital region, cheeks and the upper lips represent mean values of measurements taken on the left and right side of the face. *Significance of difference vs. young adults. Cen.=central; lat.=lateral; r.=region.

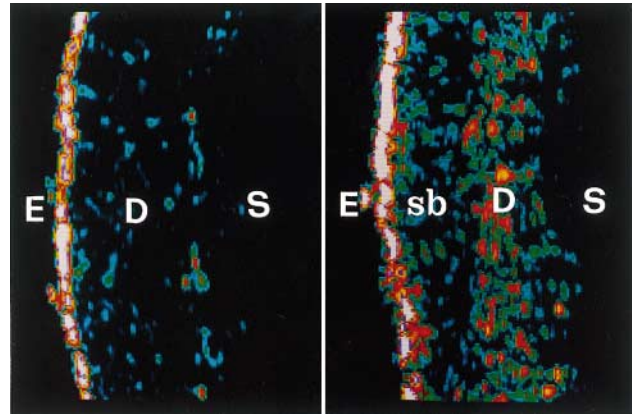


Fig. 5. Images representing the echographic aspect of the skin of the central forehead in a young subject (left) and an elderly subject (right). Increased echogenicity and thickening of the skin with age are observable. E=epidermis; D=dermis; S=subcutis; sb=sub-epidermal hypoechoic band.

elderly subjects, where the extension of hypo-reflecting (0–30) areas increases.

DISCUSSION

Skin thickness is a widely used parameter to evaluate the influence of different factors on skin ageing. Employing A-scan ultrasound, Tan et al. found that skin thickness on the volar forearm increased progressively up to the age of 20 years and subsequently decreased (10). In contrast, de Rigal et al. observed that skin thickness on the volar and on the dorsal aspect of the forearm remains constant until the seventh decade of life and diminishes thereafter (5). Skin thickness measurements of facial skin in different age groups yielded contrasting results. Denda & Takahasi measured skin thickness on the forehead and cheek and observed a decrease with age (11), whereas Takema et al. found an increase on the forehead, the eye corner, cheek and mouth corner (3). Both authors employed an A scanner, which provides a unidimensional representation of skin echogenicity. With this method the determination of the dermis-subcutis interface is based on the observation of a peak corresponding to the impedance jump between adjacent parts of the tissue. This makes the determination of the dermis-subcutaneous tissue interface difficult and may explain the contrasting results obtained for facial skin. Moreover, the inaccurate specification of the evaluated skin area in both studies may also represent a confusing factor. In fact, thickening with age is an uneven process: we observed a greater increase in skin thickness in the lateral regions of the forehead than in the central one.

The B scanner employed by us allows cross-sectional imaging of the skin and enables a more reliable evaluation of skin thickness at sites where the dermis-hypodermis interface is not easy to identify.

In our study skin thickness variations of facial skin related to ageing did not show a decreasing trend as on other skin areas (12). On the contrary, significant increments in skin thickness values were observed at most of the assessed facial skin sites, with a 7% overall increase.

Evaluating the skin of the arms of cyclists in the Tour de France, Leveque et al. found an increase in skin thickness in

areas exposed to sunlight (13). Also Takema et al. considered the increase in facial skin thickness in elderly persons associated with exposure to sunlight (3). On the contrary, employing ultrasound for studying skin thickness on 2 adjacent skin sites, one chronically sun-exposed and the other protected, Richard et al. found a decrease in skin thickness on the exposed area (14). Therefore, we may assume that an increase in skin thickness is a characteristic aspect of chrono-ageing of facial skin not necessarily associated to chronic sun-exposure.

Collagen content is a major component of skin thickness. However, it has been observed that, with ageing, skin collagen decreases more rapidly than skin thickness (15). Therefore, it is possible that, on actinically-damaged facial skin, the decrease in collagen and ground substance content, which gradually takes place with ageing, is counterbalanced by the overall rearrangement of the dermal collagen network and the accumulation of elastotic material (1).

The main source of dermal echogenicity is represented by well-arranged collagen bundles. Conversely, skin reflectivity decreases when the water content of the dermis increases, as in allergic or toxic oedema (16). In chronologically damaged skin, collagen bundles are replaced by a more homogeneously stained material, that appears to take up elastic-specific stains in the mid- and upper dermis (5, 17), leading to the dissolution of the regular architecture of the collagen fibres (18). Moreover, a greater amount of hydrated proteoglycans and glycosaminoglycans (19, 20) and of unbound water, probably due to modifications in water-macromolecule interactions (21), is observable.

The hypoechogenic subepidermal band, which is invisible in young subjects, appears in most elderly subjects on the forearm and is situated in the upper dermis, in some cases occupying the greatest part of the dermis thickness (5). It can be assessed by thickness determination (5, 14), or it can be more precisely quantified by selecting a low-amplitude interval for segmentation of the image and highlighting and calculating its extension (6). De Rigal et al. observed that it progressively increases with age, especially on sites exposed to the sun, and they considered this band to be a marker of skin ageing at the dermal level (5). Comparing exposed and unexposed skin of the lower neck in 30 elderly women, Richard et al. noticed that the thickness of the subepidermal hypoechogenic band is greater on sun-exposed sites and concluded that it corresponds to those areas histologically defined as elastotic (14).

Compared with other skin sites, such as the forearm, where the dermis is highly echogenic and the dermis-hypodermis boundary is well outlined, facial skin shows poor reflectivity, both in young and elderly subjects. As evaluated by the extension of 30–255 areas, overall echogenicity increases with age. On our echographic images of different facial skin sites a relatively homogeneous subepidermal echo-poor area was observable only in some elderly subjects. Moreover, this echo-poor area was visible in the elderly subjects mainly because of an enhancement of the lower dermis echoes, rather than because of a decreased echogenicity of the upper dermis. This phenomenon is also observable at other skin sites, as we have already shown in a study involving exposed and unexposed skin areas (6). Thus, both the dermal hyper-reflecting band and the hypoechogenic subepidermal band are expressions of chronological ageing and sun exposure.

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