S&S

Senses Sci 2019: 6 (3) 828-840
doi: 10.14616/sands- 2019-6-828840

Article

Ultrasound Biomicroscopy for Evaluation of Skin of the Temporal Region in Obese Middle Aged Females

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Received: 29 November 2019; Accepted: 14 December 2019; Published: 26 December 2019

Abstract. *Background*: skin of the temporal region is a common site for aging marks and hence rejuvenation procedures. Accurate localization of the layer of the skin to deliver the injected material is crucial for highly aesthetic outcomes. This study was conducted to evaluate the structure of the skin of the temporal region using UBM.
Methods: study participants (45 healthy female volunteers) were screened by a specialized dermatologist and the temporal region was examined. Fitzpatrick skin classification scheme was applied and the anthropometric measurements (weight and height) were obtained. The UBM machine (Acutome (Sonomed, USATM)) was used. The captured scans were then examined to extract the relevant data (thicknesses of the epidermis, dermis and its layers, hypodermis).
Results: the mean(± standard deviation) age of the study participants was 47.8 ± 8.2 years and the mean(± standard deviation) body mass index (BMI) was 30.6 ± 3.9 Kg/m2. The mean(±Standard deviation,range,median) of the epidermis, dermis and hypodermis layers of the skin were 0.08(±0.02,0.04–0.13,0.08), 1.28(±0.32,0.69–1.96,1.27) and 0.84(±0.21,0.46–1.73,0.82) mm respectively. There was a statistically significant positive correlation between the BMI and the thickness of the hypodermis layer of the skin (p=0.03).

Conclusion: UBM provides valuable information on and measurements of the skin of the temporal region of the face in females. Skin layers thicknesses do not change significantly with age or with skin pigmentation. Plumper females have thicker hypodermis in the skin of the temporal region of the face.

Keywords: Temporal region; Epidermis; Dermis; Hypodermis; ultrasound biomicroscopy.

Introduction

The skin of the temporal region of the face is a common site for aging marks, including wrinkles and crow feet and hollowness[1], hence is a common target for rejuvenation procedures[2,3] . Societal and behavioural norms as well as published literature point out that women seek aesthetic and cosmetic procedures far more than men[4], specially in the Orient[5] and especially so for plump females in attempts to improve their self image and societal position. Rejuvenation procedures include several interventions, among which are injection procedures in the different layers of the skin[6,7]. Hence, thorough knowledge of the anatomy of the different layers of the skin of the temporal region cannot be overemphasized. Several techniques are currently available for imaging of the skin and studying the different layers of the skin, including optical coherence tomography (OCT)[2], B-scan ultrasound (US)[8], reflectance confocal microscopy[9] and ultrasound biomicroscopy (UBM)[10]. UBM images depend on the probe frequency, the higher frequency provides less penetration and more resolution, and vice versa[11]. Hence, accurate imaging of living tissues mandates a high frequency probe UBM. This study was conducted to study the utility of the UBM for imaging of the skin of the temporal region in plump middle aged women.

Methods

This observational cross sectional study was conducted on 45 volunteer females in the Ophthalmology department of Alexandria Main University Hospital. The study participants were from the nursing and administrative staff in Alexandria Main University hospital who volunteered in the study. The study adhered to the tenets of the declaration of Helsinki and its 2013 Ammendment and was approved by the ethical committee of the Faculty of Medicine of Alexandria University and written informed consent was obtained from all study participants.

Inclusion criteria included plump middle aged women with normal skin and facial features with no known systemic or local dermatological disease and no routine use of any dermal creams or preparations with potential effect on the skin structure and texture. Patients with recent aesthetic procedures in the temporal region within the 6 months prior to examination were also excluded from the study. Study participants were screened by a specialized dermatologist (AI) and the study area of interest was examined to ensure suitability for the study. Fitzpatrick skin classification scheme was applied to all study participants and the anthropometric measurements (weight and height) were obtained. The area of interest of the study was the temporal region on both sides of the face, specifically an area about the size of the cup of the ultrasound biomicroscopy (UBM) machine that lies 1 cm superior and 1 cm lateral to the tail of the eye brow (**Figure 1**).

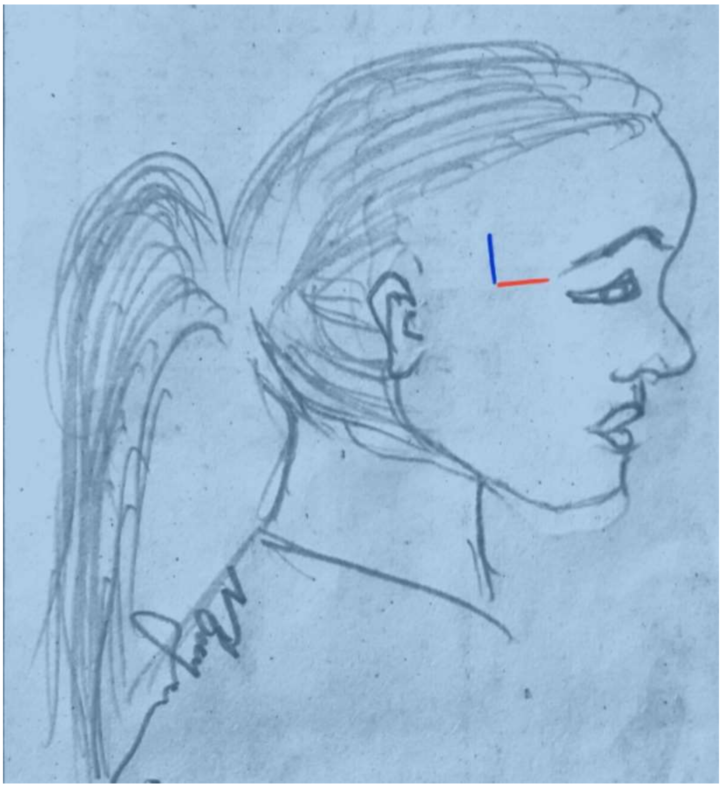

Figure 1: Diagram demonstrating the area of the temporal region examined by the UBM

The UBM machine used in the study was the Acutome (Sonomed, USA™) with a probe frequency of 48 MHz and all the scans were performed by the same operator (NB). In brief, in the supine position the study participants were instructed to turn the head to the left side so that the right temple was horizontal. The cup of the UBM was then applied to the designated area of the study and filled with fluid (normal saline after a seal of ophthalmic gel at the lower cup border) and the probe (48 MHz) applied. The cup was applied was just sufficient pressure on the skin to retain the fluid avoiding undue pressure that would result in bulging of the scanned area skin into the cup and without undue sliding force on the skin that would result in the appearance of striation artfacts in the acquired scans. Image acquisition was limited to high quality scans with no bulging of the intervening skin area into the cup or any visible traction lines on the scan. The layers of the skin scanned included the epidermis, dermis and hypodermis, together with an area of the underlying frontalis fascia and muscle. The probe was lowered onto (more proximal) to the skin to image the deeper layers of the skin in better focus. The same procedure was then repeated for the other side of the face. The captured scans were then examined to extract the relevant data (thicknesses of the epidermis, dermis and its layers, hypodermis). For every parameter studied, 3 different measurements were taken at 3 different locations and averaged. All measurements were taken by the calipers incorporated in the software of the Acutome UBM machine. The epidermis was defined by the hyperechoic line at the superficial most part of the skin. The dermis comprised the next layer deeper to the epidermis till the hypoechoic zone defining the hypodermis layer. The hypodermis was defined as the deeper layer from the dermis to the hyperechoic line representing the frontalis fascia (**Figure 2**).

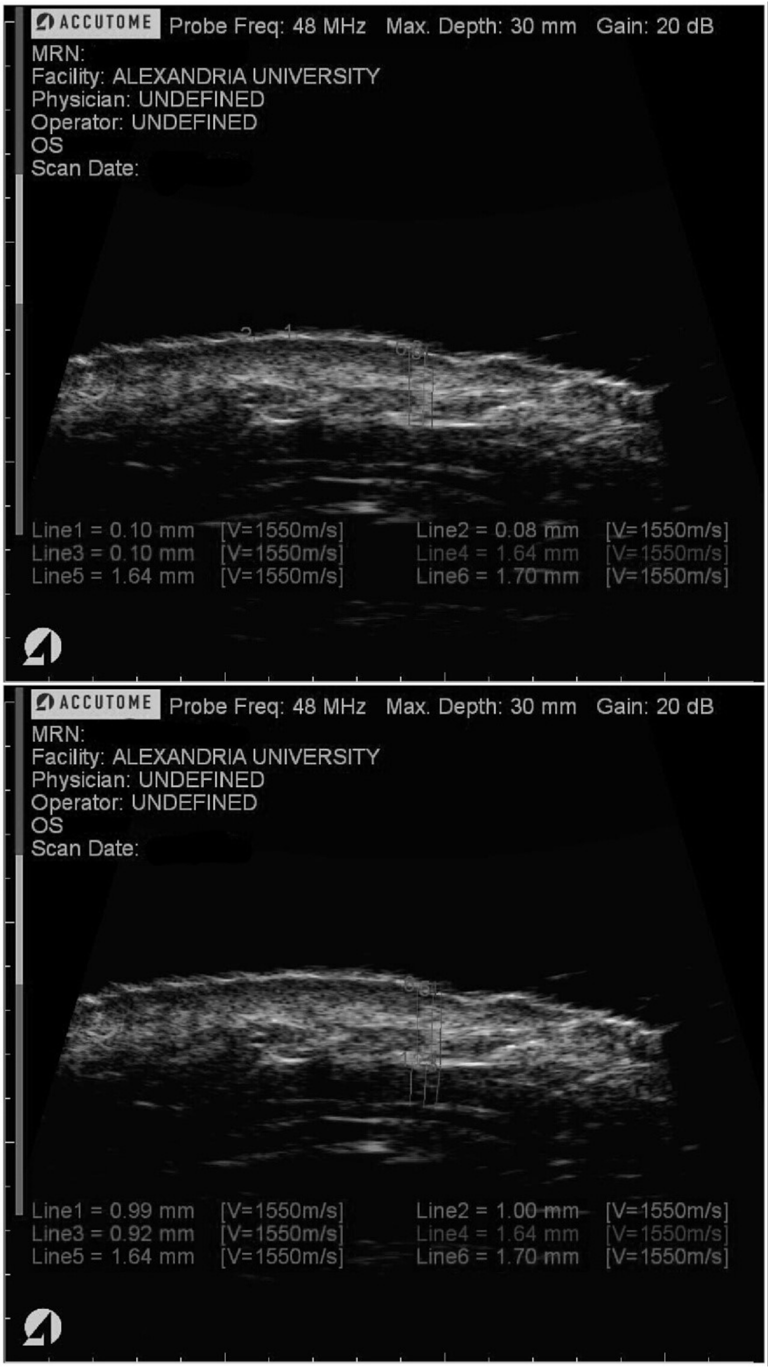

Figure 2: UBM scan demonstrating the measurements of the different layers of the skin of the temporal region of the face.

Data were tabulated and studied for statistical correlations and significance. Data was fed into Microsoft EXCEL software (Microsoft, USA) which was used to make the necessary calculations. Student t-test was used to study differences between groups. Pearson correlation coefficient was used to study correlations between variables. A p value of 0.05 was set for the statistical significance.

Results

The study was conducted on 45 volunteer females in the Ophthalmology Department of Alexandria Main University Hospital. The demographic, anthropometric and dermatological characteristics of the study participants are presented in table 1.

Table 1. Demographic and clinical characteristics of the study participants

Participants (n,%)	**45 (100%)**
Age (mean±Standard deviation, range, median) in years	47.8±8.2, 35 – 69, 46
Body Mass Index (mean±Standard deviation, range, median) in kg/m^2	30.6±3.9, 24.0 – 41.0, 29.7
Height (mean±Standard deviation, range, median) in meters	1.62±0.06, 1.36 – 1.75, 1.63
Weight (mean±Standard deviation, range, median) in Kg	80.1±11.4, 65 – 113, 78
Fitzpatrick Skin Type (n,%)	45 (100%)
Type I	0 (0)
Type II	0 (0)
Type III	20 (44.4)
Type IV	20 (44.4)
Type V	5 (11.1)
Type VI	0 (0)
Hollowness Severity Rating Scale (n,%)	45 (100%)
Grade 0	3 (6.7)
Grade 1	16 (35.6)
Grade 2	15 (33.3)
Grade 3	11 (24.4)

The mean (± standard deviation) age of the study participants was 47.8 ± 8.2 years and the mean (± standard deviation) body mass index (BMI) was 30.6 ± 3.9 Kg/m^2. Almost one tenth of the study participants fit into Fitzpatrick skin type 5 whereas the majority of the study participants were equally split between Fitzpatrick skin types 3 and 4. Study participants were classified according to the Hollowness Severity Rating Scale (HSRS) which revealed an almost equal distribution between grades 1, 2 and 3, with only 6.7% or participants belonging to grade 0. The UBM measurements of the study participants are presented in **Table 2**.

Table 2: Ultrasound Biomicroscopy measurements of the study participants' temporal skin

(mean±Standard deviation, range, median) in mm	Right	Left	Total
Epidermis	0.08±0.02, 0.04 – 0.13, 0.08	0.08±0.02, 0.05 – 0.13, 0.08	0.08±0.02, 0.04 – 0.13, 0.08
Dermis	1.26±0.33, 0.69 – 1.92, 1.24	1.28±0.29, 0.71 – 1.96, 1.29	1.28±0.32, 0.69 – 1.96, 1.27
Hypodermis	0.86±0.21, 0.46 – 1.73, 0.86	0.81±0.19, 0.51 – 1.47, 0.78	0.84±0.21, 0.46 – 1.73, 0.82

There were no statistically significant differences between the UBM measurements of the skin layers between the right and left sides of the face (p=0.9, 0.7, 0.06 for the epidermis, dermis and hypodermis respectively). The study participants were then stratified according to age into 4 groups, the 4^{th}, 5^{th}, 6^{th} and 7^{th} decades (**Table 3**) and according to BMI into 5 groups (**Table 4**).

Table 3: Ultrasound Biomicroscopy measurements of the study participants' temporal skin (Age stratification)

(mean±Standard deviation, range, median) in mm		*Right*	*Left*	*Total*
30 – 40 *(11)*	***Epidermis***	0.08±0.02, 0.04 – 0.13, 0.07	0.08±0.02, 0.05 – 0.12, 0.09	0.08±0.02, 0.04 – 0.13, 0.08
	Dermis	1.35±0.36, 0.72 – 1.89, 1.41	1.41±0.31, 0.77 – 1.96, 1.44	1.38±0.33, 0.72 – 1.96, 1.44
	Hypodermis	0.94±0.28, 0.60 – 1.73, 0.92	0.90±0.24, 0.51 – 1.47, 0.83	0.93±0.26, 0.51 – 1.73, 0.87
41 – 50 *(20)*	***Epidermis***	0.08±0.02, 0.05 – 0.11, 0.08	0.08±0.02, 0.05 – 0.11, 0.07	0.08±0.02, 0.05 – 0.11, 0.07
	Dermis	1.14±0.27, 0.69 – 1.82, 1.14	1.18±0.25, 0.71 – 1.7, 1.18	1.17±0.26, 0.69 – 1.82, 1.16
	Hypodermis	0.79±0.17, 0.46 – 1.13, 0.81	0.79±0.18, 0.54 – 1.22, 0.78	0.79±0.18, 0.46 – 1.22, 0.79
51 – 60 *(12)*	***Epidermis***	0.08±0.02, 0.05 – 0.13, 0.08	0.08±0.02, 0.05 – 0.13, 0.08	0.08±0.02, 0.05 – 0.13, 0.08

	Dermis	1.40±0.34, 0.73 – 1.92, 1.54	1.38±0.29, 0.76 – 1.86, 1.45	1.39±0.32, 0.73 – 1.92, 1.49
	Hypodermis	0.88±0.15, 0.70 – 1.23, 0.86	0.79±0.15, 0.54 – 1.05, 0.72	0.83±0.15, 0.54 – 1.23, 0.79
61 – 70 *(2)*	***Epidermis***	0.07±0.02, 0.06 – 0.10, 0.07	0.07±0.01, 0.06 – 0.09, 0.06	0.07±0.01, 0.06 – 0.10, 0.06
	Dermis	1.16±0.20, 0.97 – 1.41, 1.15	1.02±0.11, 0.85 – 1.13, 1.05	1.09±0.16, 0.85 – 1.41, 1.09
	Hypodermis	0.89±0.25, 0.64 – 1.15, 0.90	0.66±0.07, 0.58 – 0.74, 0.67	0.78±0.16, 0.58 – 1.15, 0.78

Table 4: Ultrasound Biomicroscopy measurements of the study participants' temporal skin (BMI stratification)

(mean±Standard deviation, range, median) in mm		**Right**	**Left**	**Total**
20 - <25 *(2)*	***Epidermis***	0.07±0.01, 0.06 – 0.10, 0.07	0.08±0.01, 0.07 – 0.09, 0.08	0.08±0.01, 0.06 – 0.10, 0.07
	Dermis	1.15±0.29, 0.84 – 1.44, 1.15	1.24±0.24, 0.97 – 1.48, 1.25	1.19±0.27, 0.84 – 1.48, 1.20
	Hypodermis	0.71±0.23, 0.48 – 0.95, 0.69	0.67±0.08, 0.54 – 0.75, 0.68	0.68±0.15, 0.48 – 0.95, 0.69
25 - <30 *(21)*	***Epidermis***	0.08±0.02, 0.05 – 0.13, 0.08	0.08±0.02, 0.05 – 0.12, 0.08	0.08±0.02, 0.05 – 0.13, 0.08
	Dermis	1.34±0.31, 0.73 – 1.92, 1.32	1.34±0.28, 0.76 – 1.87, 1.38	1.34±0.29, 0.73 – 1.92, 1.35
	Hypodermis	0.83±0.19, 0.46 – 1.23, 0.79	0.80±0.18, 0.51 – 1.11, 0.76	0.82±0.18, 0.46 – 1.23, 0.78
30 - <35 *(16)*	***Epidermis***	0.08±0.02, 0.05 – 0.13, 0.08	0.08±0.02, 0.05 – 0.13, 0.08	0.08±0.02, 0.05 – 0.13, 0.08
	Dermis	1.14±0.31, 0.69 – 1.74, 1.14	1.18±0.31, 0.71 – 1.86, 1.17	1.16±0.31, 0.69 – 1.86, 1.16
	Hypodermis	0.86±0.15, 0.52 – 1.19, 0.87	0.80±0.16, 0.54 – 1.11, 0.79	0.83±0.15, 0.52 – 1.11, 0.83
35 - <40 *(5)*	***Epidermis***	0.07±0.02, 0.04 – 0.10, 0.07	0.08±0.01, 0.06 – 0.10, 0.08	0.08±0.01, 0.04 – 0.10, 0.08

	Dermis	1.47±0.30, 0.98 – 1.87, 1.60	1.41±0.33, 1.01 – 1.96, 1.44	1.44±0.32, 0.98 – 1.96, 1.52
	Hypodermis	1.07±0.35, 0.70 – 1.73, 0.98	1.00±0.23, 0.67 – 1.47, 1.05	1.04±0.31, 0.67 – 1.73, 1.02
40 - <45 *(1)*	***Epidermis***	0.09	0.10	0.09±0.01, 0.95 – 0.10, 0.09
	Dermis	0.95	1.20	1.08±0.05, 0.95 – 1.20, 1.08
	Hypodermis	0.77	0.55	0.66±0.01, 0.55 – 0.77, 0.67

BMI: Body Mass Index

Almost half of the study participants belonged to the fifth decade (41 – 50 years) and almost half of the study participants belonged to the overweight category of BMI (25 - <30 Kg/m^2). There was no correlation between the age and the thicknesses of the different layers of the skin (p=0.3, 0.5, 0.5 for the epidermis, dermis and hypodermis respectively), the skin type and the thicknesses of the different layers of the skin (p= 0.5, 0.07, 0.6 for the epidermis, dermis and hypodermis respectively), the HSRS and the thicknesses of the different layers of the skin (p=0.06, 0.35, 0.23 for the epidermis, dermis and hypodermis respectively) and the BMI and the thicknesses of the epidermis and dermis layers of the skin (p= 0.3, 0.8 for the epidermis and dermis respectively) whereas there was a statistically significant positive correlation between the BMI and the thickness of the hypodermis layer of the skin (p=0.03). There was a statistically significant positive correlation between the thicknesses of the hypodermis and dermis layers of the skin (p=0.004).

Discussion

This study described the utility of UBM in characterization of the thicknesses of the different layers of the skin of the temporal region in plump healthy middle aged volunteer females. The average age of the study participants was close to that reported to be the most demanding for aesthetic and rejuvenation facial procedures, as reported by Sobanko et al[12-14] and as reported by the most recent survey of the American Academy of Facial Plastic and Reconstructive Surgery[15] .

The fact that females were the only substrate in the study is a reflection to the reported predominance of females over males in doctor visits for aesthetic facial procedures[16-18]. More than half of the study participants fit into the overweight classification[19,20]. After all, it is the females, in the fifth decade, that are slightly "plump" in appearance, that care –at least in oriental communities- to improve their image, both self and to others[21]; this explains the character of the study participants. Conducted in the Mediterranean region, it is not surprising that most of the study participants fitted into Fitzpatrick skin types 3 and 4[22].

Although absolute symmetry is not the rule in all biologic parameters, yet this study demonstrated no difference in the measurements between both sides of the face. This is in agreement with the study by Gawdat et al[2] and Iyengar et al[23]. Though skin changes are an important marker for aging, yet these changes apparently do not occur through changes in the thicknesses of the different layers of the skin as obvious by the lack of correlation between the age and the measurements reported in the study. After all, the effect of aging on skin thickness has been controversial among different reports[24]. The fact that all of the study participants were veiled meant they had almost no sun exposure to the studied temporal region of the face. The authors hypothesise that this clothing-induced sun shielding of the study area has minimized the effect of photoaging in the study participants. The Fitzpatrick skin types are based on the pigmentation, the inherent skin color and patient response to sun exposure, a property clearly independent from the thicknesses of the skin layers, as already reported[25]. Being a major dependant on the amount of fat in the body, it is not surprising to find a positive correlation between the BMI and the thickness of the layer of the skin harboring the fat, namely the hypodermis, as already reported[26] as well as a correlation between the thicknesses of the hypodermis and the dermis layers. Strikingly enough, study participants, although plump, were almost equally distributed among the 3 HSRS grades which were not correlated to any of the measured thicknesses of the skin in the study area.

The reported thicknesses of the layers of the skin in this study are in agreement with that reported in the study by Iyengar et al[23], both being different from other studies utilizing other imaging modalities such as optical coherence tomography (OCT)[2] or conducted histopathologically on cadavers[27].

To the best of the authors' knowledge, this is the first study to utilize UBM with a probe frequency of 48 MHz with such relatively high resolution to study the skin of the temporal region in females. The measurements provided in this study provide guidance to the different interventional procedures on that part of the face, including aesthetic procedures. The clear definition of the different layers of the skin and the relatively sharp demarcations imaged could provide a basis for UBM-guided injection procedures. Though not the subject of the study, yet the UBM images provide also important information on the structure, namely through echogenicity, of the different layers of the skin in the temporal region. Further studies to correlate these findings to clinical practice are encouraged.

This study has limitations. The restriction of the study population to females, though a target of the study, yet excludes males from the assessment and precludes the generalization of the study results to males. The numbers of the study participants were not equally distributed among the different age groups, yet, the age groups in focus in this study are the most in need of studying these skin parameters are these are the most demanding for aesthetic interventions. The relatively small number of study participants is another obvious limitation. Though theoretically a limitation, lack of a gold standard for comparison, namely biopsy and histopathology, is clearly not possible in an in-vivo study of a region in the face.

In conclusion, UBM provides valuable information on and measurements of the skin of the temporal region of the face in females. Skin layers thicknesses do not change significantly with age or with skin pigmentation. Plumper females have thicker hypodermis in the skin of the temporal region of the face.

Acknowledgement

None. The study was not funded by any institution or body.

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