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Effects of Age and Gender on Facial Movements: Utilizing Moire Topography

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ABSTRACT

Objective: The purpose of this study was to investigate the effect of different age groups and gender on facial movement by using Moiré Topography.Design: one shot non experimental design.Setting: The Faculty of Physical Therapy, Cairo University.Materials and Methods: One hundred and fifty healthy subjects, both genders (75 males, 75 females), Age range from 20-50years. it was classified into three groups(20-30),(30-40)and (40-50 years old) five facial angles were measured at both sides of the face for each subject three times during static position and during contraction ,this angles were raising, closing, smiling, kissing and blowing angles and the AutoCAD program used to calculate and analyze this angles.Results: There were a significant effect of age groups on the five facial movements including right and left raising, closing, smiling, kissing and blowing, also there was a significant effect of sex on the five facial angles and finally there was a significant interaction effect of age groups and sex difference on the same five facial movements by Two Way ANOVA. The regression analysis indicated that the correlations between age groups and facial movement were moderate negative significant correlation for all the five angles at right and left side and also there was a moderate negative significant correlation between sex and five facial angles.Conclusions: there were a significant effect of age and sex different on the facial movements including the five angles of the face right and left side and that the female are more than male in the five facial movements and that with increasing age, there is a decrease in the range of the five angles of the face.Keywords: Moiré topography, Healthy, Auto CAD.

INTRODUCTION

The face reveals our innermost expressions, it is an essential part of human communication and its traces mark our individuality. This happens by means of the fine control over facial muscle contraction, either voluntary or involuntary, carried out by the Facial Nerve or VII cranial nerve.(1) Facial mobility exists from birth and has a remarkable diversity even at a young age. Previous studies have focused on the development and maturation of motor capacity from childhood to adulthood. (2,3) The development and maturation of the mimic muscles that perform facial expressions has not been given the same amount of attention. It is not clear if the mimic muscles undergo the same process of maturation with changes in facial expression, or whether these expressions remain constant throughout growth. There are indications that there are differences in facial movements between the genders in adulthood.(4)

Age as an attribute related to human faces is being increasingly studied and there has been a growing interest in problems such as face recognition across ages, automatic age estimation from face images, appearance prediction across aging etc. The research initiatives pertaining to this problem have reached a critical stage and it is essential to streamline future research on this topic in order to make a significant impact on the many day-to-day applications that benefit from solving this problem. (5)The aging of the human face is the result of both superficial textural wrinkling of the skin and changes in the 3-dimensional (3-D) topography of the underlying structures. The skin, soft tissues (subcutaneous fat, muscle, and fascia), and structural support (bone and teeth) are individually affected by the aging process, but they also act in dynamic unison to determine the phenotypic presentation of the face throughout life.(6)

Individuals vary in terms of their facial expressions; there are also differences between the two facial sides, gender and agedifferences as well, which makes it difficult to standardize the measure of movements.(7)Facialmotion measurement is a topic that receives important contributions from different sciences, since facial emotions give information about personality, mood, internal state and behavior of human beings. (8,9) It is very important to evaluate facial movements adequately in the diagnosis, planning of treatment, prognosis and surgical outcomes of patients, trauma, malignant tumor, neurological disease. In such clinical situations, facial movements have been conventionally evaluated and treatment methods have been selected by an observer or an operator subjectively. (10)

Subjective grading scales such as The House-Brackmann facial nerve grading system (11) have been widely used for reporting facial nerve paralysis. Although the grading is achieved through expert assessment, the primary problems in such evaluations has been the lack of objective, reliable and sensitive measures of the spatial and

temporal aspects of facial function.[12] There is a significant and increasing need for an objective method of quantifying facial movement. [13,14] Although some authors have attempted to develop objective measures of facial function, none have been adapted for widespread clinical use due to the generally cumbersome, non-automatedmodes of recording and analysis.[15,16,17,18]

The Moiré Topography method is an optic measure which enables the visualization of the facial contour in three dimensions, creating stria as a geographic map with a high degree of accuracy. The Moiré frame occurs when a latticed frame is placed in front of the face and a light is illuminated from one side, a shadow of the lattice is generated on the face. This shadow is curved according to the shape of the face, and waved contour lines are generated on the face. This phenomenon is the Moiré effect.[19] Due to a lack of information concerning gender and age differences, a study need to determine the tendencies and patterns between the groups of individuals and whether gender and age played a role in facial movement. So the purpose of this study was to investigate the effect of age and gender on facial movement utilizing Moiré Topography.

MATERIAL AND METHODS:

Subjects

150 healthy subjects randomly selected equally from both gender were participated in the study after signing institutionally approved consent form prior to data collection, they were recruited from the students, employees and the out clinic of Faculty of Physical therapy with their age from 20-50years old.[20,21] Exclusive criteria ,The subjects were excluded if they had: Neuromusculo-skeletal diseases, Burn face, Facial trauma, Face skin disease, History of neurologic disorders, Facial plastic surgery.

Procedure:

The moiré topography apparatus consist of the frame which was a rectangular aluminum frame with 40X30 cm dimension, 30cm width and 40cm height, the frame was attached with transparent screen which divided horizontally with an equal spaced back lines that were separated by a distance equal to their thickness (2mm) i.e. the diameter of each line and the space between each two lines were both (2mm).The frame could be raised or lowered on an adjustable metallic frame in order to facilitate the investigation of subjects of various heights. A studio light with an intensity of 800 watt after adjustment with light meter was used as a light source , it was fixed to its tripod at a distant 50cm apart from the camera and it was on a level with the central of the moiré topography frame .[22]

The camera used was (Nikon, D3200 24MP camera, 4 FS) the distance between the light source, the camera and moiré frame was 170 cm horizontally, while the distance between the light source and the

camera was 50cm vertically measured by tape measurement, the camera was supported on its tripod and adjusted by water scale to be balanced parallel to the ground.(23)

Skin markers and Double face adhesive plaster: Twenty two passive reflective markers made of plastic balls of 5mn diameter, coated with reflective material were used as face surface markers for this study as in figure 1 .The markers were attached bilaterally to both side of the face for each subject with a well defined anatomical landmarks with double faced adhesive tape to ensure proper fitting on the face. The adhesive plaster was used to ensure good contact of the dots to the skin and we used three markers on the frame to make standardization of the head position.(24)The Subjects were given a full explanation about the study protocol and we described each movement of the face in front of the subjects and then allowed the subjects to perform each movement as in fig.1.

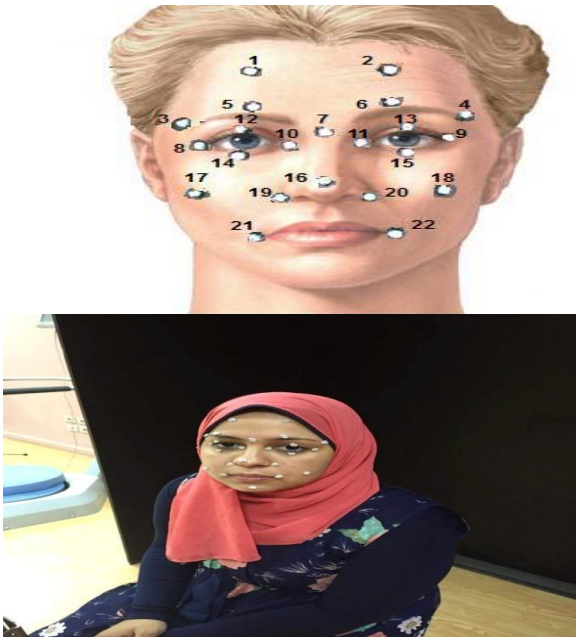

Figure 1:the markers placement. The facial landmarks of the upper face :1, rightfrontal; 2, left frontal; 3, right external eyebrow; 4,left external eyebrow; 5, right middle eyebrow; 6, leftmiddle eyebrow; 7, nasium point; 8, right externalcanthus; 9, left external canthus; 10, right internalcanthus; 11, left internal canthus; 12, right uppereyelid; 13, left upper eyelid; 14, right lower eyelid;15, left lower eyelid. The facial landmarks of thelower face: 16, middle nasal point; 17, right zygomaticus; 18, left zygomaticus; 19, rightnasogenian; 20, left nasogenian; 21, right commissure; 22, left commissure.(25,26)

The angle of each movement were measured for each side (right and left).To make standardization to the position of the head; the chin of the subject was parallel to the middle marker on the frame of the screen. The distance between the light source, the camera and moiré frame was 170cm. horizontally, while the distance between the light source and the camera was 50cm. vertically.(23) The frame of the screen was supported on an adjustable metallic frame that was adjusting according to the subject's height, the balance of this metallic frame was maintained by water scale as fig.2.

Figure 2: the water scale and the screen

The subjects were instructed to sit comfortably and remain as still as possible while fully performing the facial expression, then to relax after each expression was performed. The subject began motion after a verbal

signal from the examiner (go) until the end of the session. To record the upper face expression, subjects were instructed to close and open the eyes (not blinking) and to lift the eyebrows and relax. [24]To smile with the mouth closed, with their lips together, and then allowing the lips to return to a resting state, they were then asked to draw the angle of the mouth straight upward and relax finally the subjects were asked to make blowing and then relax. Three sets of movement were required from the subjects. The capture process might last from a few seconds to up to one minute. Muscles tested were: frontalis ,orbicularis oculi ,levatorangulioris ,zygomaticus major, buccinator. The parameters studied on both sides of the face were the amplitude of the selected facial angles including: Raising angle, closing angle, smiling, kissing and blowing angles during static position and after contraction. The analysis was done by AutoCAD 2009 Program; the angles measured were in fig.3.

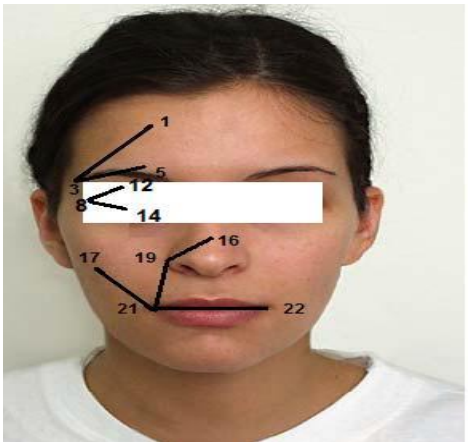

Figure 3: Main facial plots used for determination of Facial angles among landmarks during static position including: -1,3,5 Raising angle (R E) -12,8,14 Closing angle (L E) -17,21,22 Smiling angle(S) -16,19,21 kissing angle (K) -19,17,21 Blowing angle (B)

Statistical analysis:

Data were analyzed using descriptive statistics (mean and standard deviation) and Two Ways ANOVA test was applied to analyze significant difference in moiré angles between male and female in different age groups and Regression analysis to test correlation between age and sex and each movement of the five angles of the face. Level of significance for all tests was set at 0.05 for all statisticaltests.

RESULTS

Seventy-five male and seventy-five female participated in this study. Subjects were divided according to age into three age groups. Group A with age ranged 20- 30 years, group B with age ranged 30-40 years, and group C with age ranged 40-50 years. Data obtained from groups regarding raising eyebrow, light eye closing, smiling, kissing, and Blowing were statistically analyzed and compared. The descriptive statistics for the mean age groups found in table 1 anddescriptive statistics for the mean age of males and females in the three groups found in table 2.

Table1: Descriptive statistics for the mean age of study groups (A, B, and C).

	Group A	**Group B**	**Group C**
$\bar{X}$ **±SD**	24.36 ± 3.48	35.48 ± 3.02	47.08 ± 3.21
Maximum	30	40	50
Minimum	20	31	41
Range	10	9	9

$\bar{x}$**: Mean** **SD: Standard Deviation**

Table2: Descriptive statistics for the mean age of males and females in study groups (A, B, and C).

	Group A		**Group B**		**Group C**	
	Females	**Males**	**Females**	**Males**	**Females**	**Males**
$\bar{X}$ **±SD**	23.96±3.43	24.76±3.56	35.48±3	35.48±3.11	48.08±2.92	46.08±3.23
Maximum	29	30	40	40	50	50
Minimum	20	20	31	31	42	41
Range	9	10	9	9	8	9

$\bar{x}$**: Mean** **SD: Standard Deviation**

Two- way ANOVA was conducted to investigate the effect of age and sex on facial movement. There was a significant effect of age on the five facial movements (p = 0.0001), also there was a significant effect of sex on the five facial movements (p = 0.0001) and finally there was a significant interaction effect of age and sex on the same five facial movements (p = 0.0001)as in table 3.The results of each movement are including the following: There was a significant effect of age on raising eyebrow right and left (p = 0.0001), while there was no significant effect of sex on raising eyebrow right and left. There was no significant interaction effect of age and sex on raising right eyebrow but there was a significant interaction effect of age and sex on raising left eyebrow.

Table3:Two-way ANOVA for the effect of age and sex on facial movement:

Two way ANOVA	
Effect of age	
F = 270	***p = 0.0001***
Effect of sex	
F = 135	***p = 0.0001***
Interaction effect (age * sex)	
F = 270	***p = 0.0001***

There was a significant effect of age on light closing of right and left eye (p = 0.0001), also there was a significant effect of sex on light closing of right and left eye (p = 0.0001). There was a significant interaction effect of age and sex on light closing of right, left eye (p = 0.0001). There was a significant effect of age on smiling on right and left sides (p = 0.0001), also there was a significant effect of sex on smiling on right and left sides (p = 0.0001, 0.002). There was a significant interaction effect of age and sex on smiling on right and left sides (p = 0.04, 0.0001). There was a significant effect of age on kissing on right and left sides (p = 0.0001), also there was a significant effect of sex on kissing on right and left sides (p = 0.02, 0,001). There was a significant interaction effect of age and sex on kissing on right and left sides (p = 0.001, 0.005). There was a significant effect of age on blowing on right and left sides (p = 0.0001), also there was a significant effect of sex on blowing on right and left sides (p = 0.001). There was a significant interaction effect of age and sex on blowing on right and left sides (p = 0.009, 0.0001).

The regression analysis indicated that the correlations between age and facial movement were moderate negative significant correlation as with increasing the age of the subject there were a decreasing in the angles of the face measured as it follows, for raising right eye brow was moderate negative significant correlations (r = -0.52, p = 0.0001), for raising left eye brow was moderate negative significant correlations (r = -0.56, p = 0.0001), for light closing of right eye was moderate negative significant correlations (r = -0.54, p = 0.0001), for light closing of left eye was moderate negative significant correlations (r = -0.54, p = 0.0001), for smiling on right side was moderate negative significant correlations (r = -0.48, p = 0.0001), for smiling on left side was moderate negative significant correlations (r = -0.47, p = 0.0001), for kissing on right side was moderate negative significant correlations (r = -0.59, p = 0.0001), for kissing on left side was moderate negative significant correlations (r = -0.53, p = 0.0001), for blowing on right side was moderate negative significant correlations (r = -0.59, p = 0.0001), and for blowing on left side was moderate negative significant correlations (r = -0.61, p = 0.0001) and also for sex difference, there was a moderate negative significant correlations

between sex different and five facial angles as with increase the female age, there were decreased in the angles values and with increase the age of the male, there were also decreased in the angles but the decreased angles of female were more than the decreased angles of male.

DISCUSSION

This study was conducted to study the range of motion of five movements of the face: eye brow raising, light eye closure, smile ,kissing and blowing by moiré topography on different age groups on both genders, It gives us angles for the muscles performing five movements: Frontalis, Orbicularis Occuli, Zygomatic Major , Orbicularis Oris and Buccinator. These muscles are involved in the facial paralysis. This experiment was run on 150 normal subjects(75males ,75 females) divided into three groups from 20-30 years, 30-40 years and 40-50years old, the subjects were instructed to light close and open the eyes (not blinking) and to lift the eyebrows and relax, to smile with the mouth closed, with their lips together, and then allowing the lips to return to a resting state, they were then asked to draw the angle of the mouth straight upward(kissing) and relax finally the subjects were asked to make blowing and then relax.

The result indicated thatthere was a significant effect of age on facial movement ($p = 0.0001$), also there was a significant effect of sex on facial movement ($p = 0.0001$). There was a significant interaction effect of age and sex on facial movement ($p = 0.0001$) by two –way ANOVA. The correlations between age and facial movement were moderate negative significant correlation for raising eye brow, light eye closing, smiling, kissing and blowing for right and left side of the face.

Facial appearance and our expressive behaviors have a major impact on how we perceive ourselves and how others in society perceive us. For an individual with a facial functional impairment and/or disfigurement, however, these interactions and associated perceptions may be very different. To aid in the diagnosis, treatment planning, and outcome assessment for these individuals, it is important that objective and quantitative methods are available to measure the severity of impairment and to compare the effectiveness of different operative or medical procedures.[25,27]

The moiré topography is a faster and more economic technique than the traditional one used in the diagnosis of asymmetries in patients and can be used by non-specialized staff. It allows the evaluation and quantification of parts of the human body, such as the face, the back, the legs and the sole of the foot.[28]It also has the advantages of being a non-invasive technique as it does not involve radiation as occurs in x ray exams [19,28] it does not require a highly trained professional to apply the method, [28,29,30] it allows for fast

evaluation of a large number of subjects in a short time period. [28]It is a reproducible [30]and low-cost [28,30], technique that can either substitute X-ray examination or be applied as a complementary diagnostic technique.[28,31,32] The use of MT in the topographical analysis of the human body is possible because it is able to indirectly identify places with structural deformities under the skin through the form of the surface area. [33] MT has, therefore, many possible applications and uses for health professionals in clinical evaluation of patients and for researchers and professors in their academic activities with students.

In the literature we found subjective methods, which the examiner, based on scales, assigns paralysis grading as House-Brakmann,[11]Yanagihara[34]or, even, the system called Toronto Facial Grading System developed by Ross.[35] Until today, in clinical practice as well as in clinical studies or reports, the method utilized is the one adopted by the Facial Nerve Disorders Committee of the American Academy of Otolaryngology and Head and Neck Surgery, in 1985, created by House and Brackmann.[36]There were objective methods, from the simplest – such as the Facial Nerve Functional Index, described by Fields and Peckitt,[37] only measured the value between the corner of the mouth and the external corner of the eye, or those which assess the facial movements at rest and in contraction with a simple ruler,[38,39]done directly on the patient, or assessed by means of photographs and films.[36,40]

There was several computer-assisted measurement systems designed to measure movement of facial surfaces. Neely et al.1992[41] manipulated digitized video images and compared pixel values of areas of the face at rest and in animation. Meier Gallatiet al.1998 [42] recorded videos and used a computer program to evaluate the variations of luminance during facial movement. The variations in reflected light between the resting face and the animated face indicate the movement of facial surfaces. These variations were given a numerical value for each area of the face. However, these techniques have not provided the type of measurements that allow evaluation of the effectiveness of a facial paralysis in reanimation procedure.[42]

The findings of this study are in agreement with that opinion that both age groups were more accurate in identifying facial expressions in young compared to older faces. This better performance with young as opposed to older faces could reflect some preference for young over older adults, or could indicate that due to age-related changes in physical features (e.g., muscle tissue, wrinkles) expressions in older faces are more ambiguous than in young faces, which makes facial expression decoding more difficult. This finding suggests that there may be important life situations in which older adults may be more likely to be misinterpreted than young adults.[43] The current findings may also agree with this explanation for older compared to young adults' decreased

ability to identify expressions of, and their reduced memory for, angry faces. One such explanation is based on observations suggesting that different brain structures modulate the effects of negative versus positive stimuli for perception and identification of emotional faces.[44,45] Another explanation draws upon evidence of age-related differences in visual scan patterns of emotional faces. Certain visual scan patterns appear to be more efficient for some than for other facial expressions (happiness).[46]

The findings of this study showed that all the five movements were more in female compared to male and this findings may explained that the responses of emotional facial muscular in female more than male participants, that women were overall more emotionally responsive than men. This is in line with our expectation and the majority of studies investigating gender differences in emotionality using EMG and facial expressions.[47,48,49]The findings of this study are in agreement with Brody & Hall, 2000 and Fischer, 1993.[50,51] They found that men's and women's emotion displays differ from each other because women report smiling more and are considered by others to smile more than men, and that men's displays of anger have been reported to be both more pervasive and are generally more acceptable.[50,51] Hess et al. 1997 [52]found that lower intensity expressions of sadness were rated more intense when shown by men, whereas the 100% expression was rated more intense when shown by women.[52]

The findings may accept this explanation that shows that women are more likely to seek the company of others in times of stress, compared to men. Therefore, for women it is of much importance to pick up emotional cues from others and to facilitate communication and increase social bonding by also being expressive themselves. For men, anger recognition, especially the recognition of threatening cues from other men (competitors) might have proven particularly adaptive over the course of evolution.[53]Men's behavior under stress is typically characterized by fight (aggression) and by flight (social withdrawal, substance abuse).[54] So, men and women may be biologically primed to react to threat in a certain way, but the environment reinforces these reaction patterns. For example, aggression is seen as socially acceptable for men but not for women which positively reinforces men and women to behave in a gender-stereotypical way.[55,56]

Limitations of this study were first, The gliding of the markers were considered one of the limitations with moiré topography as they could be gliding from some faces according to the nature of the skin of the subjects during the measurement and they need to be relocated again at the same place. Second, the possible effects of skin vs muscle movements of the face. The facial muscles insert directly into the skin of the face.[57] As such, movements of the face are due mainly to the movement of the underlying

muscle, and any skin movement can be expected to be minimal compared with the muscle movement.[13]

CONCLUSION

From the measurements done in this study for the ROM of five movements of face at right and left sides, the value of the angles for the muscles performing movements (Frontalis, Orbicularis Occuli, Zygomatic Major, Orbicularis Oris and Buccinator). The information gained in this study may be useful for diagnosis, planning, prognosis, surgical procedure and post surgical function outcome evaluated comprehensively and allow the clinicians to determine that the female are more than male in this facial movement and that with increasing age there is a decrease in the range of the angles of the face. So, these are important in rehabilitation process especially in case of facial paralysis and cleft lip and palate and in cosmetic appearance.

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الملخص العربى

مدى تأثير السن والجنس على حركات الوجهباستخدام المويرتوبوجرافى

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الهدف:دراسه مدى تاثيرمجموعات السن المختلفة والجنس على حركات الوجه باستخدام المويرتوبوجرافى **التصميم:**دراسة واحدة غير تجريبيه. **المواد والطرق:** 150 اشخاص اصحاء من الجنسين (75ذكر–75 انثى) يتراوح اعمارهم من 20–50 سنه تمت توزيعهم على ثلاث مجموعات من(20–30سنه)، (30–40سنه)، (40–50سنه) خمس زوايا للوجه تمت قياستهم لكلا الجانبين من الوجه، كل شخص له ثلاث قراءت لكل زاويه خلال موقف الثبات والانقباض، هذه الزوايا هى الرفع، الغلق، الابتسام، التقبيل والنفخ وتم استخدام برنامج الاوتوكاد لحساب وتحليل هذه الزوايا. **النتائج:** يوجد تاثير نوعى لمجموعات السن على خمس زوايا للوجه تضم الرفع، الغلق، الابتسام، التقبيل والنفخ لكلا الجانبين اليمين واليسار وايضا يوجد تاثير نوعى للجنس على نفس الخمس زوايا وهناك تاثير نوعى بين مجموعات السن والجنس المختلفة على نفس الخمس زوايا للوجه بواسطة تحليل التباين ثنائى الاتجاه. وبالنسبه للتحليل الانحدارى اشار الى ان مدى الارتباط بين مجموعات السن وحركات الوجه هو ارتباط سلبي متوسط لكل خمس زوايا الوجه لكلا الجانبين وايضا هناك نفس الارتباط السلبي المتوسط للجنس مع خمس زوايا الوجه. **الخلاصة:**هناك تاثير نوعى لمجموعات السن والجنس المختلفة على حركات الوجه تضم الخمس زوايا لكلا الجانبين اليمين واليسار وان الاناث اكثر من الذكور فى قيم الخمس زوايا وان مع زيادة السن هناك انحدار فى قيم الخمس زوايا.

الكلمات الدالة :المويرتوبوجرافى ، اصحاء، الاوتوكاد.