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Anthropometric analysis of Turkish fetuses' face

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ABSTRACT

Aims: This study aims at collecting data on the morphology of the face during its development in order to get detailed information on the neighboring structures and its variations using anatomical dissections and obtain normal morphometric values of the face growth and human fetuses during the 1st, 2nd and 3rd trimester.

Methods: This study was performed on spontaneously aborted 97 fetuses (49 males, 48 females) (11 first trimester, 63 second trimester and 24 third trimester) that have no observable congenital malformations or maternal history of risky pregnancy. The fetuses were taken from a Gynecology Department of a School of Medicine and a Maternity Hospital in Konya. Thirteen direct facial anthropometric measurements were performed on 97 volunteers. The data obtained were compared with the data of previous studies.

Results: Means and standard deviations of the parameters in regard to gestational weeks and trimesters were calculated. A significant correlation was observed between all parameters and gestational age ($p<0.05$). There were also significant differences between sexes for any of the parameters ($p<0.05$). All measurements were determined to be greater in male fetuses than female fetuses except for en-gn, sn-gn, sa-sba and ex-en.

Conclusion: The data acquired in this study is expected to help other studies on face anomalies, pathologies and variations in addition to diagnoses and treatments of such conditions conducted in anatomy, pathologic anatomy (feto pathology), forensic medicine, medical imaging, obstetrics and pediatrics.

Keywords: Face, development, morphometry, fetus

INTRODUCTION

Chantal index and circumference-interorbital index acquired from the measured parameters are also essential tools for anatomists and cranio facial surgeons.[1,2] Craniofacial dimensions may be identified by a single gene, gene groups or environmental factors.[3] For diagnosis of certain anomalies and syndromes, abnormal facial features such as telechantus, ocular hypertelorism or hypotelorism are taken into account by many clinicians, geneticists and maxillofacial surgeons. The measurement becomes stable by the time it reaches adult levels in the mid-to late twenties.[4,5]

The face is separated into three parts; upper, middle and lower thirds. The basic aesthetic feature of the lower third is created by lips, especially the upper lip has a significant effect mainly on the aesthetic judgment of the face.[6] The size and curvature of the exposed red lip surface is liable to substantial individual, gender and ethnic variations.[7] Lips and their relationship with the position of anterior teeth have a significant effect on a person's smile and overall facial aesthetics.[8] The lips become thinner as people age and the wet line moves caudally, oral commissure also begins to downturn with advancing age.[9] Almost all measurements demonstrate a downward trend after the fifth or sixth decade of life.[10]

Since there was no systematic study on facial morphometric measurements, this study was desired to be performed. The study is expected to provide valuable information to the forensic odontologists, plastic surgeons and the forensic experts. That is, it can be beneficial for cosmetic correction and identification.

METHODS

The study was carried out with the permission of Selçuk University Meram Faculty of Medicine Clinical Researches Ethics Committee (Date: 27.06.2008, Decision: 2008/171). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

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This study was conducted on human fetuses aged between 7 and 37 weeks of gestation (crown rump length [CRL]). Measurements were made on 97 fetuses. The fetuses were detected with immersion method using %10 formalin in the fetus collection of Necmettin Erbakan University, Meram Faculty of Medicine, Anatomy Department in 2016-2017.

Fetuses were grouped in accordance with their gestational ages: Group1 (first trimester), group 2 (second trimester) and group 3 (third trimester) included fetuses aged 7-12 weeks, 13-25 weeks and 26-37 weeks, respectively. A digital compass sensitive to 0.01 mm was used for the measurements.

The vertical measurements are as follows[19] (**Figure 1**):

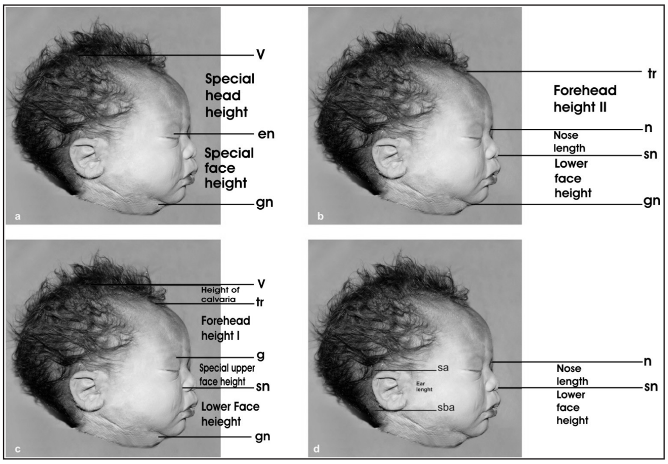

Figure 1. Vertical measurements (11): a; special head height [vertex-endocanthion (v-en)], special face height [endocanthion-gnathion (en-gn)], b; forehead height II [trichion-nasion (tr-n)], nose length [nasion-subnasale (n-sn)], lower face height [subnasale-gnathion (sn-gn)], c; height of calvaria [vertex-trichion (v-tr)], fore head height I [trichion-glabella (tr-g)], special upper face height [glabella-subnasale (g-sn)], lower face height [subnasale-gnathion (sn-gn)], d; nose length [nasion-subnasale (n-sn)], ear length [supraaurale-subaurale (sa-sba)].

The head:

- Height of calvaria (vertex-trichion) (v-tr),
- Forehead height I (trichion-glabella) (tr-g),
- Forehead height II (trichion-nasion) (tr-n),
- Special head height(vertex-endocanthion) (v-en),

The face:

- Special face height (endocanthion-gnathion) (en-gn),
- Special upper face height (glabella- subnasale) (g-sn),
- Lower face height (subnasale-gnathion) (sn-gn),

The ear:

- Ear length (supraaurale-subaurale) (sa-sba),

The horizontal measurements are as follow (**Figure 2**):

The orbits:

- Left eye fissure length (exocanthion-endocanthion) (ex-en),
- Intercanthal distance (endocanthion-endocanthion) (en-en),

The nose:

- Nose width (alare-alare) (al-al),
- The labio-oral region:
- Mouth width (cheilion-cheilion) (ch-ch).

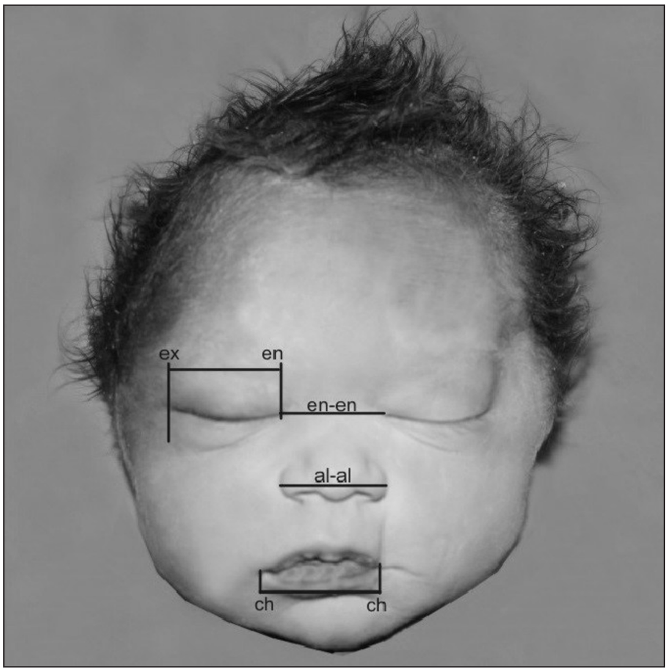

Figure 2. Horizontal measurement (11): right eye fissure length [exocanthion-endocanthion (ex-en)], intercanthal distance (endocanthion-endocanthion (en-en)], nose width [alare-alare (al-al)], mouth width [cheillion-cheillion (ch-ch].

Statistical Analysis

SPSS 20.0 (IBM Inc., Chicago, IL, USA) software was used for the analyses of the study. Descriptive statistics were presented as frequencies and percentages for categorical variables, and mean±SD for numerical variables in addition to percentile values. Continuous variables were examined for normality by Kolmogorov-Smirnov method. Student t-test was employed for two independent samples, and the analysis of variance was employed for several independent samples. Pearson correlation coefficients were calculated between measurements and gestational age. P<0.05 was considered statistically significant as 5% Type-I error.

RESULTS

A total of 98 fetuses were included in the study. The sex ratios were close to each other and the proportion of males was 51% (n=50). Trimester rates for fetuses were 2nd trimester (64.3%), 3rd trimester (24.5%) and 1st trimester (11.2%), respectively. Gestational ages were between 8 and 28 weeks. The average age in male fetuses was 19.67±7.29 weeks, 16.66±5.85 weeks in female fetuses and 18.18±6.75 weeks in general.

Values measured from fetuses were compared between genders. En-gen (p=0.013) and tr-r (p=0.012) were found to differ significantly between genders. Both measured values were significantly higher in male fetuses. However, although the measurement result of r-sn was higher in male fetuses, the difference between genders was not statistically significant (p=0.115). Sn-gn, tr-g, g-sn and ex-en measurement results were also significantly higher in male fetuses. Sa-sba, en-en, al-al and ch-ch measurement results did not differ significantly between gender groups (Table 1).

Table 1. Measurement results according to gender

Measurements		Male (n=50)	Female (n=48)	p
		Mean±SS		
en_gn	mm	29.15±12.36	23.79±8.33	0.013*
tr_r	mm	22.58±9.79	17.97±7.42	0.012*
r_sn	mm	15.05±6.0	13.26±5.58	0.115
sn_gn	mm	20.46±7.93	16.8±5.25	0.008*
tr_g	mm	19.17±7.87	14.77±5.8	0.002*
g_sn	mm	16.59±6.1	14.11±5.68	0.041*
sa_sba	mm	17.58±9.07	15.13±6.31	0.109
ex_en	mm	13.08±5.88	10.67±3.87	0.020*
en_en	mm	13.29±5.12	11.6±4.15	0.076
al_al	mm	12.98±4.99	11.53±5.09	0.140
ch_ch	mm	16.03±5.98	14.58±5.65	0.231

*: significant at 0.05 level according to Independent Sample t-test

Comparisons of measurement for trimester periods are presented in Table 2. All measurements differed significantly between periods (p <0.001). All of the measurements increased in proportion to the trimester period (Figure 3). Comparing all measurements with respect to trimester periods in terms of gender difference, all mean values between the periods were found to be significantly different. Measurement values of the face increased in both male and female fetuses in proportion to trimester periods (p <0.001). In addition, the mean, minimum, maximum and quartile (25th, 50th and 75th percentile) values for all morphometric measurements in terms of gender difference are presented in Table 3. All morphometric measurement values correlated positively and significantly with gestational age (week) in terms of gender difference. The highest correlation in male fetuses belonged to sa-sba (r=0.973). The lowest correlation was found between al-al and gestational week (r=0.746). In female fetuses, the highest correlation was found to be r-0903 with en-gn and the lowest correlation was r=0.750 with al-al measurements.

Table 2. Measurement results for Trimester periods

	1st trimester (n=11)	2nd trimester (n=63)	3rd trimester (n=24)	p
		Mean±SS		
en_gn	12.31±2.81	23.76±5.25	40.31±10.23	<0.001*
tr_r	10.14±1.97	18.18±5.7	30.6±8.83	<0.001*
r_sn	5.6±1.42	13.2±3.92	20.67±4.42	<0.001*
sn_gn	9.38±2.25	17.23±3.94	26.7±6.81	<0.001*
tr_g	8.78±1.59	15.25±4.6	25.43±6.96	<0.001*
g_sn	5.99±1.9	14.47±3.85	22.05±4.4	<0.001*
sa_sba	7.35±1.69	14.15±4.56	26.39±6.96	<0.001*
ex_en	5.48±1.05	10.87±2.6	17.53±6.0	<0.001*
en_en	7.02±1.55	11.37±3.16	17.81±4.34	<0.001*
al_al	4.75±1.27	11.77±3.98	17.03±3.66	<0.001*
ch_ch	7.43±1.61	14.33±3.62	21.34±5.64	<0.001*

*: significant at 0.05 level according to One-way ANOVA test with Tukey HSD post-hoc test showing that every trimester period is significantly different from others

Table 3. Descriptive measures according to trimester periods according to gender

	1st trimester	2nd trimester	3rd trimester	p	Min-Max	P25-P50-P75
		Mean±SS				
Male						
en_gn	9.95±0.92	23.18±5.0	43.51±10.11	<0.001*	9.3- 56.7	20.47-26.6-36.8
tr_r	11.7±0.42	18.14±5.17	32.8±9.43	<0.001*	11.0- 50.5	14.97-20.4-28.8
r_sn	6.15±1.2	12.37±3.64	21.54±4.38	<0.001*	5.3- 26.6	10.02-13.6-20.27
sn_gn	7.4±0.57	16.84±3.64	29.34±6.58	<0.001*	7.0- 38.7	14.7-19.4-24.2
tr_g	10.1±1.13	15.42±4.0	27.8±6.98	<0.001*	7.0- 39.3	13.0-18.55-22.9
g_sn	6.95±0.07	13.97±3.7	23.03±4.7	<0.001*	6.9- 28.6	11.35-15.85-20.02
sa_sba	7.05±0.07	13.13±4.44	27.8±7.73	<0.001*	6.7- 39.1	10.92-15.0-22.47
ex_en	5.8±0.57	10.64±2.09	18.86±6.96	<0.001*	5.4- 31.0	9.3-11.9-14.5
en_en	7.35±0.49	11.12±3.18	18.38±4.73	<0.001*	6.7- 24.1	9.5-12.5-17.0
al_al	5.5±1.13	11.01±3.45	17.86±3.93	<0.001*	4.7- 23.7	8.97-11.8-16.8
ch_ch	8.4±1.7	13.37±3.24	21.97±5.65	<0.001*	7.2- 32.0	12.1-14.75-18.7
Female						
en_gn	12.83±2.84	24.35±5.51	33.9±7.36	<0.001*	8.9- 47.1	17.47-24.4-28.02
tr_r	9.79±2.02	18.23±6.28	26.19±5.71	<0.001*	5.8- 37.6	12.3-15.8-22.3
r_sn	5.48±1.49	14.06±4.08	18.91±4.21	<0.001*	3.6- 28.9	9.05-12.8-17
sn_gn	9.82±2.25	17.63±4.25	21.43±3.44	<0.001*	6.6- 26.2	12.45-16.0-21.82
tr_g	8.49±1.57	15.07±5.21	20.68±4.02	<0.001*	6.0- 29.0	9.52-13.0-17.95
g_sn	5.78±2.06	14.99±4.0	20.1±3.1	<0.001*	3.4- 26.0	10.1-14.8-18.2
sa_sba	7.41±1.89	15.19±4.51	23.58±4.2	<0.001*	4.9- 32.3	10.0-14.6-21.3
ex_en	5.41±1.15	11.11±3.06	14.89±1.56	<0.001*	4.0- 17.9	7.1-10.55-14.2
en_en	6.94±1.71	11.64±3.18	16.65±3.43	<0.001*	4.0- 19.7	8.55-11.2-14.3
al_al	4.59±1.3	12.55±4.37	15.39±2.51	<0.001*	2.4- 21.2	7.65-11.8-14.7
ch_ch	7.21±1.61	15.4±3.77	20.09±5.79	<0.001*	5.0- 29.0	10.0-14.45-17.85

*: significant at 0.05 level according to One-way ANOVA test with Tukey HSD post-hoc test showing that every trimester period is significantly different from others

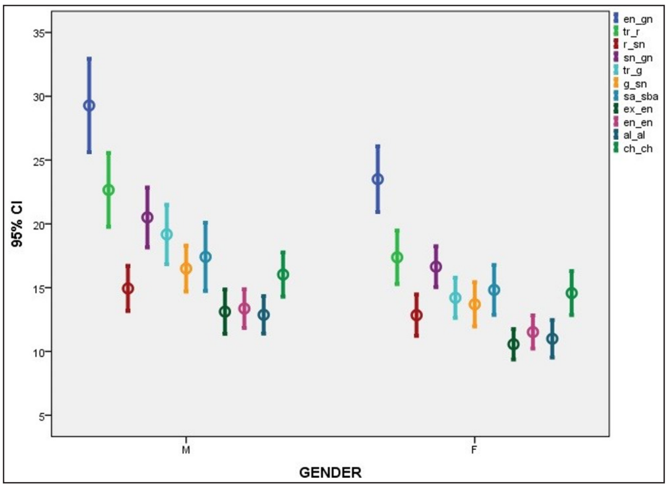

Figure 3. Fetus face measurements according to gender

DISCUSSION

Age, gender, race, climate and regional conditions cause body sizes to vary. The most important part of this variation is the facial area. The eyes are the parts of the face that have the most distinctive characteristics. Parameters related to the eyes play an important role in the diagnosis and the treatment of some anomalies and syndromes, in treatment of abnormal appearance such as hypertelorism, hypotelorism and telecanthus by many clinicians, geneticists and the plastic surgeons, in eyeglasses production and in setting physical anthropologic standards.[11,12]

Lately, craniofacial anthropometry has developed into a crucial tool benefitted by geneticists, opticians, anthropologists, forensic medicine specialists and reconstructive surgeons. Direk, Deniz Uslu et al.[13] observed a significant decrease in the nasoprontal angle with age in measurements of the orbital region. When the studies on different races were compared, the narrowest nasofrontal angle was identified as 134.[3] in North American Caucasians and the widest nasofrontal angle was identified as 149.2 in Direk, Deniz Uslu et al.[13-16] study.

As in other parts of the body, the external nose, head and face develop rapidly during adolescence. Knowing the pattern of development and timing of maturity are of great importance to set the best time for the reconstruction nasal deformities. Farkas, Hreczko, Koral et al. (1981) observed that the width and height of the nose basically stopped growing at the age of 12 in women and 14 or 15 in men, and that the size and shape of the external nose changed less after maturity.[19] We conducted an anthropometric study on selected normal young Han Chinese between 17 and 24 years old in order to provide reliable reference data during reconstruction of secondary nasal deformity after cheiloplasty, nasal reconstruction and repair of nasal defects and rhinoplasty in adults for Chinese population.

Anthropologists have stated that various nasal shapes and sizes emerged from the evolutionary adaptation of the nose to climate. According to Negus, populations adjusted to dry environments are inclined to have wide and protruding external noses, downwardly directed nostrils, and narrower skeletal apertures.[17] It is believed that these features induce turbulence to nasal airflow and that they maximize filtration and humidification of air within nasal passages. On the contrary, the ones who have smaller and flatter external nares, more anteriorly directed nares and shorter pyriform apertures are more effectively adapted to humid environments. These findings are also in line with our study conducted on people from West India mostly involving subjects from Rajasthan who have large external nares with downwardly directed nasal tips and subjects from the Himalayan region who have flatter noses with more anteriorly directed nares and shorter nasal apertures.

To consider objective factors in external nose reconstruction, systematic anthropometric methods are commonly used for measuring the soft tissue of the external nose before surgery. Preoperative evaluation and surgical planning should be carried out according to the shapes of face, mouth, eyes and body, while also referring to the measurement values of the normal population in the same gender and ethnic to decide the degree of reconstruction and the morphology of implant and objectively guide the actual surgery.[18]

Faces with four equal sections of the profile canon were not found in either of the populations. Among the variations of this canon, the height of the calvaria was smaller than the special upper and lower face heights in the majority of the other study group.[19] However, in our population the height of the calvaria while also smaller than the upper face height was greater than the lower face height. The upper face height was smaller than the lower face height in both populations. The most striking difference was that the forehead height I was smaller than the upper and lower face heights in high percentages of the other data.[19] In our measurements, although the forehead height I was smaller than the lower face height it was greater than the upper face height. The last vertical canon was equal in 2.9% and 2.2% of our women and men respectively. The literature data are similar to our results.[19] In both populations the most common variation reported was the nose length smaller than the ear length.

The interpretation of reference anthropometric data of the orbital region is both a fundamental phase for the quantitative specification of normal individuals and it can also be effectively used in the diagnostic procedures (treatment of traumas, chromosomal, and single gene alterations; teratogenically induced conditions such as fetal alcohol syndrome).[20-22] In fact, measurements are important to distinguish different pathologies and individual morphological variations.

CONCLUSION

The facial growth of the fetus is crucial in terms of anatomic and anthropologic perspective as well as oral and maxillofacial surgery. It plays a vital role in lower jaw surgery and intervention. Awareness of the facial position will help identify chromosomal deviations, genetic syndromes and other facial defects so that the anesthesia implemented in the lower jaw intervention and surgical interventions is achieved.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Selçuk University Meram Faculty of Medicine Clinical Researches Ethics Committee (Date: 27.06.2008, Decision: 2008/171).

Informed Consent: Written consent was obtained from the patient participating in this study.

Referee Evaluation Process: Externally peer reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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Author Contributions: All the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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