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Full Length Research Paper

Study of cephalometric parameters among 4 to 11 years old Persian girls resident in Iran

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Anthropometry is applied in medical profession such as maxillofacial surgery, growth and development studies, plastic surgery, bioengineering and non-medical branches such as like shoe-making and eye-glasses industries. The aim of the present study was to determine facial and cranial parameters among 4 to 11 years old Mashhadian young girls in order to assess growth pattern in this age range. 564 Persian girls aged between 4 to 11 years old resident in Mashhad and had normal facial patterns were selected from schools and kindergartens of the town. At first, frontal photographs in natural head position were taken by an expert person and after scanning all the photographs. They were transmitted to smile analyzer software to measure 13 anthropometric parameters. Pared t-test was used for statistic analysis. Anthropometric results obtained from 4 to 11 years old Fars girls residing in the city of Mashhad show that there is a special discipline in growth of different parts of face and skull. We reached formulas that may have a wide range of applications such as prediction of facial situation of an individual before or after his/her present situation. Such predictions can be helpful in forensic medicine, for instance in finding the lost kids. Reaching a normal range for face dimensions through studies about growth will play an important role in maxillofacial surgery and plastic surgery as well as in study of growth disorders. There are different factors such as ecologic, racial, age, and sex besides all genetic factors that influence the dimensions of human body and the way of its growth and development. Since the Iranian race is a compound one and consists of different races, and there are a wide variety of body dimensions in different parts of Iran, it is necessary to conduct more studies according to the geographical factors and the facial and skull anthropometric data shall be studied in different tribes of Iran. Obtaining an average for each of the variables in Iranian race, the anthropometry studies shall be conducted for different tribes.

Key words: Anthropometry, parameters, girls, growth pattern.

INTRODUCTION

As a part of physical anthropology, anthropometry measures and examines linear and angular skeletal dimensions on living individuals (Chamella, 1997). Understanding anthropometric parameters of face and cranium gives researchers and clinicians considerable insight into craniofacial growth and development which, in turn, has many practical applications including classification, diagnosis and treatment of craniofacial anomalies (Ainsowrth, 1979; Narayanan and Rama, 2006), correction of craniofacial deformities using maxillofacial and plastic surgical methods and forensic medicine. By finding the mean value of anthropometric parameters in normal samples of a population, it is possible to create a template for facial analysis of this specific population (Chamella, 1997).

As anthropometric and cephalometric parameters vary considerably depending on age, sex, geographical habitat and racial and ethnic backgrounds of human beings (Chamella, 1997; Williams et al., 1995) each anthropometric study should be conducted on a particular and predetermined age range, sex or racial group (Afak

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and Turgut, 1998). In his study, Porter compared anthropometric parameters of African-American males with those of North American whites and found significant differences (Porter, 2004). In a similar study, Choeks et al. (2004) showed significant differences between facial anthropometric measurements of Korean-American women and those of North American women (Choeks et al., 2004). Farkas et al. (2005) depicted that the breadth of nose in Asians and Africans is larger than in North American whites. However, Middle Eastern people have nasal width similar to that of North American whites (Farkas et al., 2005). By analyzing the anthropometric features of a group of 18 to 21 year old Croatians, Buretic-Toljanovic et al. (2007) showed that cranial measure-ments are influenced by geographical conditions Buretic-Toljanovic et al. (2007). The aim of our study was to measure the anthropometric parameters of 4 to 11 year old girls of Fars ethnic origin.

MATERIALS AND METHODS

This study was conducted on 564 (4 to 11 year old girls) of Fars ethnic origin. All the participants had Angle Class I dental occlusion and no history of orthodontic treatment, tooth extraction, maxillofacial surgery, cleft lip and palate or other facial anomalies.

A D40 Nikon digital camera with 18/135 lens (Nikon inc., Japan, 2007) was used to take frontal full-face photographs of each child while his/her head was in natural head position (NHP). The samples were relaxed during imaging and no special facial expressions such as smiling, laughing or frowning were detectable in their faces. A 10 mm wide sticker on each sample forehead was employed to calculate the image magnification.

The images transferred to a computer and classified according to the age of samples. Using Adobe Photoshop software (Adobe Inc., USA), the points indicating the desired anthropometric landmarks were put on each image. Newly developed software by the Orthodontic Department of Mashhad Dental School which is called "Smile Analyzer" was used to measure the anthropometric parameters on each image. This software has specifically been designed for precise measuring of desired distances or angles on images and radiographs.

Thirteen following measurements were taken in this study:

1. The width of the nose or Alare width (al-al),
2. The width of the mouth or the distance between Cheilion points (ch-ch),
3. Intercanthal width or the distance between left and right Endocanthion points (en-en),
4. Binocular width or the distance between left and right Exocanthion points (ex-ex),
5. Forehead width or the distance between soft tissue Frontotemporale points (ft'-ft'),
6. Intergonial width or the distance between left and right soft tissue Gonion points (go'-go'),
7. Facial height or the distance between soft tissue Nasion and Gnathion (n'-gn'),
8. The height of the nose or the distance between soft tissue Nasion and Subnasal points (n'-sn),
9. The depth of the upper third of face or the distance between Tragion and soft tissue Glabella (t-g'),
10. The depth of the lower third of face or the distance betwee Tragion and soft tissue Gnathion (t-gn'),
11. The depth of the middle third of face or the distance between Tragion and Subnasal points (t-sn),
12. Cranial base width or the distance between Tragion points (t-t),
13. Facial width or the distance between soft tissue Zygion points (zy'-zy'),

Data was analyzed using t-test, ANOVA and linear regression models of the SPSS software (SPSS Inc., Chicago, Il, USA).

RESULTS

As Table 1 shows 564 (4 to 11 year old girls) of Fars ethnic origin participated in the study. The table also includes the mean and standard deviation of 13 anthropometric measurements.

Anthropometric parameter al-al

Figure 1 shows a gradual increase in mean alare width by age although it suddenly drops at 8. The linear regression model shows the following equation between alare width and age.

al-al = 0.5 × age + 26.8

Anthropometric parameter ch-ch

Figure 2 depicts a sharp increase in mouse width between 5 and 6 years of age followed by a steady growth. The following ch-ch / age equation shows more growth in mouse compared to nose width by age.

ch-ch = 1.25 × age + 30

Anthropometric parameter en-en

According to Figure 3, intercanthal width shows a sharp drop between 4 and 5 and then a dramatic increase between 5 and 6 followed by a gradual rise after 7. Based the linear regression equation, intercanthal width grows much more slowly compared to mouse and nose widths.

en-en = 0.35 × age + 25

Anthropometric parameter ex-ex

Figure 4 indicate that the binocular width follows a noticeable increase between 5 and 6 years of age to reach a plateau between 6 and 7 and then, it rises gradually. The binocular width / age equation reveals that the binocular growth rate is about four times as growth rate as the intercanthal width.

ex-ex = 1.35 × age + 68

Anthropometric parameter ft'-ft'

Forehead width increases more steadily, compared to

Table 1. Mean and SD of measured parameters by age.

Age	4	5	6	7	8	9	10	11
No	**74**	**66**	**62**	**87**	**62**	**64**	**86**	**63**
al-al (mm) (Mean±SD)	28.95 ± 1.61	29.14 ± 1.74	30.12 ± 2.10	30.43 ± 1.96	30.22 ± 1.85	31.08 ± 2.22	31.58 ± 2.15	32.90 ± 2.12
ch-ch (mm) (Mean±SD)	35.14 ±2.59	35.43 ± 2.49	38.36 ±2.78	38.86 ± 2.49	39.54 ± 2.77	40.92 ± 2.98	42.39 ± 3.37	44.10 ± 3.37
en-en (mm) (Mean±SD)	26.38 ± 1.89	25.87 ± 2.27	27.74 ± 2.30	27.68 ± 1.99	27.93 ± 1.92	28.10 ± 2.33	28.35 ± 2.28	28.68 ± 2.62
ex-ex (mm) (Mean±SD)	73.12 ± 3.49	73.57 ± 4.25	77.59 ± 4.11	77.75 ± 3.50	79.12 ± 3.43	79.66 ± 3.64	81.21 ± 4.00	82.84 ± 3.74
ft'-ft' (mm) (mean±SD)	95.39 ± 4.19	96.44 ±4.81	99.07 ± 9.33	100.34 ± 4.54	102.32 ± 5.60	102.86 ± 4.63	104.87 ± 4.86	106.54 ± 4.52
go'-go' (mm) (Mean±SD)	83.57 ± 5.55	84.71 ± 5.66	89.21 ± 5.14	90.15 ± 5.29	90.55 ± 5.11	90.64 ± 5.75	93.69 ± 6.47	96.79 ± 6.11
n'-gn' (mm) (Mean±SD)	82.26 ± 5.43	84.03 ± 5.31	88.45 ± 5.24	89.54 ± 4.51	92.11 ± 4.50	93.39 ± 5.38	98.63 ± 5.99	100.31 ± 5.67
n'-sn (mm) (Mean±SD)	35.23 ± 6.26	36.27 ± 2.62	37.60 ± 2.49	37.87 ± 2.26	40.11 ± 2.96	40.85 ± 3.38	43.92 ± 2.94	44.63 ± 2.87
t-g' (mm) (Mean±SD)	61.71 ± 4.74	62.04 ± 4.50	65.88 ± 4.69	65.89 ± 3.85	66.58 ± 4.64	67.22 ± 5.16	68.30 ± 4.83	71.27 ± 5.09
t-gn' (mm) (Mean±SD)	84.88 ± 4.80	88.15 ± 5.90	90.82 ± 4.55	91.20 ± 4.70	94.09 ± 4.97	96.53 ± 5.46	99.62 ± 6.08	99.92 ± 5.37
t- sn (mm) (Mean±SD)	58.04 ± 3.58	60.01 ± 3.96	61.97 ± 3.76	61.88 ± 4.13	63.72 ± 4.44	65.09 ± 4.35	66.54 ± 4.98	67.01 ± 4.72
t-t (mm) (Mean±SD)	106.93 ±5.94	109.42 ± 6.01	114.45 ± 5.64	114.50 ± 5.23	115.70 ± 5.64	117.76 ± 6.08	120.22 ± 6.52	123.60 ± 6.30
zy'-zy' (mm) (Mean±SD)	99.35 ± 5.56	101.10 ± 5.68	105.70 ± 5.23	106.76 ± 5.30	107.65 ± 5.38	109.73 ± 6.29	112.68 ± 6.39	115.25 ± 5.90

other above mentioned parameters (Figure 5). The linear regression equation for ft'-ft' / age is as follows:

$$ft'\text{-}ft' = 1.6 \times age + 89$$

Anthropometric parameter go'-go'

Figure 6 demonstrates two growth acceleration periods between 5 to 6 and 9 to 11 years in intergonial width separated by an almost steady state. The intergonial width at any age is predictable using the following equation:

$$go'\text{-}go' = 1.7 \times age + 77.3$$

Anthropometric parameter n'-gn'

According to Figure 7, facial height increases gradually

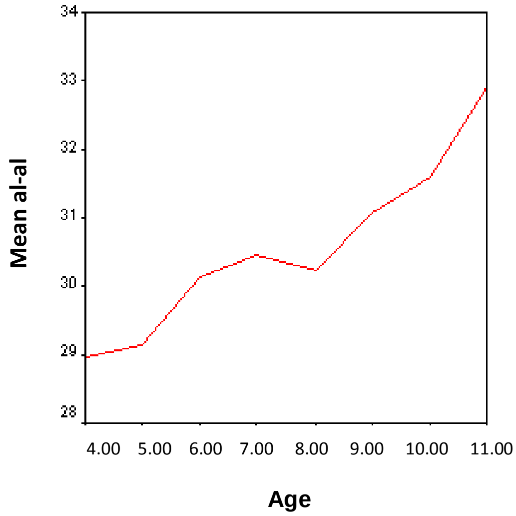

Figure 1. Mean al-al by age.

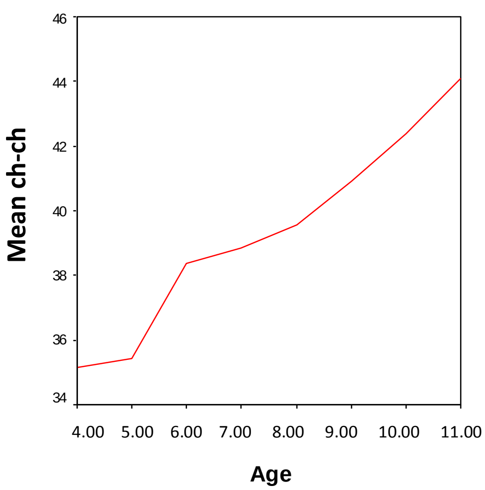

Figure 2. Mean ch-ch by age.

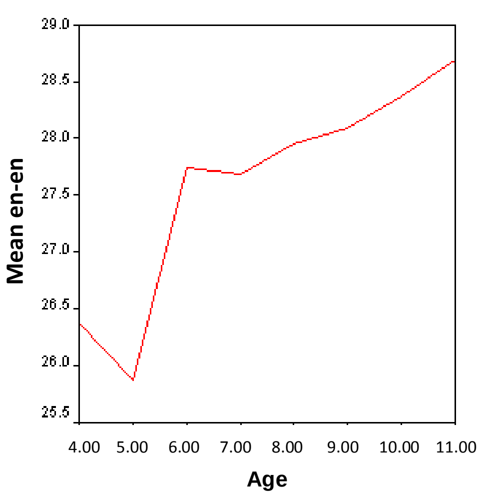

Figure 3. Mean en-en by age.

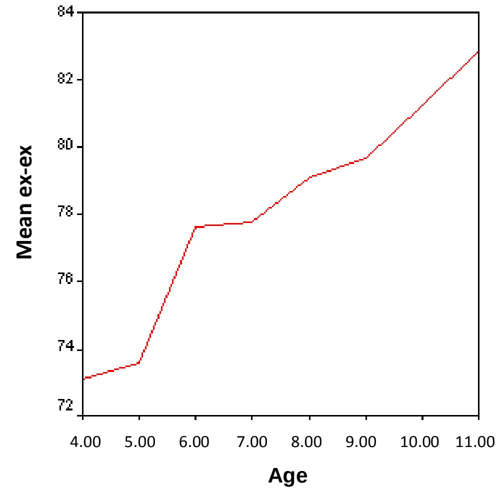

Figure 4. Mean ex-ex by age.

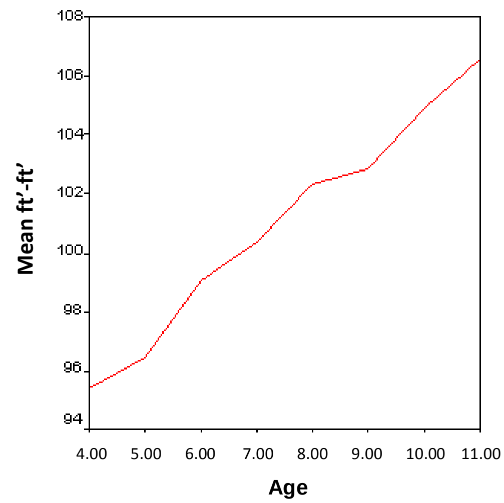

Figure 5. Mean ft'-ft' by age.

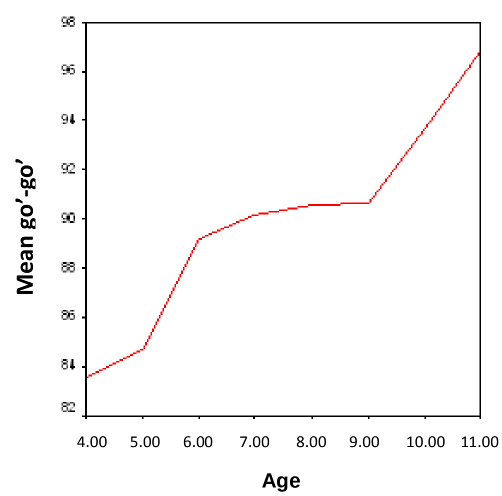

Figure 6. Mean go'-go' by age.

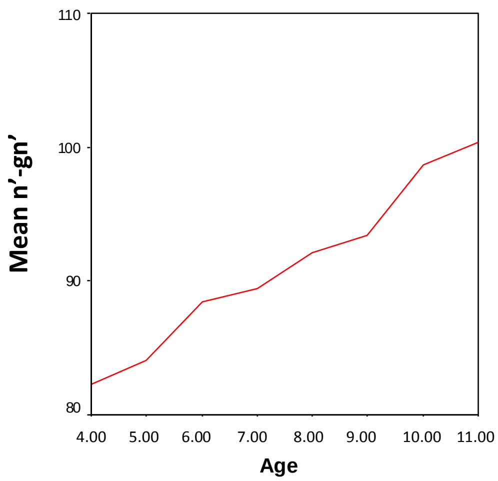

Figure 7. Mean n'-gn' by age.

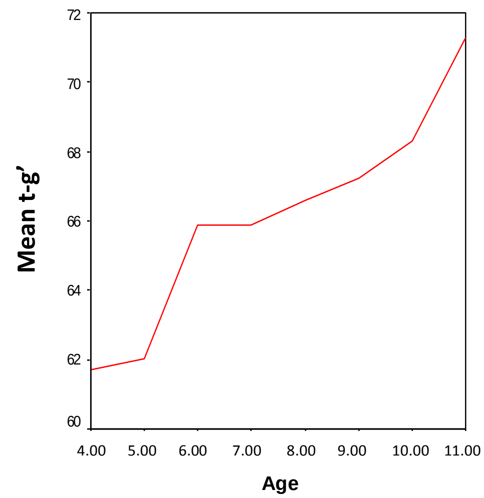

Figure 9. Mean t-g' by age.

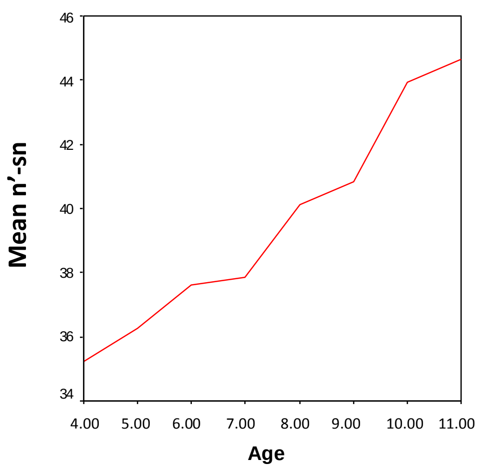

Figure 8. Mean n'-sn by age.

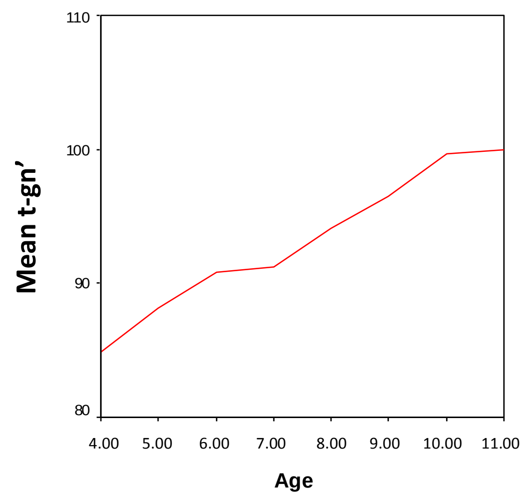

Figure 10. Mean t-gn' by age.

by age, although it accelerates at 5-6 and 9-10 intervals. Based on the following equation, facial height has the largest growth rate among anthropometric measurements of the face.

n'-gn' = 2.6 × age + 71.5

Anthropometric parameter n'-sn

The height of nose accelerates in three age ranges: 4 to 6, 7 to 8 and 9 to 10 (Figure 8). The equation shows the changes is nasal height as age increases:

n'-sn = 1.4 × age + 29

Anthropometric parameter t-g'

The depth of the upper third of face increases dramatically between 5 to 6 and 10 to 11 years (Figure 9). The linear regression equation for t-g' / age is as follows:

t-g' = 1.2 × age + 57

Anthropometric parameter t-gn'

Figure 10 illustrates that the depth of the lower third of face increases steadily except for two plateaus between 6 to 7 and 10 to 11 years of age. The following equation suggests rapid growth in this part of face:

t-gn' = 2.2 × age + 76.6

Anthropometric parameter t-sn

Growth-related changes in the depth of the middle third of

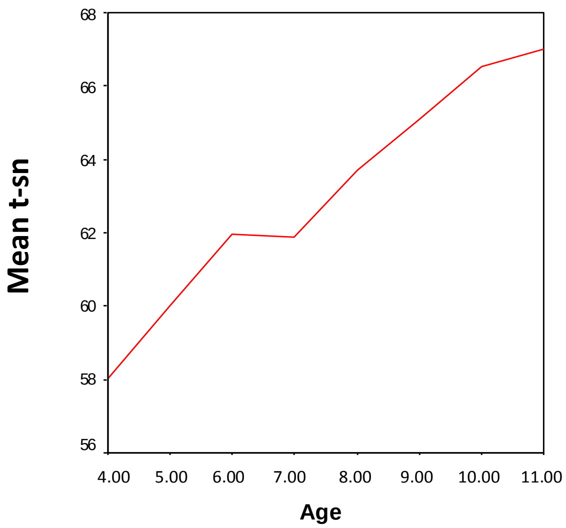

Figure 11. Mean t-sn by age.

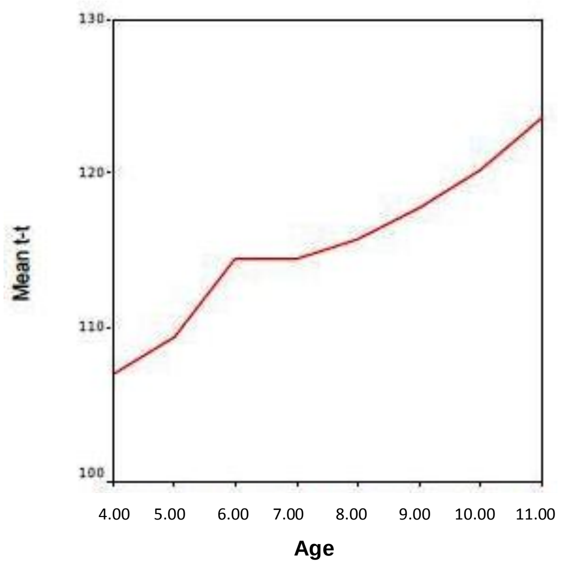

Figure 12. Mean t-t by age.

the face resemble those of the lower third (Figure 11). However, the growth rate is slower according to the equation.

t-sn = 1.28 × age + 53.4

Anthropometric parameter t-t

As Figure 12 represents, the growth curve of the cranial base width follows a sharp rise between 5 and 6 years to reach a plateau and then increase gradually after 7. The equation indicates a relatively fast growth in cranial base width.

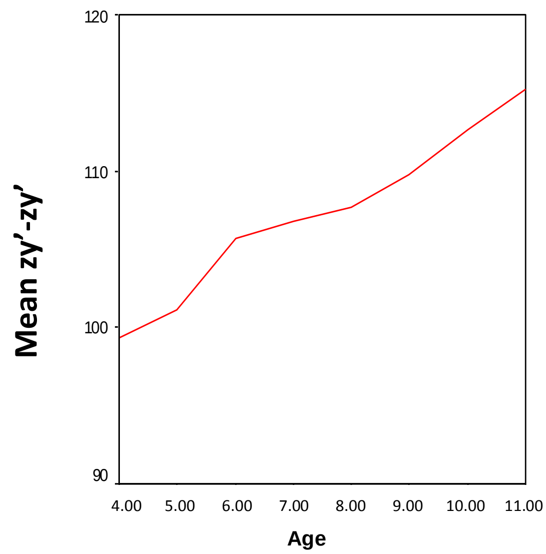

Figure 13. Mean zy'-zy' by age.

t-t = 2.1 × age + 99

Anthropometric parameter zy'-zy'

Facial width growth rate increases almost gradually except for a sharp rise between 5 and 6 years (Figure 13). The following equation shows that facial width has a rapid growth rate compared to most other parts of the face:

zy'-zy' = 2.17 × age + 90.98

DISCUSSION

As each racial and ethnic group possesses its own specific facial and cranial form which changes by age as well, to determine the anthropometric standards, it is essential to specify that anthropometric parameters are determined among which ethnic group and in which age range. The aim of our study was to measure 13 anthropometric parameters on facial frontal images of 564 (4 to 11 year old girls) of Fars ethnic origin to determine and predict growth-related changes in this age range.

The photo-anthropometric method Ferrario et al. (2003) was employed to measure the desired anthropometric dimensions. The method is relatively simple and fast, the required equipments are easily accessible and the findings are reliable. During imaging, the subject should stand still with no detectable facial expression. The photographs should be taken with a high resolution camera to ensure that all angles and lines are easily identifiable. To reduce the measuring error, all measurements were performed by the same operator.

However, some landmarks such as Cheilion or Endocanthion are more precisely identifiable compared to landmarks like Gonion.

Our findings show that craniofacial dimensions change at different rates at each age range, as other investigators mentioned as well (Enlow and Hans, 1996; Proffit et al., 2007). In other words, the changes may be faster at an age but insignificant at another age. Interestingly, in almost all measured dimensions we found significant growth acceleration between 5 and 6 years of age. Another growth spurt was also seen between 9 and 11, although it was less significant.

Comparing the linear regression equations suggests that different craniofacial dimensions do not grow similarly. Some parts grow at much slower pace compared to others. The intercanthal width has the least growth rate followed by the alar width while facial height and then facial width show fastest growth.

The intercanthal width growth curve displays a dramatic rise before 7 years of age. The growth of this dimension is related to the growth of brain and cranial base which is essentially complete by this age (Proffit et al., 2007). The orbital dimensions also reach the adult size at about 7. This is the reason why intercanthal growth continues much slowly after age 7.

As body grows by age, facial height increases more than facial width. Thus, nasal cavities length progressively increases to facilitate air flow to expanding lungs. We found faster growth rate in facial height compared to width.

Being able to predict an individual's facial form at different ages has many practical applications. For instance, in forensic medicine, by analyzing a picture of a kidnapped child, the experts can guess how his /her facial form is after many years. Based on our and other researchers' findings and by using artificial intelligence technology, computer programs can be designed to reconstruct facial forms of the individuals from a specific ethnicity at different ages.

Conclusions

Based on our findings in Fars 4 to 11 year old girls, we concluded that:

1. By age, craniofacial dimensions change at different rates.
2. Different craniofacial dimensions do not grow at consistent rates. Some parts grow slower compared to others.
3. The intercanthal width has the slowest growth.
4. Facial height shows the fastest growth.
5. Using linear regression equations, at any age, each craniofacial dimension can easily and precisely be determined.

REFERENCES

Chamella M (1997). Biological anthropology. Translated to Persian by Naderi A. 1st Ed. Tehran Gostar Publisher, p: 57-114.

Ainsowrth H (1979). Numerical evaluation of facial pattern in children with isolated pulmonary stenosis. Arch. Dis. Child, 54(9):62-9.

Narayanan R, Rama C (2006). Modeling age progression in young faces. University of Maryland West Point, 31(3):387-394.

Williams PL, Dyson M, Dussak JE, Bannister LH, Berry MM, Collins P (1995). Skeletal system in Gray's anatomy. 38th Ed. London. Elbs with Churchill Livingston, p: 607-612.

Afak SY, Turgut HB (1998). Weight, head and face measurements in Turkish newborns of central Anatolia. Gazi Med. J., 9:116-20.

Porter J (2004). The average African American male face: an anthropometric analysis. Arch Facial Surg., 6:78-81.

Choeks K, Sclafani A, Litner J (2004). The Korean American woman's face: anthropometric measurements and quantitative analysis of facial aesthetics. Arch Facial Plats Surg., 6:244-52.

Farkas LG, Katic MJ, Katic MJ (2005). International anthropometric study of facial morphometry in various ethnic groups/ races. Craniofac Surg., 16(4):615-46

Buretic-Toljanovic A, Giacometti J, Ostojic S, Kapovic M (2007). Sex-specific differences of craniofacial traits in Croatia: the impact of environment in a small geographic area. Ann. Hum. Biol., 34(3):296-314.

Ferrario V, Sforza C, Dellavia C (2003). A quantitative three-dimensional assessment of abnormal variations in facial soft tissues of adult patients with cleft lip and palate. Cleft Palate Craniofac J., 40:544-9.

Enlow DH, Hans MG (1996). Essentials of facial growth. 2nd ed. Philadelphia .WB Saunders Company, p: 122-165.

Proffit WR, Fields HW, Sarver DM (2007). Contemporary Orthodontics. 4th ed. St. Louis: Mosby Elsevier.