A Comparison between Craniofacial Templates of Iranian and Western Populations

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Abstract- Templates are very useful tools for diagnosis of malocclusions. A number of templates have been provided for some populations in previous years. Since craniofacial characteristics of different ethnic groups are not the same, each population needs its own norms. The aim of this study was to provide orthodontic craniofacial templates for 8-16 year old Iranian boys and compare dentoskeletal features between Iranian and western populations. 3330 boys with the age range of 8-16 years were examined in Tehran, and 107 cases were finally chosen for the study and their lateral cephalograms were traced. Since there is no universal, consensus about the selection of one specific point or line for cephalometric superimposition, both the sella nasion (SN) and basion nasion (Ba-N) lines were chosen for this purpose. Based on both SN and Ba-N lines, a template was prepared for each age. Simple linear regression analysis was used to evaluate the angles and the multivariant regression analysis for evaluation of landmark vectors. Posterior cranial base, maxillary and mandibular lengths, upper and lower anterior facial heights (N-ANS and ANS-Me) and posterior facial height (S-Go) are greater in Iranian population. But anterior cranial base, height and inclination of the incisors and molar height are similar in two populations.

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Introduction

Templates are not new entities in orthodontics. Baum designed four transparent templates in 1952. They were used on X-ray films directly (1). These templates contained the outer outline of the upper first molars and the incisor teeth. In 1958 Popovich and Grainger used 1300 records from the Burlington growth study center to design templates for 3, 6, 8, 10 and 12 year old children (2). All these templates were based on the data derived from acceptable occlusions and facial profiles. Moorrees and Lebert introduced mesh diagrams in 1962 (3). In this type of templates, the proportions of different parts of the face of each patient are evaluated with each other, and no norms are used in this regard. Johnston, Moyers, Broadbent, Golden, Thompson and Ackerman also proposed different templates for several ages in the next years (1,3). The templates were evolving year after year (4-8). For example, Jacobson designed proportionate templates for orthognatic surgeries in adults. They were produced in four different sizes based on 5000 cases with perfect occlusions and esthetics. These templates can be used for both sexes. Jacobson also provided different analytic templates for both sexes between the ages of 6 and 16.

In 2001 Akhoundi and Moghadam designed templates for Iranian girls with the ages of 8, 10, 12 and 14 years (8). They were based on 177 acceptable occlusions and profiles.

Materials and Methods

3330 boys from 15 schools in Tehran were examined, and 328 boys were selected. A second examiner re-evaluated the selected group and chose 242 boys who met the inclusion criteria. A panel of 3 orthodontists chose balanced profiles among them, and their parents were consulted, and 151 persons agreed to take a lateral cephalogram. Study was approved by the ethical committee of research center of Tehran University of

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Medical Sciences and performed under its observation. After giving comprehensive explanations about the expected advantages and disadvantages of templates, Informed consent was signed by parents before starting treatment.

From the 151 taken X-rays, 107 cephs with the highest quality were finally selected and traced (Table 1). The inclusion criteria were as following:

The boys were all Iranians.

The age range was 8-16 years (yrs).

The occlusions were Class I with normal overjet and overbite.

The profiles were balanced and acceptable.

The upper and lower dental midlines were "on" in both open and closed mouth conditions.

Those cases with crowding, spacing, crossbite, missing teeth, supernumerary teeth, jaw deviation, great restorations, tempro-mandibular disorder (TMD), systemic diseases, deviated dental midlines and previous history of orthodontic treatment were excluded from the study. We chose 26 boys with the age of 8 yrs, 30 boys with the age of 10 yrs, 33 boys with the age of 12 yrs, 34 boys with the age of 14 yrs and 28 boys with the age of 16 yrs for this purpose. After checking the quality of the radiographs, 21 cases with the age of 8 yrs, 22 cases with the age of 10 yrs, 21 cases with the age of 12 yrs, 21 cases with the age of 14 yrs and 22 cases with the age of 16 yrs were selected and traced by three operators. Since there is no universal consensus about the selection of one specific point or line for cephalometric superimposition, both the sella nasion (anterior cranial base or SN) and basion nasion (Ba-N) lines were chosen for this purpose. In the first method, the (S point) was chosen as the reference of coordinates, SN as the X axis and the perpendicular to SN at S as the Y axis. Then the coordinates of all landmarks were measured to the nearest 0.5 mm. Besides, the angle between the upper incior plan and SN "upper 1-SN", the angle between the lower incisor plan and SN "lower 1-SN", the angle between occlusal plan and SN "occlusal plane-SN" and the angle between pterygo maxillary plan and SN "PTM-SN" were also measured. In the second method, the cross point of Ba-N plan and PTM line was chosen as the reference of coordinates, PTM as the Y axis and the perpendicular to PTM at the cross point as the X axis. Since the angel between anterior cranial base (SN) and posterior cranial base (Ba-S) varies among individuals, the position of S point is not constant. So Ba-N line seems a better reference than SN or Ba-S, because it is not affected by the position of S (7). Using computer superimpositions, Ricketts et al also found that Frankfurt Horizontal plan (FH) and vertical pterygoid lines have fewer errors in comparison to SN line (9).

All the measurements were similar to the first method except that there was no PTM point in this method, and the S point replaced it. All the measurements were made twice and then entered into the Microsoft Excel software. The simple linear regression analysis was used to evaluate the angles and the multivariant regression analysis for evaluation of landmark vectors. The level of significance was 0.05 and the SAS software was used for statistical manipulations.

Results

When the age increase from 8 to 16 was considered in the first method, almost all the landmarks showed significant statistical changes. But Por and PTM were exceptions to this regard (Table 2). The related template is shown in figure 1.

In the second method, the changes of all the landmarks were statistically significant with the increase of the age (Table 3). The resulted template can be seen in figure 2.

When this template was superimposed on Johnston' template, it was shown that Posterior cranial base, upper and lower anterior facial heights, posterior facial height and maxillary/ mandibular lengths were greater in the Iranian population than those of the western population. But Jaraback index, anterior cranial base, height and inclination of the incisors and molar height were similar in two populations.

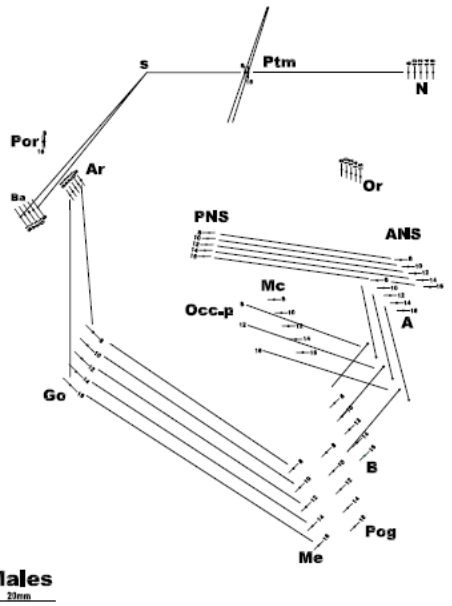

Figure 1. Templates derived by the first method.

Table 1. The definitions of the landmarks selected for tracing.

Landmarks	Definitions
S	The constructed point as the center of Sella Turcica
N	Nasion: The most superior Anterior point of the nasion bone
Or	Orbitale: The Lower-most point of the orbit
Por	Porion: The highest point on the bony external acoustic meatus
ANS	Anterior Nasal Spine
PNS	Posterior Nasal Spine
A	Point A: Subspinale
B	Point B: Supramentale
Pog	Pogonion : The most anterior point of bony chin
Me	Menton: The lowermost point on the mandibular symphysis
Go	Gonion : The most posterior Inferior point on the angle of the mandible
Ar	Articulare :A constructed point at the intersection of the images between posterior border of ramus and cranial base
Ba	Basion : Lowest point on the anterior margin of the foramen magnum
Is	Incision superius
Ii	Incision Inferius
Mc	The most mesial contact point of the first molar & it's mesial tooth
PTM	The Anterior border of the pterygopalatine fossa

Table 2. First method's multivariate regression analysis to evaluate the changes of cephalometric vectors with regard to the age.

Points		$\beta x + \alpha$	Level of Significance of Angles	Level of Significance of Vectors
N	X	64.17 + 0.83 (age)	$P<0.0001$	$P<0.0001$
	Y	0	-	
Or	X	47.59+0.64 (age)	$P<0.0001$	$P<0.0001$
	Y	-24.53-0.23 (age)	$P<0.0001$	
Por	X	-27.20-0.06 (age)	$P<0.0001$	$P=0.8369$
	Y	-18.51-0.03 (age)	$P<0.0001$	
ANS	X	60.91+0.98 (age)	$P<0.0001$	$P<0.0001$
	Y	-43.36-0.92 (age)	$P<0.0001$	
PNS	X	18.37-0.19 (age)	$P<0.0001$	$P<0.0001$
	Y	-36.97-0.80 (age)	$P<0.0001$	
A	X	55.17+0.89 (age)	$P<0.0001$	$P<0.0001$
	Y	-48.11+1.02 (age)	$P<0.0001$	
B	X	47.72+1.01 (age)	$P<0.0001$	$P<0.0001$
	Y	-75.15+1.79 (age)	$P<0.0001$	
Pog	X	40.91+0.96 (age)	$P<0.0001$	$P<0.0001$
	Y	-82.70+0.83 (age)	$P<0.0001$	
Me	X	32.89+0.85 (age)	$P<0.0001$	$P<0.0001$
	Y	-86.21-2.61 (age)	$P<0.0001$	
Go	X	-8.40-0.77 (age)	$P<0.0001$	$P<0.0001$
	Y	-55.95+1.79 (age)	$P<0.0001$	
Ar	X	-14.88-0.37 (age)	$P<0.0001$	$P<0.0001$
	Y	-25.17-0.50 (age)	$P<0.0001$	
Ba	X	-24.9-0.58 (age)	$P<0.0001$	$P<0.0001$
	Y	-33.98-0.32 (age)	$P=0.0168$	
IS	X	53.18+1.11 (age)	$P<0.0001$	$P<0.0001$
	Y	-65.48+1.45 (age)	$P<0.0001$	
Ii	X	51.13+1.08 (age)	$P<0.0001$	$P<0.0001$
	Y	-60.99-1.55 (age)	$P<0.0001$	
Mc	X	26.69+0.97 (age)	$P<0.0001$	$P<0.0001$
	Y	-47.14+1.79 (age)	$P<0.0001$	
Ptm	X	25.66+0.11 (age)	$P=0.2897$	$P=0.2897$
	Y	0	-	

Table 3. Second method's multivariate regression analysis to evaluate the changes of cephalometric vectors with regard to the age.

Points		βx + α	Level of Significance of Angles	Level of Significance of Vectors
S	X	-23.79-0.14 (age)	*P*=0.0931	*P*=0.0051
	Y	9.28+0.19 (age)	*P*=0.1410	
N	X	36.16+0.71 (age)	*P*<0.0001	*P*<0.0001
	Y	32.18+0.20 (age)	*P*=0.1693	
Or	X	28.92+0.53 (age)	*P*<0.0001	*P*<0.0001
	Y	3.40-0.05 (age)	*P*=0.0001	
Por	X	-42.59-0.30 (age)	*P*=0.0166	*P*=0.0092
	Y	-17.91-0.24 (age)	*P*=0.1672	
ANS	X	47.93+1.01 (age)	*P*<0.0001	*P*<0.0001
	Y	-9.42-0.68 (age)	*P*=0.0011	
PNS	X	6.11-0.18 (age)	*P*<0.0001	*P*<0.0001
	Y	-18.95-0.72 (age)	*P*<0.0001	
A	X	44.73+0.89 (age)	*P*<0.0001	*P*<0.0001
	Y	-16.01+0.77 (age)	*P*=0.0001	
B	X	42.90+1.09 (age)	*P*<0.0001	*P*<0.0001
	Y	-45.04-1.50 (age)	*P*<0.0001	
Pog	X	43.97+1.23 (age)	*P*<0.0001	*P*<0.0001
	Y	-52.70+2.19 (age)	*P*<0.0001	
Me	X	37.67+1.14 (age)	*P*<0.0001	*P*<0.0001
	Y	-59.18-2.29 (age)	*P*<0.0001	
Go	X	-12.06-0.54 (age)	*P*=0.0068	*P*<0.0001
	Y	-46.56-1.74 (age)	*P*<0.0001	
Ar	X	-28.65-0.47 (age)	*P*<0.0001	*P*<0.0001
	Y	-19.71-0.36 (age)	*P*=0.0134	
Ba	X	-35.09-0.75 (age)	*P*<0.0001	*P*<0.0001
	Y	-31.33-0.24 (age)	*P*=0.1236	
IS	X	48.99+1.16 (age)	*P*<0.0001	*P*<0.0001
	Y	-32.88+1.13 (age)	*P*<0.0001	
Ii	X	45.30+1.20 (age)	*P*<0.0001	*P*<0.0001
	Y	-29.40-1.23 (age)	*P*<0.0001	
Mc	X	17.98+1.16 (age)	*P*<0.0001	*P*<0.0001
	Y	-24.79-1.42 (age)	*P*<0.0001	

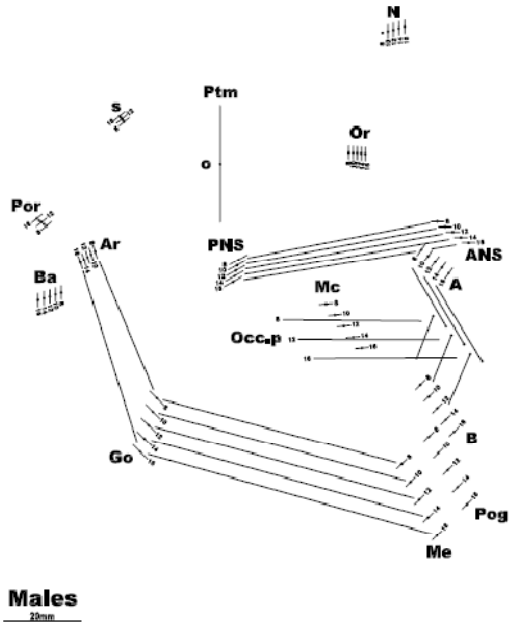

Figure 2. Templates derived by the second method.

The α, β, and x values are used in the tables are defined as follows:

α+βx is the equation of the line that shows the changes of the coordinates of X and Y with regard to the age.

α is a constant value.

β is the tangent of the angle between the vector and the X axis. It shows the amount of the changes of one point in X or Y directions with regard to the age.

x represents the age.

Discussion

In recent years, direct comparison of patients with templates derived from the various growth studies has become a reliable method of analysis, with the considerable advantage that compensatory skeletal and dental deviations within an individual can be observed directly (10).

This study were assigned to make a template for Iranian boys. From 3330 cases, only 107 persons were finally chosen for the study. The examiners meticulously followed the inclusion and exclusion criteria to choose the right cases. That is why such a large number of cases ended up to 107.

Although the age range of 8-16 years includes several growth maturation times, it does not cause any problem in this study. The reason is that separate templates are provided for different ages. For example, 8-year-old boys are not mixed with 16-year-old ones, so different growth maturation times do not interfere in the study.

The other issue is different ethnic groups of Tehran's population. Although most of the residents of Tehran immigrated into this city from different parts of Iran, they are so mixed up and cross-married that it is not possible to distinguish clear cut points between these ethnic groups now. So from a racial point of view, Tehran's population is almost uniform now.

Choosing acceptable profiles are an important consideration in developing orthodontic templates. Patient race or ethnicity and sex contribute significantly to the judgments of profile esthetics (11). According to some authors, attractive faces have ideal proportions that are related to the Divine Proportion (1.618:1). However, if the Divine Proportion is to be used to choose acceptable profiles, it should be used along with other factors[12]. Balanced facial profiles are currently used to develop orthodontic templates (13,14). So this approach was used for this study too.

The graphic models resulted from the two coordinate systems are quite similar. This is in accordance with the logics of mathematics. Rotation or translation of the coordinate axes will not affect a template because all the points will move according to the same rule. Besides, the similarities of the two resulted templates confirm the accuracy of the measurements. Therefore, using any other reference line would not affect the final result. The fact that the authors could not commit themselves whether superimposition method 1 or 2 is superior clearly shows the arbitrariness of any superimposition technique - a fact that has already been pointed out by Fred Book stein (15).

This study also showed that the nearer landmarks to the cranial base move less with the increase of the age. This can be a mathematical and not an anatomical result because they are closer to the reference system or may be due to this fact that structures near the cranial base have greater stability in growth.

This template reveals that, during growth and with increasing age, the maxilla moves downward and forward in relation to SN, the mandible rotates clockwise with an increase in body length and ramus height, FH plane has clockwise rotation and occlusal plane rotates counter clockwise. These findings are similar to the Iranian girls' template (8).

Comparing Iranian girls and boys templates shows that both have similar Jarabak Index and approximately equal anterior upper facial height. Overall, boys have bigger face than girls. For example, boys have longer anterior and posterior cranial bases, maxillas, mandibles, anterior lower and posterior facial heights (8).

Similar to Popovich and Broadbent's' findings, almost all the landmarks of the face significantly move forward and downward and the downward movement is usually greater than the forward one (3,7). This is not surprising because all observations concerning growth, in particular the directions of the resulting growth vectors depend on the reference system used. By increasing age, all landmarks in this study and Johnston's template (with one exception), move far from the centre of coordinates (5).

Johnston's template does not evaluate the growth pattern of porion and orbital points, but this study is able to do so (5).

The Jar aback Index was one of the findings that were similar between Iranian and Western population. Superimposing the Johnston's template on Iranian boys' template revealed that posterior cranial base, maxillary and mandibular lengths, upper and lower anterior facial heights (N-ANS and ANS-Me) and posterior facial height (S-Go) are greater in Iranian ones. But anterior cranial base, height and inclination of the incisors and molar height are similar in two populations (5). In conclusion, the template based on PTM reference is relatively in accordance with the template based on S reference. But since S is more easily located and changes less with the growth, the first method seems better and more convenient.

Almost all the landmarks of the face significantly move forward and downward and the downward movement is usually greater than the forward one. Iranian boys template in most of the parameters is similar to the Iranian girls template and Johnston template.

It must be remembered that today's templates show the mean craniofacial changes for different ages for a person who grows normally. So using these templates for growth prediction in skeletal malocclusions is

questionable. It is suggested that different templates be provided for various malocclusions in both sexes.

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