

## Cephalometric norms of Tweed diagnostic facial triangle in North East adolescents of Iran

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### Abstract

**Aim:** There are significant differences in morphological features of various racial and ethnic groups. The purpose of the present study was to identify cephalometric norms of Tweed diagnostic facial triangle in North East adolescents of Iran and to evaluate the effect of sexual dimorphism on cephalometric criteria of this population.

**Materials and methods:** The sample comprised lateral cephalograms taken in natural head position of 40 pupils with normal occlusion (20 girls, 20 boys). Tweed diagnostic triangle was traced on each cephalogram and its angles were measured to the nearest 0.5°. The data were analyzed by SPSS software using independent samples t-tests and Hotelling's test.

**Results:** The lower incisors were significantly more proclined and mandibular plane was significantly steeper in north eastern Iranians compared to Caucasians ( $p < 0.001$ ). The average FMIA angle was significantly smaller than 65° as proposed by Tweed ( $p < 0.001$ ). There was no statistical difference in mean values of the three angles between boys and girls ( $p > 0.05$ ).

**Conclusion:** There are significant differences in cephalometric norms of Tweed triangle between Iranians and Caucasians, showing important implications in orthodontic treatment planning. With respect to the significant differences in cephalometric norms of Iranians and Caucasians, it seems necessary to use standards of each racial group for orthodontic diagnosis and treatment of malocclusions in that population.

**Keywords:** Cephalometry, Tweed triangle, FMA, FMIA, IMPA  
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From the advent of cephalometry nearly 80 years ago, many analyses have been presented by various investigators and have been used extensively in diagnosis and treatment planning of orthodontic abnormalities. A simple, applicable and extremely accurate diagnostic analysis was offered in 1946 by

Tweed<sup>1</sup> as a suitable guide in treatment of malocclusions. Working more than 6 years with nonextraction technique, Tweed was unable in creating harmony and balance in more than a few of his patients. He began analyzing the treatment results and found that in virtually all the patients possessing balance and harmony of facial proportions, mandibular incisors were upright over basal bone. This finding provoked him to secure models and photographs of normal persons without previous orthodontic treatment. The results showed that in the average non-orthodontic normal subject, the inclination of the mandibular incisors is 90° in relation to the mandibular border.<sup>2</sup> He also defined the norm of 25° for the Frankfort mandibular angle and standard of 65° for the Frankfort mandibular

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incisor angle in subjects with facial balance and harmony.<sup>2</sup>

Tweed<sup>1</sup> as a suitable guide in treatment of malocclusions. Working more than 6 years with nonextraction technique, Tweed was unable in creating harmony and balance in more than a few of his patients. He began analyzing the treatment results and found that in virtually all the patients possessing balance and harmony of facial proportions, mandibular incisors were upright over basal bone. This finding provoked him to secure models and photographs of normal persons without previous orthodontic treatment. The results showed that in the average non-orthodontic normal subject, the inclination of the mandibular incisors is 90° in relation to the mandibular border.<sup>2</sup> He also defined the norm of 25° for the Frankfort mandibular angle and standard of 65° for the Frankfort mandibular incisor angle in subjects with facial balance and harmony.<sup>2</sup>

Although orthodontic treatment goals should be individualized and the teeth should be positioned in relation to surrounding structures and environmental factors, it seems reasonable that ideal occlusion as provided by nature could show clearly what might be optimal in treatment of malocclusions.<sup>3</sup> However, there is consensus that it is important to compare patients with a sample of normal occlusion cases that are similar in ethnic origin, age and sex with these patients.

Certainly, it is not reasonable to use Caucasian norms for other populations. Numerous studies have shown racial differences in cephalometric norms of different populations.<sup>4-10</sup> For example, Black population has bi-maxillary dental and skeletal protrusion<sup>11-13</sup>, so it has been suggested that the normal measurements of Downs analysis is not applicable for these subjects.<sup>14</sup> Comparing Iranian and American children with normal occlusion, Riaz Davoodi and Saussoni<sup>15</sup> concluded that Iranians have increased lower anterior face height, bidental protrusion and less overbite compared to Caucasians. The studies of Cooke and Wei on Chinese children showed that these people have bimaxillary dental and skeletal protrusion.<sup>16</sup>

Since the morphological features of various racial and ethnic groups differ significantly, there has been a considerable interest to

determine normative values and ranges of variation about these norms in different population groups. So the purpose of the present study was (1) to define the cephalometric norms of Tweed diagnostic facial triangle in North East adolescents of Iran with normal occlusion and compare findings with the Tweed standards and (2) to evaluate the effect of sexual dimorphism on cephalometric criteria of this population.

#### Materials and methods:

The material contained records of 40 pupils with normal occlusion which were available in archive of Orthodontic Department of Mashhad Dental School. This sample had been selected randomly through random cluster sampling of 1940 middle school children from different areas of Mashhad. The race of these people is probably Mediterranean. The sample included 20 girls (mean age 12 years 4 months) and 20 boys (mean age 13 years 4 months). The criteria for sample selection were as follows: (1) all permanent teeth mesial to the first molars have been erupted, (2) Angle class I molar and canine relationships (bilateral) with well aligned teeth, (3) acceptable facial relationships with normal lip seal, (4) normal overjet and overbite, (5) good health, (6) no history of previous orthodontic treatment. Only negligible rotations and spacing were acceptable.

#### Measurements:

The lateral cephalograms of subjects had been prepared in NHP position with the teeth in centric occlusion. All radiographs were traced on acetate paper. On each tracing, the points Orbitale, Porion and Menton were marked with a sharp pencil by one investigator (S.M) and then checked by the other (M.P). To minimize the error caused by head positioning, the midline of double contour bilateral structures was drawn. Then, Tweed diagnostic facial triangle was traced, as indicated in Fig 1 and the angles of this triangle were measured to the nearest 0.5°. All of the cephalograms were traced by one investigator. To assess intraobserver reliability, 20 cephalograms (10 boys and 10 girls) were selected randomly and traced after 1 week. The results showed excellent agreement of consecutive measurements (ratios of consecutive measurements were equal to 1).

**Statistical analysis:**

Using SPSS, the means, standard deviation, standard error and 95% confidence intervals of FMA, IMPA and FMIA in both sexes were calculated. Independent samples t-tests were used to examine statistically significant differences between the mean values of each variable in Iranian and Caucasian samples. Hotelling's test in Multivariate one way ANOVA was used to study differences between the mean values of boys and girls in all the variables. A 5% (0.05) level was accepted as the level of significance in this study.

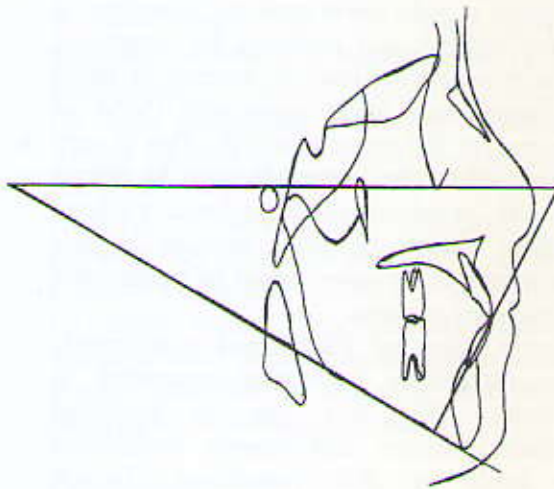


Fig 1. Cephalometric reference points and plans used in the present study.

	Mean	SE	SD	95% Confidence Interval	
				Lower Bound	Upper Bound
FMA	30.1	1.61	9.20	26.8	33.4
IMPA	100.1	1.13	4.76	97.7	102.4
FMIA	49.7	1.89	10.19	45.9	53.5

Table 1: Cephalometric norms of Tweed diagnostic triangle for boys.

	Mean	SE	SD	95% Confidence Interval	
				Lower Bound	Upper Bound
FMA	28.2	1.61	4.38	25	31.5
IMPA	97.7	1.13	5.38	95.4	100
FMIA	53.9	1.89	6.24	50.1	57.8

Table 2: Cephalometric norms of Tweed diagnostic triangle for girls.

**Results:**

The results of angular measurements for boys and girls have been presented in Tables 1 and 2. The lower incisors were significantly more proclined in Iranians than the norm presented by Tweed for Caucasian subjects ( $p < 0.001$ ). The average IMPA in the present study was  $100^\circ$  for and  $97.7^\circ$  for girls. The mandibular plane to FH line was  $30.1^\circ$  for boys and  $28.2^\circ$  for girls. The difference with Caucasian norm was statistically significant ( $p < 0.001$ ). The average FMIA angle was  $49.7^\circ$  for boys and  $53.9^\circ$  for girls, which shows significant differences with  $65^\circ$  norm for FMIA as proposed by Tweed ( $p < 0.001$ ). The results of Hotelling's test showed no statistical difference in mean values of the three angles between boys and girls ( $p > 0.05$ ).

**Discussion:**

In this study, we defined cephalometric norms of Tweed facial diagnostic triangle in North East adolescents of Iran. The results showed that there are significant differences in cephalometric norms of Tweed triangle between Iranians and Caucasians that should be considered during diagnosis and treatment planning of orthodontic patients in this area.

Our samples consisted children with mean age of 12-13 years, since most of the orthodontic patients are in this age range. The cephalograms were taken in natural head position, because it has been shown that this position has a high reliability and increases precision in diagnosis and treatment planning and decreases the probability of errors.<sup>17</sup>

One important point in cephalometric studies is homogeneity of the samples for racial comparison. Some of the previous studies evaluated cephalometric criteria of subjects possessing normal or ideal occlusion<sup>14,18,19</sup>, while other studies such as Bjork's<sup>20</sup> used samples with different types of malocclusion. In this study, we used a sample with normal occlusion because it seems reasonable that people with normal occlusion are better candidates to extract cephalometric norms of each racial group. We selected subjects with similar age range to eliminate contradictory findings due to age variation of subjects which can reduce the reliability of the results.

In this study there was no significant difference in the angular measurements between males and females. Similar finding has been reported by several investigators.<sup>21,22</sup> In contrast the effect of sexual dimorphism on cephalometric norms of different populations has been shown in various studies. For example, some studies demonstrated a tendency to more upright lower incisors in females than in males<sup>15,19,23</sup>, while others reported the reverse finding.<sup>24,25</sup>

The mean value of IMPA in this study showed that the lower incisors were more proclined in the present material compared to Tweed ideal mean value. Similarly, Riaz Davoodi and Sassouni demonstrated a more protrusive face in Iranians compared to Americans which was due to bidental protrusion rather than the skeletal configuration of Iranians<sup>15</sup>. Protrusion and forward inclination of mandibular incisors in subjects with normal occlusion are in good agreement with the results of Park et al. on Korean adults<sup>26</sup>, Ben Bassat et al. on Jewish adolescents<sup>27</sup>, Swlerenga et al. on Mexican adults<sup>9</sup>, Bascifteci et al on Turkish adults<sup>28</sup> and Platou and Zachrisson on Scandinavian children<sup>3</sup>. In comparison, Argyropolis and Saussoni showed that Greek people have

prognathic profile with more lingually positioned mandibular incisors probably due to compensation for prognathic mandible<sup>29</sup>. Similarly, Bjork et al showed IMPA angle of 90° in Swedish 12-13 year old boys.<sup>20</sup>

Today, general population prefers fuller lips and more protrusive facial profile and dentofacial pattern than that suggested by some orthodontic standards.<sup>30,31</sup> There is an increasing concern among clinicians about the risks and disadvantages of excessive profile flattening during orthodontic treatment of growing children.<sup>30,31</sup> According to this background, it is not acceptable to modify lower incisor inclination of Iranians toward Tweed norm and create more upright lower incisors. Therefore, at least for esthetic and probably for functional reasons, it seems desirable to attempt to finish most Iranian orthodontic cases with IMPA of approximately 99° rather than 90°. This is very important when one makes decision to extract some teeth in adolescent orthodontic patients. Inadequate torque of lower incisors in first premolar extraction cases would be undesirable from this point of view.

The mean value of FMIA was significantly smaller in Iranian population compared to Caucasians. This was due to proclined mandibular incisors and steeper mandibular plane angle in this population. Tweed<sup>2</sup> emphasized the importance of the size of FMIA in creating desirable facial esthetics and harmony of lower face in orthodontic patients. He observed that the values of FMIA in well treated orthodontic subjects were very similar. Consequently, he evaluated 100 subjects with balance and harmony of facial esthetics and found that those samples whose Frankfort mandibular angles were higher than 30°, demonstrated natural compensation in lower incisors inclinations, which maintained FMIA around the norm of 65°.

The mean value of FMA in this study was significantly higher than the norm of Caucasians as presented by Tweed. This indicates slight backward rotation of mandible in our cases. This finding corroborates the results of a previous study that showed downward growth of the mandible and excessive lower anterior face height in Iranians compared to American Caucasians.<sup>15</sup> Large FMA and excessive lower

anterior face height on excellent occlusion cases has been reported in several studies.<sup>28,32</sup>

Tweed<sup>2</sup> found less need for extraction when FMA was 16° to 25°. According to him, when FMA was more than 30°, there would be a need for lingual compensation of the lower incisors which decreased arch length and generally made it necessary to extract some teeth. Similarly, Hasund and Boe<sup>33</sup> stated that satisfactory guidance for the position of lower incisors must also take the vertical dimension into account.

It should be emphasized that differences in the cephalometric norms of Iranians compared to Caucasians is a normal occurrence and does not in itself imply any need for orthodontic treatment, unless it is accompanied by dental irregularities or malocclusions. It is important for those performing orthodontic treatment of Iranian children to use cephalometric norms of this population.

Finally, it should be emphasized that cephalometry is more an art than the science and esthetics of the face should not be judged only by numeric values. Therefore, the cephalometric norms of each population should be used as a general guideline in diagnosis and treatment planning of orthodontic patients.

#### Conclusions:

- 1-There were significant differences in cephalometric norms of Tweed triangle between Iranians and Caucasians. North East Iranians have more prominent mandibular incisors, larger FMA and consequently smaller FMIA compared to Caucasians.
- 2-There was no significant difference in cephalometric norms of Tweed triangle between Iranian boys and girls, showing that the effect of sexual dimorphism can be ignored in cephalometric criteria of this population.
- 3-The significant differences in cephalometric norms between Iranians and Caucasians show that it is necessary to use standards of each racial group for orthodontic diagnosis and treatment of malocclusions in that population.

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