Soft-tissue cephalometric norms for a sample of Iraqi adults with class I normal occlusion in natural head position

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ABSTRACT

Background: The purposes of this study were to establish the cephalometric norms for Iraqi adults with normal occlusion and well-balanced faces for both genders using Arnett et al. (2011) analysis, to establish the mean values of (the dentoskeletal factor, the soft tissues structures, the facial length, true vertical line (TVL) projection and the harmony values measurements) and to verify the existence of gender difference.

Materials & methods: 60 Iraqi adult subjects (30 males and 30 females) with an age ranged between 18-25 years having normal occlusion and well-balanced face were chosen for this study. Each individual was subjected to clinical examination and digital true lateral cephalometric X-ray in the natural head position which is mirror position in which the patient looking straight into his eyes into the mirror mounted on the stand. The radiographs were analyzed using AutoCAD program 2007 to measure the distances and angles used in the Soft Tissue Cephalometric Analysis. Descriptive statistics was obtained for the measured variables for both genders and independent samples t-test was performed to evaluate the genders difference.

Results & Conclusions: The results indicated that: females have high mean value of the angle between the maxillary occlusal plane and TVL, increase in upper lip angle more than males. The males have thicker upper & lower lips, more soft tissue chin thicknesses, higher mean value of the facial height, lower third of the face height, upper & lower lip length, mandibular height, the projection of the maxillary & mandibular central incisor crown tip, soft tissue B & A, nasal tip projection on the TVL and backward position of point Pog', and point B' than female.

Key words: Soft-tissue cephalometric analysis, class I normal occlusion, natural head position. (J Bagh Coll Dentistry 2011;23(3): 160-166).

INTRODUCTION

A commonly used craniofacial reference plane is sella-nasion, SN, while this plane is reliable and, by representing the anterior cranial base, is biologically meaningful it has been illustrated to have large inter-individual standard deviations when related to vertical (VER). The use of SN as a plane of reference has questionable validity (2).

Another reference plane in widespread use is Frankfort Horizontal, FH, as it may produce the most acceptable estimation of HOR. The Frankfort horizontal supposedly yields maximal differences in the configuration of the cranium between racial groups and smallest variability within each group. (3)

Since intracranial landmarks are not stable points in the cranium, their vertical relationship to each other is therefore also subject to biologic variation(e.g. sella to nasion, porion to orbitale). (4,5)

Natural head position (NHP) was introduced into orthodontics in the late 1950 (3,4,6). Broca (7) defined this head position as “when man is standing and his visual axis is horizontal, he is in the natural position”.

A typical method of registering natural head position is based on Solow and Tallgren’s work in which subjects are asked to stand in “orthoposition” and look into their own eyes in a mirror after a series of neck flexion exercises (8).

Several lines and angles have been used to evaluate soft tissue facial esthetics. The Riedel plane and the Steiner aesthetic plane have been used to describe the facial profile (9,10).

Arnett et al. (1) introduced a new soft tissue cephalometric analysis tool. This analysis may be used by the orthodontist and surgeon as an aid in diagnosis and treatment planning.

The analysis is a radiographic instrument that was developed directly from the philosophy expressed in Arnett and Bergman “Facial keys to orthodontic diagnosis and treatment planning, Parts I and II” The novelty of this approach, as with the “Facial Keys” articles, is an emphasis on soft tissue facial measurement (11,12).

MATERIALS AND METHODS

The Sample

Out of 125 clinically and radiographically examined subjects, only 60 subjects (30 females and 30 males) fulfilled the inclusion criteria. The sample included undergraduate students in the College of Dentistry, University of Baghdad and some students from nursing secondary in the medical city. All of them were Iraqis Arabs with
an age ranged between 18-25 years. According to Arnett et al. (1), Kalha et al. (13), Uysal et al. (14), Lalitha & Kumar (15) the following criteria were used in the selection of the total sample:

1. Full permanent dentition regardless the third molars.
2. No history of previous orthodontic treatment.
3. No history of facial trauma or craniofacial disorder, such as cleft palate.
4. Class I occlusion with normal overjet and overbite (2-4 mm).
5. Acceptable facial profile
6. Bilateral Class I buccal segments "molar and canine" (16).
7. Skeletal Class I relationship determined clinically by the two fingers method (17) and radiographically by measuring the ANB angle (18).
8. Minor or no spacing or crowding. (19).

The Equipment
1. X-Ray Unit.
2. Analyzing Equipments
   a) Pentium IV portable computer.
   b) Analyzing software (AutoCAD 2007).

The method
Each individual was seated on a dental chair and asked information about name, age, origin, history of facial trauma and previous orthodontic treatment.

Clinical Examination
1. Assessment of the anteroposterior skeletal relationship.
2. Assessment of the dental relationship
3. Measurement of the Overjet

Lateral Cephalometric Exposure (User’s Manual, 2004): In Natural Head Position
For the cephalometric profile recordings, the subject stands relax in natural head position which is mirror position which involved each subject performing a series of neck-bending exercises, by incline his head up and down in increasingly smaller movements until they feel comfortably positioned before Lateral Cephalometric Exposure (8), (Fig.1).

The patient after that looking straight into his eyes into mirror mounted on the stand 20 X 100 cm, 137 cm in front of the plane of the ear rods (8).

A freely suspended chain was mounted in front of the nasal rod of the cephalostate unite to represent the True Vertical Line (TVL) which the extra-cranial reference line of the cephalometric radiographs (20), (Fig. 1).

The body posture was controlled and the subject was asked to assume a convenient head position while looking straight into his eyes in the mirror. After adjustment of the cephalometer the ear and nasal rods were inserted. Each subject was then instructed to keep their teeth lightly closed together (8).

Figure 1: Subject in the cephalostat in natural head position

Cephalometric Analysis
Every lateral cephalometric radiograph was analyzed by AutoCAD program to calculate the linear and angular measurements
The TVL was positioned through subnasale and was perpendicular to the natural horizontal head position (21).

Firstly, the ANB angle was measured to confirm that the subjects had Class I skeletal relationship. Then, Arnett et al. (1) soft tissue cephalometric analysis was used to diagnose the subjects in five different but interrelated areas; dentoskeletal factors, soft tissue components, facial lengths, TVL projections, and harmony of parts.

Cephalometric Landmarks (Figure 2):
1. Point G’ (glabella).
2. Point N (Nasion).
3. Point Na’ (Nasion soft tissue).
4. Point NT (Nasal tip).
5. Point cm (Columella).
6. Point A’ (soft tissue A).
7. Point ULA (upper lip anterior).
8. Point ULI (Upper labial inferior).
9. Point LLS (Lower labial superioris).
11. Point B’ (soft tissue B).
12. Point Pog’ (soft tissue pogonion).
13. Point Me’ (Menton soft tissue).
14. Point NTP (neck-throat point)
15. Point Me (hard tissue menton)
16. Point Pog (hard tissue pogonion).
17. Point Ap 1 (Apicale 1).
18. Point B (Supramentale).
19. Point lower lip inside (LL inside).
20. Point Is (Incisor superius).
22. Point II or (Md1), (Incisor inferius).
23. Point L6 (mandibular first molar).
24. Point U6 (maxillary first molar).
26. Point A (Subspinale).

According to Arnett et al. the following measurements were obtained. These measurements were grouped into:

1. **Dentoskeletal factors measurements**; include the following measurements (Fig. 3):
   a. Upper incisor to maxillary occlusal plane (Mx 1- Mx OP).
   b. Lower incisor to mandibular occlusal plane (Md 1- Md OP)
   c. Maxillary occlusal plane (Mx OP-TVЛ).

2. **Soft tissue structures measurements**; include the following measurements (Fig. 4.):
   a. Tissue thickness at upper lip.
   b. Tissue thickness at lower lip.
   c. Tissue thickness at Pogonion (Pog- Pog’).
   d. Tissue thickness at Menton (Me- Me’). Upper lip angle
   e. Naso-labial angle.

**Facial lengths measurements:** include the following measurements; (Figure 5)
1. Facial height
2. Lower one-third height (Lower 1/3 height).
3. Upper lip length (ULL)
4. Lower lip length (LLL)
5. Inter-labial gap (ILG).

Maxillary incisor exposure (Mx 1 exposure).
6. Maxillary incisor exposure
7. Maxillary height (Mx height)
   Mandibular height (Md height).

**4. True vertical line (TVL) projection measurements:** These include the following measurements (Figure 6.):
1. Glabella point projection.
2. Nasal tip point projection.
3. Soft tissue A’ (point A’ projection).
4. Upper lip anterior (ULA) point projection:
5. Lower lip anterior (LLA) point projection:
6. Soft tissue B’ (point B’ projection):
7. Soft tissue Pogonion’ (point Pog’ projection):
8. Soft tissue Subnasale (point Sn projection).
9. Upper incisor tip measured to TVL (Mx1 projection):
10. Lower incisor tip measured to TVL (Md1 projection).

**Figure 6: True vertical line (TVL) projection measurements**

5. Harmony values measurements: In which there are three types of measurements:
   a. Intra-mandibular relations
      (1) Md1-Pog’.
      (2) LLA-Pog’
      (3) B’-Pog’
      (4) Throat length (NTP to Pog’).

   b. Inter-jaw relations
      (1) Sn-Pog’
      (2) A’-B’
      (3) ULA-

   c. Full facial harmony
      (1) Facial angle.
      (2) G’-A’.
      (3) G’-Pog’

**Figure 7: (A), (B) and (C) Harmony values measurements.**

**RESULTS AND DISCUSSION**

Arnett et al. (1) soft tissue cephalometric analysis was used to diagnose the subjects in five different but interrelated areas; dentoskeletal factors, soft tissue components, facial lengths, TVL projections, and harmony of parts.

All subjects were within normal range of antero-posterior skeletal relationship (ANB angle for male is: 3.05 ± 0.88, for female is : 3.07 ± 0.94 and total: 3.06 ± 0.91).

This study is the first study established in Iraq as a cephalometric study by the Natural head position method and Arnett et al (1).

Soft tissue cephalometric analysis is the first time used. The sexual differences are due to the influence of the sex hormones on the facial contour, which become very evident by adolescence. The male bony structure is bolder more prominent, with dominance of the forehead, nose, chin and stronger contour of the mandible (22). This comes with the general trend of males.
having greater measurements than females, this is because males have longer growth period.

This comes with the general trend of males having greater measurements than females, this is because males have longer growth period than females (23-25).

From the results in table 1, for dentoskeletal factors it has been shown that the mean value of the angle between the maxillary occlusal plane and TVL shows significant genders difference; this comes in agreement with Kalha et al. (15), although the results of the present study indicates higher mean value in females than males, while this disagrees with Arnett et al. (1), Uysal et al. (14) and Lalitha and Kumar (13) who found non-significant differences between both sexes.

All remaining parameters measured, maxillary central incisor to occlusal plane and mandibular central incisor to occlusal plane do not show statistically significant differences between males and females in our study and this agrees with Arnett et al. (1), Kalha et al. (15), Uysal et al. (14) and Lalitha and Kumar (13).

Generally, the sample in this study in comparison with other ethnic groups have slight proclined upper central incisors and slight retroclined lower central incisors this may be due to difference in sample size or due to ethnic factor.

The findings of the present study for the soft tissue factors as it is show in the table 1, indicated that there is significant differences between the sexes; males have higher mean values for upper lip thickness, lower-lip thickness, pogonion-pogonion’, and menton-menton’, this indicates that the males have thicker upper and lower lips and soft tissue chin, this comes in agreement with Arnett et al. (1), Kalha et al. (13), Uysal et al. (14) and Lalitha and Kumar (15). The mean value of naso-labial angle is higher in males, due to more anterior position of the point upper lip anterior, with a non-significant difference between the sexes; this comes in agreement with Arnett et al. (1), Uysal et al. (14) and Lalitha and Kumar (15), while disagrees with Kalha et al. (13) who found significant difference between both sexes with a higher mean value in females. The upper lip angle shows significant higher mean value in females than males due to more anterior position of the point upper lip anterior in females; this comes in accordance with Arnett et al. (1) while disagrees with Kalha et al. (13), Uysal et al. (14) and Lalitha and Kumar (15) who found a non-significant genders difference.

In comparison with Arnett et al. (1), in this study, the upper and lower lips and soft tissue chin thicknesses are thinner than that of Arnett et al. (1) and nearly the same to that of Kalha et al. (13) this may be attributed to the ethnic factor or sample size.

From the results in table 1, for the facial lengths it is clear that the mean values of facial height, lower third of the face, upper lip length, lower lip length and mandibular height are greater significantly in males than in females; this comes in agreement with Al-Taani (26) for only the mean values of facial height, lower third of the face, upper lip length which are larger in male than female and Nasir (27), Rasheed (28) for only total facial height all above comes in agreement with Arnett et al. (1), Kalha et al. (13), Uysal et al. (14), and Lalitha and Kumar (15). On the other hand, the inter-labial gap shows non-significant genders difference; this comes in accordance with Uysal et al. (14), while disagrees with Arnett et al. (1), Kalha et al. (13) and Lalitha and Kumar (14). These studies share in the same results that the mean value of inter-labial gap is higher in females than males, while the maxillary central incisos exposure show significantly difference in females than males this come in agree with Arnett et al. (1) and Kalha et al. (13) and disagree with Uysal et al. (14) who show very highly significant difference in females than males and Lalitha and Kumar (15) who show non significant difference between both genders. In comparism with other studies, all of the parameters are lower than Arnett et al. (1), Kalha et al. (13), Uysal et al (14) and Lalitha and Kumar (15), this may be attributed to the ethnic factor or sample.

The findings of the present study for the TVL projections as it is show in the table 1. The maxillary height shows non-significant genders difference; this comes in agreement with Kalha et al. (13) and Lalitha and Kumar (15) and disagree with Arnett et al. (1) and Uysal et al. (14).

The males show significant higher mean values regarding the projection of the maxillary central incisor crown tip, and mandibular central incisor crown tip on the TVL; this comes in agreement with Arnett et al. (1), Kalha et al. (13), Uysal et al. (14) and Lalitha and Kumar (15). The distance between maxillary incisor crown tip and TVL is more in males due to the increase of the angle between the maxillary occlusal plane and maxillary central incisor in males as previously discussed in dentoskeletal factor.

The projection of upper and lower lip anterior, glabella, soft tissue pogonion and subnasale on the TVL show non-significant genders difference, this agrees with Arnett et al. (1) and Uysal et al. (14), while disagrees with
Kalha et al. (13) who found significant genders differ.

Generally; the sample in this study in comparison with other ethnic groups have retruded soft tissue pogonion point and soft tissue B point this may be attributed to the ethnic factor or sample size.

From the results in table 1 for the Harmony values it has been shown that the distance between LLA-Pog', NTP- Pog', Sn-Pog', ULA-LLA, G'-A', G'- Pog' and facial angle show non-significant difference between both genders; this comes in agreement with Arnett et al. (14), Kalha et al. (13), Uysal et al. (14) and Lalitha and Kumar (15). Generally, the males have backward position of point B' in comparison with females. Generally; the sample in this study in comparison with other ethnic groups has slightly protrusive lower lip.

**Table 1:** The mean values, standard deviations and genders difference for dentoskeletal factors, soft tissue components, facial lengths, TVL projections, and harmony of parts of the present study

<table>
<thead>
<tr>
<th>Variables</th>
<th>Males (N=20)</th>
<th>Females (N=26)</th>
<th>Genders difference</th>
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<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>S.D</td>
<td>Mean</td>
</tr>
<tr>
<td>Mx 1-Mx OP</td>
<td>59.52</td>
<td>5.22</td>
<td>57.53</td>
</tr>
<tr>
<td>Md 1-Md OP</td>
<td>61.08</td>
<td>5.94</td>
<td>62.47</td>
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<tr>
<td>Max OP-TVL</td>
<td>95.64</td>
<td>4.13</td>
<td>97.9</td>
</tr>
<tr>
<td>Upper lip thickness</td>
<td>13.57</td>
<td>1.5</td>
<td>12.29</td>
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<tr>
<td>Lower lip thickness</td>
<td>14.26</td>
<td>1.38</td>
<td>12.18</td>
</tr>
<tr>
<td>Pog-Pog'</td>
<td>12.89</td>
<td>1.71</td>
<td>11.87</td>
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<tr>
<td>Me-Me'</td>
<td>9.09</td>
<td>1.34</td>
<td>7.43</td>
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<tr>
<td>Naso-labial angle</td>
<td>106.88</td>
<td>10.06</td>
<td>103.37</td>
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<tr>
<td>Upper lip angle</td>
<td>5.56</td>
<td>6.97</td>
<td>10.1</td>
</tr>
<tr>
<td>Facial height</td>
<td>121.84</td>
<td>6.91</td>
<td>114.1</td>
</tr>
<tr>
<td>Lower 1/3 space</td>
<td>68.63</td>
<td>4.21</td>
<td>63.03</td>
</tr>
<tr>
<td>Upper lip length</td>
<td>20.4</td>
<td>2.21</td>
<td>18.13</td>
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<tr>
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<td>47.35</td>
<td>3.08</td>
<td>43.45</td>
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<td>Inter-incisal gap</td>
<td>0.73</td>
<td>0.23</td>
<td>0.9</td>
</tr>
<tr>
<td>Mx1 exposure</td>
<td>2.33</td>
<td>1.26</td>
<td>3.09</td>
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<td>Mx height</td>
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<td>21.65</td>
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<tr>
<td>Md height</td>
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<td>3.24</td>
<td>44.38</td>
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<tr>
<td>Glabella</td>
<td>9.94</td>
<td>5.41</td>
<td>-9.74</td>
</tr>
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<td>Nasal projection</td>
<td>16.2</td>
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<td>A'</td>
<td>-0.61</td>
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<tr>
<td>B'</td>
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<td>Pog'</td>
<td>-6.62</td>
<td>2.89</td>
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<td>Sn</td>
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<td>0</td>
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<tr>
<td>Mx1</td>
<td>-11.7</td>
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<td>Md1</td>
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<td>1.33</td>
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<td>8.94</td>
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<td>5.59</td>
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<td>5.38</td>
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<td>B'-Pog'</td>
<td>3.28</td>
<td>1.66</td>
<td>1.84</td>
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<td>51.86</td>
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<tr>
<td>Sn-Pog'</td>
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<td>2.89</td>
<td>6.28</td>
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<td>A'-B'</td>
<td>9.24</td>
<td>1.94</td>
<td>7.85</td>
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<tr>
<td>ULA-LLA</td>
<td>2.39</td>
<td>1.34</td>
<td>2.54</td>
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<td>Facial angle</td>
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<td>G'-Pog'</td>
<td>4.99</td>
<td>5.61</td>
<td>4.56</td>
</tr>
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</table>

The males show significantly higher mean values in the distance between Md1-Pog', B'-Pog' and A'-B' than females. The last variable is higher in male due to increase the distance of mean value of the angle between the maxillary occlusal plane and TVL shows significant genders difference; this comes in agreement with Kalha et al. (13), although the results of the present study indicates higher mean value in females than males, while this disagrees with Arnett et al. (14), Uysal et al. (14) and Lalitha and Kumar (15) who found non-significant differences between both sexes. Generally; the sample in this study in comparison with other ethnic groups has slightly protrusive lower lip.

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