Evaluation of Facial Soft Tissue Thickness in Normal Adults with Different Vertical Discrepancies

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Abstract: This study aimed to evaluate and compare the soft tissue facial thickness among different vertical skeletal relations in Iraqi normal adults, and to verify the presence of gender difference. Sixty true lateral cephalometric radiographs for Iraqi adults with normal dental, sagittal and transverse skeletal relations were selected from the archive of the Orthodontic department in the College of Dentistry, University of Baghdad. Using SN-MP angle, the sample was divided into three groups each with twenty (10 males and 10 females). The soft tissue facial thickness was measured at different points using AutoCAD program. Gender difference was evaluated by independent sample t-test, while difference among the various vertical relations was determined by one-way ANOVA then Tukey HSD test. Generally, males had thicker soft tissue than females and low angle groups possessed thicker soft tissue in comparison with high and normal angle groups especially in male group.

Keywords: Face, soft tissue thickness, cephalometrics

1. Introduction

One of the main objectives of orthodontic treatment is to achieve and conserve best possible facial beauty. To attain this, it's imperative that the orthodontist perform a thorough facial examination [1]. Faces can be classified in the vertical dimension into high, low and normal angle groups. The types of faces are influenced by the vertical growth patterns, presence of bad oral habits, development of alveolar processes, eruption of teeth and the action of the soft tissues (lips, cheek and tongue) [2].

The soft tissue covering the face including the muscles may develop in proportion or disproportionate to the underlying skeletal structures [3]. Facial esthetics can be affected by the variation of these tissues with regard to their thickness, length, and tonicity [4]. Such difference between skeletal and soft tissues can cause a disassociation between the position of the underlying bony structures and the facial appearance that may alter treatment into the range of orthognathic and cosmetic surgery, so assessment of soft tissue thickness was performed in normal individuals [5]-[9], among different skeletal [10]-[17], and occclusal relations [18].

The purpose of the current study was to investigate and compare the soft tissue thickness among different vertical skeletal relations in Iraqi normal adults, and to verify the presence of any sexual dimorphism.

2. Materials and Methods

Materials
A total of 60 true lateral cephalometric radiographs belong to Iraqi adult dental students with an age ranged between 18-25 years were selected for this study.

All of the students had full complement of permanent teeth, class I sagittal and transverse skeletal and dental relations with the ANB angle (2º-4º) and Class I molar and canine classifications [19]. Subjects who had any facial asymmetry, history of any orthodontic treatment, mouth breathing or tongue thrusting, facial anomalies and maxillary sinus pathology were excluded from the study.

The samples were divided based on the vertical jaws relation using SN-mandibular plane angle [20] into three groups each with 20 subjects (10 males, 10 females).

Subjects with SN-MP angle measured 28 to 36.5º were included in group 1 (Normal angle); subjects in whom SN-MP angle measured >36.5º were included in group 2 (High angle group) and those had SN-MP angle measured <28º were included in group 3 (Low angle).

Methods
After taking student approval, clinical examination was done then standardized digital true lateral cephalometric radiographs were taken using Planmeca ProMax Dimax3 X-ray unit.

All cephalometric radiographs were analyzed using AutoCAD program (2015) and the linear measurements were divided by scale in the nasal rod to overcome the magnification.

Skeleto-dental Cephalometric Landmarks [21]-[23]

The following landmarks were identified:
[1] Point S (Sella): The midpoint of the hypophysial fossa.
[2] Point N (Nasion): The most anterior point on the nasofrontal suture in the median plane.
[3] Point G (Glabella): The most prominent point of the bony forehead in the median plane.
[4] Point Go (Gonion): A point on the curvature of the angle of the mandible located by bisecting the angle formed by the lines tangent to the posterior ramus and inferior border of the mandible.
[5] Point Me (Menton): The lowest point on the symphysial shadow of the mandible seen on a lateral cephalogram.
[6] Point Pog (Pogonion): The most anterior point of the bony chin in the median plane.

[7] Point A (Subspinale): The deepest midline point in the curved bony outline from the base to the alveolar process of the maxilla.

[8] Point B (Supramentale): It is the most posterior point in the outer contour of the mandibular alveolar process in the median plane.

[9] Point Pr (Prosthion): The alveolar rim of the maxilla; the lowest most anterior point on the alveolar portion of the premaxilla in the median plane between the upper central incisors.

[10] Point Id (Infradentale): The alveolar rim of the mandible; the highest most anterior point on the alveolar process in the median plane between the mandibular central incisors.

[11] Point U1: The most anterior prominent point on the crown of the most anterior maxillary central incisor.

[12] Point ANS (Anterior Nasal Spine): It is the tip of the most anterior maxillary central incisor.

[13] Point PNS (Posterior Nasal Spine): This is a constructed radiological point, the intersection of a continuation of the anterior wall of the pterygopalatine fossa and the floor of the nose.

[14] Point Is (Incisor superius): The tip of the crown of the most anterior maxillary central incisor.

[15] Point Ii (Incisor inferius): The tip of the crown of the most anterior mandibular central incisor.


Soft Tissue Landmarks [21]-[23]

[1] Point g (soft tissue glabella): The most prominent point in the midsagittal plane of forehead.

[2] Point n (soft tissue nasion): The most posterior point at the root of the nose in the median sagittal plane.

[3] Point sn (subnasale): It is the point where the lower border of the nose meets the outer contour of the upper lip.

[4] Point ls (labrale superius): It is the median point in the upper margin of the upper membranous lip.


[6] Point li (labrale inferius): It is the median point in the lower margin of the lower membranous lip.

[7] Point sm (submentale): The point of greatest concavity in the midline of the lower lip between labrale inferius and pog.

[8] Point pog (soft tissue pogonion): The most anterior prominent point on the chin in the median sagittal plane.

[9] Point me (soft tissue menton): The constructed point of intersection of a vertical co-ordinate from menton and the inferior soft tissue contour of the chin.

Cephalometric planes [21]-[23]

[1] Sella-Nasion (SN) plane: It is the anteroposterior extent of anterior cranial base.


[4] N-A line: Formed by a line joining Nasion and point A.

[5] N-B line: Formed by a line joining Nasion and point B.


Cephalometric Angular measurements [21]-[23]

[1] SNA angle: Angle formed between lines SN and NA.

[2] SNB angle: Angle formed between lines SN and NB.

[3] ANB angle: Differences between SNA and SNB.


[7] L1-MP angle: That angle formed by the long axis of the most labial mandibular incisor to the mandibular plane, posteriorly.

Cephalometric Linear measurements [16]-[18] (Figure 1)

[1] G-g: The linear distance from the most prominent point on the frontal bone to the soft tissue prominence on the forehead.

[2] N-n: Distance from point Nasion to soft tissue nasion.


[5] Pr-Ia: Distance between Prosthion and labrale superius.

[6] Sto-U1: Distance between stomion and the most prominent point of the crown of upper incisor.

[7] Id-li: Distance between infradentale and labrale inferius.

[8] B-sm: Distance from point B to submentale.


Figure 1: Some landmarks and measurements [16]

Statistical analyses

Data were statistically analyzed using Statistical Package for the Social Sciences SPSS software (version 21). Statistical analyses comprised descriptive statistics that included means, standard deviations of all variables and inferential statistics that consisted of independent sample t-test to verify the gender difference, one way ANOVA test to verify the groups' difference and Tukey honestly significant difference (HSD) test to compare between each two groups if ANOVA gives statistically significant difference.
3. Results

The descriptive statistics of the sagittal and vertical jaw relations in addition to the inclinations of the maxillary and mandibular incisors in different groups were presented in table 1. Generally, the positions of maxilla and mandible to the cranial base were retruded in high angle group and just the reverse for low angle group. The incisors were also retrTO.1 in high angle group in comparison with low and normal angle groups.

Table 2 demonstrated the descriptive statistics and genders difference for all measurements. Generally, males had thicker soft tissue than females with variable degree of significance; mostly seen in normal and low angle groups.

Table 3 showed the groups' difference in both genders. In males, there was six variables revealed significant difference in reverse to females where there was non-significant groups' difference. Comparing each two groups in male sample was presented in table 4. Most of the difference found between the high and low angle groups.

Table 1: Descriptive statistics of skeletal and dental parameters

<table>
<thead>
<tr>
<th>Variables (°)</th>
<th>Males</th>
<th>Females</th>
<th>Males</th>
<th>Females</th>
<th>Males</th>
<th>Females</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>SN-MP°</td>
<td>31.30</td>
<td>4.80</td>
<td>30.60</td>
<td>5.06</td>
<td>23.40</td>
<td>2.63</td>
<td>28.40</td>
<td>2.09</td>
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<tr>
<td>ANB°</td>
<td>3.40</td>
<td>0.84</td>
<td>3.94</td>
<td>0.94</td>
<td>2.70</td>
<td>0.67</td>
<td>2.70</td>
<td>0.67</td>
</tr>
<tr>
<td>SNA°</td>
<td>81.80</td>
<td>1.93</td>
<td>77.10</td>
<td>2.69</td>
<td>85.30</td>
<td>2.58</td>
<td>85.30</td>
<td>2.58</td>
</tr>
<tr>
<td>SNB°</td>
<td>78.10</td>
<td>1.85</td>
<td>74.20</td>
<td>2.45</td>
<td>82.80</td>
<td>2.35</td>
<td>82.80</td>
<td>2.35</td>
</tr>
<tr>
<td>SN-Pog°</td>
<td>79.70</td>
<td>1.72</td>
<td>75.70</td>
<td>2.21</td>
<td>84.10</td>
<td>2.02</td>
<td>84.10</td>
<td>2.02</td>
</tr>
<tr>
<td>U1-PP°</td>
<td>111.40</td>
<td>6.95</td>
<td>109.20</td>
<td>8.59</td>
<td>113.40</td>
<td>8.35</td>
<td>113.40</td>
<td>8.35</td>
</tr>
<tr>
<td>L1-MP°</td>
<td>98.50</td>
<td>5.40</td>
<td>90.50</td>
<td>5.17</td>
<td>102.30</td>
<td>4.00</td>
<td>102.30</td>
<td>4.00</td>
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</tbody>
</table>

Table 2: Descriptive statistics and genders for soft tissue thickness in different groups

<table>
<thead>
<tr>
<th>Groups</th>
<th>Variables (mm.)</th>
<th>Males</th>
<th>Females</th>
<th>Males</th>
<th>Females</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>G-g</td>
<td>6.30</td>
<td>1.17</td>
<td>5.89</td>
<td>1.08</td>
<td>0.838</td>
<td>0.413</td>
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<tr>
<td></td>
<td>N-n</td>
<td>6.55</td>
<td>1.37</td>
<td>5.98</td>
<td>1.06</td>
<td>1.038</td>
<td>0.313</td>
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<tr>
<td></td>
<td>Rh</td>
<td>2.94</td>
<td>0.42</td>
<td>2.40</td>
<td>0.52</td>
<td>2.540</td>
<td>0.021</td>
</tr>
<tr>
<td></td>
<td>A-sn</td>
<td>16.63</td>
<td>1.28</td>
<td>14.36</td>
<td>1.40</td>
<td>3.778</td>
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<td></td>
<td>Pr-Iṣ</td>
<td>14.47</td>
<td>1.76</td>
<td>11.92</td>
<td>1.74</td>
<td>3.262</td>
<td>0.004</td>
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<tr>
<td></td>
<td>S-Ul</td>
<td>6.25</td>
<td>2.24</td>
<td>4.29</td>
<td>1.23</td>
<td>2.535</td>
<td>0.021</td>
</tr>
<tr>
<td></td>
<td>Id-li</td>
<td>15.13</td>
<td>0.89</td>
<td>13.80</td>
<td>0.76</td>
<td>5.598</td>
<td>0.002</td>
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<tr>
<td></td>
<td>B-sm</td>
<td>11.90</td>
<td>1.31</td>
<td>11.15</td>
<td>1.11</td>
<td>3.820</td>
<td>0.184</td>
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<tr>
<td></td>
<td>Pog-pog</td>
<td>13.70</td>
<td>1.95</td>
<td>11.24</td>
<td>1.70</td>
<td>2.998</td>
<td>0.008</td>
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<tr>
<td></td>
<td>Me-mo</td>
<td>9.10</td>
<td>1.30</td>
<td>7.24</td>
<td>1.83</td>
<td>2.619</td>
<td>0.017</td>
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<tr>
<td>High</td>
<td>G-g</td>
<td>3.60</td>
<td>0.86</td>
<td>3.55</td>
<td>0.59</td>
<td>0.750</td>
<td>0.463</td>
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<tr>
<td></td>
<td>N-n</td>
<td>6.11</td>
<td>0.88</td>
<td>4.84</td>
<td>1.05</td>
<td>2.594</td>
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<tr>
<td></td>
<td>Rh</td>
<td>2.87</td>
<td>0.59</td>
<td>2.01</td>
<td>0.51</td>
<td>3.469</td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td>A-sn</td>
<td>16.09</td>
<td>1.43</td>
<td>14.95</td>
<td>1.17</td>
<td>1.945</td>
<td>0.068</td>
</tr>
<tr>
<td></td>
<td>Pr-Iṣ</td>
<td>14.32</td>
<td>1.33</td>
<td>12.29</td>
<td>1.81</td>
<td>2.849</td>
<td>0.011</td>
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<tr>
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<td>S-Ul</td>
<td>3.44</td>
<td>0.86</td>
<td>3.15</td>
<td>1.90</td>
<td>2.620</td>
<td>0.006</td>
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<tr>
<td></td>
<td>Id-li</td>
<td>16.35</td>
<td>1.35</td>
<td>13.95</td>
<td>1.55</td>
<td>3.147</td>
<td>0.006</td>
</tr>
<tr>
<td></td>
<td>B-sm</td>
<td>11.85</td>
<td>2.01</td>
<td>10.61</td>
<td>1.49</td>
<td>5.566</td>
<td>0.135</td>
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</table>

Table 3: Groups' difference in each gender

<table>
<thead>
<tr>
<th>Variables (mm.)</th>
<th>Groups</th>
<th>Males</th>
<th>Females</th>
<th>Mean difference</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>G-g</td>
<td>Normal</td>
<td>2.01</td>
<td>0.285</td>
<td>0.779</td>
<td>0.040</td>
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<tr>
<td>N-n</td>
<td>7.17</td>
<td>3.22</td>
<td>6.54</td>
<td>2.71</td>
<td>0.808</td>
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<tr>
<td>Rh</td>
<td>3.19</td>
<td>0.82</td>
<td>2.41</td>
<td>0.70</td>
<td>2.305</td>
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<tr>
<td>A-sn</td>
<td>17.48</td>
<td>0.80</td>
<td>15.32</td>
<td>1.23</td>
<td>4.654</td>
</tr>
<tr>
<td>Pr-Iṣ</td>
<td>17.40</td>
<td>1.31</td>
<td>13.36</td>
<td>0.72</td>
<td>8.536</td>
</tr>
<tr>
<td>S-Ul</td>
<td>7.75</td>
<td>1.77</td>
<td>4.49</td>
<td>1.30</td>
<td>4.684</td>
</tr>
<tr>
<td>Id-li</td>
<td>17.18</td>
<td>1.40</td>
<td>13.71</td>
<td>1.15</td>
<td>6.064</td>
</tr>
<tr>
<td>B-sm</td>
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<td>1.51</td>
<td>10.23</td>
<td>1.08</td>
<td>3.240</td>
</tr>
<tr>
<td>Pog-pog</td>
<td>13.96</td>
<td>1.58</td>
<td>11.07</td>
<td>1.87</td>
<td>3.722</td>
</tr>
</tbody>
</table>

4. Discussion

This study aimed to evaluate the soft tissue thickness of the face in a sample of Iraqi adults with normal dental, sagittal and transverse jaw relations and different vertical patterns.

Generally, all the skeletal and dental measurements tend to be high in low angle groups followed by the normal angle then the high angle group, so the jaws bases tend to be retruded in high angle in comparison with the normal group. The same is true for the inclinations of the maxillary and
mandibular incisors which were retroclined in high angle subjects.

The results indicated that the soft tissue thickness in all groups is higher in males than females because of the testosterone effect in facilitating the synthesis of collagen that provide males with a thick skin, on the other hand, the estrogen hormone in females facilitates the synthesis of hyaluronic acid in addition to the decreasing in the synthesis of collagen making their skin thinner [24].

Regarding female sample, the results revealed nonsignificant group difference for all measurements. For males, the soft tissue thickness at glabella showed nonsignificant group difference being thicker in low angle group. On the other hand, significant difference was reported in nasion point especially between the high and low angle groups.

Unlike the facial soft tissue structures, the sagittal lip position is influenced by the skeletal structures, so in the presence of protrusive alveolar processes and teeth like in low angle group the lips will be thicker as shown in A-sn, Pr-I, St-U1 and Id-li.

In normal situations and after orthognathic surgery of the mandible and chin, as the vertical expansion of the skeletal tissue increases, there will be an impingement on the soft tissue thickness in a corresponding ratio of 1:1 [25]. In some instances, the soft tissue over the chin is not even in thickness. The findings of the present study indicated that the soft tissue at menton point was thicker in low angle group than the normal and high angle groups. This comes in agreement with Macari and Hanna [14], moreover the thickness at point pogonion was non-significantly different and this in accordance with Feres et al. [7] and Macari and Hanna [14] and disagreed with Celikoglu et al. [15] who reported a significant difference. This may be attributed to the difference in sample size and selection and different ethnic groups.

Low angle group had thicker soft tissue in most areas, Singh [27] stated that the thickness of soft tissue chin differs with each facial type. Thickness of soft tissue chin was greater in brachyfacial type than the dolicofacials where the direction of facial growth is forward just reverse to the high angle which is backward. Hammelton [28] and Hillesund et al. [29] found that the soft tissue chin thickness is closely related to the degree of prognathism of the chin symphysis and the more retruded chin symphysis, the less soft tissue chin thickness.

5. Conclusions

- Males had thicker soft tissue than females.
- Low angle male group possessed thicker soft tissue in comparison with high and normal angle groups.
- Females showed non-significant difference in the soft tissue thickness among different groups.

References


Author Profile

Sara M. Al-Mashhadany received the B.D.S. and M.Sc. degrees in Orthodontics from the College of Dentistry, University of Baghdad in 2004 and 2009, respectively. During 2004-2007, she was a resident in the same college. In 2007, she joined the higher studies to get the M.Sc. degree in 2009. Now, she is a lecturer in the department of Orthodontics, College of Dentistry/ University of Baghdad.

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