Dentoalveolar Heights in Vertical and Sagittal Facial Patterns
Zafar Ul Islam1, Attiya Jawaid Shaikh2 and Mubassar Fida2

ABSTRACT
Objective: To determine and compare the mean dentoalveolar heights (mm) in different vertical and sagittal facial patterns.
Study Design: Cross-sectional study.
Place and Duration of Study: Orthodontics Clinic, The Aga Khan University Hospital, Karachi, from September to November 2013.
Methodology: Subjects, aged 15 - 20 years, having fully erupted first permanent molars and central incisors were included in the study from orthodontic records. The pretreatment cephalographs of subjects were traced manually over an illuminator. The various parameters like angles and dentoalveolar heights were measured and recorded on data collection form. Mean value ± SD for the variables were generated. ANOVA was used to compare the means of dentoalveolar heights among the vertical and sagittal facial patterns. Post Hoc Bonferroni test was applied to show difference among the three vertical and three sagittal facial patterns. P-value equal to or less than 0.05 was taken as statistically significant.
Results: The mean age of subjects was 15.8 ±3.2 years in vertical group and 16.3 ±2.9 years in sagittal group. There was statistically significant difference (p=0.008) for the upper anterior dentoalveolar height (UADH) among vertical groups, with statistically significant difference for UADH between hyperdivergent and normodivergent (p=0.04) and hyperdivergent and hypodivergent (p=0.01) facial patterns.
Conclusion: The UADH were significantly greater in the hyperdivergent group as compared to both the normodivergent and hypodivergent groups. The sagittal groups showed no statistically significant difference for dentoalveolar heights.

Key Words: Dentoalveolar heights. Vertical facial patterns. Sagittal facial patterns.

INTRODUCTION
Orthodontic patients present with different combinations of vertical and sagittal skeletal discrepancies and associated varying degrees of dentoalveolar compensations. 1 Skeletal malocclusion is usually associated with dental malocclusion too. 2-5 Therefore, a subject may present with a combination of sagittal and vertical dysplasia as well as dental characteristics of malocclusion. This identification and inclusion in the diagnosis and treatment planning is very important in treatment perspectives. 5-7

One of the aims in orthodontic treatment is levelling of teeth in the dental arches. 8 However, the decision of intrusion and extrusion of teeth to level is crucial and depends upon the correct identification of dentoalveolar heights in the anterior and posterior segments of the dental arches, for dentoalveolar compensation. Therefore, it is important to know the degree of dentoalveolar compensation to the underlying vertical and sagittal skeletal discrepancies.

Dentoalveolar segment has the innate ability to adapt to the underlying developing or established skeletal dysplasia. 4-9 This has been referred to as dentoalveolar compensation. 5-10 Some investigators believe that the face height is genetically determined and is established early in life. On the other hand, some investigators believe that the excessive eruption of teeth during growth or even during adulthood may result in the increase of facial height. 9,11-12

Some studies reported no difference in dentoalveolar heights between the hyperdivergent and normodivergent facial types. 13-15 Others reported that the hyperdivergent subjects show greater while the hypodivergent subjects display a decreased dentoalveolar heights as compared to the normodivergent subjects. 16-18 However, a decrease in the dentoalveolar heights has been also reported by some authors in hyperdivergent as compared to the normodivergent facial patterns. 19 When the dentoalveolar heights were compared in sagittal facial patterns, there was no significant difference except for the upper posterior dentoalveolar heights. 16,20,21 However, in sagittal facial patterns the Class III subjects are never included for comparison. The present study also addressed the dentoalveolar heights in Class III subjects.

The degree of the dentoalveolar compensation to the skeletal dysplasia in a subject is very crucial to discern in order to meet the most important objectives of orthodontic treatment such as function, esthetics, and stability. Therefore, the aim of this study was to establish
the dentoalveolar heights in subjects with various skeletal discrepancies in vertical and sagittal dimension and the difference in dentoalveolar compensation among these facial patterns.

**METHODOLOGY**

It was a cross-sectional study that was carried out on a sample of 258 subjects of Pakistani descent at The Aga Khan University Hospital from September to November 2013. The sample size was calculated using NCSS PASS software. The inclusion criteria were age range from 15 to 20 years and fully erupted permanent incisors and first molars. All the subjects having previous orthodontic treatment, trauma to teeth, restored teeth and craniofacial anomalies or syndromes were excluded from the study. The pretreatment lateral cephalographs of the subjects were traced manually over the illuminator (Figure 1). The relevant landmarks were identified and the various parameters like angle ANB, angle SNMP, and the dentoalveolar heights were drawn (Figure 2). The angle ANB was used to divide the subjects in three sagittal skeletal patterns, i.e. Class I (ANB = 3º ± 1º), Class II (≥ 6º), and Class III (≤ -1º). The angle SNMP was used to divide the subjects in three vertical skeletal patterns, i.e. normodivergent (32º ± 4º), hypodivergent (≤ 26º), and hyperdivergent (≥ 38º). The upper anterior dentoalveolar height (UADH) and upper posterior dentoalveolar height (UPDH) were measured as perpendicular distances (mm) from maxillary incisor tip and mesiobuccal cusp tip of maxillary first permanent molar to palatal plane, respectively. The lower anterior dentoalveolar height (LADH) and lower posterior dentoalveolar height (LPDH) were measured as perpendicular distances (mm) from the mandibular incisor tip and mesiobuccal cusp tip of mandibular permanent first molar to the mandibular plane, respectively. The parameters were then recorded on a data collection form. Twenty pretreatment lateral cephalographs were randomly selected at two weeks interval and were redrawn by a second examiner for inter examiner reliability.
The data was analyzed using SPSS for windows version 20, (Chicago Inc). Descriptive statistics were used to generate mean values and standard deviation for various variables like age, angle ANB, angle SNMP and dentoalveolar heights. Analysis of variance was applied to show the difference in dentoalveolar heights among various vertical and sagittal skeletal patterns. Post Hoc Bonferroni test was applied for the difference in dentoalveolar heights among the three vertical and three sagittal skeletal patterns. To rule out measurement errors, Cronbach's alpha test was used for determining the inter-examiner reliability. The p-value of ≤ 0.05 was taken to be statistically significant.

RESULTS

The whole sample of 258 subjects comprised of 100 (38.76%) males and 158 (65.01%) females. The mean age of subjects in vertical group was 15.8 ±3.2 years and that of subjects in sagittal group was 16.3 ±2.9 years. The mean values and standard deviation for age and angles ANB and SNMP are given in Table I, which shows that subjects in vertical group were predominantly skeletal Class I and those in sagittal group were normodivergent.

The analysis of variance for the three sagittal skeletal patterns is shown in Table II. The results showed a statistically insignificant difference in dentoalveolar heights among the three sagittal skeletal patterns. The difference in dentoalveolar height among the three vertical facial patterns is shown in Table III. The analysis of variance shows a statistically significant difference for UADH among the vertical skeletal patterns (p = 0.008). The Post Hoc Bonferroni test that was applied to determine the difference in dentoalveolar heights among the three vertical skeletal patterns shows a statistically significant difference in UADH between normodivergent and hyperdivergent (p = 0.04); and hypodivergent and hyperdivergent skeletal patterns (p = 0.01).

The inter-examiner reliability was assessed by Cronbach's alpha test. There was a strong reliability among the values which excludes the measurement errors in the study.

DISCUSSION

The adaptation of the dentoalveolar segment to the underlying skeletal pattern and oral environment is a known fact.1-14 The contribution of over eruption and under eruption of teeth to the open bite or deep bite malocclusions respectively has been considerably discussed in orthodontics literature.7,9,14-15,20 A number of studies have been carried out to address the subject of dentoalveolar adaptation to skeletal dysplasia.5-10,16,19-21 Each of these studies utilized different parameters to classify the faces into sagittal and vertical skeletal types. However, the focus of the studies was to explore the amount of dentoalveolar adaptation to the skeletal patterns.

During the vertical growth of the face, the teeth erupt into the space thus provided to them by the established skeletal patterns.15,16,20,21 Therefore, it is generally believed that hyperdivergent subjects display greater dentoalveolar heights as compared to normodivergent subjects.7,9,11,23 On the other hand, the hypodivergent subjects are characterized by lower dentoalveolar heights as compared to normodivergent subjects.16,17 When the dentoalveolar heights were investigated and compared among the various vertical skeletal patterns, Janson et al. concluded that hyperdivergent subjects

<p>| Table I: The mean values of age, angle ANB, angle SNMP and dentoalveolar heights (n=258). |</p>
<table>
<thead>
<tr>
<th>Variables</th>
<th>Vertical (mean ±SD)</th>
<th>Sagittal (mean ±SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normodivergent</td>
<td>Hypodivergent</td>
<td>Hyperdivergent</td>
</tr>
<tr>
<td>n = 30</td>
<td>n = 30</td>
<td>n = 30</td>
</tr>
<tr>
<td>Age (years)</td>
<td>12.76 ± 0.56</td>
<td>18.96 ± 5.71</td>
</tr>
<tr>
<td>ANB (degrees)</td>
<td>2.5 ± 1.3</td>
<td>2.5 ± 1.2</td>
</tr>
<tr>
<td>SNMP (degrees)</td>
<td>31.7 ± 2.5</td>
<td>23.5 ± 2.8</td>
</tr>
<tr>
<td>UADH (mm)</td>
<td>28.1 ± 2.7</td>
<td>27.7 ± 2.6</td>
</tr>
<tr>
<td>UPDH (mm)</td>
<td>22.0 ± 2.2</td>
<td>23.2 ± 2.6</td>
</tr>
<tr>
<td>LADH (mm)</td>
<td>40.2 ± 2.3</td>
<td>39.8 ± 3.6</td>
</tr>
<tr>
<td>LPDH (mm)</td>
<td>30.3 ± 2.9</td>
<td>31.6 ± 3.3</td>
</tr>
</tbody>
</table>

Table II: Difference in dentoalveolar heights among sagittal facial patterns (n = 168).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Class I</th>
<th>Class II</th>
<th>Class III</th>
</tr>
</thead>
<tbody>
<tr>
<td>n = 56</td>
<td>n = 84</td>
<td>n = 28</td>
<td></td>
</tr>
<tr>
<td>UADH</td>
<td>28.1 ± 2.7</td>
<td>28.6 ± 2.3</td>
<td>27.4 ± 3.4</td>
</tr>
<tr>
<td>UPDH</td>
<td>23.4 ± 2.6</td>
<td>22.6 ± 2.3</td>
<td>23.1 ± 3.1</td>
</tr>
<tr>
<td>LADH</td>
<td>41.6 ± 3.2</td>
<td>42.0 ± 2.5</td>
<td>41.2 ± 4.5</td>
</tr>
<tr>
<td>LPDH</td>
<td>32.1 ± 3.1</td>
<td>31.6 ± 2.9</td>
<td>31.4 ± 3.7</td>
</tr>
</tbody>
</table>

Table III: Difference in dentoalveolar heights among vertical facial patterns (n = 90).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Normodivergent</th>
<th>Hypodivergent</th>
<th>Hyperdivergent</th>
</tr>
</thead>
<tbody>
<tr>
<td>n = 30</td>
<td>n = 30</td>
<td>n = 30</td>
<td></td>
</tr>
<tr>
<td>UADH</td>
<td>28.1 ± 2.7</td>
<td>27.7 ± 2.6</td>
<td>29.2 ± 3.0</td>
</tr>
<tr>
<td>UPDH</td>
<td>22.0 ± 2.2</td>
<td>23.2 ± 2.6</td>
<td>23.3 ± 3.2</td>
</tr>
<tr>
<td>LADH</td>
<td>40.2 ± 2.3</td>
<td>39.8 ± 3.6</td>
<td>41.2 ± 3.3</td>
</tr>
<tr>
<td>LPDH</td>
<td>30.3 ± 2.9</td>
<td>31.6 ± 3.3</td>
<td>31.2 ± 2.7</td>
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</tbody>
</table>

One way ANOVA; Level of significance ≤ 0.05*

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show significantly greater values than the normodivergent subjects. In contrast, Betzenberger et al. showed in their study that the hyperdivergent subjects have decreased dentoalveolar heights as compared to the normodivergent subjects. In the present study, subjects with hyperdivergent skeletal profile showed significant increase only in UADH as compared to the normodivergent skeletal patterns. All the other dentoalveolar heights were also increased but statistically insignificant. This shows that in achieving a normal overbite, it is the maxillary incisors that erupt the most to compensate for the vertical growth.

In the same study, Janson et al. concluded that with the exception of UPDH, the hypodivergent subjects show significant decrease in dentoalveolar heights than the normodivergent subjects. These results were in agreement with the other studies carried out at different population groups. However, in this study, the authors found no significant difference in the dentoalveolar heights between the hypodivergent and normodivergent skeletal patterns. Owing to the fact that vertical growth in hypodivergent subjects provides less space for teeth eruption, it may be the vertical growth of ramus that compensates for the decrease in dentoalveolar height. The difference in results may be due to the difference in classification criteria for the vertical skeletal patterns. Janson et al. has utilized the facial height ratios; whereas in this study, angle SNMP has been used to classify the subjects in vertical facial patterns. This phenomenon has been described by Martina et al. in their study on molar dentoalveolar heights in relation to craniofacial heights. According to them the amount of molar dentoalveolar height was positively influenced by the length of lower anterior facial height; whereas, the divergence of jaws (mandibulo-palatal plane angle) had a negative influence on the amount of molar dentoalveolar heights.

According to Harvold, increase eruption of the upper molars contributes to the rotation of the Class I molar relation into a Class II relation. On the contrary, a decrease in maxillary molars will rotate the Class I molar relation to a Class III molar relation. The dentoalveolar heights among the sagittal facial patterns in this study, not significantly different. These results are more or less similar to that presented by the investigators in previous studies. Popovich found no significant difference in maxillary molars height in skeletal Class I and Class II subjects. More or less similar results for the sagittal facial patterns were shown by the Janson et al. They concluded that with exception of UPDH, there was no difference in dentoalveolar heights in Class I and Class II subjects. These results by the present study and others contradict the hypothesis of Harvold for the effect of increase molar eruption on the sagittal facial patterns.

From the above discussion on the dentoalveolar heights, it can be reasoned that vertical growth of the craniofacial skeletal pattern can be more influential than the horizontal growth variance. The subjects in sagittal groups included in this study were predominantly normodivergent. Similarly, the subjects in vertical groups were predominantly skeletal Class I. The difference in dentoalveolar heights was only seen in vertical groups in this and the previous studies. Furthermore, the difference in vertical groups was more obvious when the subjects were divided into different vertical patterns by facial heights rather than the divergence of the jaws. Thus it can be said that dentoalveolar height is the manifestation rather than the cause of malocclusion. Because the vertical space provided by the facial growth is all, that is adapted by the teeth otherwise, when vertical growth is kept constant, the sagittal variability does not produce any significant change in the dentoalveolar heights.

The clinical significance of the present study lies in addressing the patients with excessive vertical facial patterns during orthodontic treatment. As the UADH is significantly increased in hyperdivergent subjects as compared to the normodivergent subjects, particular emphasis and due consideration are required in treatment of these individuals. The intrusion of the maxillary incisors may be considered during the treatment, otherwise the excessive tooth display at the end of treatment may challenge the objectives of mini esthetics. Furthermore, the normal overbite will not be achieved if the posterior teeth intrusion is not supplemented with the intrusion of maxillary incisors.

**CONCLUSION**

The evaluation of the dentoalveolar heights is an important consideration in orthodontic treatment planning to fulfill the objectives of the treatment. Dentoalveolar heights for the vertical and sagittal facial patterns are established for our patients. The UADH is significantly increased in hyperdivergent facial patterns as compared to hypodivergent or normodivergent facial patterns. There is no significant difference in dentoalveolar heights among sagittal facial patterns.

**REFERENCES**


