Role of Cranial Base Morphology in Determining Skeletal Anteroposterior Relationship of the Jaws

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ABSTRACT

Objective: To investigate the cranial base morphology in skeletal Class I, II, III patients and to find any correlation.

Materials and methods: Pretreatment lateral cephalograms of 75 patients were taken, 25 patients each belonged to Class I, II and III skeletal malocclusion respectively, between age group of 14 and 25 years.

Results: The significantly more acute angle N-S-Ar reflected increased cranial base flexure. Resulting anterior condylar displacement was shown by significant reduction of Se-S-Cd and Ar-Ca. Relative mandibular length was significantly increased.

Conclusion: Decreased basicranial angulation associated with increase in mandibular length was clearly confirmed for skeletal Class III patients. The correlation between cranial base morphology and Class II skeletal base remains unclear.

Keywords: Anteroposterior relations, Cranial base morphology, Cephalometrics.

INTRODUCTION

The correlation between cranial base morphology and poor anteroposterior relationship of the jaws, due to its functional and esthetic implications, is an interesting topic for an orthodontist. Bjork, using cephalometric radiographs, demonstrated the existence of a relationship between cranial base morphology and jaw relationship. The cranial base is a pivotal structure forming the floor of the cranial vault and extends from the foramen caecum anteriorly to the basi-occipital bone posteriorly. For cephalometric purpose, sella (S) divides the cranial base into anterior leg, extending to frontonasal suture (N), and posterior leg, extending to anterior border of foramen magnum, defined as basion (Ba). The anterior and posterior segments articulate with maxilla and mandible respectively. Thus, any change in the flexion would alter maxillary and mandibular positions relative to cranial base as well as each other, in turn influencing skeletal pattern and type of malocclusion. Many studies have been carried out in the past to study this relationship. Hopkin et al. using articulare to represent the posterior limit of the cranial base, described a linear relationship between the cranial base angle and prognathism with the angle systematically reducing from Class II, via Class I, to Class III individuals. Cranial base angulation was found to be decreased by many researchers in Class III skeletal malocclusion. Dibbets found the cranial base angle (Ba-S-N) was reduced and the legs (S-N) and (S-Ba) were shortened systematically from Class II, via Class I, to Class III malocclusions, although mandible exhibited no systematic difference between these three classes. However, some conflicting literature is also available.

The following study aims to examine the contribution of cranial base angular and linear measurements in three different groups of skeletal malocclusion emphasizing the importance of its morphology and its role in establishing the malocclusion.

MATERIALS AND METHODS

This retrospective study is based on the pretreatment lateral cephalograms of 75 patients from the Department of Orthodontics and Dentofacial Orthopedics, YMT Dental College and Hospital. A total of 25 patients each belonged to Class I, II and III skeletal malocclusion respectively. Skeletal classification was mainly based on ANB angle Wits appraisal (Table 1). Patients with any craniofacial disorders, such as cleft anomalies, craniosynostosis or other syndromes, were excluded. Pubertal growth peak of the patients were passed (males > 15 years, females > 13 years).

Cephalometric Analysis

Analysis of lateral radiographs was performed using a modified Bergen analysis. Two additional important landmarks, sphenoidale (Se) and foramen caecum (Ca), were used (Fig. 1).
Linear and angular measurements are enumerated in Table 2. To estimate the reliability of cephalometric analysis, all 75 lateral cephalograms were traced by the same investigator within a week’s time.

**Statistical Analysis**

Since, all the dependent variables were measured on a ratio type scale and the three classes were compared using one-way ANOVA (Table 3). Before applying the test, basic statistics and both the assumptions of normality and equality of variances of classes are checked.

In this case, nonparametric test was also applied as the distribution for Class III was seriously skewed. The results of

<table>
<thead>
<tr>
<th>Variables</th>
<th>Pairs of classes compared</th>
<th>Mean difference</th>
<th>Std. error</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Se-S-Cd (degree)</td>
<td>I &amp; II</td>
<td>3.52</td>
<td>2.62</td>
<td>0.459</td>
</tr>
<tr>
<td></td>
<td>I &amp; III</td>
<td>17.02</td>
<td>1.67</td>
<td>&lt;0.0005</td>
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<tr>
<td></td>
<td>II &amp; III</td>
<td>20.54</td>
<td>2.19</td>
<td>&lt;0.0005</td>
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<td></td>
<td></td>
<td>0.00</td>
<td>0.87</td>
<td>&lt;0.0005</td>
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<td></td>
<td></td>
<td>0.92</td>
<td>0.85</td>
<td>&lt;0.0005</td>
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<td></td>
<td></td>
<td>0.42</td>
<td>0.49</td>
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<tr>
<td></td>
<td></td>
<td>5.98</td>
<td>0.49</td>
<td>&lt;0.0005</td>
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<td></td>
<td></td>
<td>5.56</td>
<td>0.49</td>
<td>&lt;0.0005</td>
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<tr>
<td></td>
<td></td>
<td>5.14</td>
<td>2.28</td>
<td>0.085</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25.27</td>
<td>2.28</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20.14</td>
<td>2.28</td>
<td>&lt;0.0005</td>
</tr>
</tbody>
</table>

*Results are significant as the p-value is less than 0.05; **Results are significant as the p-value is less than 0.017
The Kruskal-Wallis were significant (Chi-square = 51.03, p < 0.0005) implying significant differences in the distributions of at least one pair of classes.

Results of post-hoc tests are presented in Table 4.

RESULTS

Table 4 allows us to conclude that:

1. A closer analysis reveals differential effect with respect to the Se-S-Cd (degree) in the posterior sections of the cranial base of Class III patients compared to that of the Class I and II patients. Class III patients have reduced Se-S-Cd (17.02 from Class I and 20.54 from Class II).

2. Comparisons for N-S-Ar (degree) between three pairs reveal differences similar to those discussed for Se-S-Cd. Class III patients have reduced N-S-Ar when compared with Class I (reduced by 9.52) and Class II (reduced by 9.00).

3. In the case of S-Ba-Ca (degree), there is systematic increase in the measure. However, the increase in Class III patients from Class I (5.98) and Class II (5.56) is significant. Results are identical even with the non-parametric equivalent test, Mann-Whitney. Medians for three classes are Class I = 19.0, Class II = 20.0 and Class III = 25.0.

4. Like the angle S-Ba-Ca (degree), the relative mandibular length shows systematic increase from Class I through Class III. However, again Class III yields a significant difference in length from that of Class I (25.27) and Class II (20.14). Results are identical even with the nonparametric equivalent test, Mann-Whitney. Medians for three classes are Class I = 153.38, Class II = 156.45 and Class III = 173.23.

DISCUSSION

The etiology and expression of a malocclusion must be understood before it can be clinically corrected. Many morphometric studies suggest the existence of local shape and size differences in the skeletal Class III cranial base, thus making it necessary to analyze the cranial base sections in greater details. The shortcomings of the conventional controversial landmarks nasion or basion vs articular are overcome by involving more landmarks, such as Foramen caecum, sphenoidal.

The cranial base provides support for the brain and adaptation during growth between developing neurocranium and viscerocranium. Because of this junctional location between cranium, midface and glenoid fossa, the cranial base has the potential to grow both cranium and face. Enlow has shown growth of maxilla to be under the influence of the cranial base which in turn is influenced by growth of the brain. The mandible, by virtue of its remoteness from the region, acts in a more independent way although its articulation at the glenoid fossa does provide potential for influence from the cranial base. Thus in the past, it was said that changes in cranial base angle may not be directly translated to the mandibular articulation, as the temporomandibular joint is positioned at the lateral edges of the cranial base is considerably separated spatially from midsagittal plane on which cephalometric analyses are based. Although many studies have confirmed the reduction in cranial base angle associated with Class III malocclusions. In the present study, also we find a decrease in total cranial base angle, i.e. N-S-Ar angle. The cranial base angulation in between anterior and posterior legs of cranial base of Class III patients compared to that of Class I and II patients. Class III patients have reduced cranial base angulation in between anterior and posterior legs of cranial base of Class III patients.

Also, a decrease in posterior cranial base angle, Se-S-Cd, was confirmed in the present study with a slight decrease in length Ar-Ca. All these suggest anterior displacement of condyles in Class III malocclusions.

A complementary increase is seen in S-Ba-Ca angle in skeletal Class III patients along with a more closed cranial base angle. Increase in anterior part of cranial base apparent by N-Ca is also observed in Class III patients.

An increase in sagittal mandibular length relative to cranial base is noted in skeletal Class III patients. The jaw lengths are measured relative to cranial base (N-S) and a ratio is taken. Point A is taken as the anterior limit of maxilla and pogonion, Pg as anterior limit of mandible. Condylar hyperplasia with concomitant remodeling has been suggested for this mandibular lengthening. Maxillary length is not affected in Class III or Class II patients. Though a few studies have suggested an increase in maxillary length in skeletal Class II patients, no significant findings were obtained in the present study.

No significant correlation was observed in between linear parameters and cranial base morphology.

CONCLUSION

1. Increase in sagittal mandibular length is a very significant finding in skeletal Class III patients.

2. Also, cranial base flexure evident through decreased angulation in between anterior and posterior legs of cranial base is seen which may be due to anterior displacement of condyles and mandible.

3. No correlation is seen in cranial base angular and linear measurements and skeletal Class II malocclusion.

Thus from the following study, we can conclude that the cranial base angulation which is statistically significant finding seen only in Class III skeletal malocclusion may not be the sole factor involved in determining the malocclusion.

But, we cannot deny that specific traits are definitely suggestive of certain malocclusions.
REFERENCES