COMPARISON OF CLASS III MALOCCLUSION SUBGROUPS WITH DIFFERENT SKELETAL COMPONENTS

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ABSTRACT

Background and Aim: The aim of this study was to evaluate and compare dental and craniofacial structures in subjects with Class III malocclusions associated with maxillary retraction, mandibular protrusion and a combination of maxillary retraction and mandibular protrusion.

Subjects and Methods: The subjects were grouped as to the evaluations of pre-treatment lateral cephalometric radiographs, as follows: Group 1: maxillary retraction (n=23; mean age: 13.44±1.71); Group 2: mandibular protrusion (n=22; mean age: 13.31±1.34); Group 3: maxillary retraction and mandibular protrusion (n=21; mean age: 13.04±1.18). Cephalometric differences among groups were evaluated by Analysis of Variance (ANOVA) and Duncan’s tests.

Results: Significant differences were observed in Nperp-A, SNA, SNB, ANB, B-VR and Pg-VR among all groups (p<0.01); in Nperp-Pg, U1/ANS-PNS and Li-VR between Group 1 and Groups 2 and 3 (p<0.01); in A-VR and Ls-VR between Group 2 and Groups 1 and 3 (p<0.01); and in S-N between Group 1 and Group 2 (p<0.05).

Conclusions: Variables associated with maxillary and mandibular lengths were nearly the same in all groups; however, differences were observed among all three groups in maxillary and mandibular positions.

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INTRODUCTION

The terms “mandibular prognathism” and “Class III malocclusion” have generally been used to describe the same discrepancy; however, several studies have shown that a Class III malocclusion can exist with any number of combinations of skeletal and dental components within the facial skeleton. Skeletal Class III malocclusion has been classified according to the position of the maxilla, the mandible, the maxillary alveolus, the mandibular alveolus and vertical development. Sanborn and Jacobson divided Class III malocclusion into subgroups according to maxillary and mandibular position, angle of convexity and alveolar process, and Ellis and McNamara categorized Class III malocclusions based on the horizontal and vertical positions and alveolar structures of the maxilla and mandible. A study by Sanborn found that 45.2% of a sample of adults with Class III malocclusions had mandibular skeletal protrusion and an orthognathic maxilla, 33% had mandibular skeletal retrusion and a mandible within the normal range of protrusion, and approximately 9.5% had a combination of maxillary skeletal retrusion and mandibular skeletal protrusion. By contrast, a study of 302 adult patients, Ellis and McNamara found the most common type of Class III malocclusion to be maxillary skeletal retrusion combined with mandibular skeletal protrusion. In another study of 495 growing children, Battagel found children with Class III malocclusions had shorter, more retrusive maxillas and longer, more prominent mandibles when compared to a control group of children with normal occlusion.

Orthopedic and orthodontic treatment approaches to Class III malocclusion may vary in line with the differences in the craniofacial system. For this reason, it is important to evaluate not only maxillo-mandibular relations, but also the structure of the craniofacial skeleton responsible for these relations. Therefore, this study aimed to evaluate and compare linear measurements and dental and craniofacial structures of Class III malocclusion types associated with maxillary retrusion, mandibular protrusion and a combination of maxillary retrusion and mandibular protrusion.

SUBJECTS AND METHODS

The study population was comprised of 66 patients (21 male, 45 female) with Class III malocclusions referred to the Ankara University, Department of Orthodontics for orthodontic-orthopedic correction from 1981-1996. The mean age of subjects was 13.26±2.27 years (age range: 10.50-16.50 years) (Table 1). Inclusion criteria were: (1) skeletal Class III malocclusion (ANB<0°); (2) dental Class III molar and canine relationship; (3) concave facial profile; (4) no history of orthodontic treatment; and (5) good-quality pretreatment lateral cephalograms. Exclusion criteria were: (1) cranio-dento-facial anomalies such as cleft lip and palate; and (2) syndromes.

The study was conducted using pre-treatment lateral cephalometric radiographs to classify the study population into one of the three groups according to the position of the maxilla and mandible in relation to the cranial base and cranial structures, as follows:

Group 1: Class III malocclusion due to maxillary retrusion.
Group 2: Class III malocclusion due to mandibular protrusion.
Group 3: Class III malocclusion due to a combination of maxillary retrusion and mandibular protrusion.

Maxillary position was determined by the angle Sella-Nasion-Point A (SNA; norm value: 82°) and the distance from Point A to the nasion perpendicular (Nperp-A; norm value: 0 to +1 mm). Mandible position was determined by the angle Sella-Nasion-Point B (SNB; norm value: 80°) and the distance from the pogonion to the nasion perpendicular (Nperp-Pg; norm value: -4 to +2 mm). The subjects exhibiting inconsistencies between SNA and Nperp-A or between SNB and Nperp-Pg (e.g. SNA >82° with an Nperp-A indicating maxillary retrusion) were excluded from further consideration in order to eliminate the possibility of methodological error.

Cephalometric Analysis

Lateral cephalometric films were obtained under standardized conditions with the head in the natural position and using ear rods for stabilization (median plane focal distance: 155 cm; detector-to-midsagittal distance 12.5 cm; exposure settings: 73 kVp, 14mA for 0.64 s). Cephalograms were traced and 20 reference points marked using a 0.3 mm lead pencil on acetate tracing paper. Landmarks were digitized and 23 variables analyzed using the PorDios® (Purpose on Request Digitizer Input Output System, Institute of Orthodontic Computer Science, and Aarhus, Denmark) cephalometric analysis program (Figure 1). In addition, horizontal (HR) and vertical (VR) reference planes were generated, as described by Arman et al. as follows: VR – perpendicular to the occlusal plane from...
RESULTS

There were no significant differences between the initial and repeat measurements. Reliability coefficients (r) ranged between 0.93 and 0.99, indicating no random error. Table 1 shows the mean chronological age and the distribution of gender of the all subjects. Table 2 shows the means and standard deviations of means of linear and angular cephalometric variables for all three groups and the results of ANOVA and Duncan's Tests showing differences among groups.

Cranial Base

S-N was significantly shorter in Group 2 when compared to Group 1 (p<0.05).

Maxilla

The position of the maxilla differed significantly among all three groups (p<0.01). The severity of maxillary retrusion (Nperp-A and SNA) was the greatest in Group 1, followed...
COMPARISON OF SKELETAL CLASS III SUBGROUPS

### Table 1
The means (X), standard deviations (Sd), minimum (min) and maximum (max) values of the ages of the subjects in the Class III malocclusion groups are presented.

<table>
<thead>
<tr>
<th>CLASS III MALOCCLUSION TYPES</th>
<th>N</th>
<th>Chronological age (year)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Maxillary Retrusion Group</td>
<td>23</td>
<td>13.44</td>
</tr>
<tr>
<td>Mandibular Protrusion Group</td>
<td>22</td>
<td>13.31</td>
</tr>
<tr>
<td>Max. Retrusion + Mand. Protrusion Group</td>
<td>21</td>
<td>13.04</td>
</tr>
</tbody>
</table>

F: female, M: male

by Group 3 and Group 2, the latter of which was almost within normal range. A-VR was significantly higher in Group 2 when compared to Groups 1 and 3 (p<0.01). Maxillary length (ANS-PNS) did not differ significantly among groups.

### Mandible
Both the length and position of the mandible differed significantly among all three groups. The severity of mandibular protrusion (Nperp-Pogonion) was greatest in Group 2, followed by Group 3 (SNB, B-VR and Pg-VR; P<0.01), whereas the mandible was almost retrognathic in Group 1.

### Maxillo-Mandibular Relations
ANB varied significantly among all 3 groups (p<0.01). ANB was smallest in Group 3, followed by Groups 1 and 2.

### Dentoalveolar Relations
Maxillary incisor protrusion (U1/ANS-PNS; p<0.01) was significantly greater in Group 1 than in Groups 2 and 3, but nearly identical in Groups 2 and 3. Mandibular incisor relationships (L1/MeGo) showed no statistical differences among groups.

### Soft Tissue
Upper and lower lip positions varied significantly among groups (P<0.01). While the distance between the upper lip and the vertical reference plane (Ls-VR) was greater in Group 2 than in Groups 1 and 3, the distance between the lower lip and the vertical reference plane (Li-VR) was found to be shorter in Group 1 than in Groups 2 and 3 (p<0.01). Therefore, rather than examining skeletal proportions, the present study examined the linear differences among different categories of Class III malocclusion.

### DISCUSSION
Studies have shown that a Class III malocclusion can exist with a variety of facial skeletal relationships. Therefore, rather than examining skeletal proportions, the present study examined the linear differences among different categories of Class III malocclusion.

### Subjects
Subjects were grouped based on SNA, SNB, Nperp-Point A and Nperp-Pogonion measurements. Interestingly, the overall distribution of subjects among the three types of malocclusion groups was similar, as were the age and sex distributions among the groups (Table 1). The majority of subjects with Skeletal Class III malocclusion were female.

### Cranial Base
Most studies investigating the craniofacial morphology of Skeletal Class III malocclusion have reported a shorter anterior cranial base (S-N) among these patients when compared to Skeletal Class I control groups. Previous cephalometric studies have suggested that the reduced angulation between the anterior and posterior cranial base (i.e. a change in saddle angle) in individuals with Class III malocclusion displaces the temporomandibular joint forward, resulting in a prognathic facial profile. Chang et al. suggested that shortening and angular bending of the cranial base and a diminished angle between the cranial base and the mandibular ramus might be associated with the formation of Class III malocclusion and Class III facial morphology. In the present study, a significant difference in S-N was found between Group 1 (maxillary retrusion) and Group 2 (mandibular protrusion). Although not statistically significant, the cranial base angle (NSBa) was slightly larger in Group 1 than in Groups 2 and 3. This finding is in line with the earlier studies that suggested an obtuse bending of the cranial base is responsible for the backward relocation of the mandible.
Table 2. The comparison of Group 1 (maxillary retrusion), Group 2 (mandibular protrusion) and Group 3 (maxillary retrusion combined with mandibular protrusion) by Analysis of Variance (ANOVA) and Duncan tests. (X: Mean, Sd: Standard deviation)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Norm Values</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
<th>Test 1-2</th>
<th>2-3</th>
<th>1-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cranial Base</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. S-N</td>
<td>68.8±2.9 mm</td>
<td>70.02</td>
<td>67.70</td>
<td>69.32</td>
<td>0.71</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>2. NSba</td>
<td>130.8±3.6°</td>
<td>127.97</td>
<td>125.46</td>
<td>126.47</td>
<td>1.34</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maxilla</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Nperp-A¥¥</td>
<td>0.4±2.3 mm</td>
<td>-7.69</td>
<td>-0.91</td>
<td>-4.61</td>
<td>0.56</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>4. SNA</td>
<td>81.2±2.8°</td>
<td>75.90</td>
<td>79.80</td>
<td>78.11</td>
<td>2.22</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>5. A-VR</td>
<td>-</td>
<td>56.11</td>
<td>60.48</td>
<td>57.05</td>
<td>0.64</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>6. Co-A¥¥</td>
<td>91.0±4.3 mm</td>
<td>82.18</td>
<td>84.51</td>
<td>83.52</td>
<td>5.59</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>7. ANS-PNS</td>
<td>52.7±2.4 mm</td>
<td>48.94</td>
<td>49.88</td>
<td>49.54</td>
<td>3.93</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mandible</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>8. Nperp-Pg¥¥</td>
<td>-1.8±4.5 mm</td>
<td>-7.79</td>
<td>2.45</td>
<td>-0.18</td>
<td>1.07</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>9. SNB</td>
<td>78.9±2.5°</td>
<td>77.90</td>
<td>82.10</td>
<td>81.96</td>
<td>2.07</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>10. B-VR</td>
<td>-</td>
<td>51.18</td>
<td>58.66</td>
<td>55.34</td>
<td>0.73</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>11. Co-gn¥¥</td>
<td>120.2±5.3mm</td>
<td>116.99</td>
<td>120.56</td>
<td>120.23</td>
<td>6.85</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>12. Co-Go</td>
<td>58.7±4.3 mm</td>
<td>56.62</td>
<td>58.72</td>
<td>58.40</td>
<td>5.70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Go-Gn</td>
<td>69.8±5.3 mm</td>
<td>75.54</td>
<td>78.12</td>
<td>78.48</td>
<td>5.37</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>14. Pg-VR</td>
<td>-</td>
<td>50.73</td>
<td>58.28</td>
<td>55.34</td>
<td>0.84</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Maxillo-mandibular Relations</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>15. ANB</td>
<td>2.2±1.5°</td>
<td>-1.99</td>
<td>-2.30</td>
<td>-4.85</td>
<td>1.72</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>16. ANS-Me</td>
<td>67.2±4.4 mm</td>
<td>66.07</td>
<td>63.61</td>
<td>63.77</td>
<td>0.97</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. SN/GoGn</td>
<td>32.3±4.7°</td>
<td>35.53</td>
<td>32.44</td>
<td>31.12</td>
<td>4.31</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>18. Overjet</td>
<td>2.9±0.5 mm</td>
<td>-1.05</td>
<td>-1.49</td>
<td>-2.01</td>
<td>2.42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. Overbite</td>
<td>1.9±0.7 mm</td>
<td>0.17</td>
<td>0.45</td>
<td>2.18</td>
<td>2.11</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Dentoalveolar</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. U1/ANSPNS</td>
<td>110.8±4.5°</td>
<td>67.95</td>
<td>63.73</td>
<td>62.13</td>
<td>0.92</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>21. L1/MeGo</td>
<td>95.3±4.4°</td>
<td>87.30</td>
<td>84.85</td>
<td>85.76</td>
<td>1.23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soft Tissue</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22. Ls-VR</td>
<td>-</td>
<td>72.98</td>
<td>77.55</td>
<td>74.93</td>
<td>0.84</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>23. Li-VR</td>
<td>-</td>
<td>71.64</td>
<td>77.16</td>
<td>74.61</td>
<td>0.71</td>
<td>**</td>
<td>**</td>
</tr>
</tbody>
</table>

*p<0.05*  **p<0.01**  ***p<0.001***


(-) Norm values for those variables are not available.
Imbalanced Relationship versus Linear Maxillary and Mandibular Measurements

Precious and Delaire\textsuperscript{17} have stated that the relative movement and positioning of the skeletal parts are the most important factors in craniofacial growth and equilibrium. In the present study, most of the variables that showed statistically significant variations among the different Class III malocclusion groups were indicators of maxilla and mandible positioning—which is a logical finding, given that the groups were comprised based on the positional variables $N_{perp-A}$, $N_{perp-Pg}$, SNA, SNB, ANB, A-VR and B-VR. In addition, the variables used to define the size of the maxilla and mandible [Co-A (effective midfacial length of the maxilla), Co-Gn (mandibular length), and Go-Gn (mandibular corpus length)] was found to be statistically different for the groups. These results can be explained by the fact that the main discrepancy in Class III malocclusion is related to both malpositioning, and the size of the maxilla and mandible.

The relationship of skeletal imbalance with age

The mean age of participants in the current study was 13.26 years, and it is possible to suggest that the observed malocclusions may worsen with time as a result of continuing growth of the maxilla and mandible. This could be considered as a limitation of the present study. This hypothesis would be in line with Jamison et al.\textsuperscript{18} and who recommended treating antero-posterior discrepancies as soon as they are observed rather than waiting for the pubertal "spurt", since the magnitude and timing of this spurt is highly individualized and unpredictable. However, the same authors also state that the maxillo-mandibular relationship does not change significantly between the ages of 8 and 17 years.\textsuperscript{18} Conversely, Spalj et al.\textsuperscript{12} in their retrospective study, found difference in 11-12 and 17-18 ages group between the mandibular and maxillary lengths (Co-Gn minus Co-A). However, clinicians should be cautioned that in this study, all subjects were adolescent and had significant growth changes.

Soft tissue

As for soft tissue differences, patients in the maxillary retrusion group had a shorter upper and lower lip position than the others. On the other hand, maxillary incisor position was found to be greater in the maxillary retrusion group. This might be associated with the possible compensation mechanism of reduced negative overjet. In addition an increase in the maxillary incisor proclination influences the position of the lips.\textsuperscript{19} In the present study it might be concluded that despite the maxillary retrusion group had shorter lip positions and greater maxillary incisor, maxillary skeletal position had more prominent effect than the incisor position on the soft tissue for this study group.

Clinical Implications

In planning the treatment of a Class III malocclusion, it is important for the orthodontist to identify the source of the dento-skeletal imbalance and understand the factors that have influenced the development of craniofacial structures. Especially in the case of adult orthognathic surgery candidates, recognizing the source of disharmony is extremely important in determining the extent of surgical intervention required. The results of our study suggest that the maxillo-mandibular relationship plays a more important role in Class III malocclusion than the size of either the maxilla or the mandible. Thus, it would not be wise to conclude from this limited sample that every skeletal Class III patient has a normal size maxilla and mandible; rather, each patient needs to be examined regarding the individual variations, and treatment planning should be conducted accordingly.

CONCLUSION

\begin{itemize}
  \item The lengths of the maxilla and mandible were nearly similar among Class III malocclusion subgroups. However, the position and relationship of the jaws differed among Class III malocclusion subgroups.
  \item The linear measurement S-N was shorter in the mandibular protrusion group than in the maxillary retrusion and mandibular protrusion/maxillary retrusion groups.
  \item The degree of maxillary incisor inclination ($U1/ANSPNS$) was greater in the maxillary retrusion group than in the mandibular protrusion and mandibular protrusion/ maxillary retrusion groups. This could be a result of dentoalveolar compensation for skeletal deformity.
\end{itemize}

REFERENCES


