Dental and Alveolar Arch Widths in Normal Occlusion and Class III Malocclusion

Tancan Uysal a; Serdar Usumez b; Badel Memili c; Zafer Sari d

Abstract: The aim of this study was to compare the transverse dimensions of the dental arches and alveolar widths of Class III malocclusion group with a group of untreated normal occlusion subjects. This study was performed using measurements on dental casts of 150 normal occlusion (mean age, 21.6 ± 2.6 years) and 100 Class III malocclusion (mean age, 15.4 ± 2.2 years) subjects. Independent samples t-test was applied for comparing the groups. The findings of this study indicated that the mandibular intercanine and intermolar alveolar widths were significantly larger in the Class III group when compared with the normal occlusion sample (P < .001). Maxillary interpremolar, intermolar widths and all maxillary alveolar width measurements were significantly narrower in the Class III group (P < .001). In addition, the lower canine and premolar alveolar width measurements were also statistically significantly larger in the normal occlusion group when compared with the Class III malocclusion group (P < .001). Subjects with Class III malocclusion tend to have the maxillary teeth inclined to the lingual and mandibular teeth inclined to the buccal direction because of the restriction of maxillary growth and development according to dental arch width measurements. Therefore, rapid maxillary expansion should be considered before or during the treatment of a Class III patient with or without face-mask therapy. (Angle Orthod 2005;75:809–813.)

Key Words: Class III; Normal occlusion; Dental width; Alveolar arch width

INTRODUCTION

Investigators have recommended strongly the early detection of all Classes of malocclusion. Furthermore, they endorse preventive and interceptive orthodontics and dentofacial orthopedics for young patients to avoid, or at least to minimize the occurrence of Class III malocclusion at the adult stage.

The prevalence of Class III malocclusion is reported to be 16.8% by Garner and Butt in the Kenyan, 14% by Salzmann in the American, and 1.4% by Solow and Helm in the Danish populations. Among 965 Turkish children, in the region of Konya, Turkey, a 3.5% incidence of Class III malocclusion was found. The size and form of the dental arches can have considerable implications in orthodontic diagnosis and treatment planning, affecting the space available, dental esthetics, and stability of the dentition. The growth changes of arch widths in normal occlusion subjects and a comparison of arch widths in normal occlusion and different malocclusion samples have been studied extensively.

Most of the studies in the literature compare dental arch widths of Class II patients with the normal occlusion samples. Some of them indicate that absolute arch widths of children with malocclusion did not differ appreciably from those with normal occlusion. However, in other studies, statistically significant differences were determined in dental and alveolar width measurements of Class II patients. Braun et al indicated that the mandibular dental arches associated with Class III malocclusions are wider than the Class I mandibular arches beginning in the premolar area. In addition, they found that Class III maxillary dental arch widths are larger than the Class I widths. This begins in the lateral incisor–canine area and proceeds distally.
occlusion groups with those of 150 untreated normal occlusion subjects. The null hypothesis to be tested states that there is no statistically significant difference in maxillary and mandibular dental arch and alveolar width dimensions between Class III malocclusion and normal occlusion samples.

MATERIALS AND METHODS

This study was performed on dental casts of 150 normal occlusion and 100 Class III malocclusion subjects from the archives of the Selcuk University, Faculty of Dentistry, Department of Orthodontics. The distribution of age in different groups for all subjects is shown in Table 1.

Normal occlusion sample

Dental casts were taken from 150 adult subjects (72 male and 78 female) with normal occlusion, which met the following criteria:15 (1) Class I canine and molar relationship with minor or no crowding, normal growth and development, well-aligned upper and lower dental arches; (2) all teeth present except third molars; (3) good facial symmetry determined clinically; (4) no significant medical history; (5) no history of trauma; and (6) no previous orthodontic or prosthodontic treatment, maxillofacial or plastic surgery.

Class III malocclusion sample

A sample of 100 subjects (42 males and 58 females) with Class III malocclusion was selected from the patient’s record files. The criteria used to select the malocclusion sample were: (1) bilateral Class III molar relationship in centric occlusion with the cusp tip of the maxillary second premolar within the range of one mm (anterior or posterior) from the buccal groove of the mandibular first molar, (2) Class III permanent canine relationship with excessive negative overjet, (3) all teeth present except third molars, (4) no significant medical history, (5) no history of trauma, and (6) no previous orthodontic or prosthodontic treatment, maxillofacial or plastic surgery.

Twelve width measurements were performed on the dental casts of each subject.13 The arch width measurements were recorded from each subject’s dental casts by one examiner, using a dial caliper and re-

A review of the literature revealed few studies that evaluated transverse dimensions in Class III patients in the permanent dentition. Therefore, the aim of this study was to compare the transverse dimensions of the dental arches and alveolar widths of Class III mal-

| TABLE 1. | The Distribution of Age in Different Malocclusion Groups
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>n</td>
<td>Mean Age (y)</td>
<td>SD (y)</td>
<td>Sex</td>
<td>n</td>
<td>Mean Age (y)</td>
<td>SD (y)</td>
<td>Min (y)</td>
</tr>
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<td>---</td>
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<td>---</td>
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</tr>
<tr>
<td>Normal occlusion</td>
<td>150</td>
<td>21.6</td>
<td>2.6</td>
<td>Male</td>
<td>72</td>
<td>22.1</td>
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<td></td>
<td></td>
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<td></td>
<td>Female</td>
<td>78</td>
<td>21.1</td>
<td>2.1</td>
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<tr>
<td>Class III malocclusion</td>
<td>100</td>
<td>15.4</td>
<td>2.2</td>
<td>Male</td>
<td>42</td>
<td>13.5</td>
<td>2.9</td>
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<tr>
<td></td>
<td></td>
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<td></td>
<td>Female</td>
<td>58</td>
<td>16.3</td>
<td>1.8</td>
</tr>
</tbody>
</table>

* n indicates sample size; SD, standard deviation; Min, minimum; and Max, maximum.
ARCH WIDTHS IN CLASS III MALOCCLUSION

TABLE 2. Maxillary and Mandibular Dental and Alveolar Width Measurements Used in the Study

1. Maxillary intercanine width (UC-C): the distance between the cusp tips of the right and left canines or the center of the wear facets in cases of attrition.
2. Maxillary inter premolar width (UP-P): the distance between the cusp tips of the right and left first premolars.
3. Maxillary inter molar width (UM-M): the distance between the mesiobuccal cusp tips of the right and left first molars.
4. Mandibular intercanine width (LC-C): the distance between the cusp tips of the right and left mandibular canines.
5. Mandibular inter premolar width (LP-P): the distance between the cusp tips of the right and left mandibular first premolars.
6. Mandibular inter molar width (LM-M): between the most gingival extensions of the buccal grooves on the first molars or, when the grooves had no distinct terminus on the buccal surface, between points on the grooves located at the middle of the buccal surfaces.
7. Maxillary canine alveolar width (UAC-C): the distance between two points at the mucogingival junctions above the cusp tips of the maxillary right and left canines.
8. Maxillary premolar alveolar width (UAP-P): the distance between two points at the mucogingival junctions above the interdental contact point of the maxillary first and second premolars.
9. Maxillary molar alveolar width (UAM-M): the distance between two points at the mucogingival junctions above the mesiobuccal cusp tips of the maxillary first molars.
10. Mandibular canine alveolar width (LAC-C): the projection of UAC-C point in the lower jaw.
11. Mandibular premolar alveolar width (LAP-P): the projection of UAP-P point in the lower jaw.
12. Mandibular molar alveolar width (LAM-M): the projection of UAM-M point in the lower jaw.

TABLE 3. Error of the Method

<table>
<thead>
<tr>
<th>Transverse Measurement</th>
<th>Dahlberg's Calculation</th>
<th>Reliability Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>UC-C</td>
<td>0.910</td>
<td>0.956</td>
</tr>
<tr>
<td>UP-P</td>
<td>0.913</td>
<td>0.983</td>
</tr>
<tr>
<td>UM-M</td>
<td>0.589</td>
<td>0.923</td>
</tr>
<tr>
<td>LC-C</td>
<td>0.750</td>
<td>0.945</td>
</tr>
<tr>
<td>LP-P</td>
<td>0.911</td>
<td>0.985</td>
</tr>
<tr>
<td>LM-M</td>
<td>0.674</td>
<td>0.934</td>
</tr>
<tr>
<td>UAC-C</td>
<td>0.789</td>
<td>0.919</td>
</tr>
<tr>
<td>UAP-P</td>
<td>0.590</td>
<td>0.918</td>
</tr>
<tr>
<td>UAM-M</td>
<td>0.502</td>
<td>0.913</td>
</tr>
<tr>
<td>LAC-C</td>
<td>0.475</td>
<td>0.951</td>
</tr>
<tr>
<td>LAP-P</td>
<td>0.427</td>
<td>0.916</td>
</tr>
<tr>
<td>LAM-M</td>
<td>0.561</td>
<td>0.949</td>
</tr>
</tbody>
</table>

According the data to the nearest 0.1 mm. These dental and alveolar arch width measurements are shown in Table 2, and Figure 1 and 2.

Three weeks after the first measurements, 20 dental casts were selected randomly and remeasured. A paired samples t-test was applied to the measurements. The difference between the first and second measurements was insignificant. Correlation analysis yielded the highest r value, .985, for LP-P and the lowest r value, .913, for UAM-M measurements. The method error was calculated using Dahlberg’s formula. Values changed from 0.427 mm to 0.913 mm and were within acceptable limits (Table 3).

Independent samples t-test was applied for comparison of the groups. All statistical analyses were performed using the SPSS software package (Statistical Package for Social Sciences for Windows, version 10.1, SPSS Inc, Chicago, Ill).

RESULTS

Descriptive statistics (mean, standard deviation, and minimum and maximum) and statistical comparisons of dental and alveolar width measurements for dental casts in two groups (normal occlusion and Class III malocclusion) are shown in Table 4. According to independent samples t-test, statistically significant differences were found in maxillary and mandibular dental arch and alveolar width dimensions between Class III malocclusion and normal occlusion samples. Thus, the null hypothesis was rejected.

Statistical comparisons of the two groups showed no significant differences in maxillary intercanine (UC-C), maxillary premolar alveolar width (UAP-P) and mandibular molar alveolar width (LAM-M) measurements (P > .05).

Statistically significant differences were found in nine of the 12 measurements. The mandibular intercanine and intermolar alveolar widths were significantly larger in the Class III group when compared with the normal occlusion sample (P < .001). Maxillary inter premolar, intermolar widths and all maxillary alveolar width measurements were significantly narrower in the Class III group (P < .001). The lower canine and premolar alveolar (P < .001) width measurements were also significantly larger in the normal occlusion group when compared with the Class III malocclusion group (P < .001) (Table 4).

DISCUSSION

Information regarding maxillary arch dimensions in human populations is important to clinicians in orthodontics, prosthodontics, and oral surgery. It also is of interest to anthropologists and other students of human oral biology. A survey of arch size could help the clinician in choosing correctly shaped stock impression trays for prosthodontic treatment. In addition to the selection of stock trays, the sizes of artificial teeth and the overall form of the artificial dental arch
at the wax trial stage are amenable to modification by the dental surgeon in orthodontic treatment.\textsuperscript{14}

This study was carried out to compare the dental arch and alveolar base widths of Class III malocclusion groups with the untreated normal occlusion sample. Width measurements described in this article will help clinicians diagnose and plan the treatment of patients with Class III malocclusions.

Because of the scarcity of Class III patients in the general population, a larger sample size in this study might have increased its power. Increasing the sample size would lead to a greater probability of establishing statistical significance for the observed trends in all dental and alveolar width measurements. Investigators who have studied transverse arch changes in subjects have reported that molar and canine arch widths did not change after 13 years of age in females and 16 years of age in males.\textsuperscript{17-20} The minimum ages of the subjects measured in this study were chosen on the basis of these previous studies. Therefore, we assumed that the arch widths of the subjects studied were fully developed.

Clinicians have speculated that nasal obstruction, finger habits, tongue thrusting, low tongue position, and abnormal swallowing and sucking behavior were reasons for narrower maxillary dental arch widths in malocclusion patients compared with normal occlusion sample. Braun et al\textsuperscript{14} investigated the form of the human dental arch using 40 sets of pretreatment orthodontic models of patients and found that Class III maxillary dental arch widths are an average of 5.1 mm greater than the arch widths of Class I widths and this begins in the lateral incisor–canine area and proceeds distally. They explained this surprising result by frequently referring to the anteroposterior skeletal discrepancy and the fact that the mandibular arch is advanced relative to the maxillary arch. In contrast, in this study the maxillary premolar, intermolar widths and all maxillary alveolar width measurements were found to be significantly narrower in the Class III group than in the normal occlusion sample. When the corresponding interarch widths were matched correctly, the maxillary arch widths were usually narrower than the mandible arch widths.

Lingually positioned maxillary posterior crossbites are often seen in the Class III malocclusion. One could speculate that during eruption in Class III subjects, the maxillary posterior teeth compensate for the buccal relationships (that result from the anteroposterior displacement of the jaws) by palatal movement to avoid inappropriate contacts with the lower teeth. Besides, it was widely believed that a wide and big mandible obstructed growth and development of the maxillary dental and alveolar arches. Braun et al\textsuperscript{14} found that the mandibular dental arch widths associated with Class III occlusions are, on an average, 2.1 mm wider than the Class I mandibular arches beginning in the pre-molar area.

In this study, the mandibular dental arches associated with Class III occlusions were wider than the normal occlusion sample. This begins in the canine area and proceeds distally. A possible explanation for the increased arch width associated with Class III dental arches is that the sum of all the mesiodistal widths of the dental units around an arch represents a specific dimension. Sperry et al\textsuperscript{21} showed that the Class III group with mandibular prognathism more commonly had mandibular tooth size excess for the overall ratio than the Class I and Class II groups. Similarly, Lavelle\textsuperscript{22} and Nie and Lin\textsuperscript{23} showed that Class III cases are characterized by smaller maxillary tooth dimensions and bigger lower teeth. Hnat et al\textsuperscript{24} also reported

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**TABLE 4.** Descriptive Statistics and Statistical Comparisons of Dental and Alveolar Widths of Normal Occlusion and Class III Malocclusion Samples\textsuperscript{a}

<table>
<thead>
<tr>
<th>Normal Occlusion</th>
<th>Class III Malocclusion</th>
<th>Normal Occlusion vs Class III\textsuperscript{b}</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>UC-C</td>
<td>34.4</td>
<td>2.1</td>
</tr>
<tr>
<td>UP-P</td>
<td>42.1</td>
<td>2.5</td>
</tr>
<tr>
<td>UM-M</td>
<td>50.7</td>
<td>3.7</td>
</tr>
<tr>
<td>LC-C</td>
<td>25.9</td>
<td>1.7</td>
</tr>
<tr>
<td>LP-P</td>
<td>34.6</td>
<td>1.9</td>
</tr>
<tr>
<td>LM-M</td>
<td>45.7</td>
<td>2.8</td>
</tr>
<tr>
<td>UC-A</td>
<td>38.6</td>
<td>2.4</td>
</tr>
<tr>
<td>UP-A</td>
<td>49.8</td>
<td>2.6</td>
</tr>
<tr>
<td>UM-A</td>
<td>58.1</td>
<td>5.3</td>
</tr>
<tr>
<td>LC-A</td>
<td>35.7</td>
<td>2.3</td>
</tr>
<tr>
<td>LP-A</td>
<td>48.5</td>
<td>2.7</td>
</tr>
<tr>
<td>LM-A</td>
<td>58.0</td>
<td>2.8</td>
</tr>
</tbody>
</table>

\textsuperscript{a} SD indicates standard deviation; Min, minimum; Max, maximum; NS, not significant.

\textsuperscript{b} Statistical significance as per independent samples t-test.

*** P \textsuperscript{.001}.
that, when the mandibular tooth size is increased, mandibular arch length and arch width increase occurs, and this suggestion supports our results.

The findings of this study indicated that almost all the upper dental and alveolar width measurements were narrower in patients with Class III malocclusion when compared with the normal occlusion sample. In addition, the mandibular dental width measurements were larger in the Class III group. Subjects with Class III malocclusion tend to have the maxillary teeth inclined to the lingual and mandibular teeth inclined to the buccal direction because of the restriction of maxillary growth and development. Therefore, rapid maxillary expansion may be considered before or during the treatment of a Class III patient.

CONCLUSIONS

• Maxillary interpremolar, intermolar widths and all maxillary alveolar width measurements were significantly narrower in the Class III group.
• The mandibular intercanine and intermolar alveolar widths were significantly larger in the Class III group.
• The lower canine and premolar alveolar width measurements were statistically significantly larger in the normal occlusion group when compared with the Class III malocclusion group.

REFERENCES