Alveolar base and dental arch widths with segmental arch measurements in different classes of malocclusions
(A comparative study)

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ABSTRACT
Background: The size and shape of the arches have considerable implications in orthodontic diagnosis and treatment planning. The aim was to evaluate and compare alveolar bases, dental arches and segmental arch dimensions of class II division 1, class III malocclusion groups with normal occlusion subjects and to check gender differences and maxillary and mandibular arch widths difference.

Materials and Methods: Dental casts of 62 subjects aged between 18 - 28 years were included in the study. They were equally divided between males & females, consisting of 26 class I normal, 22 Class II division 1, and 14 Class III malocclusion and eleven linear measurements were utilized for each dental arch.

Results: All measured dimensions were greater in males than in females except for mandibular inter alveolar premolar width and maxillary left canine molar distance in class III malocclusion and in maxilla than in mandible except inter molar width in class II and class III groups and alveolar base dimensions in class III malocclusion. In class I all measurements were wider than class II division 1 while, in class III was wider than class I in all maxibular alveolar base and mandibular inter premolar width and wider in all maxillary dental arch widths, all mandibular alveolar base dimensions and mandibular inter canine and premolar widths than class II division 1 group.

Conclusion: Maxillary molar teeth in subjects with Class II division 1 tend to incline buccally to compensate the insufficient alveolar base, while subjects with Class III malocclusion maxillary posterior teeth tend to incline lingually and mandibular posterior teeth inclined buccally due to the restriction in maxillary arch.

Key words: Alveolar base; dental arch; class I normal; class II division 1 and III.

INTRODUCTION
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. (1)

The size and shape of the arches have considerable implications in orthodontic diagnosis and treatment planning, affecting the space available, dental esthetics, and stability of the dentition. (2)

Investigators have studied the growth of arch widths in persons with normal occlusion, and compared these values with those of different malocclusion samples. (3-8) however; there is considerable controversy among the results presented in the literature.

Information regarding maxillary arch dimensions in human populations is important to clinicians in orthodontics, prosthodontics, and oral surgery. It is also of interest to anthropologists and other students of human oral biology. (9)

Class II malocclusion is reported as the most frequently seen skeletal disharmony in orthodontic population. (10-15)

Transverse component in Class II patients is of great importance as sagittal or vertical components. Some of the authors evaluating transverse dimensions had reported that maxillary arch was narrower in patients with Class II, division I malocclusion, and an expansion was needed during or before treatment. (16-20) besides, Varella (21) had reported that the deficient transversal growth of the maxilla and the sagittal growth of the mandible appeared to cause the typical Class II occlusion. However, in one of the earlier studies, Fröhlich (4) found no difference in transverse dimension between Class I and Class II subjects.

Investigators have recommended strongly the early detection of all Classes of malocclusion (22) 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 (23) in the Kenyan, 14% by Salzmann (24) in the American, and 1.4% by Solow and Helm (25) in the Danish populations. Among 965 Turkish children, in the region of Konya, Turkey, a 3.5%
incidence of Class III malocclusion was found.\(^{(26)}\)

**MATERIALS AND METHODS**

Out of randomly selected subjects 320 Iraqi adults (156 males and 164 females) aged between 18 and 28 years were examined from the students and patients of College of Dentistry, Baghdad University. Only 64 subjects met the criteria of the samples, two of them were excluded due to defects in the cast.

**Sample criteria**

1. All the subjects were Iraqi Arab in origin.
2. Having complete permanent dentition regardless the third molars.
3. The age ranged between 18-28 years.
4. No attrition, no abrasion in all teeth
5. Healthy gingival tissue with no gingivitis or periodontitis or any gum recession.
6. Mild (1-2mm) or no crowding or spacing in all dental classes.
7. No rotation and normal canine inclination.
8. Intact tooth structure, no fracture, caries, trauma or heavy restoration.
9. No history of significant medical disease or trauma.
10. No previous orthodontic, prosthetic or surgical treatment was recorded.

The sample was categorized by the subjects’ angle classification and then by gender, the subjects’ angle classification was done according to Uysal et al.\(^{(27-28)}\) into three dental classes:

1. **Class I normal occlusion**, Class I canine and molar relationship with well-aligned upper and lower dental arches and overjet ranged between 1-4 mm and no cross bite even in single tooth.
2. **Class II malocclusion**, Bilateral Class II molar relationship in centric occlusion with the distobuccal cusp tip of the maxillary first molar within one mm (anterior or posterior) from the buccal groove of the mandibular first molar, bilateral canine class II and protrusive maxillary incisors and overjet ranged 4 - 10 mm and no cross bite even in single tooth exclusion of class II division 2 and class II subdivision.
3. **Class III malocclusion**, 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, bilateral canine class III with edge to edge or reversed over jet and no posterior cross bite.

Then each group was subdivided into two even subgroups according to their gender, males and females. Accordingly, the sample was distributed into 6 unequal groups (Table1).

Certain selected tooth-related points, visible in an occlusal and buccal, view were carefully marked bilaterally with a sharp pencil (0.5 pencil marker) in the maxillary and mandibular study casts to identify the landmarks that will be used for measuring the planned dental arch dimensions for this study (Figure 1 and 2).

One hundred and twenty four upper and lower dental casts were marked and analyzed. Twenty two measurements were taken for each subject. The dental arch dimension measurements were carried out using a digital vernier “Serial No.: 7156682; sensitivity: 0.01; Mitutoyo Digimatic, Japan. (Table 2).
RESULTS

Descriptive statistics (mean, standard deviation, minimum, maximum and range) and statistical comparisons of dental and alveolar width measurements for dental casts in three groups (normal occlusion, class II division I and Class III malocclusion) are obtained. According to independent samples t-test to differentiate between genders, in class I normal occlusion the mean values for all measurements were higher for males than for females with significant differences at P<0.001 in all alveolar base dimensions, UC-C, UP-P, LM-M, ULIC and LRIC and at P<0.01 in UM-M, LC-C, LP-P, URIC and LDAP and P<0.05 in UDAP, LLIC and LRCM while in class II division I also all values were higher in males than in females with significant differences at P<0.001 in only UAC-C and P<0.01 inter canine widths, UAP-P, UAM-M, left IC distance and UDAP and P<0.05 in LAP-P and right IC distances. Finally in class III malocclusion all measurements had a higher mean values in males than in females except LAP-P and ULCM distance and no significant at P>0.05 in all except in UC-C and LP-P at P<0.01 and LM-M at P<0.05

One way analysis of variance (ANOVA) and least significant difference (LSD) test to compare between three groups as in table 3, showed a very highly significant difference in mandibular inter alveolar canine and premolar widths and a highly significant difference in mandibular inter alveolar molar width and no significant difference in the rest of measurements among females in class I normal occlusion, class II and class III malocclusion groups; these results were specified by least significant difference (LSD) test as follow (Table 5):

1. Maxillary inter alveolar canine width: LSD test showed a significant difference between class I normal occlusion and class III malocclusion groups.
2. Mandibular inter alveolar canine width: LSD test showed a very highly significant difference between class II and class III malocclusion groups, and a highly significant difference between class I normal occlusion and class II malocclusion groups.
3. Mandibular inter alveolar premolar width: LSD test showed a highly significant difference between class I normal occlusion and class II malocclusion groups and a significant difference between class II and class III malocclusion groups.
4. Mandibular inter alveolar molar width: LSD test showed a highly significant difference between class I normal occlusion and class II malocclusion groups and a significant difference between class II and class III malocclusion groups.

DISCUSSION

In general, it is obvious that the mean values of all the measured variables (dental arch width, alveolar width and perimeter) confirmed the accepted view that the maxillary dental arch is larger in all dimensions than the mandibular dental arch as the maxillary dental arch overlaps the mandibular dental arch, except in class III where it was found that alveolar widths are larger in mandible than in maxilla this may be attributed to prognathic mandible in class III cases.

This study has confirmed the view that male’s dental arches are larger than that of female’s ones since all of the mean values are larger in male subjects than that of the females and this agrees with Brodie, Younes and Al – Hadithy and this may be attributed:
- The smaller and smoother bony ridge and alveolar process in females.
- The average weakness of musculature in females that play an important role in facial
breath measurements, width and height of the dental arch.

In genders differences some of variables showed significant differences and other no. these may agree with some studies and may be disagreed with other which could be due to ethnic differences or sample size and selection differences or may be different in point selection.

**Class I normal occlusion and Class II division 1 malocclusion**

All the measured variables were higher in both maxillary and mandibular arches for both males and females in class I normal occlusion group than in class II malocclusion group except for the mandibular inter premolar width. Clinicians have speculated that nasal obstruction, finger habits, tongue thrusting, low tongue position, and abnormal swallowing and sucking behaviors were reasons for narrower maxillary dental arch widths in Class II division 1 malocclusions compared with a normal occlusion sample. (28) moreover Staley et al. (37); Sayin and Turkkahrman (36) showed that the maxillary dental arch as a whole is narrower in adults with Class II division 1 malocclusion than it is in adults with normal occlusion this appeared to be caused by palatally tipped teeth and also by narrower bony bases of the dental arch. Their results showed that transverse discrepancy in Class II division 1 patients originated from upper posterior teeth and not from the maxillary alveolar base.

The results of this study supported by Uysal et al. (28) who reported that subjects with Class II division 1 malocclusion tend to have the maxillary molar teeth inclined buccally to compensate for the insufficient alveolar base. For that reason, rapid maxillary expansion rather than slow expansion may be considered before or during the treatment of a Class II division 1 patient.

Disagreement among studies of arch widths in Class II malocclusions may be explained by several factors: gender dimorphism, ethnic and racial differences, sample selection and size, and age of the subjects.

**Class I normal occlusion and Class III malocclusion**

In this study, the mandibular alveolar and mandibular inter premolar measurements associated with Class III occlusion were wider than the normal occlusion sample. A possible explanation for the increased arch width associated with Class III occlusion is that the sum of all the mesiodistal widths of the dental units around an arch represents a specific dimension and this supported by Sperry et al. (38) 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 (39) and Nie and Lin (40) showed that Class III cases are characterized by smaller maxillary tooth dimensions and bigger lower teeth. Hnat et al. (41) also reported 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 all the maxillary dental and alveolar width measurements were narrower in subjects with Class III malocclusion when compared with the normal occlusion sample.

Lingually positioned maxillary posterior cross bites 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 and agree with Braun et al. (1) 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 premolar area and the finding of Uysal et al. (27) showed subjects with Class III malocclusion tend to have the maxillary posterior teeth inclined to the lingual direction and mandibular posterior 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.

**REFERENCES**

Table 1: Sample size and mean age and over jet for each group

<table>
<thead>
<tr>
<th>Samples</th>
<th>N</th>
<th>Males</th>
<th>Females</th>
<th>Age</th>
<th>Over jet</th>
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<tbody>
<tr>
<td>Class I</td>
<td>26</td>
<td>13</td>
<td>13</td>
<td>22.57±2.39</td>
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<tr>
<td>Class II</td>
<td>22</td>
<td>11</td>
<td>11</td>
<td>21±2.51</td>
<td>5.55±2.17</td>
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<tr>
<td>Class III</td>
<td>14</td>
<td>7</td>
<td>7</td>
<td>20.79±1.53</td>
<td>-2.03±1.66</td>
</tr>
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</table>

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 interpemolar width (UP-P): the distance between the cusp tips of the right and left first premolars.
3. Maxillary intermolar 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 interpemolar width (LP-P): the distance between the cusp tips of the right and left mandibular first premolars.
6. Mandibular intermolar 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.
13. Maxillary and mandibular incisor canine distance (IC): distance from midway between two central incisors to canine cusp tip for right and left to represent anterior arch segment length
14. Maxillary and mandibular canine molar distance (CM): distance from canine cusp tip to misobuccal cusp tip of 1st molar for right and left representing buccal segment length.
15. Maxillary and mandibular dental arch perimeter (DAP): sum of anterior and buccal segmental length.
### Table 3: Differences among dental classes for all the measured variables by ANOVA test according to gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>Female N=31</th>
<th>Male N=31</th>
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<tbody>
<tr>
<td>UOC</td>
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<tr>
<td>UPP</td>
<td></td>
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<tr>
<td>UM,M</td>
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<td>UAC</td>
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<tr>
<td>UAM</td>
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<tr>
<td>RUC</td>
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<td>LUIC</td>
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<td>LUC</td>
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<td>RUCM</td>
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<td>LUOM</td>
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<tr>
<td>LUCM</td>
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<tr>
<td>DAP</td>
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### Table 4: Least significant difference (LSD) test of females in different classes

<table>
<thead>
<tr>
<th>Variables</th>
<th>Class I and class II</th>
<th>Class I and class III</th>
<th>Class III and class III</th>
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</thead>
<tbody>
<tr>
<td>Mean difference</td>
<td>P-value</td>
<td>Mean difference</td>
<td>P-value</td>
</tr>
<tr>
<td>LAC</td>
<td>3.256</td>
<td>0.039</td>
<td>3.647</td>
</tr>
<tr>
<td>LAP</td>
<td>3.510</td>
<td>0.040</td>
<td>3.595</td>
</tr>
<tr>
<td>LAM</td>
<td>2.001</td>
<td>0.078</td>
<td>2.463</td>
</tr>
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### Table 5: Least significant difference (LSD) test of males in different classes

<table>
<thead>
<tr>
<th>Variables</th>
<th>Class I and class II</th>
<th>Class I and class III</th>
<th>Class III and class III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean difference</td>
<td>P-value</td>
<td>Mean difference</td>
<td>P-value</td>
</tr>
<tr>
<td>LAC</td>
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<td>0.410</td>
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<tr>
<td>LAP</td>
<td>4.297</td>
<td>0.001**</td>
<td>3.191</td>
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<tr>
<td>LAM</td>
<td>2.044</td>
<td>0.011**</td>
<td>1.931</td>
</tr>
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