Dental arches dimensions, forms and the relation to facial types in a sample of Iraqi adults with skeletal and dental class I normal occlusion

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ABSTRACT
Background: The face is a three dimensional object, facial structures are arranged to give the face its normal form. The teeth are arranged in an arch that’s based on the jaw which is a part of the facial structure. The dental arch has certain forms depending on several factors including the skeletal form of the jaw and it is calculated in terms of different ratios of several arch dimensions. The aim of this study is to establish normative values for the Maxillary and Mandibular Dental arches dimensions represented by dental arch width, length and to find out the most frequent dental arch form and facial type and the role of gender differences and to find out if there is a relationship between the facial type and dental arches form and which is the most frequent facial type and dental arch form.

Materials and methods: The sample was selected from Baghdad University, college of Dentistry. A total of 72 Iraqi adult Dental students fit the criteria of this research with an age range between 18 and 25 years. The sample composed of one hundred forty four Dental casts, seventy two frontal photographs, seventy two profile photographs and One hundred forty four Dental casts’ photographs six linear measurements for Maxillary dental cast and six linear measurements for Mandibular Dental cast and two liner measurements for frontal and profile facial photographs. Orthodontics is one of the fields that took advantage of high speed personal computers such as Pentiums by utilizing specialized orthodontic programs (software) which have automated some of the more laborious tasks in diagnosis and treatment planning, storage and sorting of information. So the use of computers is obligatory in our modern life that’s why it was used in almost everything in this study from obtaining the record and analyzing them for typing and directing this thesis. Specialized computer software for orthodontic record analysis (AUTO CAD 2007) were used, which simplified the analyzing process and reduced the time and effort spent on taking measurements directly from the records to facilitate work and to gain more accurate results.

Results: It had been found that all of the maxillary dental arch dimensions are greater than mandibular dental arch dimensions in the total sample and both genders and all of the measured dental arch dimensions have a significantly greater mean value in males than in females also in general facial measurements were higher in males than males with a high significant difference except in the nasion gnathion distance in which it was not significant differences between both genders. The most frequent facial type in males and females is the Mesoprosopic one, followed by the Euryprosopic while the least frequent is the Leptoprosopic face type while the mid arch form is the most frequent arch form and it is usually associated with Mesoprosopic face type in both genders followed by the wide dental arch form and the narrow dental arch form.

Conclusions: It was concluded that the relation between facial type and dental arch form is a perfect positive correlation and as the facial type graduated from Leptoprosopic to Mesoprosopic to Euryprosopic then the Maxillary Dental arch form increases from narrow to mid to wide.

Key words: facial types, dental arch dimensions.

INTRODUCTION
It might be expected that faces would display some common features, but they are often as different from each other as they are from the rest of us. If we are able to accept that appreciation of facial beauty is innate, then presumably it must depend on recognizable difference in our faces. If so then it should be possible to define and measure them. (1)

One of the objectives of the orthodontic treatment is the improvement of facial appearance; therefore it is necessary to be able to define the good looking face. The introduction of anthropometric direct method, for measurement of facial features was first practiced by Hellman for orthodontic purposes.

From that time and up to date this direct facial measurements is used in the clinical diagnosis and treatment planning. (2)

MATERIALS AND METHODS
Sample
The sample was selected from Baghdad University, college of Dentistry. A total of 200 Iraqi adult Dental students were clinically examined (100 female, 100 male) and only 72 of them (29 male and 43female) fit the criteria of this research of class I skeletal and dental relationship with an age range between 18 and 25 years old were selected. The sample composed of 144 Dental casts, 144 Photographs of the dental casts, 72 Frontal photographs for the person and 72 Profile photographs for the person.

(1) M.Sc. Student, Department of Orthodontics, Dental College, University of Baghdad.
(2) Professor, Department of Orthodontics, Dental College, University of Baghdad.
Criteria of the Sample
1. Iraqi Arabs Dental subjects.
2. Age range between 18 and 25 years old.
3. Full permanent teeth excluding the third molars (3).
4. Class I incisor classification (4).
5. Bilateral Class I molar and canine relationships (5).
6. Class I skeletal relationship, diagnosed clinically by using the two fingers technique mentioned by (6).
7. Free of local factors that disturb the integrity of the dental arches. (Congenital missing teeth; retained deciduous; supernumerary teeth) (7).
8. No crown and bridge prosthesis or large dental fillings (8).
9. Competent lips and absence of gross asymmetry of the face and the jaws with acceptable facial esthetic (9).
10. No or minor spacing or crowding (10).
11. No history of bad oral habits like thumb sucking, tongue thrust or mouth breathing (11).
12. No previous orthodontic, orthopedic, or facial surgical treatments (12).
13. No active periodontal diseases and gingivitis, also no periodontal treatment except for ordinary scaling and polishing (13).
14. No crossbite, no instanding incisor (14).
15. Overjet and overbite of 2-4 mm (8).

Methods
Standardization of the facial photographs
The camera was fixed in position and adjusted in height to be at the level of subject’s eyes in the frontal photograph with a height adjustable tripod. The distance from the camera to the subject was fixed at a distance of about 1.01m measured from the tripod’s column to the ear rods that were fit in the external auditory meatus in order to avoid the forward, backward, and tilting of the subject head (Cephalostate based head position). The subject was asked to look to the center of the lens of the camera in the frontal photograph and to look at a distant mirror which is placed in front of his/her face in the lateral photograph with ear rods in the external auditory meatus (16).

Facial landmarks: (figure 1)
1. nasion (n) The point in the midline of both the nasal root and the nasofrontal suture, always above the line that connects the two inner canthi, identical to bone nasion (17).
2. Gnathion (gn): The soft tissue point corresponding to skeletal Gnathion (18) which is the most anterior and inferior point of the soft tissue chin (19).
3. zygion (zyg): The most prominent point on the cheek area beneath the outer canthus and slightly medial the vertical line passing through it; different from bony zygion (17).

Linear measurements
1. Interzygomatic distance (IzD): It is the transverse distance between soft tissue zygion on both sides (20).
2. Anterior facial height (n-gn): It is the distance between soft tissue nasion and soft tissue gnathion (7).
Facial types

Facial Form was determined using  
method by calculating the ratio between interzygomatic distance and anterior facial height, and then the face type for each subject is classified as follows:

- Euryprosopic IzD/n-gn. The facial index is > 0.93
- Mesoprosopic IzD/n-gn. The facial index is ≤ 0.93 and ≥ 0.83
- Leptoprosopic IzD/n-gn. The facial index is < 0.83

Standardization of the Dental casts photographs:

After taking the proper impression for the maxillary and mandibular arches and preparing the casts, a photograph was taking to each dental cast using an apparatus designed by Dr. Saadi.

Dental cast landmarks (figure 2)

1. Incisal point: The point in the midway between the incisal edges of the two central incisors.
2. Canine point: The cusp tip of the right and left permanent canines.
3. Mesiobuccal cusp tip of the first molars: the mesiobuccal cusp tips of the right and left first permanent molars.
4. Distobuccal cusp tip of second molars: the distobuccal cusp tips of the right and left second permanent molars.

Dental Arch Width

1. The inter canine distance (ICD): The linear distance from cusp tip of one canine to the cusp tip of the other.
2. Inter First Molar Distance (IMD): The linear distance from the mesiobuccal cusp tip of first permanent molar, to the mesiobuccal cusp tip of the other.
3. Inter-second molar distance (I2ndMD): The linear distance between the distobuccal cusp tip of one second permanent molar, to the distobuccal cusp tip of the other.

Dental Arch Length

1. Canine vertical distance (CVD): The vertical distance from the incisal point perpendicular to a line joining the inter-canine distance at the cusp tips.
2. Molar Vertical Distance (MVD): The vertical distance from the incisal point perpendicular to a line joining the mesiobuccal cusp tips of first permanent molars.
3. Total Arch Length (TAL): The inter – incisal point to the mid distance of the maxillary and mandibular inter – second molar width at the mesiobuccal cusp.

Six dental cast’s measurements were divided into three sagittal measurements, and three transverse measurements were utilized to calculate three independent ratios, which are:

- Canine vertical distance / inter-canine distance.
- Molar vertical distance / inter-first molar distance.
- Total arch length / inter-second molar distance.

The standardized number was calculated for each of three ratios for each subject by the excel program. Then the mean of these standardized numbers was calculated for each subject which gave the base for classification as follows:

1. Narrow form the mean of standardized number >+1.
2. Mid form the mean of standardized number between (+1 and -1).
3. Wide the mean of standardized number < -1 (Jassim, 2010).

Statistical Analysis

All the data of the sample were subjected to computerized statistical analysis using SPSS version 15 (2006) computer program. The statistical analysis included:

A. Descriptive Statistics
- Mean
- Standard deviation
- Standard error
- Minimum and maximum values

B. Inferential Statistics
- Independent- samples t-test for the comparison between both genders (Levene’s Test for Equality of Variances).
- Chi square test.
- Pearson’s correlation coefficient to test the correlation between the dental arches and facial measurements. If r² value is ≥ 1 then the relation is direct positive, while if r² value is ≤ -1 the relation is reverse.

In the statistical evaluation, the following levels of significance are used:

- Non-significant NS: P > 0.05
- Significant *: 0.05 ≥ P > 0.01
- Highly significant **: 0.01 ≥ P > 0.001

RESULTS

Descriptive statistics for the maxillary dental arch dimensions for the total sample and both genders and Comparison between males and females (table 1)

All of the widths measurements have significantly greater mean value in males than females. All of the lengths measurements have
greater mean value in male than females but the difference is not significant.

**Descriptive statistics for the mandibular dental arch dimensions for the total sample and both genders and Comparison between males and females (table 2)**

All of the widths measurements have significantly greater mean value in males than females. All of the lengths measurements have greater mean value in males than females but the difference is not significant except for the total arch length in which the difference was highly significant.

**Comparison between maxillary and mandibular arches in males, females and the total sample (table 3 and 4)**

All of the widths and lengths measurements have significantly greater mean value in maxillary arch than mandibular arch in males, females and the total sample.

**Descriptive statistics of the Facial measurements and Comparison between males and females Facial measurements (table 5)**

We can notice that females have higher mean value in all of the facial measurements (interzygomatic distance, nasion-gnathion distance and interzygomatic distance / nasion-gnathion distance ratio).

**Spearman’s rank correlation coefficient ($r^2$) (figure 3).**

By applying spearman’s rank correlation coefficient ($r^2$) we gave the facial form the following ranks: Leptoprosopic facial type rank 1, Mesoprosopic facial type rank 2, Euryprosopic facial type rank 3. While we gave the Dental arch form the following ranks: Narrow arch form rank 1, Mid arch form rank 2, Wide arch form rank 3.

**DISCUSSION**

**Explanation for the genders difference in Maxillary and Mandibular dental arch measurement**

1. The smaller and smoother bony ridge and alveolar process of females (26).
2. The average weakness of musculature in females that play an important role in width and height of dental arch (26).
3. Longer growth period for males than females (27).

**Explanation for the inter arches difference between both genders:**

Since our sample is a class I normal occlusion then maxillary dental arch should overlap the mandibular dental arch (28, 14).

**Explanation for the Descriptive statistics of the Facial measurements and Comparison between males and females Facial measurements**

Our result was near to that of (14) but far from that of (29) since he used skeletal zygoin on a frontal radiograph and because of fitness and obesity of the individual which was not considered in this study or the other studies since it has a direct effect on the soft tissue thickness that overlay the face bone and so affects on facial measurements also ethnic variations and sample size.

Inter Zygomatic Distance and Anterior facial height (n-gn) Ratio is influenced directly by (zy-zy) and (n-gn) measurements and since the (zy-zy) was larger in females than males and that is why the ratio was higher in females than males which gives females faces toward an oval shape in comparison with the males faces. This in agreement with (30) who found that the females face are more smooth and rounded contours, while males face are angular and square with accentuated ridges and prominence.

**Relationship between the Facial Type and Dental arch Forms:**

The most frequent facial type in males, females and the total sample is the Mesoprosopic one, followed by the Euryprosopic while the least frequent is the Leptoprosopic face type. The most frequent arch form in males and females and the total sample is the mid arch form followed by wide then narrow arch form. The mid arch form which is the most frequent arch form is usually associated with Mesoprosopic face type in both genders. The relation between facial type and dental arch form is a positive relation and as the facial type graduated from Leptoprosopic to Mesoprosopic to Euryprosopic then the mandibular Dental arch form increases from narrow to mid to wide. (Perfect positive correlation).

This study agrees with other studies (31, 32, 33, 7, 10, 29) in that the mid arch form was associated with Mesoprosopic; Narrow arch forms with Leptoprosopic and wide arch forms with Euryprosopic face type This study is like a support to these findings, however the result of this study can be more confident since the only study that uses the spearman’s rank correlation
coefficient (r^2) to determine the association between facial type and Dental arch form. It is clear that there is a Perfect positive correlation between facial form and Maxillary/Mandibular Dental arch form. While \(^{(7)}\) stated that the association was not unexpected, \(^{(34)}\) agrees on that there is no clear relationship between facial forms and arch forms.

![Figure 1: Facial land marks](image)

**Figure 1: Facial land marks**

![Figure 2: Dental cast land marks and linear measurements](image)

**Figure 2: Dental cast land marks and linear measurements**

![Figure 3: The association between facial type and Maxillary-Mandibular dental arch form (spearman’s rank correlation coefficient r^2).](image)

**Figure 3: The association between facial type and Maxillary-Mandibular dental arch form (spearman’s rank correlation coefficient r^2).**

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Table 1: Descriptive statistics for the maxillary dental arch dimensions for the total sample and both genders and Comparison between males and females.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Sex</th>
<th>Min-Max.</th>
<th>Descriptive statistics</th>
<th>Genders differences</th>
<th>t-test</th>
<th>p-value</th>
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<td>Male</td>
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<td>38.16</td>
<td>4.24</td>
<td>0.001</td>
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<td>Canine vertical distance</td>
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<td>35.60</td>
<td>4.24</td>
<td>0.001</td>
<td>***</td>
</tr>
<tr>
<td></td>
<td>Total</td>
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<td>4.24</td>
<td>0.001</td>
<td>***</td>
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<td>38.16</td>
<td>4.24</td>
<td>0.001</td>
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<td>35.60</td>
<td>4.24</td>
<td>0.001</td>
<td>***</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>29.7</td>
<td>36.63</td>
<td>4.24</td>
<td>0.001</td>
<td>***</td>
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<td>Molar vertical distance</td>
<td>Male</td>
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<td>30.13</td>
<td>1.39</td>
<td>0.17</td>
<td>(NS)</td>
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<td>Female</td>
<td>25.3</td>
<td>29.41</td>
<td>1.39</td>
<td>0.17</td>
<td>(NS)</td>
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<td>Total</td>
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<td>1.39</td>
<td>0.17</td>
<td>(NS)</td>
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<td>57.32</td>
<td>4.4</td>
<td>0.001</td>
<td>***</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>47.60</td>
<td>53.69</td>
<td>4.4</td>
<td>0.001</td>
<td>***</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>47.60</td>
<td>55.15</td>
<td>4.4</td>
<td>0.001</td>
<td>***</td>
</tr>
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<td>Total arch length</td>
<td>Male</td>
<td>41.3</td>
<td>46.40</td>
<td>1.12</td>
<td>0.27</td>
<td>(NS)</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>39.9</td>
<td>45.57</td>
<td>1.12</td>
<td>0.27</td>
<td>(NS)</td>
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<td>Total</td>
<td>39.9</td>
<td>45.90</td>
<td>1.12</td>
<td>0.27</td>
<td>(NS)</td>
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<td>Inter second molar</td>
<td>Male</td>
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<td>64.81</td>
<td>5.5</td>
<td>0.001</td>
<td>***</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>53.68</td>
<td>60.03</td>
<td>5.5</td>
<td>0.001</td>
<td>***</td>
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<tr>
<td></td>
<td>Total</td>
<td>53.68</td>
<td>61.95</td>
<td>5.5</td>
<td>0.001</td>
<td>***</td>
</tr>
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</table>

*N 72, ♀43, ♂29,d.f.=70, p<0.05, all measurements are in mm. N.S: No Significant difference at P > 0.05.
Table 2: Descriptive statistics for the mandibular dental arch dimensions for the total sample and both genders and Comparison between males and females.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Sex</th>
<th>Descriptive statistics</th>
<th>Genders differences</th>
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<td></td>
<td>Min-Max.</td>
<td>Mean</td>
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<td>5.32</td>
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<td>Female</td>
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<td>5.06</td>
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<td></td>
<td>Total</td>
<td>2.3 8.2</td>
<td>5.17</td>
</tr>
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<td>Inter canine distance</td>
<td>Male</td>
<td>24.1 34.4</td>
<td>28.77</td>
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<td></td>
<td>Female</td>
<td>23.3 32.7</td>
<td>27.42</td>
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<tr>
<td></td>
<td>Total</td>
<td>23.3 34.4</td>
<td>27.96</td>
</tr>
<tr>
<td>Molar vertical distance</td>
<td>Male</td>
<td>21.1 28.5</td>
<td>25.11</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>20.4 28.8</td>
<td>24.36</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>20.4 28.8</td>
<td>24.66</td>
</tr>
</tbody>
</table>
| Inter molar distance             | Male  | 40 55.3                | 49.11             | 3.67 | 0.68 | 4.24   | 0.001   ***
|                                  | Female| 40 53.4                | 45.77             | 2.98 | 0.45 |        |         |
|                                  | Total | 40 55.3                | 47.12             | 3.65 | 0.43 |        |         |
| Total arch length                | Male  | 37.8 46.7              | 42.04             | 2.60 | 0.48 | 2.36   | 0.02    *|
|                                  | Female| 35.4 46.8              | 40.51             | 2.76 | 0.42 |        |         |
|                                  | Total | 35.4 46.8              | 41.13             | 2.78 | 0.33 |        |         |
| Inter second molar               | Male  | 51.4 66.2              | 58.68             | 3.95 | 0.73 | 3.97   | 0.001   ***
|                                  | Female| 49 63.6                | 55.17             | 3.46 | 0.53 |        |         |
|                                  | Total | 49 66.2                | 56.58             | 4.03 | 0.48 |        |         |

* N 72, ♀43, ♂29 d.f.=70, p<0.05, all measurements are in mm. N.S: No Significant difference at P > 0.05.

Table 3: Comparison between maxillary and mandibular arches in males

<table>
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<tr>
<th>Variables</th>
<th>Arch</th>
<th>Descriptive statistics</th>
<th>Arch differences</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>S.D.</td>
</tr>
</tbody>
</table>
| Canine vertical distance   | Maxillary arch             | 9.31 | 1.31 | 0.24 | 12.86  | 0.001   ***
|                            | Mandibular arch            | 5.32 | 1.03 | 0.19 |        |         |
| Inter canine distance      | Maxillary arch             | 38.16 | 2.79 | 0.52 | 13.4   | 0.001   ***
|                            | Mandibular arch            | 28.77 | 2.54 | 0.47 |        |         |
| Molar vertical distance    | Maxillary arch             | 30.13 | 2.24 | 0.42 | 8.92   | 0.001   ***
|                            | Mandibular arch            | 25.11 | 2.05 | 0.38 |        |         |
| Inter molar distance       | Maxillary arch             | 57.32 | 4.11 | 0.76 | 8.03   | 0.001   ***
|                            | Mandibular arch            | 49.11 | 3.67 | 0.68 |        |         |
| Total arch length          | Maxillary arch             | 46.40 | 2.88 | 0.54 | 6.04   | 0.001   ***
|                            | Mandibular arch            | 42.04 | 2.60 | 0.48 |        |         |
| Inter second molar         | Maxillary arch             | 64.81 | 3.95 | 0.73 | 5.9    | 0.001   ***
|                            | Mandibular arch            | 58.68 | 3.95 | 0.73 |        |         |

* ♀29, p<0.05, all measurements are in mm. N.S: No Significant difference at P > 0.05.
Table 4 Comparison between maxillary and mandibular arches in females

<table>
<thead>
<tr>
<th>Variables</th>
<th>Arch</th>
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<tr>
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<td></td>
<td>Mean</td>
<td>S.D.</td>
</tr>
<tr>
<td>Canine vertical distance</td>
<td>Maxillary arch</td>
<td>9.11</td>
<td>1.34</td>
</tr>
<tr>
<td></td>
<td>Mandibular arch</td>
<td>5.06</td>
<td>1.13</td>
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<tr>
<td>Inter canine distance</td>
<td>Maxillary arch</td>
<td>35.60</td>
<td>2.32</td>
</tr>
<tr>
<td></td>
<td>Mandibular arch</td>
<td>27.42</td>
<td>1.97</td>
</tr>
<tr>
<td>Molar vertical distance</td>
<td>Maxillary arch</td>
<td>29.41</td>
<td>2.10</td>
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<td>Mandibular arch</td>
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<tr>
<td>Inter molar distance</td>
<td>Maxillary arch</td>
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<td>Mandibular arch</td>
<td>45.77</td>
<td>2.98</td>
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<td>Total arch length</td>
<td>Maxillary arch</td>
<td>45.57</td>
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<td></td>
<td>Mandibular arch</td>
<td>40.51</td>
<td>2.76</td>
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<tr>
<td>Inter second molar</td>
<td>Maxillary arch</td>
<td>60.03</td>
<td>3.37</td>
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<td></td>
<td>Mandibular arch</td>
<td>55.17</td>
<td>3.46</td>
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* N 72, \( \mathcal{d}.3, \mathcal{d}.29 \) p<0.05, all measurements are in mm. N.S: No Significant difference at P > 0.05.

Table 5: Descriptive statistics of the Facial measurements and Comparison between males and females Facial measurements

<table>
<thead>
<tr>
<th>Variables</th>
<th>Sex</th>
<th>Descriptive statistics</th>
<th>Genders differences</th>
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<td>Max.</td>
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<td>Male</td>
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<td>112.53</td>
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<td></td>
<td>Female</td>
<td>98.91</td>
<td>124.3</td>
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<td>n-gn</td>
<td>Male</td>
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<td>131.83</td>
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<td></td>
<td>Female</td>
<td>97.14</td>
<td>138.86</td>
</tr>
<tr>
<td>IzD/n-gn</td>
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<td>1.05</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>0.76</td>
<td>1.21</td>
</tr>
</tbody>
</table>

* N 72, \( \mathcal{d}.3, \mathcal{d}.29 \) p<0.05, all measurements are in mm. N.S: No Significant difference at P > 0.05.

REFERENCES