

## COMPONENTS OF CLASS III MALOCCLUSION OF ADULT SAUDI MALE

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### ABSTRACT

*The purpose of this study was to investigate the components of class III malocclusion in adult Saudi male, and to compare the results to the control group with normal occlusion. Thirty standardized pre-treatment cephalometric radiographs of adult Saudi males with skeletal class III malocclusion and thirty cephalometric radiographs of dental students with normal occlusion were traced and digitized. Forty linear and angular variables were obtained to measure five major components of craniofacial structures; the cranial base, maxillary skeletal, mandibular skeletal, dentoalveolar, and soft tissues. The intra- and inter-examiner method errors were small and acceptable. The results showed statistically significant differences in the comparisons of the five major craniofacial components between the adult Saudi male with class III malocclusion and those with normal occlusion. The Saudi adult males with class III malocclusion have shorter anterior, posterior and total cranial base length and smaller cranial base angle (saddle angle), retrognathic maxilla with short maxillary length, prognathic mandible and chin, longer total mandibular length, steeper mandibular plane with obtuse gonial angle, decreased posterior facial height, protruded maxillary incisors and retruded mandibular incisors with larger interincisal angle, retrusion of upper and lower lips to "E" line, and smaller nasiolabial angle.*

*Key words: Class III malocclusion, Components, Saudi male adults, Cephalometric radiographs.*

### INTRODUCTION

The human head is a very complex three-dimensional structure. It consists of different components of underlying skeletal structures covered by soft tissue. The different components are related to each other and the balanced facial appearance is achieved when there is favorable relationship between these components. The anteroposterior relationship was of great importance therefore the facial profile was classified into three types, class I, class II and class III. The class III malocclusion with the appearance of protruded mandible and lower incisors has been the subject of interest and concern to the orthodontist since the beginning of

the specialty. It represents many problems in diagnosis and treatment planning and management.<sup>1,2,3,4,5</sup> It is classified into dental and skeletal. The dental class III malocclusion has no significant skeletal component and can be managed without much difficulty. Whereas the skeletal class III malocclusion is associated with a wide variety of underlying skeletal and dental patterns. It confused and frustrated the clinicians more than any other occlusal anomalies. The factors contributing to the anomaly are complex and they may act synergistically or in isolation. There is considerable controversy as to the relative contributions of the cranial base, the maxilla, and the mandible. Once the skeletal abnormality in class III malocclusion has been

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identified and classified, the treatment plan and treatment modality can successfully proceed. Although class III malocclusion is easy to identify, the cephalometric radiography enabled the orthodontist to view the underlying bony structure and to study the size and relationships of different components of the craniofacial structures. The morphological structure and the manifestation of class III malocclusion make it an important subject-of-study for research and clinical observation. Several studies were conducted in different parts of the world and the literature is packed with publications that describe the morphological features of class III malocclusion in different ethnic groups such as the Caucasian,<sup>6,7,8,9,10,11,12,13,14</sup> Mongoloid<sup>15,16,17,18,19,20,21,3,22,23,24,25</sup> and Negroid<sup>26,27,28,29,30</sup> unfortunately, there was a deficiency in the comprehensive description of class III malocclusion of the Saudis in the literature. The lack of such study stimulated the interest to conduct the present study.

The aim of the study was to study the components of class III malocclusion in the adult Saudi male and to compare the results to control group. In an attempt to achieve the above objective, the following hypothesis was formulated and tested Battagel.<sup>33</sup> here is no difference in the morphological structures between the Saudi male with class III malocclusion and the normal occlusion".

## MATERIALS AND METHODS

### The Sample

The sample of the present study comprised of two groups, the study sample with class III malocclusion and the control group with normal occlusion. The study group consisted of 30 pretreatment lateral cephalometric radiographs of adult Saudi male with class III malocclusion. The radiographs were derived from the files of patients diagnosed with skeletal class III malocclusion at the Orthodontic Department of King Saud University. The criteria for selection included; (1) Adult Saudi ethnicity patients 18 years of age or above (2) Class III skeletal relationships [ $ANB > -1^\circ$ ] (3) Cross bite of anterior teeth [Overjet  $> -1$  mm] (4) No previous orthodontic treatment (5) No trauma or jaw fracture (6) No cleft palate or craniofacial syndrome.

The control group was selected from the pool of cephalometric radiographs belonging to the undergraduate dental students of King Saud University. Out

of 230 radiographs, 30 lateral cephalometric radiographs of adult Saudi male were selected as control group. The criteria for selection included; (1) Adult Saudi ethnicity student 18 years of age or above (2) Normal skeletal relationship [ $ANB = 1^\circ - 3^\circ$ ] (3) Normal overjet and overbite [2-4 mm] (4) No previous orthodontic treatment (5) No cleft palate or craniofacial syndrome.

### Cephalometric radiography

All lateral cephalometric radiographs were taken under standardized technique within the premises of the college. The cephalographs of the study and the control group were traced by the investigator following the procedures described by Houston.<sup>31</sup> Tracing was carried out in a darkened room using an illuminated viewing screen with a black surrounded to reduce extraneous light. Each radiograph was firmly secured to the surface of a viewing box and a sheet of fine grade, semi-matt acetate tracing paper 8" x 10" was taped over the radiographs. Using a hard 4H pencil, landmarks were identified by a single point, in a predetermined order. For bilateral structures and double images, the midpoint was chosen by construction. Each radiograph traced twice and the average of two measurements used in subsequent analysis as recommended by Houston<sup>32</sup> and Battage1.<sup>33</sup>

### Cephalometric Landmarks

The following anatomical landmarks were identified and located for digitization. Nasion (N), Sella Turcica (S), Basion (Ba), Articulare (Ar), Orbitale (Or), Porion (Po), Anterior nasal spine (ANS), Posterior nasal spine (PNS), Point (A), Upper incisor edge (UIE), Upper incisor apex (UIA), Gonion (Go), Menton (Me), Pogonion (Pog), Point (B), Lower incisor edge (LIE), Lower incisor apex (LIA), Pronasale (Pr), Collumella (Cm), Subnasale (Sn), Laberale Superius (UL), Laberale inferius (LL), Soft tissue pogonion (SPog).

Figure (1) illustrates the anatomical landmarks and the definition of each landmark was presented in Bhatia and Leighton,<sup>34</sup> and Riolo *et al.*<sup>35</sup>

### Digitization

The latest edition of a program called Jiffy Orthodontic Evaluation (JOE 32) was used for digitization. Following point identification, the tracings were se-

cured to the illuminated surface of the digitizing table (20 X 20 inch) linked to a computer for recording. Each cephalometric point marked on the tracing Paper was subsequently digitized, again in the same order using cursor and recorded by clicking a mouse button. From these digitized points the computer software calculated the X and Y value. The X and Y co-ordinates of these Points were subsequently used to calculate the various angular and linear measurements. Although 23 anatomical landmarks were needed for analysis, each radiograph was digitized by the investigator using 138 points that was required by the software to complete the digitization. To avoid investigator fatigue no more than 10 radiographs were digitized at any one time. The radiographs were retraced and redigitized after a period of six week interval to evaluate the method errors.

### Computation of Measurement

From the digitized points, the following 40 linear and angular variables were measured. The variables were presented according to the five major components of the craniofacial structures.

#### a. Cranial Base Measurements (Figure 2)

1. **S-N (mm)** Anterior cranial base measured as the distance between sella and nasion
2. **S-Ar (mm)** Posterior cranial base measured as the distance between sella and articulare
3. **N-Ar (mm)** Total cranial base measured as the distance between Nasion and articulare
4. **N-S-Ar (dg)** Cranial base angle (saddle angle)
5. **N-S-Ba (dg)** Cranial base angle (saddle angle)

#### b. Maxillary Skeletal Measurements (Figure 3)

6. **S-A (mm)** The distance between sella and A point.
7. **Ar-A (mm)** The distance between articulare and A point

8. **A-N-Pog (mm)** Maxillary prognathism measured from point A perpendicular to facial plane
9. **S-N-A(dg)** Angle between the sella-nasion line and the nasion-point A line
10. **N-ANS(mm)** Upper anterior facial height measured as the distance between nasion and anterior nasal spine.
11. **PP/S-N(dg)** Angle measured between the palatal line and sella-nasion line.
12. **ANS-PNS(mm)** Maxillary base length measured as the distance between anterior nasal spine and posterior nasal spine.

#### c. Mandibular Skeletal Measurements(Figure 4)

13. **S-B(mm)** The distance between sella and B point.
14. **S-N-B(dg)** The angle between the sella nasion line and the nasion-point B line.
15. **S-Pog(mm)** The distance between sella and pogonion.
16. **S-N-(dg)** The angle between the sella-Nasion line and nasion-pogonion line.
17. **ANS-Me(mm)** Lower anterior facial height measured as the distance between anterior nasal spine and menton.
18. **N-Me(mm)** Total facial height measured as the distance between nasion and menton.
19. **S-Go(mm)** Posterior facial height measured as the distance between Sella and gonion.
20. **S-N/Go-Me(dg)** The angle between sella-nasion line and the mandibular plane.

21. **PP/Go-Me(dg)** The angle between palatal Plane & the mandibular Plane.
22. **S-Ar-Go(dg)** The angle between sella-Articulare line and the articulare-gonion line known as joint angle.
23. **Ar-Go(mm)** The ramus height measured as the distance between articulare and gonion.
24. **Go-Pog(mm)** The ramus height measured as the distance between gonion and pogonion.
25. **Ar-Go-Me(dg)** Total mandibular length as the distance between articulare and pogonion.
26. **Ar-Go-Me(dg)** The angle between articular – gonion line and mandibular plane known as gonial angle.
27. **A-N-B(dg)** The angle between nasion-A point line and nasion-B Point line.

#### **d. Dentoalveolar Measurements (Figure 5)**

28. **U1/S-N(dg)** The angle between the long axis of the upper incisor and Sella-nasion line.
29. **U1/S-N(dg)** The angle between the long axis of the upper incisor and The maxillary plane.
30. **U1/N-A(dg)** The angle between the long axis of the upper incisor and nasion-A point line.
31. **U1/N-A(mm)** The perpendicular distance between upper incisor edge and nasion-A point line.
32. **L1/Go-Me(dg)** The angle between the long axis of the lower incisor and mandibular plane.
33. **L1/N-B(dg)** The angle between the long axis of the lower incisor and nasion-B point line.

34. **L1/N-B(mm)** The perpendicular distance between lower incisor edge and nasion-B point line.
35. **U1/L1(dg)** The angle between the long axis of the upper incisor and the long axis of the lower incisor.
36. **OJ(mm)** The horizontal distance between the lower central incisors to the upper central incisor.
37. **OB(mm)** The vertical distance between the lower central incisors to the upper central incisor.

#### **e. Soft Tissue Measurements (Figure 6)**

38. **UL/E-line(mm)** The perpendicular distance between the mucocutaneous border of the upper lip and the E-line.
39. **LL/E-line(mm)** The perpendicular distance between the mucocutaneous border of the lower lip and the E-line.
40. **NLA(dg)** Nasiolabial angle formed by the Intersection of a line tangent to the columella of the nose and a line drawn from subnasale to mucocutaneous border of the upper lip.

#### **METHOD ERROR**

The magnification factor of the radiographic image was calculated as follow:

Magnification factor= True measurement ÷ image measurement.

The magnification factor of 0.91 was calculated and entered in the computer to compensate for the magnification of the linear measurements.

The errors of the measurement method was evaluated by repeated measurement of thirty cephalograms retraced and re-digitized, after six weeks interval. The method errors were assessed by the Double

deter-

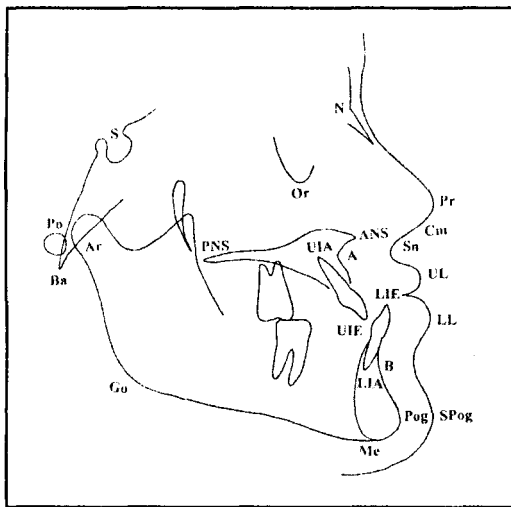


Fig. 1. Cephalometric landmarks

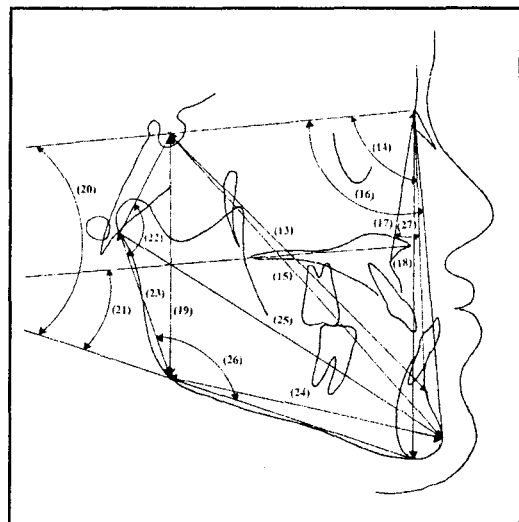


Fig. 4. Mandibular skeletal measurements

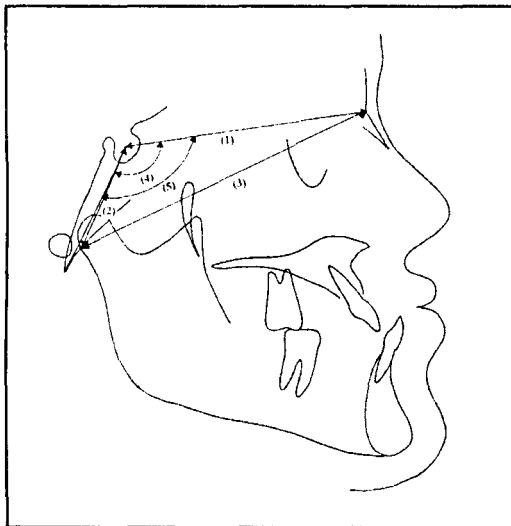


Fig. 2. Cranial base measurements

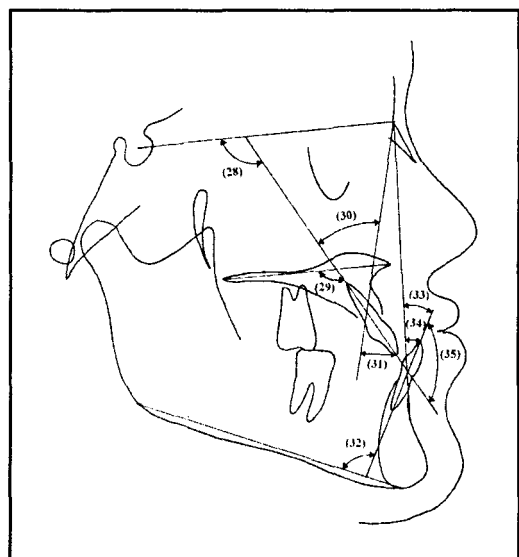


Fig. 5. Dentoalveolar measurements

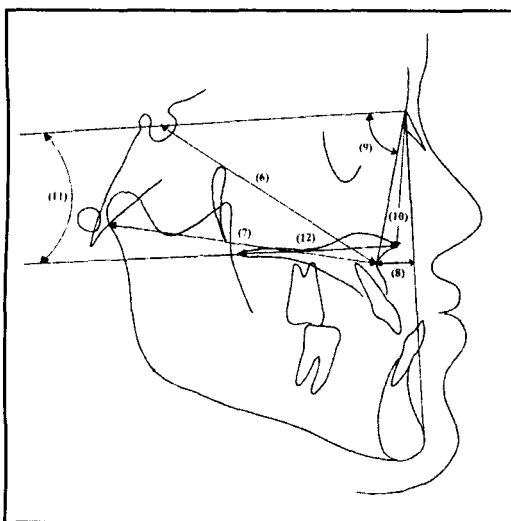


Fig. 3. Maxillary skeletal measurements

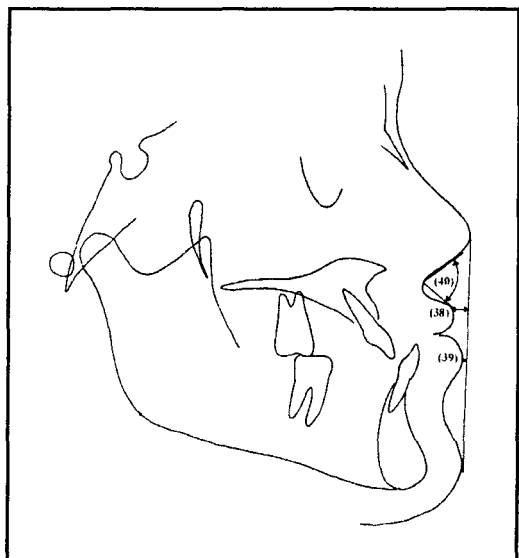


Fig. 6. Soft tissue measurements

mination method of Dahlberg<sup>36</sup> and the coefficient of reliability.

The Double determination method of Dahlberg or Dahlberg's method error was calculated as follow:

$$\text{Dahlberg's method error} = \frac{ID}{2n} \text{ (Dahlberg)}^{36}$$

Where d = The difference between two value when measured on two occasions

n = The number of observations of the variable

The coefficient of reliability was calculated for each measurement as follow:

$$\text{Coefficient of reliability} = 1 - \frac{See}{St^2} \text{ (Guilford and Fruchter)}^{37}$$

Where See = Variance due to random errors

St<sup>2</sup> = Total variance of the measurements

The errors of the repeated measurements, of the intra- and inter-examiner errors, were generally small and acceptable, with the values being less than 1 mm for the linear measurement and less than 1 degree for the angular measurements. The coefficient of reliability showed that the measured variables were highly correlated with the values between 0.98 and 0.85.

## Statistical Analysis

The statistical analysis was performed using the SPSS version 10 statistical package. The mean and standard deviations for each of the five components of class **III** malocclusion and the control were calculated. The means of the class **III** malocclusion and the control were subjected to the independent Student's t test for significant differences between the means values. The significance of the difference was presented as one asterisk (\*) to indicate significant difference at 5% level of confidence where  $P < 0.05$ , (\*\*) indicate high significant difference at 1% level of confidence where  $P < 0.01$ , (\*\*\*) indicate very high significant difference at 0.1% level of confidence where  $P < 0.001$ , and (NS) indicating no significant difference.

## RESULTS

The five major components of the craniofacial structure of the adult Saudi male with class **III** malocclusion were measured and compared to the measurements of the adult Saudi with normal occlusion using 40 variables and presented in Tables 1 to 5.

Table 1 presented the results of the cranial base measurements. The table showed that all cranial base measurements (linear and angular) were smaller for class **III** Saudi male compared to the control. The means differences were statistically significant at  $P > 0.01$  and  $P > 0.001$ .

Table 2 presented the results of the maxillary skeletal measurements. The measurements of the maxillary skeletal relationship were smaller for class **III** Saudi male compared to the control except for N-ANS(mm) and PP/S-N(dg). The mean differences of the measurements were statistically significant except for N-ANS (mm) and PP/S-N(dg) respectively.

Table 3 demonstrated the result of the mandibular skeletal measurements. The results showed that, the measurements of the mandibular skeletal relationship were larger for class **III** Saudi male compared to the control except for S-Go(mm), S-Ar-Go(dg), Ar-Go(mm) and A-N-B(dg). On the other hand, the means difference were significant for the measurements except for ANS-Me(mm), N-Me(mm), S-Ar-Go(dg), Ar-Go(mm), and Go-Pog(mm).

Table 4 showed the results of the dentoalveolar measurements. There was significant differences for all comparison of the dentoalveolar relationship between the class **III** Saudi male compared to the control except for the two parameters U1/S-N(dg) and OB(mm). The upper anterior teeth were protruded and the lower anterior teeth were retruded in the class **III** Saudi male compared to the control at statistically significant differences.

Table 5 presented the results of the soft tissue measurements. The upper and lower lips were retruded in class **III** Saudi male compared to the control Saudi male at a very high significant level of difference ( $P < 0.001$ ). Whereas, the nasiolabial angle was smaller for the class **III** Saudi male compared to the control Saudi male at a significant level of ( $P < 0.001$ ).

TABLE 1: THE MEAN AND STANDARD DEVIATION OF THE CRANIAL BASE MEASUREMENTS AND THE MEANS DIFFERENCE, T-VALUE, P-VALUE AND LEVEL OF SIGNIFICANT BETWEEN THE SAUDI MALE WITH CLASS III MALOCCLUSION AND THE SAUDI CONTROL.

| No | Variables   | Sex | Class III |      | Control |      | M-diff. | t-value | P-value | Sig. Level |
|----|-------------|-----|-----------|------|---------|------|---------|---------|---------|------------|
|    |             |     | Mean      | SD   | Mean    | SD   |         |         |         |            |
| 1  | S-N(mm)     | M   | 69.11     | 3.65 | 71.78   | 3.17 | -2.67 - | -2.89 - | 0.001   | **         |
| 2  | S-Ar(mm)    | M   | 32.67     | 3.76 | 36.29   | 3.06 | 3.63 -  | 4.09 -  | 0.000   | ***        |
| 3  | N-          | M   | 90.45     | 4.42 | 95.47   | 4.11 | 5.02 -  | 4.56 -  | 0.000   | ***        |
| 4  | Ar(mm)mm    | M   | 120.62    | 5.72 | 125.60  | 5.01 | 4.98 -  | 3.58 -  | 0.002   | **         |
| 5  | S-Ar(dg) N- | M   | 125.32    | 5.46 | 129.67  | 5.21 | 4.35    | 3.13    | 0.003   | **         |

SD : Standard deviation.

M-diff : Means difference.

Sig. leve : Level of significant difference presented as \*\*\*, \*\*, or NS.

Min : millimeter.

dg : Degrees.

M : male.

TABLE 2: THE MEAN AND STANDARD DEVIATION OF THE MAXILLARY SKELETAL MEASUREMENTS AND THE MEANS DIFFERENCE, T-VALUE, P-VALUE AND LEVEL OF SIGNIFICANT BETWEEN THE SAUDI MALE WITH CLASS III MALOCCLUSION AND THE SAUDI CONTROL.

| No | Variables   | Sex | Class III |      | Control |      | M-diff. | t-value | P-value | Sig. Level |
|----|-------------|-----|-----------|------|---------|------|---------|---------|---------|------------|
|    |             |     | Mean      | SD   | Mean    | SD   |         |         |         |            |
| 6  | S-A(mm)     | M   | 83.32     | 6.12 | 86.72   | 4.26 | -       | -2.49   | 0.015   | *          |
| 7  | Ar-A(mm)    | M   | 82.19     | 5.01 | 88.31   | 4.53 | -6.12   | -4.96   | 0.000   | ***        |
| 8  | A1N-Pog(mm) | M   | -4.49     | 4.02 | 1.56    | 2.54 | -6.06   | -6.97   | 0.000   | ***        |
| 9  | S-N-A(dg)   | M   | 80.90     | 5.82 | 83.87   | 4.42 | -2.96   | -2.22   | 0.030   | *          |
| 10 | N-ANS(mm)   | M   | 53.62     | 5.56 | 53.39   | 4.12 | 0.23    | 0.18    | 0.857   | NS         |
| 11 | PP/S-N(dg)  | M   | 9.52      | 4.22 | 7.94    | 2.51 | 1.58    | 1.77    | 0.082   | NS         |
| 12 | ANS-PNS(mm) | M   | 50.99     | 3.51 | 54.62   | 3.31 | -3.62   | -4.11   | 0.000   | ***        |

## DISCUSSION

This retrospective comparative study was based on the measurements of the cephalometric radiographs of adult Saudi male with class III skeletal malocclusion and control group with normal occlusion. The components of class III malocclusion were divided into five major craniofacial structures: the cranial base, the

maxillary skeletal, the mandibular skeletal, the den-toalveolar, and the soft tissue. Similar division of the components of class III malocclusion were used by Ellis and McNamara,<sup>1</sup> Guyer *et al.*,<sup>13</sup> Battagel<sup>12</sup> and Ishii *et al.*<sup>24</sup> In the present study, a total of 40 variables, 22 linear and 18 angular, were used for comparison between the class III malocclusion and the control group of the Saudi male. Out of the 40 variables, 31 variables

TABLE 3: THE MEAN AND STANDARD DEVIATION OF THE MANDIBULAR SKELETAL MEASUREMENTS AND THE MEANS DIFFERENCE, T-VALUE, P-VALUE AND LEVEL OF SIGNIFICANT BETWEEN THE SAUDI MALE WITH CLASS III MALOCCLUSION AND THE SAUDI CONTROL.

| No | Variables     | Sex | Class III |      | Control |      | M-diff. | t-value | P-Value | Sig. Level |
|----|---------------|-----|-----------|------|---------|------|---------|---------|---------|------------|
|    |               |     | Mean      | SD   | Mean    | SD   |         |         |         |            |
| 13 | S-B(mm)       | M   | 119.28    | 8.13 | 113.76  | 4.95 | 5.53    | 3.18    | 0.002   | **         |
| 14 | S-N-B(dg)     | M   | 85.32     | 6.12 | 81.82   | 3.67 | 3.49    | 2.68    | 0.010   | **         |
| 15 | S-Pog(mm)     | M   | 132.00    | 8.29 | 126.40  | 5.52 | 5.59    | 3.08    | 0.003   | **         |
| 16 | S-N-Pog(dg)   | M   | 86.66     | 5.77 | 82.80   | 3.40 | 3.86    | 3.12    | 0.003   | **         |
| 17 | ANS-Me(mm)    | M   | 71.51     | 6.14 | 70.05   | 3.80 | 1.46    | 1.11    | 0.271   | NS         |
| 18 | N-Me(mm)      | M   | 125.59    | 8.22 | 123.48  | 4.09 | 2.12    | 1.14    | 0.095   | NS         |
| 19 | S-Go(mm)      | M   | 80.21     | 7.57 | 84.73   | 4.61 | -4.51   | -2.78   | 0.007   | *4-        |
| 20 | S-N/Go-Me(dg) | M   | 35.96     | 7.09 | 32.46   | 4.94 | 3.50    | 2.22    | 0.030   | *          |
| 21 | PP/Go-Me(dg)  | M   | 25.19     | 6.08 | 21.29   | 3.82 | 3.91    | 2.98    | 0.004   | **         |
| 22 | S-Ar-Go(dg)   | M   | 141.02    | 5.36 | 142.83  | 6.49 | -1.81   | -1.17   | 0.244   | NS         |
| 23 | Ar-Go(mm)     | M   | 51.25     | 6.75 | 52.44   | 4.18 | -1.19   | -0.84   | 0.547   | NS         |
| 24 | Go-Pog(mm)    | M   | 80.33     | 4.25 | 79.04   | 3.86 | 1.28    | 1.28    | 0.225   | NS         |
| 25 | Ar-Pog(mm)    | M   | 117.72    | 7.49 | 111.67  | 5.50 | 6.04    | 3.56    | 0.001   | **         |
| 26 | Ar-Go-Me(dg)  | M   | 135.02    | 5.78 | 126.16  | 4.51 | 8.86    | 6.63    | 0.000   | ***        |
| 27 | A-N-B(dg)     | M   | -4.44     | 3.42 | 2.31    | 2.15 | -6.75   | -9.14   | 0.000   | *,**       |

TABLE 4: THE MEAN AND STANDARD DEVIATION OF THE DENTOALVEOLAR MEASUREMENTS AND THE MEANS DIFFERENCE, T-VALUE, P-VALUE AND LEVEL OF SIGNIFICANT BETWEEN THE SAUDI MALE WITH CLASS III MALOCCLUSION AND THE SAUDI CONTROL \*\*\*

| No | Variables    | Sex | Class III |      | Control |      |        | t-value | P-value | Sig. Level |
|----|--------------|-----|-----------|------|---------|------|--------|---------|---------|------------|
|    |              |     | Mean      | SD   | Mean    | SD   |        |         |         |            |
| 28 | U1/S-N(dg)   | M   | 110.68    | 7.94 | 108.37  | 5.48 | 2.31   | 1.48    | 0.572   | NS         |
| 29 | U1/PP(dg)    | M   | 120.74    | 6.97 | 116.20  | 5.20 | 4.55   | 3.05    | 0.004   | **         |
| 30 | U1/N-A(dg)   | M   | 28.79     | 5.00 | 24.68   | 5.97 | 4.11   | 2.88    | 0.005   | **         |
| 31 | U1/N-A(mm)   | M   | 7.79      | 2.46 | 6.56    | 2.19 | 1.24   | 2.05    | 0.044   | *          |
| 32 | L1/GO-Me(dg) | M   | 81.71     | 7.23 | 95.87   | 5.32 | -14.16 | -8.64   | 0.000   | ***        |
| 33 | L1-N-B(dg)   | M   | 21.38     | 5.83 | 26.79   | 3.89 | -5.41  | -4.23   | 0.000   | ***        |
| 34 | L1/N-B(mm)   | M   | 3.32      | 2.27 | 6.16    | 1.76 | -2.84  | -4.20   | 0.000   | ***        |
| 35 | U1/L1(dg)    | M   | 134.48    | 8.83 | 126.33  | 6.34 | 8.15   | 4.11    | 0.000   | ***        |
| 36 | OJ(OJ(mm     | M   | -3.77     | 2.61 | 2.85    | 0.78 | -6.62  | -13.31  | 0.000   | ***        |
| 37 | OB(mm)       | M   | 1.49      | 2.72 | 2.75    | 0.88 | -1.25  | -2.41   | 0.190   | NS         |

TABLE 5: THE MEAN AND STANDARD DEVIATION OF THE SOFT TISSUE MEASUREMENTS AND THE MEANS DIFFERENCE, T-VALUE, P-VALUE AND LEVEL OF SIGNIFICANT BETWEEN THE SAUDI MALE WITH CLASS **III** MALOCCLUSION AND THE SAUDI CONTROL.

| No | Variables     | Sex | Class III |       | Control |       | M-diff. | t-value | P-value | Sig. Level |
|----|---------------|-----|-----------|-------|---------|-------|---------|---------|---------|------------|
|    |               |     | Mean      | SD    | Mean    | SD    |         |         |         |            |
| 38 | UL/E line(mm) | M   | -7.08     | 2.86  | 3.74    | 2.06  | -10.83  | -15.20  | 0.000   | ***        |
| 39 | LL/E line(mm) | M   | -1.37     | 2.89  | 2.48    | 2.01  | -3.85   | -6.18   | 0.000   | **         |
| 40 | NLA(dg)       | M   | 94.27     | 17.99 | 107.47  | 11.53 | -13.20  | -5.74   | 0.000   | ***        |

showed significant differences that represent 77.5% of the comparisons.

### Cranial Base Relationship

The first components measured and compared was the cranial base. The anterior cranial base dimension (S-N) was significantly shorter in the Saudi male with Class **III** malocclusion compared to the control group at 1 percent level of significance. This finding was in agreement with the results of Sanborn,<sup>6</sup> Chan,<sup>15</sup> Jacobson *et al.*,<sup>8</sup> Jarvinen,<sup>11</sup> Baik *et al.*,<sup>21</sup> Mouakeh<sup>38</sup> Ishii *et al.*,<sup>24</sup> and Hayashi,<sup>39</sup> but disagreed with Guyer *et al.*,<sup>13</sup> Toms<sup>40</sup> and LiLu *et al.*,<sup>18</sup> who found no significant difference between the class **III** malocclusion and control group. The posterior cranial base measured from S to Ar also showed significant difference between the Saudi male with class **III** malocclusion and the control group at 0.1 percent level of significance was in the agreement with the findings of Bjork,<sup>41</sup> Toms<sup>41</sup> Jarvinen<sup>11</sup> Ngan *et al.*,<sup>1</sup> Baik *et al.*,<sup>21</sup> and Mouakeh.<sup>38</sup> Other investigators measured the posterior cranial base dimension from different anatomical landmarks (S to Ba). Their findings were conflicting. Battage<sup>12</sup> found significant difference whereas Jacobson *et al.*,<sup>8</sup> reported no significant difference between the class **III** malocclusion and the control. The total cranial base measured from point N to Ar was also significantly shorter in the Saudi male with class **III** malocclusion compared to the control group at 0.1 percent level of significance. This finding was in agreement with the results of Baik *et al.*,<sup>21</sup> but disagreed with Toms<sup>41</sup> and Ngan *et al.*,<sup>1</sup> who found no significant difference between the class **III** malocclusion and control group. The short total cranial base may have resulted from the short anterior and posterior cranial bases, but the angle between the anterior and the posterior cranial bases, known as the cranial base angle or the saddle angle has a major role to play regarding the dimension

of the total cranial base which must be considered and evaluated. In this study, the cranial base angle or the saddle angle was measured by the angle N-S-Ar and N-S-Ba. The two measurements indicated smaller cranial base angle for the class **III** malocclusion compared to the control group for the Saudi male. The significant difference in the cranial base angle was consistent with the findings of Dietrich,<sup>1</sup> Toms,<sup>41</sup> Battage<sup>12</sup> and Mouakeh. This finding may support the role of this angle in producing Class **III** skeletal relationship as proposed by Bjork<sup>41</sup> and agreed with the findings of several investigators that include Jarvinen,<sup>11</sup> Houston *et al.*,<sup>42</sup> Klocke *et al.*,<sup>42</sup> and Hayashi.<sup>39</sup> However, the finding of this study on the relationships between the cranial base angle and the class **III** malocclusion contradict with the finding of Baik *et al.*,<sup>21</sup> who reported that the cranial base angle increased in class **III** malocclusion and, Sanborn<sup>6</sup> and Guyer *et al.*,<sup>13</sup> who reported that there was no significant difference in the cranial base angle between class **III** malocclusion and normal occlusion. The evaluation of the first component gives the picture that the Saudi male with class **III** malocclusion had shorter cranial base and smaller cranial base angle compared to the control.

### Maxillary Skeletal Relationship

The maxillary skeletal relationship was studied by ALN-Pogriables, five linear and two angular. Significant differences were found in the position and the size of the maxilla in the Saudi male with class **III** malocclusion compared to the control group. The anteroposterior position of the maxilla evaluated by S-A, Ar-A, A\_LN-Pog and S-N-A angle indicated that significant differences exist between the class **III** malocclusion and the control. The evaluation of the distance from point A to point S and point Ar demonstrated smaller linear measurements indicating the retrusive position of the maxilla. This finding was in agreement with

Sanborn,<sup>6</sup> Jacobson *et al.*,<sup>8</sup> Ellis and McNamara,<sup>10</sup> Toms<sup>9</sup> and Mouakeh<sup>38</sup> but disagree with Lew and Foong,<sup>17</sup> LiLu *et al.*,<sup>18</sup> Ngan *et al.*<sup>1</sup> and Baik *et al.*" The retruded position of the maxilla in the class **III** malocclusion may have resulted from the small dimension of the cranial base found in the class **III** malocclusion as observed previously. However, the examination of the maxillary position in relation to the N-Pog line indicated that the maxilla was behind the reference line. The assessment of the angle S-N-A confirmed the retrusive position of the maxilla. The observation of the maxillary position was in agreement with Ellis and McNamara," Guyer *et al.*" and Nojima *et al.*,<sup>25</sup> but disagreed with LiLu *et al.*<sup>18</sup> and Baik *et al.*"

No significant difference was found in the vertical relationship of the maxilla in the class **III** Saudi male compared to the control group. The vertical position of the maxilla in relation to the anterior cranial base measured by the upper anterior facial height (N-ANS) and the angulation of the maxilla to the cranial base (PP/S-N angle) indicated the similarity between the class **III** malocclusion and the control group. This observation was in agreement with Ishii *et al.*<sup>24</sup> but disagreed with Toms."

The length of maxilla was shorter in the Saudi male with class **III** malocclusion compared to the control group. The length of the maxilla was measured from point ANS to point PNS. Such finding contributed and confirmed the retrusiveness of the maxilla. This result agreed with Dietrich,' Jones ,<sup>9</sup> Guyer *et al.*," Toms," Battagel," Kao *et al.*,<sup>44</sup> Ngan *et al.*<sup>1</sup> and Mouakeh,<sup>38</sup> who reported similar result. The evaluation of the second component showed that the Saudi male with class **III** malocclusion, in addition to the short cranial base and smaller cranial base angle had retruded small size maxilla and normal vertical relation compared to the control.

### **Mandibular Skeletal Relationship**

Considerable differences were found between the Saudi male with class **III** malocclusion and the control in the position, size, form and relationship of the mandible.

The anteroposterior position of the mandible was evaluated by measuring S-B and S-N-B angle. The mandible was protruded and located in a forward

position relative to the cranial base in class **III** malocclusion for the male compared to the control group. The differences were statistically significant at 1 percent level of confidence for the two parameters. The protruded position of the mandible resulted from forward positioning of the mandible or increase size of the mandible. The short cranial base and small cranial base angle in class **III** malocclusion reported earlier contributed to the protrusive position of the mandible. However, the size of the mandible measured by the distance S-B demonstrated an increase in the size of the mandible. The result of the mandibular position found in the present study was in agreement with Sanborn,<sup>6</sup> Jacobson *et al.*,<sup>8</sup> Ellis and McNamara,<sup>10</sup> Battagel,<sup>12</sup> Ngan *et al.*, ' Baik *et al.*" and Nojima *et al.*<sup>25</sup> In addition to evaluating the anteroposterior position of the mandible, the anteroposterior position of the chin was evaluated by measuring the distance of S-Pog and S-N-Pog angle. Similar to the mandible, the chin was also protruded and located in a forward position relative to the cranial base in class **III** malocclusion compared to the control group. This was true at 1 percent level of confidence for the two parameters. This result was in agreement with Sanborn,<sup>6</sup> Ellis and McNamara" and Battagel.<sup>12</sup>

The vertical position of the mandible was evaluated by measuring N-Me, S-Go, S-N/Go-Me angle and S-Ar-Go angle. The measurement of the total anterior facial height (N-Me) for the male with class **III** malocclusion was larger than the control, but the difference was not significant. However, the total posterior facial height (S-Go) was significantly reduced for the class **III** malocclusion compared to the control. That was true at 1 percent level of confidence. There was no significant difference in the joint angle (S-Ar-Go). The mandibular plane angle to the anterior cranial base (S-N/Go-Me) in the class **III** malocclusion was significantly increased compared to the control group. This might be related to the short posterior facial height and high position of point Go which was formed with point Me in the mandibular plane. This result was in agreement with Ellis and McNamara" and Nojima *et al.*<sup>25</sup>

The form of the mandible was evaluated by Ar-Go, Go-Pog, Ar-Pog and Ar-Go-Me angle. The ramus height (Ar-Go) was significantly shorter in the class **III** group compared to control. With respect to the body of the mandible (Go-Pog), there was no significant difference

between the class **III** and the control indicated similar size of the body of mandible in both groups. Similar result was reported by Sanborn.<sup>6</sup> However, the total size of the mandible measured from point Ar to point Pog demonstrated that the male with class III malocclusion had larger total mandibular length than the control. The difference was statistically significant at 1 percent level of confidence. Investigating the gonial angle indicated that the angle was markedly increased in the class **III** malocclusion compared to the control ( $P>0.001$ ). The marked increase in the gonial angle was observed and reported by Sanborn,<sup>6</sup> Dietrich,<sup>7</sup> Jacobson *et al.*,<sup>8</sup> Guyer *et al.*,<sup>13</sup> Toms,<sup>40</sup> Battagel,<sup>12</sup> Baik *et al.*,<sup>21</sup> and Ishii *et al.*<sup>24</sup> The increase in the gonial angle might lead to an increase in the total length of the mandible in the class **III** malocclusion. The ramus and the body of the mandible seemed to be bent away from each other and increased the distance between the anatomical landmark Ar and Pog. This point of view was proposed by Subitny and Sakuda,<sup>45</sup> and supported by the finding of the current study and by other investigators such as Sanborn,<sup>6</sup> Jacobson *et al.*,<sup>8</sup> Ellis and McNamara,<sup>10</sup> Battagel,<sup>12</sup> Kao *et al.*,<sup>44</sup> and Baik *et al.*<sup>21</sup> On the other hand, the significant difference noted in the gonial angle between the class **III** malocclusion and the control group supported the suggestion of Ellis and McNamara<sup>10</sup> that in malocclusion the skeletal discrepancy was observed in the lower part of the facial structure.

The anteroposterior relationship between the maxilla and the mandible was evaluated by the A-N-B angle. There was significant difference between the two groups. The class III malocclusion had negative AN-B angle and the control group had positive values. Similar results were reported by Jacobson *et al.*,<sup>8</sup> Toms,<sup>40</sup> Battagel,<sup>12</sup> Miyajima *et al.*,<sup>19</sup> Baik *et al.*<sup>21</sup> and Mouakeh.<sup>38</sup> The vertical relationship between the maxilla and the mandible was examined by the lower anterior facial height (ANS-Me) and the maxillary mandibular plane angle (PP/Go-Me angle). There was no significant difference in the lower anterior facial height indicating the similarity in the lower face height between the class III malocclusion and the control group. The findings reported previously on the total facial height and the upper anterior facial height, in addition to the finding on the lower facial height, indicated the similarity between the class **III** malocclusion and the control regarding the facial heights.

However, Jacobson *et al.*<sup>8</sup> found significant differences between the class **III** and the control. The maxillary mandibular plane angle was significantly steeper in the class **III** malocclusion compared to the control group. The significant increase in the maxillary mandibular plane angle in the class III malocclusion might be related to the increase in the gonial angle and the short ramus height reported previously. This finding was in agreement with the results of Sanborn,<sup>6</sup> Jacobson *et al.*,<sup>8</sup> Toms<sup>40</sup> and Baik *et al.*<sup>21</sup> but disagreed with Chan<sup>15</sup> and Mouakeh<sup>38</sup> who found no significant difference in the gonial angle.

In the light of the above finding, it can be said that there were significant differences in the form, position and size of the mandible between the class III malocclusion and the control. The class III malocclusion had protruded and forwarded the position of the mandible and chin, increased total mandibular length, obtuse gonial angle, increased mandibular plane angle, and short posterior facial height. Evaluating the skeletal mandibular component completed the picture of the skeletal configuration of the class **III** malocclusion.

### Dentoalveolar Relationship

The maxillary incisors were significantly proclined in the class **III** malocclusion compared to the control. Significant differences were observed in the angles measured between the long axis of the maxillary incisors and the palatal plane and the NA reference line. The linear measurement of the NA line was also significantly different between the class III malocclusion and the control group. The protruded maxillary incisor in the class III malocclusion was observed and reported by many investigators such as Sanborn,<sup>6</sup> Jacobson *et al.*,<sup>8</sup> Ellis and McNamara,<sup>10</sup> Toms,<sup>40</sup> Baik *et al.*,<sup>21</sup> Rabie and Gu,<sup>46</sup> and Ishii *et al.*<sup>24</sup>

There were significant difference in the position and the relation of the mandibular incisor in the male with class III malocclusion and the control group. The lower incisors were retruded significantly in relation to the mandibular plane and NB reference line. This was at 0.1 percent levels of significance. This finding was in agreement with many investigators such as Sanborn,<sup>6</sup> Jacobson *et al.*,<sup>8</sup> Ellis and McNamara,<sup>10</sup> Guyer *et al.*,<sup>13</sup> Toms,<sup>40</sup> Kao *et al.*,<sup>44</sup> Baik *et al.*<sup>21</sup> and Nojima *et al.*<sup>23</sup> Such finding, however, supported the theory of the dentoalveolar compensation described by Bjork<sup>47</sup> and Solow.<sup>48</sup>

In the class **III** malocclusion, the lower incisors tend to compensate for the forward and protruded position of the mandible by changing the angle formed with the mandibular plane. However, the position of the incisal tip of the lower incisors in relation to NB reference line was significantly retruded in the class **III** malocclusion compared to the control group. This was confirmed by the linear measurement of the incisal tip to the NB reference line. This finding was in agreement with Tome who explained such findings were a result of the protruded position of the mandible and the chin in the class **III** malocclusion.

The interincisal angle was significantly larger in the class **III** malocclusion compared to the control. This could be due to the retroclination of the lower incisor, although the upper incisors were significantly proclined. However, several investigators such as Jacobson *et al.*,<sup>8</sup> Guyer *et al.*" and Tome indicated that the increase in the interincisal angle in class **III** malocclusion mainly resulted from the retroclination of the lower incisors. The degree of the lower incisor retroclination was usually more than the degree of the upper incisor proclination. This finding was in agreement with Sperry *et al.*," Ellis and McNamara,<sup>10</sup> Toms,<sup>40</sup> Miyajima *et al.*," Ishikawa *et al.*,<sup>50</sup> Ishikawa *et al.*<sup>51</sup> and Mouakeh."

The occlusal relationship of the maxillary and mandibular incisors showed clearly the difference in the overjet and overbite between the two groups as expected. Significant difference was observed in the overjet (OJ) between the class **III** malocclusion and the control. However, the overjet was a selection criterion in the class **III** malocclusion. On the other hand, no significant difference was observed in the overbite (OB) between the class **III** malocclusion and control.

### Soft Tissue Relationship

There were significant differences in the antero-posterior position of the upper and lower lips in relation to the nose and the chin. The esthetic line recommended by Ricketts" demonstrated that both the upper and lower lips were significantly retruded in the class **III** malocclusion compared to the control. This finding was in agreement with Battagel<sup>12</sup> and Baik *et al.*<sup>21</sup> The evaluation of the nasiolabial angle showed significant differences between class **III** malocclusion and the

control. The nasiolabial angle was reduced. The retruded position of the lips and the reduction in the nasiolabial angle may be due to the retrognathic maxilla and small maxillary size. However, the protrusion of the tip of the upper incisor may project the tip of the upper lip and contributed to the reduction of the nasiolabial angle. The retrusion of the lower lip could be due to the protrusion of the mandible and the chin supplemented by the retrusion of the lower incisors. Such finding was in agreement with several studies that include Battagel,<sup>12</sup> Ngan *et al.*," Miyajima *et al.*" and Nojima *et al.*<sup>25</sup>

Evaluating the last components of the class **III** malocclusion completed the picture of the craniofacial configuration of the Saudi male with class **III** malocclusion.

The Saudi with class **III** malocclusion have shorter anterior cranial base, shorter posterior cranial base, shorter total cranial base, smaller cranial base angle (saddle angle), retrognathic maxilla, shorter maxillary length, prognathic mandible, prognathic chin, longer total mandibular length, steeper mandibular plane, more obtuse gonial angle, decreased posterior facial height and normal total anterior facial height, protruded maxillary incisors, retruded mandibular incisors, larger interincisal angle, retruded upper and lower lips to E- line, and reduced nasiolabial angle.

From the above findings, the stated hypothesis **"There is no difference in the morphological structures between the Saudi male with class **III** malocclusion and the normal occlusion"** was rejected. It is hoped that such study will give the orthodontist information about the relationships of different components of class **III** malocclusion of adult Saudi subjects. Such information can be useful for the diagnosis and treatment planning of conditions, which had proven to be difficult to manage.

The present study has achieved its objective although there were a few shortcomings which can be resolved or improved with further investigations. Further studies are needed to investigate the components of class **III** malocclusion of the adult Saudi female and compare the results to the male and other populations to identify any differences which can help to understand a problem that frustrated the orthodontist that is class **III** malocclusion.

## CONCLUSIONS

Based on the findings of the present study, the following conclusions were made:

Comparing the Saudi adult male with a class III malocclusion to the normal, the Saudi adult male with class III malocclusion have:

- 1 A shorter anterior, posterior and total cranial base length and smaller cranial base angle (saddle angle).
- 2 A retrognathic maxilla and shorter maxillary length.
- 3 A prognathic mandible and chin.
- 4 A longer total mandibular length.
- 5 Steeper mandibular plane with more obtuse gonial angle.
- 6 Decreased posterior facial height and normal total anterior facial height.
- 7 Protruded maxillary incisors and retruded mandibular incisors with larger interincisal angle.
- 8 Retrusion of upper and lower lips to E line
- 9 Reduced nasiolabial angle.

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