The characteristic features of skeletal class III in Iraqi adult orthodontic patient

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ABSTRACT

Background: Skeletal class III malocclusion is one of the dentofacial anomalies which associated with deviation in the sagittal relationship of maxilla and mandible. This study performed to determine the characteristic features of skeletal class III compared with skeletal class I.

Materials and methods: Skeletal class III sample included 100 pretreatment digital lateral cephalometric radiographs (18-29) years which selected on the basis of Beta angle (> 35°) and divided into five groups according to location of maxilla and mandible in relation to the anterior cranial base (SNA and SNB angles). Another 45 radiographs were selected as control group (normal SNA, SNB angles, Beta angle 27°-35°). Fourteen angular and eight linear measurements digitized and recorded using AutoCAD 2010 computer program.

Results and Conclusions: In comparison with skeletal class I, skeletal class III had: Shorter anterior cranial base length, more obtuse gonial angle, no significant difference in the articular angle and upper anterior facial height. Labially proclined upper incisor and lingually retroclined lower incisor. The prognathism of both jaws was formed 43% of the sample with the most horizontal growth pattern and protruded profile, the retrognathism of both jaws formed 20% with the most vertical growth pattern and retruded profile. 17% of the sample had normal positioned maxilla and protruded mandible and displayed horizontal growth pattern with protruded profile. Pure retruded maxilla formed 12% of the sample and the least type was the combined maxillary retrognathism and mandibular prognathism (8%); both showed vertical growth pattern with protruded profile but extremely obvious in the latest one.

Key words: Skeletal class III, Characteristic features.

INTRODUCTION

Class III malocclusion is a subject of interest and concern to the orthodontist and it has long been viewed as one of the most severe facial deformities. Severe class III malocclusion is one of the most difficult anomalies to understand and treat (1). Studies conducted to identify the etiological features of Class III malocclusion show that the deformity is not constricted to the jaws but involves the entire craniofacial complex (2). The facial dysplasia which is produced by growth disharmony may involve size, form and position of the apical bases (3-5).

In orthodontic diagnosis and treatment planning, great importance has been attached to evaluate the sagittal apical base relationship. Any cephalometric analysis based on either angular or linear measurements has obvious shortcomings, which have been discussed in detail by Moyers et al. (6). Freeman (7) stated that, even before Angle introduced his classification of malocclusion to the profession in the early 1900s, the anteroposterior relationship of mandible to maxilla was the most important diagnostic criterion.

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radiographs; that had a skeletal class I relationship (Beta angle $27^\circ - 35^\circ$).

The Inclusion Criteria
1. Clear cephalometric radiographs.
2. The samples were adult with an age ranged between 18-29 years.
3. They had no congenital anatomical defect (cleft lip and/or palate).
4. All individuals had no previous orthodontic or surgical treatment.

The method
Cephalometric analysis

Firstly, to identify the individuals with skeletal class III (the sample) and those with skeletal class I (the control group), each lateral cephalometric radiograph was analyzed by using AutoCAD program to measure the Beta angle which should be larger than $35^\circ$ in skeletal class III and $27^\circ - 35^\circ$ in skeletal class I.

After importing the picture to the AutoCAD program, the points were localized, the planes were determined, and the angles and distances were measured. The angles were measured directly as they were not affected by magnification, while the linear measurements were divided by scale for each picture to overcome the magnification.

After measuring the Beta angle, fourteen angular and eight linear measurements were recorded for each selected radiograph and all measurements were put in excel sheet for the statistical analyses.

Then the sample with class III skeletal dysplasia was divided into 5 groups according to the location of the problem; the position of the maxilla and the mandible in relation to the anterior cranial base using the SNA and SNB angles\textsuperscript{(11)}; yet, these two angles were normal in the control group ($\text{SNA}= 81^\circ-82^\circ; \text{SNB}= 78^\circ-79^\circ$)\textsuperscript{(12)}:

- **Group 1:** individuals with normal position of maxilla and protruded mandible in relation to the anterior cranial base.
- **Group 2:** individuals with normal position of mandible and retruded maxilla in relation to the anterior cranial base.
- **Group 3:** individuals with retruded maxilla and protruded mandible in relation to the anterior cranial base.
- **Group 4:** individuals with retruded maxilla and mandible in relation to the anterior cranial base.
- **Group 5:** individuals with protruded maxilla and mandible in relation to the anterior cranial base.

Cephalometric Landmarks, Planes, and Measurements

I. Cephalometric Landmarks
1. Point S (Sella): The midpoint of the Sella turcica (pituitary gland fossa)\textsuperscript{(13)}.
2. Point N (Nasion): The most anterior point on fronto-nasal suture in the median plane\textsuperscript{(13)}.
3. Point Ar (Articulare): The point of intersection of the external dorsal contour of the mandibular condyle and the temporal bone\textsuperscript{(14)}.
4. Point ANS (Anterior Nasal Spine): The tip of the anterior process of the maxilla and is situated at the lower margin of the nasal aperture\textsuperscript{(15)}.
5. Point PNS (Posterior Nasal Spine): This is a constructed radiological point, the intersection of a continuation of the anterior wall of the pterygopalatine fossa and the floor of the nose. It marks the dorsal limit of the maxilla\textsuperscript{(13)}.
6. Point A (Subspinale): The deepest midline point on the premaxilla between the Anterior Nasal Spine and Prosthion\textsuperscript{(13)}.
7. Point B (Supramentale): The deepest midline point on the mandible between Infradentale and Pogonion\textsuperscript{(13)}.
8. Point Pog (Pogonion): It is the most anterior point on the mandible in the midline\textsuperscript{(13)}.
9. Point Me (Menton): The lowest point on the symphyseal shadow of the mandible seen on a lateral cephalograms\textsuperscript{(15)}.
10. Point Go (Gonion): A point on the curvature of the angle of the mandible located by bisecting the angle formed by the lines tangent to the posterior ramus and inferior border of the mandible\textsuperscript{(15)}.
11. Point II (Incisor inferius): The tip of the crown of the most anterior mandibular central incisor\textsuperscript{(13)}.
12. Point IS (Incisor superius): The tip of the crown of the most anterior maxillary central incisor\textsuperscript{(13)}.
13. Point Ap 1 (Apicale 1): Root apex of the most anterior maxillary central incisor\textsuperscript{(13)}.
14. Point Ap 1 (Apicale 1): Root apex of the most anterior mandibular central incisor\textsuperscript{(13)}.
15. Point C (The center of the condyle): Found by tracing the head of the condyle and approximating its center\textsuperscript{(8)}.

II. Cephalometric planes
1. Sella-Nasion plane (S-N).
2. Sella-Articulare plane (S-Ar).
4. Mandibular plane (MP).
5. Ramus plane (RP).
6. Long axis of the upper incisor (U1).
7. Long axis of the lower incisor (L1).
8. N- A line.
10. Facial plane (N- Pog.).
11. Denture base limit (AB plane).

### III. Cephalometric measurements

#### A. Angular measurements

1. Beta angle (8):
   - The Beta angle is a new measurement for assessing the skeletal discrepancy between the maxilla and the mandible in the sagittal plane. It uses 3 skeletal landmarks:
     - A point (Subspinale)
     - B point (Supramentale)
     - the center of the condyle (C)
   - Next, defining 3 lines:
     - Line connecting the center of the condyle C with B point (C-B line).
     - Line connecting A and B points.
     - Line from point A perpendicular to the C-B line.
   - Finally, measuring the Beta angle which is the angle between the perpendicular line from point A to CB line and the A-B line. Its values are:
     - Class I (27° - 35°), Class II < 27° and Class III > 35.

   ![Figure 1: Beta angle.](image)

2. SNA angle: the anteroposterior position of maxilla relative to anterior cranial base (13).
3. SNB angle: It is the anteroposterior position of mandible relative to the anterior cranial base (13).

4. SN plane-Mandibular Plane Angle (SN-MP):
   - This angle gives the inclination of the mandible to the anterior cranial base. It is formed at the point of intersection of the S-N plane and mandibular plane. This angle can give an indication to the type of rotation of the mandible (16).

5. SN plane-Maxillary Plane Angle (SN-Max.P):
   - The angle of maxillary plane (ANS-PNS) inclination in relation to anterior cranial base, it is formed at the point of intersection of the S-N plane and maxillary plane (17).

6. SN-Pog angle: It represents the anteroposterior position of the chin relative to the anterior cranial base (18).

7. Gonial Angle (Ar-Go-Me): The angle between posterior border of the ramus (Ar-Go) and the mandibular plane (Go-Me) (13).
8. Articulare angle (S-Ar-Go): This angle formed at the point of intersection of the S-Ar plane and the Ar-Go plane (13).
10. Inclination of upper incisor (U1/Max.P): The angle between the long axis of upper incisor and maxillary plane (19).
11. Inter-incisal angle (U1-L1): The angle formed by the intersection of the lines representing the long axes of the most labial maxillary and mandibular incisors, posteriorly (11).
12. Basal plane angle (PP-MP): This defines the angle of inclination of the mandible to the maxillary base (13).
13. SN- AB plane angle: The angle between the S-N plane and the AB plane, posteriorly (20).
14. Saddle angle (N-S-Ar): It is the angle between the anterior and posterior cranial base (13).
15. Sum of the posterior angles: it’s the sum of saddle (NSAr), articular (S-Ar-Go) and gonial angle (Ar-Go-Me) (13).

#### B. Linear Measurements

1. S-N: A distance from Sella to Nasion (13).
2. S-Ar: A distance from Sella to Articulare (13).
4. Mandibular length: the distance from Gonion to Menton (19).
5. Ramus length: The distance between Ar and Go (13).
6. Upper anterior facial height (UAFH): It’s measured from N to ANS (21).
7. Lower anterior facial height (LAFH): It is measured from ANS to Me (21).
8. Posterior facial height (PFH): measured from S to Go (21).

**Statistical Analyses**

1. **Descriptive Statistics:** Mean and Standard deviation (SD).
2. **Inferential Statistics:** Paired sample t-test: for intra-examiner and inter-examiner calibration, ANOVA test: for the comparison among the groups and Least significant difference test LSD test: for variables that show significant differences among the study groups in ANOVA test.
RESULTS AND DISCUSSION

The sample in this study was selected at age between eighteen and twenty nine years old to minimize the effect of any remaining skeletal growth \(^{(22)}\) as the majority of facial growth is usually complete by 16-17 years of age \(^{(23)}\). According to the collected sample with skeletal class III relationship, different relations were found between the maxilla and mandible in their relation to the anterior cranial base. The results of this study showed that the mandibular skeletal protrusion is a prominent feature in the majority of these individuals and this came in agreement with Horowitz et al. \(^{(24)}\), Dietrich \(^{(3)}\) and Jacobson et al. \(^{(4)}\).

In the present study most of the individuals with skeletal class III showed a protrusion of both maxilla and mandible (43%) in relation to the anterior cranial base. For the retrusion of both jaws, it formed 20% of the collected sample. On the other hand, individuals with normal position of maxilla and protruded mandible formed about 17% of the collected sample and only 12% of the collected sample found to have retruded maxilla and normal position of mandible in relation to the anterior cranial base. The least type was those with combined retruded maxilla and protruded mandible (8%).

The comparison between different groups of skeletal Class III and skeletal Class I group showed that there are great differences in the craniofacial features as manifested in the lateral cephalometric radiograph. The differences between the results of the present study and other studies may be attributed to different sample size, criteria of sample selection, or ethnic group.

**Group one**

This group characterized by the normal position of maxilla and protruded mandible in relation to the anterior cranial base. It had a significantly acute saddle angle and short anterior cranial base; thus makes the mandibular condyle positioned beyond the normal range in relation to the cranial base.

The SN-MP, PP-MP, Ar-Go-Me and articular angle were significantly larger; all moved the mandible in a backward position to reduce the severity of prognathic feature. The upper incisor was significantly proclined while the lower was significantly retroclined. In spite of nearly unchangeable posterior facial height, the lower anterior facial height is significantly increased. This group underwent a horizontal growth pattern and showed protruded profile.

**Group two**

This group characterized by the presence of retruded maxilla and normal position of mandible in relation to the anterior cranial base. It had a significantly acute saddle angle with shorter anterior cranial base and significantly shorter posterior cranial base; this results in an anterior and superior articulation of the mandible with the cranial base. Whereas, the maxillary plane length was short and retruded; the size of mandible was within normal range. The SN-MP and PP-MP were significantly increased and the gonial angle was significantly more obtuse which led to a backward and downward rotation of the mandible and significantly increased lower anterior facial height, while a slight reduction was existed in the posterior facial height. In spite of the minor proclination of upper incisors, a retroclined lower incisor was significant. This group exhibited a significant vertical growth pattern with protruded profile.

**Group three**

This group characterized by the presence of retruded maxilla and protruded mandible in relation to the anterior cranial base. It had an acute saddle angle and short anterior and posterior cranial base. The maxillary plane had a clockwise rotation relative to the anterior cranial base which led to a significant downward rotation of the mandibular plane and significantly increased PP-MP angle; also the gonial angle showed the most significant obtuse among the five skeletal classes III groups which exaggerated the downward rotation of the mandible and led to a significant increased lower anterior facial height. In spite of the presence of significant
The characteristic features

longer posterior facial height, a significant vertical growth pattern and significant protruded profile were evident in this group.

Dentally, it characterized by the presence of proclined upper incisors with the most significant retroclined lower incisors; and the interincisal angle was significantly increased.

Group four

This group characterized by the retrusion of both jaws in relation to the anterior cranial base. The saddle angle was significantly the largest among the five skeletal class III groups with significantly the shortest anterior, posterior cranial base, maxillary plane and the smallest mandible, that’s mean this group had small sizes of the craniofacial structures. As the inclination of the SN-PP was significantly the largest in this group, a downward rotation of mandibular plane was significantly the greatest synchronized with the presence of a significant larger gonial angle and significantly shortest posterior facial height which led to the most significant increase in the lower anterior facial height. This group had the most excessive and significant vertical growth pattern but with a significant retruded facial profile. The lower incisors were significantly retroclined while the upper were almost within the normal range.

Group five

It characterized by the presence of both the maxillary and mandibular bases anterior to the anterior cranial base. The anterior cranial base was significantly short and the posterior cranial base was nearly normal but the presence of the most significant acute saddle angle among the other groups led to a further anterior position of the mandibular condyle relative to the anterior cranial base. The ramus and mandibular body length were significantly longer which means that the mandible is the largest. In spite of the significant larger gonial angle and the significant longest posterior facial height, the lower anterior facial height was kept within normal value unlike the other skeletal class III groups because the maxillary plane was tipped in a counter clockwise direction which synchronized with a significant upward mandibular rotation. This group showed the greatest amount of horizontal growth pattern with the most significant protruded profile. Dentally, this group had the most significant proclined upper incisors and the least retroclined lower incisors.

The Cranial Base

The anterior cranial base (SN) was shorter in all study groups, whether significant or not, as compared with the control group. This is came in agreement with Namankani and Bukhary (25) and Proffit et al. (26), while this finding disagrees with Guyer et al. (13) who reported larger value of the anterior cranial base in class III group.

Posterior cranial base length (SAr) showed a significant reduction in groups 2 and 4 when compared with the control group; this is in accordance with Battagel (2) and Mouakeh (5) but this result disagrees with Rakosi (13) who found it was larger in Class III subjects and this is what was found in group 5 with a no significant difference.

Lastly, group 1, 2 and 5 showed a significant reduction in the saddle angle (NSAr) compared with the control group; this is in agreement with Battagel (2) who found that this angle was significantly smaller in Class III which led to forward condylar position and mandibular prognathism. In contrast, both group 3 and 4 found to have a no significant difference and this agreed with Rakosi (13).

The Maxilla
In the present study, the length of the maxilla (PP) found to be significantly shorter only in group 4 when compared with the control group. This comes in line with Namankani and Bukhary (25), while the other groups revealed a no significant reduction.

The (SN-PP) showed a highly significant difference in group 4 compared with the control group; this was found by Namankani and Bukhary (25). While groups 1, 2, 3 and 5 showed no significant difference and this agrees with Guyer et al. (10).

The Mandible

All skeletal class III groups revealed an increased value of the mandibular body length (MP) compared with the control group but the only significant increase was found in group 5 which agreed with Rakosi (13), the other groups revealed a no significant difference in (MP) length which came in line with Guyer et al. (10).

The ramus (RL) was significantly longer in group 5 when compared with the control group, this finding was mentioned by Guyer et al. (10), at the same time the no significant difference between skeletal class III and skeletal class I in RL that have been found by Namankani and Bukhary (25) can be seen in group 1, 2, 3 and 4.

The gonial angle was found to be significantly larger in all skeletal class III groups when compared with the control group. This finding was mentioned by Guyer et al. (25), at the same time the no significant difference in group 4 compared with the control group, this was found by Namankani and Bukhary (25).

Facial heights

The lower anterior facial height (LAFH) was significantly larger in skeletal class III groups (1, 2, 3 and 4). This comes in line with Guyer et al. (13); except for group 5 it was larger than that in class I but statistically not significant and this finding was mentioned by Namankani and Bukhary (25).

There was no significant difference in the posterior facial height (PFH) in group 1, 2 and 3 when compared with control group and this agrees with Guyer et al. (10), while in group 4 it was significantly smaller and this was found by Guyer et al. (10).

The characteristic features

Dentoalveolar Relationship

The maxillary incisors were more proclined (U1/PP) and the mandibular incisors were significantly more retroclined (L1/MP) in skeletal class III groups. This is in agreement with Guyer et al. (10), Battagel (2) and Namankani and Bukhary (25). The interincisal angle (U1/L1) showed significantly larger in group 3 of Class III sample than the control group which agreed with Mouakeh (5).

<p>| Table 1: Descriptive Statistics and comparison among the study groups for the total measurements |</p>
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REFERENCES