Cephalometric investigation of Class III dentoalveolar malocclusion

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Abstract
The aim of our study was to identify the most important anatomical landmarks in the cephalometric evaluation of Class III patients and to clarify the morphological characteristics of these cases. A group of 10 Class III orthodontic patients was evaluated in this study. The control group consisted of 10 patients with average occlusion and skeletal characteristics. Digital lateral cephalometric X-rays were performed and different measurements were analyzed. Cephalometric data were evaluated with the CephX specialized software for orthodontic diagnosis and the results were statistically analyzed. The Class III group presented specific characteristics such as prognathic mandible, large gonial angle, short maxillary length, higher lower facial height. These findings can be useful for the diagnosis and treatment planning of orthodontic cases with dental/skeletal anomalies, especially in cases when surgical approach is considered. The surgical decision must be taken after an accurate investigation of the lateral cephalometric parameters.

Keywords: cephalometric analysis, Class III malocclusion, orthodontics, diagnosis, treatment planning.

Introduction
Lateral cephalometric is the gold standard in assessing hard and soft tissue cranial profiles, using a list of standard landmarks. Orthodontists have relied on radiographic cephalometry, as it has been one of the most important diagnostic tools [1, 2]. Also, lateral and antero-posterior cephalograms have been important for surgical orthodontic corrections of jaw discrepancies. Cephalometric techniques can be used in order to predict the result of orthodontic treatment combined with surgery.

The following are some of the most important cephalometric landmarks that were used in the cephalometric analysis [1–3].

Skeletal landmarks
1. A-point (A): an arbitrary point at the innermost curvature from the anterior nasal spine at the crest of the maxillary alveolar process.
2. B-point (B): an arbitrary point on the anterior profile curvature from the mandibular landmark, pogonion, to the crest of the alveolar process.
3. Gnathion (Gn): the most downward and forward point on the profile curvature of the symphysis of the mandible.
4. Gonion (Go): the most posterior and inferior point on the angle of the mandible that is formed by the junction of the ramus and the body of the mandible.
5. Nasion (N): the most anterior point of the frontal suture.
6. Pogonion (Pg): the most anterior point on the symphysis of the mandible.
7. Sella (S): a constructed point in the middle of the sella turcica.

Soft tissue landmarks
1. Naso-labial angle: the angle formed by the labial surface of the upper lip at the midline and the inferior border of the nose. It is a measure of the relative protrusion of the upper lip.
2. Soft tissue line-upper lip.

Dental landmarks
1. Interincisal angle;
2. Lower incisor position;
3. Lower incisor inclination;
4. Lower incisor protrusion;
5. Upper incisor inclination;
6. Upper incisor protrusion.

Patients and Methods
A group of 10 Class III orthodontic patients was evaluated in this study. The control group consisted of 10 patients with average occlusion and skeletal characteristics. Digital lateral cephalometric X-rays were...
performed and different measurements were analyzed. Cephalometric data were evaluated with the CephX specialized software [5] for orthodontic diagnosis and the results were statistically analyzed.

Figure 1—(a) Normal occlusion, frontal view. (b) Class III malocclusion, frontal view.

Figure 2—Initial panoramic radiographic examination.

Figure 3—(a) Lateral cephalogram of a Class I patient. (b) Lateral cephalogram of a Class III patient.

The panoramic radiography (OPG) gives an excellent view of the dental and skeletal structures extending from the left to the right mandibular condyle, showing also all existing treatments/problems regarding teeth [6, 7]. The lateral cephalogram shows clearly all dental and skeletal elements of the craniofacial structures including soft tissue profile (Figure 4).

Results

The digital lateral cephalograms from both groups were analyzed with the CephX orthodontic software in order to obtain accurate data. Results are presented in the Tables 1–4.

The typical Class III patient presented:
- Class III skeletal relationship (ANB = -6.94);
- Mandible forward to maxilla (concave profile);
- Mandible protruded;
- Upper incisor proclined forward;
- Lower incisor too upright;
- Upper lip retruded;
- Lower lip protruded;
- Concave profile.

No differences related to the skeletal, dental and soft tissue variables were found related to the gender of evaluated patients.

Figure 4—CephX image overlay of the soft tissue profile to the cephalometric X-ray.

Figure 5—DiPaulo analysis of a Class III patient (CephX) horizontal discrepancy between jaws – 20 mm.

Table 1—Burlington Woodside analysis

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Control group</th>
<th>SD</th>
<th>Class III group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mandible length</td>
<td>mm</td>
<td>114</td>
<td>5.0</td>
<td>115.07</td>
</tr>
<tr>
<td>Maxillary length</td>
<td>mm</td>
<td>114</td>
<td>5.0</td>
<td>83.06</td>
</tr>
<tr>
<td>Mdb-Mx difference</td>
<td>mm</td>
<td></td>
<td></td>
<td>32.01</td>
</tr>
<tr>
<td>Lower face height</td>
<td>ANS–GN</td>
<td>55.0</td>
<td>3.0</td>
<td>52.97</td>
</tr>
<tr>
<td>Upper face height</td>
<td>mm</td>
<td></td>
<td></td>
<td>47.55</td>
</tr>
<tr>
<td>Total face height</td>
<td>mm</td>
<td></td>
<td></td>
<td>101.11</td>
</tr>
</tbody>
</table>

SD – Standard deviation; Mdb – mandible; Mx – maxillary; ANS–GN – anterior nasal spine-gnathion.
The cephalometric prediction suggested that surgical movement would optimize the dental and facial balance (Figure 6).

Figure 6 – Cephalometric objectives of the orthognathic treatment obtained with CephX software in a Class III patient.

Figure 7 – Ricketts analysis and values in a Class III patient.

Table 2 – Skeletal analysis in the two groups taken into this study

<table>
<thead>
<tr>
<th>Parameter [degrees °]</th>
<th>Measurement</th>
<th>Control group SD</th>
<th>Class III group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palatal plane to mandibular plane</td>
<td>ANS–PNS to mandibular plane</td>
<td>28 ± 4</td>
<td>25–33</td>
</tr>
<tr>
<td>Y-axis vertical horizontal growth</td>
<td>SGN/FH</td>
<td>59.4 ± 4</td>
<td>53–66</td>
</tr>
<tr>
<td>Maxilla to cranium</td>
<td>SNA</td>
<td>82 ± 4</td>
<td>75–85</td>
</tr>
<tr>
<td>Mandible to cranium</td>
<td>SNB</td>
<td>80 ± 4</td>
<td>73–85</td>
</tr>
<tr>
<td>Maxilla to mandible</td>
<td>ANB</td>
<td>2 ± 4</td>
<td>0–3</td>
</tr>
<tr>
<td>Wits</td>
<td>0 ± 4</td>
<td>0–4</td>
<td>-8.3</td>
</tr>
</tbody>
</table>

Table 3 – Soft facial profile analysis in the two groups taken into this study

<table>
<thead>
<tr>
<th>Parameter [°]</th>
<th>Control group SD</th>
<th>Class III group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naso-labial angle</td>
<td>100 ± 4</td>
<td>90–110</td>
</tr>
<tr>
<td>Soft tissue line–upper lip</td>
<td>-2 ± 4</td>
<td>-4–+1</td>
</tr>
<tr>
<td>Soft tissue line–lower lip</td>
<td>-2 ± 4</td>
<td>-4–+1</td>
</tr>
</tbody>
</table>

Discussion

The prevalence of Class III varies widely among races and populations. Historically, the Class III malocclusion with retrognathic maxilla was described as the “Habsburg jaw” as its prevalence in this royal family was high. A recent study [8], evaluated the dentoskeletal features of the “Habsburg jaw” by analyzing the skull of Joanna of Austria. The cephalometric values of Joanna were compared to standards for adult female subjects by Lippi D et al. The cephalometric analysis revealed the presence of a skeletal Class III associated with maxillary retrusion. The mandible presented with increased dimensions both in total mandibular length (Co–Gn) and in the mandibular body (Go–Gn).

Our study evaluated the cephalometric characteristics of Class III in a group of Romanian patients. When compared with the control group, the Class III group presented specific bone characteristics such as prognathic mandible, large gonial angle, short maxillary length, wide saddle angle, increased lower facial height. The upper lip was frequently retruded, as the lower lip was protruded. The lower incisors were frequently proclined forward. The chin was frequently protruded. These findings can be useful for the diagnosis and treatment planning of orthodontic cases with dental/skeletal anomalies, especially in cases when surgical approach is considered.

When compared to a previous study that evaluated the Japanese norms [9], our Caucasian Class III group presented a slight more retrognathic maxilla and decreased values of incisor inclination. Previous studies have evaluated the cephalometric norms in different populations and races [10–15]. Studies have shown that the frequency of Class III is higher in Asia and Middle East than in European populations. The Middle East patients have a lower upper facial height comparing to the Asian and Caucasian groups. No significant differences were found between the antero-posterior position of the mandible between the Asian and Caucasian populations.

The treatment of the Class III malocclusion should be established after an accurate diagnosis [16, 17]. Therapeutical methods are varied according to the patient age and the problem severity. Camouflage treatment can be obtained in some less severe cases, but with special attention to the periodontal status of these patients [18]. After the growth completion, in severe cases, the surgical/orthodontic approach can be
considered. The esthetic changes after the completion of surgical/orthodontic treatment are significant [19]. The surgical decision must be taken after an accurate investigation of the lateral cephalometric parameters [20–22].

Conclusions
Class III skeletal problems are one of the most complicated problems in adulthood. Therefore, diagnosis is a very important step in the process of treatment and technology helps, but crucial to any evaluation of whatever analysis is used, is the accuracy and reliability of the original landmark identification.

Laterale cephalometric norms can help the diagnosis, treatment planning and the outcome evaluation in orthodontic Class III patients.

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References

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