Mandibular antegonial notch depth distribution and its relationship with craniofacial morphology in different skeletal patterns

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ABSTRACT

Background: Antegonial notch is a small concavity at the inferior surface of the mandible. The purpose of this study is to identify the distribution of mandibular antegonial notch depth and its relationship with craniofacial morphology in different skeletal patterns.

Materials and method: The sample included 191 pretreatment digital lateral cephalometric radiographs (93 males, 98 females) collected from the Orthodontic Department in the College of Dentistry, University of Baghdad. The sample was divided into three groups according to the skeletal classes, and then each group divided according to depth of mandibular antegonial notch into: shallow, medium, and deep groups. Sixteen angular and thirteen linear measurements were used.

Results: Cl I had the highest percentage of medium antegonial notch. Cl II had the highest percentage of deep notch, while Cl III had the highest percentage of shallow notch. Males had significantly deeper notch than females in Cl I and Cl II. Significant difference found between males skeletal Cl II and Cl III. The craniofacial measurements showed significant changes with the increase in antegonial notch depth variably in different classes.

Conclusions: Angular measurements of cranial base more concerned with mandibular morphology than linear measurements. The increase in vertical growth pattern and backward rotation of the mandible in association with the increase in notch depth appeared particularly in skeletal Cl II.

Keywords: antegonial notch, craniofacial morphology, skeletal patterns. (J Bagh Coll Dentistry 2009; 21(1): 107-111)

INTRODUCTION

A successful treatment of malocclusions often depends on appropriate orthopedic intervention to correct underlying skeletal discrepancies. The ability to predict the magnitude and direction of a patient's facial growth early in life would enable the clinician to identify those who required interceptive growth identification and to ensure that the appropriate treatment can be rendered while growth is possible, and to forgo unnecessary treatment on patients with skeletal discrepancies whose growth pattern would probably lead to correction without orthopedic intervention.(1) Directional growth prediction has assumed greater relevance with the increased realization that considerable individual variation occurs in craniofacial growth and morphology.(2) Since Broadbent(3) in his pioneering work on facial growth, suggested that the face of the average person develops downward and forward in more or less a straight line, many studies have shown that individual variation does occur.(4-6) Of special importance is the fact that the mandible, as a result of rotation during growth, can develop either protrusively or retrusively in relation to the maxilla and cranial base in different subjects. (7)

Mandible which demonstrates backward and downward rotation during growth experience pronounced apposition beneath the angle with excessive resorption under the symphysis. (4-6) The resulting upward curving of the inferior border of the mandible anterior to the angular process (gonion) is known as antegonial notching. (8) Subjects with deep antegonial notching have been reported to have disturbed condylar growth. (9-12) Other studies have shown that the mandibular growth potential is diminished in subjects with pronounced antegonial notching. (13) Several studies done to find relation between antegonial notch depth and direction of mandibular growth, most of them found subjects with deep antegonial notch associates with vertical growth pattern, (8,13) and the above previous studies found that deep antegonial notch become deeper during growth and shallow antegonial notch become shallower during growth.

MATERIALS AND METHOD

The sample

The sample of the present study included 191 pretreatment digital lateral cephalometric radiographs which had been collected from the files of the patients who attended the Orthodontic Department, in the College of Dentistry, University of Baghdad. All the patients are Iraqi
in origin with complete permanent dentition and age range between 18-25 years. No history of previous orthodontic, orthopedic or surgical treatment was present. Sample classification depended on the sagittal skeletal classification according to Houston\textsuperscript{(14)}, Foster\textsuperscript{(15)}, Rani\textsuperscript{(16)}, Mitchell and Carter\textsuperscript{(17)}:

- **Skeletal Cl I**: $2^\circ \leq \text{ANB} \leq 4^\circ$.
- **Skeletal Cl II**: $\text{ANB} > 4^\circ$.
- **Skeletal Cl III**: $\text{ANB} < 2^\circ$.

Every lateral cephalometric radiograph was digitized by AutoCAD (2007) software computer program to calculate angular and linear measurements. First of all every radiograph was copied twice; one for angular and one for linear measurements, then cephalometric points were located for each one and lines joined between these points to form angles and planes.


**Figure 2: Cephalometric linear measurements.** 1: anteroposterior extent of anterior cranial base. 2: lateral extent of cranial base. 3: ramus length. 4: mandibular body length. 5: total mandibular length. 6: maxillary base length. 7: ramus notch depth. 8: antegonial notch depth. AFH: total anterior facial height. UPH: upper facial height. LFH: lower facial height. PHF: posterior facial height.

After classifying the sample according to the skeletal patterns, sixteen angular and thirteen linear measurements were recorded for each radiograph. All measurements were put in excel sheet for the whole sample (each class separately); angular measurements were taken directly, while linear measurements were divided by scale for each picture to overcome magnification factor (the ruler of the nasal positioner used to calculate the magnification factor).

The sample of each skeletal class classified into three groups according to the depth of mandibular antegonial notch: shallow ($< 1\text{ mm}$), medium ($1 \leq < 3$), and deep ($\geq 3$), and analyzed statistically. Figure 1 and 2 show the angular and linear measurements used in this study.

**Table 1: Genders’ differences of AGN depth (in mm) by student t-test in the classes of skeletal pattern and differences between classes of skeletal pattern for AGN depth by ANOVA test according to gender.**

<table>
<thead>
<tr>
<th>Skeletal Pattern</th>
<th>Males Mean</th>
<th>Females Mean</th>
<th>t</th>
<th>d.f.</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I</td>
<td>2.258</td>
<td>1.660</td>
<td>2.998</td>
<td>73</td>
<td>0.004**</td>
</tr>
<tr>
<td>Class II</td>
<td>2.546</td>
<td>1.724</td>
<td>3.964</td>
<td>76</td>
<td>0.000***</td>
</tr>
<tr>
<td>Class III</td>
<td>1.826</td>
<td>1.552</td>
<td>0.962</td>
<td>36</td>
<td>0.343</td>
</tr>
</tbody>
</table>

**Table 2: Least significant difference (LSD) test of males in different skeletal patterns for the mean values of AGN depth.**

<table>
<thead>
<tr>
<th>Skeletal Pattern</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I</td>
<td>0.222</td>
</tr>
<tr>
<td>Class I Class II</td>
<td>0.127</td>
</tr>
<tr>
<td>Class II Class III</td>
<td>0.011*</td>
</tr>
</tbody>
</table>

All the data of the sample were subjected to computerized statistical analysis using SPSS software computer program version 11.00. The statistical analyses included:

- **Paired t-test:** For intra and inter-examiner calibrations.
- **Student t-test:** To detect the genders’ differences of antegonial notch total depth in the three skeletal classes.
- **Chi square test:** To find the distribution of the patients according to AGN depths.
- **ANOVA and LSD post hoc tests:** used to detect the statistically significant differences between skeletal classes for antegonial notch depth and to detect the statistically significant differences in the mean values of different
craniofacial measurements with shallow, medium and deep antegonial notch depth groups. P values less than 0.05 were considered as statistically significant.

Table 3: ANOVA test for the craniofacial measurements of skeletal Cl I, Cl II and Cl III according to the depth of AGN.

<table>
<thead>
<tr>
<th>Variables</th>
<th>S-N</th>
<th>S-Ar</th>
<th>N-S-Ar</th>
<th>N-S-Ba</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cranial Measurements</td>
<td>0.370</td>
<td>0.351</td>
<td>0.078</td>
<td>0.058</td>
</tr>
<tr>
<td>Facial Angles and Facial Convexity Measurements</td>
<td>0.457</td>
<td>0.343</td>
<td>0.798</td>
<td>0.098</td>
</tr>
<tr>
<td>Facial Heights Measurements</td>
<td>0.369</td>
<td>0.986</td>
<td>0.578</td>
<td>0.729</td>
</tr>
<tr>
<td>Mandibular and Maxillary Rotation Measurements</td>
<td>0.299</td>
<td>0.107</td>
<td>0.003**</td>
<td>0.912</td>
</tr>
<tr>
<td>Mandibular and Maxillary Length Measurements</td>
<td>0.374</td>
<td>0.786</td>
<td>0.061</td>
<td>0.762</td>
</tr>
<tr>
<td>Incisors Inclination Measurements</td>
<td>0.785</td>
<td>0.829</td>
<td>0.683</td>
<td>0.879</td>
</tr>
</tbody>
</table>

Angular measurements in degree
Linear measurements in mm.

Figure 3: Graphical presentation of the distribution of the patients according to AGN depths. X²=7.207, d.f. =4, NS.

Table 4: Least significant difference test for the craniofacial measurements of skeletal Cl I according to the depth of AGN.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Shallow - Medium</th>
<th>Shallow - Deep</th>
<th>Medium - Deep</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ramus Notch</td>
<td>0.453</td>
<td>0.071</td>
<td>0.005**</td>
</tr>
<tr>
<td>N-S-Gn</td>
<td>0.948</td>
<td>0.046*</td>
<td>0.016*</td>
</tr>
<tr>
<td>U1/Max.P</td>
<td>0.032*</td>
<td>0.774</td>
<td>0.021*</td>
</tr>
</tbody>
</table>

Table 5: Least significant difference test for the craniofacial measurements of skeletal Cl II according to the depth of AGN.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Shallow - Medium</th>
<th>Shallow - Deep</th>
<th>Medium - Deep</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ramus Notch</td>
<td>0.023*</td>
<td>0.003**</td>
<td>0.190</td>
</tr>
<tr>
<td>N-S-Ar</td>
<td>0.340</td>
<td>0.003**</td>
<td>0.004**</td>
</tr>
<tr>
<td>N-S-Ba</td>
<td>0.352</td>
<td>0.001***</td>
<td>0.001***</td>
</tr>
<tr>
<td>AFH</td>
<td>0.670</td>
<td>0.000***</td>
<td>0.000***</td>
</tr>
<tr>
<td>UFH</td>
<td>0.186</td>
<td>0.563</td>
<td>0.018*</td>
</tr>
<tr>
<td>LFH</td>
<td>0.780</td>
<td>0.000***</td>
<td>0.000***</td>
</tr>
<tr>
<td>PFH</td>
<td>0.615</td>
<td>0.006**</td>
<td>0.002**</td>
</tr>
<tr>
<td>N-S-Gn</td>
<td>0.866</td>
<td>0.064</td>
<td>0.008**</td>
</tr>
<tr>
<td>S-Ar-Go</td>
<td>0.154</td>
<td>0.001***</td>
<td>0.003**</td>
</tr>
<tr>
<td>UGo</td>
<td>0.143</td>
<td>0.000***</td>
<td>0.002**</td>
</tr>
<tr>
<td>LGo</td>
<td>0.670</td>
<td>0.005**</td>
<td>0.000***</td>
</tr>
</tbody>
</table>

RESULTS AND DISCUSSION

Genders’ differences and classes’ differences

Both in skeletal Cl I and Cl II males had significantly deeper notch than females, so it may be regarded (the notch) as one of the linear measurements of craniofacial morphology which are usually higher in males than females. This finding agrees with Dutra et al (18) who stated that the antegonial notch depth was significantly greater for males than females (table 1).

According to the classes’ differences the significant difference between the mean values of the AGN of males found to be present mainly between skeletal Cl II and skeletal Cl III (table 2); this may be attributed to extreme difference in the direction of mandibular growth in these skeletal classes.
Distribution of antegonial notch depth

The highest percentage of the patients fell in the medium group of the notch depth, so it may be regarded as the normal range for the AGN depth with normal condylar and ramus growth. The highest percentage of the deep notch (DN) found in skeletal CI II, while the highest percentage of shallow notch (SN) found in skeletal CI III. These findings may be related to the direction of the growth of the mandible, which agree with Lambrechts et al\(^{(8)}\), and Mitchell et al\(^{(17)}\) who mentioned that there is an association between pronounced notching of the lower mandibular border and the vertical growth pattern (backward rotation of the mandible), and shallow notching with the horizontal growth pattern (forward rotation of the mandible) (figure 3).

Relationships of the craniofacial morphology with the antegonial notch depth

Ramus notch depth

Skeletal CI I: There was a significant difference in the mean values of the ramus notch depth, but it was only significantly higher in the deep than the medium AGN group (table 3, 4); Al-Attar\(^{(19)}\) found that the ramus notch is significantly higher in the DN than that of SN group. This may indicate that these morphological variations of the mandible tend to be associated together in their depths.

Skeletal CI II: The ramus notch was significantly smaller in SN subjects compared to that of medium notch (MN) and DN subjects (table 3, 5). This may come in accordance with Lambrechts et al\(^{(8)}\), and also with Ali et al\(^{(20)}\) who found a close relation of the increased mandibular antegonial notch depth and ramus notch depth particularly when associated with condylar bone changes, and this suggests that condylar remodeling might therefore be closely related to changes in craniofacial morphology, especially mandibular morphology.

Cranial measurements

Skeletal CI II: The saddle angle \(N-S-Ar\) and the cranial base angle \(N-S-Ba\) were significantly smaller in the DN subjects than that of MN and SN subjects (table 3, 5), this mean that when these angles open the notch becomes shallower.

Enlow\(^{(21)}\) has suggested that an acute cranial base angle has a mandibular protrusive effect which would tend to offset the retrusive effect of the short mandible reported in DN subjects. The finding of decrease in notch depth when the cranial base angle increase agrees with Houghton\(^{(22)}\) who believed that a more obtuse cranial base angle is the most important cranial factor involved in the formation of "rocker mandibles" (rocker mandibles are mandibles with no distinct AGN).

Facial heights measurements

Skeletal CI II: The increase in the AFH, LFH and PFH (table 3, 5) may give an indication that the increase in the mandibular antegonial notch depth in skeletal CI II associated with a tendency toward a long face syndrome without open bite. Schendel et al\(^{(23)}\) found that the principal differences between long face syndrome with and without openbite were the increase in the PFH and ramus height in the long face syndrome without openbite group, while AFH and LFH were increased in both groups.

Mandibular and maxillary rotation measurements

Skeletal CI I: The higher mean value of the \(N-S-Gn\) angle in the DN group than that of MN and SN groups (table 3, 4), indicates that as the mandible rotates backward and posteriorly positioned the notch becomes deeper.

Skeletal CI II: With the exception of the UGo angle there were general increase in mandibular rotation angles in deep notch group (table 3, 5), which suggest that the notch becomes deeper when there is a tendency toward a backward rotation of the mandible.

Isaacson and associates\(^{(24)}\) suggested that the amount of condylar growth indirectly affects the direction of mandibular rotation, if the sum of vertical growth at the midfacial sutures and the alveolar processes exceeds the component of vertical condylar growth, then the mandible should exhibit a backward rotational growth pattern. DN group had reduced condylar growth, so they will be subjected to a backward rotation of the mandible.

These findings mean that the depth of AGN positively correlated with backward rotation of the mandible and demonstrate a pattern of bone remodeling as described by Bjork and Skeile\(^{(6)}\), "whereby the anterior part of the corpus is pressed down into the matrix resulting in resorption at the lower surface of the symphysis," while, "the posterior part of the corpus is lifted up from the soft tissue matrix, stretching the periosteum, and apposition takes place below the angle."

\(S-Ar-Go\) angle was higher in deep compared to the medium and shallow notch subjects, (table 3, 5), this may be attributed to the compensation of the saddle and articular angles to each others, so when the saddle angle decreases the articular angle increases resulting in increase in AGN depth.

\(N-S-Gn\) angle was significantly higher in the DN than MN groups (table 3, 5), this indicates that as the mandible becomes steeper and
backward positioned the notch deepens, which come in agreement with Singer et al. \(^{(13)}\), Lambrechts et al. \(^{(8)}\), Wu and Zhang \(^{(25)}\), and Zhang et al. \(^{(26)}\). This vertical growth pattern also explains the increase in the AFH. The mean value of \(SN\)-\(Max.P\) angle showed no significant difference between the groups (table 3), which may contribute to the increase in the lower facial height as that reported by Proffit et al. \(^{(27)}\), “In long face individuals, who have excessive lower anterior face height, the palatal plane rotates down posteriorly”.

REFERENCES