Study of the Radiographic Morphology of the Temporomandibular Joint

Mirian Aiko Nakane MATSUMOTO\(^1\)
Ana Maria BOLOGNESE\(^2\)

\(^1\)Faculdade de Odontologia de Ribeirão Preto, Universidade de São Paulo, Ribeirão Preto, SP, Brasil
\(^2\)Faculdade de Odontologia, Universidade Federal do Rio de Janeiro, Rio de Janeiro, RJ, Brasil

The radiographic images of the temporomandibular joints of 53 individuals obtained from oblique lateral transcranial projections were studied for the appearance of the articular components (depth of glenoid fossa, inclination of the posterior wall of the articular eminence, condyle shape and position in relation to the eminence at maximum opening) and correlated with one another. The study demonstrated a definite correlation between depth of the glenoid fossa and inclination of the posterior slope of the articular eminence summit. However, no significant correlations were detected in the remaining comparisons.

Key Words: temporomandibular joint, anatomy, radiographic image, radiographic morphology.

Introduction

The temporomandibular joint is a highly specialized articulation differing from most others by having articular surfaces not covered with hyaline cartilage. An avascular fibrous tissue containing some cartilage cells forms the fibrocartilaginous covering. It is considered by Bell (1990) to be a complex articulation because an articular disk is interposed between the temporal bone and the mandible, dividing the articular space into two compartments, i.e., an upper one in which gliding movements occur, and a lower one characterized by rotation or hinge movements.

The temporomandibular joint is morphologically structured to support the specialized functional demands of mastication. These demands are the result of a complex pattern of constantly changing dental relationships (Boering, 1979). Clinical problems involving the muscles of mastication and the articular components may be detected in many individuals. Gianelly et al. (1970) stated that occlusal disharmonies can produce several lesions in the stomatognathic complex, including the temporomandibular joints, causing changes in the morphology of the components of this articulation.

The objective of the present investigation was to study the radiographic morphology of the components of the temporomandibular joint.
Material and Methods

Transcranial radiographs of the right and left joints were obtained in the positions of centric occlusion and maximum opening of the mouth by the technique of Lindblom (1936), modified (Figure 1). The radiographs were obtained from 52 white subjects (36 females and 16 males aged 20 to 30 years; mean age, 22.9 years) with class I dental malocclusion according to the classification of Angle (1899), with no tooth loss and not submitted to orthodontic treatment.

The radiographs were used to prepare tracings of the following articular structures: condyle and components of the temporal bone, outline of the fossa, articular eminence, postglenoid process, and external acoustic meatus.

The tracings of the radiographs taken during centric occlusion were used to measure the fossa and the articular eminence and the following points were identified (Figure 2A): 1) Pt, the lowest point in the postglenoid process; 2) Tb, the lowest point in the outline of the articular eminence; 3) Fm, uppermost or deepest point in the outline of the glenoid fossa; 4) Cm, uppermost point in the outline of the condyle.

The following linear and angular measurements were made (Figure 2A): 1) depth of the glenoid fossa: greatest distance between the Pt-Tb line and the roof of the fossa, or, more specifically, the perpendicular distance between point Fm and line Pt-Tb; 2) β angle: angle formed by the intersection of the Pt-Tb line with the eminence line (Lt) whose measurement represents the inclination of the posterior wall of the articular eminence.

Figure 1 - Photographs of an oblique lateral transcranial radiograph in the positions of centric occlusion (A) and maximal opening of the mouth (B).
The distance covered by the condyle in an anterior direction during maximum opening of the mouth was also measured using the articular eminence as reference. This distance was measured from point Cm' to point Tb on the Pt-Tb line. The positioning of the condyle (Cm) in relation to the articular eminence (Tb) at maximal opening of the mouth (Figure 2B) was recorded in mm and classified as follows: 1) position a, anterior to the eminence (Tb), when point Cm was anterior to point Tb; 2) position p, posterior to the eminence when point Cm was posterior to point Tb; 3) position e, in the eminence, when point Cm was on the same plane as point Tb.

In the analysis of transcranial radiographs taken during centric occlusion, the shape of the condyle was classified according to the following criteria: condyle shape in a lateral view: 1) plane or straight, 2) slightly convex, 3) well rounded or convex, 4) in the shape of an inverted ‘V’.

The following correlations were calculated between the various radiographic aspects of the articular components: 1) depth of the glenoid fossa and β angle, 2) depth of the glenoid fossa and position of the condyle at maximum opening of the mouth; 3) condyle shape and depth of the glenoid fossa; 4) condyle shape and β angle; 5) β angle and condyle position at maximum opening of the mouth.

**Statistical analysis**

Data for normal samples were analyzed statistically by analysis of variance and by the Student t-test. The linear regression equation was used when possible in some correlations. When analysis of variance showed differences between samples the Tukey test was applied, with the level of significance set at P < 0.05.
Results and Discussion

The measurements of the radiographic tracings revealed that the mean depth of the glenoid fossa of this sample was 7.7 mm for the right side and 8.16 mm for the left side, ranging from 6.56 to 9.63 mm (Table 1). These values are close to those obtained by Lindblom (1960) who reported a mean value of 7.0 mm and a range from 5.5 to 9.0 mm.

Table 1 - Mean ± SD and variation of depth of the glenoid fossa, β angle and condyle position in the sample.

<table>
<thead>
<tr>
<th></th>
<th>Mean ± SD</th>
<th>Variation</th>
<th>Male mean</th>
<th>Female mean</th>
<th>Male x female difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth of glenoid fossa</td>
<td>R</td>
<td>7.7 ± 1.14</td>
<td>2.09</td>
<td>8.11</td>
<td>7.89</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>8.16 ± 1.47</td>
<td>2.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>β Angle</td>
<td>R</td>
<td>49.8 ± 11.1</td>
<td>124.32</td>
<td>50.77</td>
<td>51.75</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>52.3 ± 9.93</td>
<td>98.61</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condyle position</td>
<td>R</td>
<td>7.35 ± 2.92</td>
<td>8.53</td>
<td>6.86</td>
<td>7.41</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>7.14 ± 2.85</td>
<td>8.12</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

n.s. = Not significant.
*Significant at the 1% level.

The mean value obtained by Ricketts (1950) was 7.4 mm, with a range of 2.5 to 11.8 mm. This value was similar to that obtained in the present study but the range of variation was much wider, especially considering the minimum value of 2.5 mm which may have been due to the age of the sample studied by this author (4 to 40 years).

In the present study there was no significant difference in depth of the glenoid fossa between sexes, although higher mean values were obtained for males. Lindblom (1964) also observed that men appear to have a slightly deeper glenoid fossa than women.

The inclination of the posterior slope of the articular eminence (β angle) had a mean value of 49.8° for the right side and of 52.3° for the left side (Table 1). Lindblom (1960) obtained a range of 44 to 72° and a mean value of 58°. The results obtained by Goldman and Taylor (1985) were similar to ours, i.e., they obtained a mean articular eminence inclination of 50.3° in relation to the Frankfort plane since they used similar methods for angle measurements, although the mean age of their sample was higher and the range of variation quite wide when compared to the present study.

The position of the condyle in relation to the articular eminence at maximum opening of the mouth was anterior to the articular eminence summit in most subjects (84.6%)
and in both joints (right and left sides), thus reflecting symmetrical anterior dislocation. In only one subject (1.9%) was the condyle in a posterior position in relation to the articular eminence summit in both joints. In 11.5% of the subjects, the position of the condyle was different in the right and left joints, one of them located posterior to the articular eminence summit and the contralateral one located anterior to, or coincident with the eminence, thus revealing asymmetrical positioning of the two joints (Figure 3, left panel). Mean anterior displacement in relation to the vertex of the eminence was 7.35 mm for the right side and 7.14 mm for the left side (Table 1). The results reported by Hansson et al. (1983) were similar to those obtained here, with 267 of 503 joints analyzed being positioned anterior to the articular eminence, 164 coinciding with the vertex of the eminence, and only 72 located posterior to this point. However, the results obtained by Hansson et al. (1983) were not as striking as those obtained in the present study in which 84.6% of the joints dislocated anterior to the vertex of the eminence. This tendency to indefiniteness in the sample of Hansson et al. (1983) in terms of condyle positioning at maximal opening of the mouth when compared to the present study is probably due to the fact that the individuals examined by these researchers did not have intact arches, with 23% having a loss of molars and 7% of them a loss of premolars and molars. Of these patients, 4% had full prostheses and 14% removable partial prostheses. These characteristics may interfere with the normal function of the masticatory system, including the movements of maximal opening of the mouth, which may be hampered by asymmetrical gliding of the mandible.

The anterior dislocation of the condyle in relation to the articular eminence during maximal opening was greater in females than in males, the difference being statistically significant at the 1% level.

As to the classification of condyle shape by transcranial radiography, it can be seen that 63.4% of the subjects had a slightly convex shape (shape 2), 21.2% had an inverted "V" shape (shape 4) and 15.4% had the well rounded or convex shape (shape 3) (Figure 3,

![Figure 3](image)

Figure 3 - Left panel, percent sample distribution by condyle position at maximal opening of the mouth: (a) anterior position; (p) posterior position; (ap) asymmetrical position. Right panel, percent sample distribution by lateral condyle shape: (2) slightly convex; (3) well rounded or convex; (4) inverted "V" shape.
right panel). Solberg et al. (1985) also evaluated the lateral shape of this structure and observed that 46% of their sample had a convex shape, 22% the inverted V shape and 32% a slightly concave shape, or, more precisely, part of the outline arching inwardly. However, this classification was performed on disarticulated cadaver specimens, possibly explaining the discrepancy between their data and ours. Furthermore, the sample studied by Solberg et al. (1985) consisted of individuals who did not have intact arches, who had lost at least two teeth and varying degrees of degeneration in the shape of the articular components.

Comparison of the fossa and the β angle was statistically significant at the 1% level, indicating that the deeper the fossa, the greater the inclination of the posterior slope of the eminence (Figure 4). This result confirms the statement made by Siché (1955) that the glenoid fossa tends to become deeper with growth and its anterior wall tends to become more inclined, with the more characteristic S shape. The present results did not indicate a significant correlation between depth of the glenoid fossa and condyle position at maximal opening of the mouth. No significant correlations were detected in the comparisons between condyle shape and depth of the glenoid fossa and β angle, or between β angle and condyle position in the mandible at maximum opening of the mouth (Table 2).

Table 2 - Comparison between depth of glenoid fossa, β angle and condyle position at maximal opening of the mouth.

<table>
<thead>
<tr>
<th>Comparisons</th>
<th>r</th>
<th>d.f.</th>
<th>t</th>
<th>P (HO)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth of glenoid fossa x β angle</td>
<td>0.6018</td>
<td>102</td>
<td>8.19</td>
<td>0.00%</td>
<td>*</td>
</tr>
<tr>
<td>Depth of glenoid fossa x condyle position</td>
<td>0.0960</td>
<td>102</td>
<td>0.97</td>
<td>66.58%</td>
<td>n.s.</td>
</tr>
<tr>
<td>β angle x condyle position</td>
<td>0.1360</td>
<td>100</td>
<td>1.37</td>
<td>16.96%</td>
<td>n.s.</td>
</tr>
</tbody>
</table>

n.s. = Not significant.

*Significant at the 1% level.

Figure 4 - Linear regression for the comparison between depth of the glenoid fossa and β angle.
Conclusions

The radiographic images of the temporomandibular joints demonstrated that the shape of the condyle was slightly convex in most cases and that there was a positive correlation between depth of the glenoid fossa and inclination of the posterior slope of the articular eminence, indicating that, the greater the depth of the glenoid fossa, the greater the inclination of the posterior slope of the eminence. No significant correlations were obtained for the remaining comparisons.

References

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Correspondence: Mirian Aiko Nakane Matsumoto, Faculdade de Odontologia de Ribeirão Preto, USP, 14049-409 Ribeirão Preto, SP, Brasil.

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