MAXILLARY AND MANDIBULAR BASE SIZE IN ANCIENT SKULLS AND OF MODERN HUMANS FROM OPI, ABRUZZI, ITALY: A CROSS-SECTIONAL STUDY

Aim: The size and shape of the jaws are related to occlusion and masticatory muscle function. Consequently, teeth and muscles are considered the functional matrix for the two jaws. Existing studies did not focus on the relationship between maxillary and mandibular base but on just their absolute dimensions. As the relationship between the two is of interest to orthodontists, the aim of this study was to calculate the maxillary-mandibular ratio (m-m ratio) in individuals from Central Italy and to compare it to that of ancient skulls from the same geographic area. Methods: Forty individuals from Opi, a small, isolated mountain village in Central Italy, and 40 ancient skulls from the same region were the sample of this study. The lengths of the maxillary and mandibular base were assessed on lateral cephalograms, the m-m ratio was calculated, and the measurements between the groups were compared. Results: Due to a significantly shorter maxillary base in the modern human sample, the m-m ratio was significantly lower in these subjects. Conclusion: This finding supports the hypothesis that growth of the skull is strongly modulated by the functional matrix, within which a morphologic unit develops. World J Orthod 2010;11:e1–e4.

Key words: ancient skulls, cephalometry, maxillary and mandibular base, evolution, functional matrix

Many researchers have investigated the development of the mandibular and maxillary base. The general hypothesis of these studies is that the development of the mandible seems to be more influenced by functional factors, while the development of the maxilla primarily follows the growth pattern of the mandible mediated by the occlusion. Consequently, the development of both jaws does not seem to be characterized by identical allometric patterns. It is generally accepted that the parts of the mandible show a relatively local independent growth pattern because of locally distinct functional influences.

The masticatory muscles show more strain on the mandible than any other muscle. As such, several studies indicated that variations in mandibular morphology are strongly linked to the mechanical demands of different diets. However, not only does function contribute to mandibular development, but the development and eruption of teeth should be taken into consideration, as well.

In this study, the absolute length of the maxilla and mandible of ancient skulls and modern humans from Opi, Abruzzi, Italy, were measured on tracings of lateral cephalograms. A ratio between these two variables was calculated and compared.
Thus, the hypothesis to be tested was that the relationship between the mandibular and maxillary base changed over time as a reaction to different functional demands. The results should reveal whether there is a general pattern of ontogenetic development of skulls, as well as if potential differences support the hypothesis that the maxillary-mandibular base relationship (m-m ratio) is largely controlled by the functional matrix.

MATERIAL AND METHODS

The sample comprised 40 individuals from Opi in Central Italy (mean age 26 ± 6 years, range 18 to 47 years, 23 women and 17 men) and 40 adult skulls from the same area (dated 300 to 200 BC). According to Shea, all skull specimens were dental class 7, ie, they had a full permanent dentition, a closed basilar suture, and heavy tooth wear.22

The 40 adults were consecutive patients originating from Opi (grandparents had to have been born in Opi) who consulted the Dental Unit of the National Health System for treatment. Informed consent was obtained from all subjects.

In every case, a lateral cephalogram was taken with the same equipment under the same conditions. These cephalograms were traced and measured (Fig 1).

Statistical analyses

To assess the error due to landmark identification, duplicate measurements were made of 10 tracings. The error of variance was calculated using Dahlberg’s formula,

\[
\delta = \sqrt{\frac{\sum d^2}{2N}}
\]

where \(d\) is the difference between the first and the second measurement and \(N\) the number of double registrations.

Differences of the various parameters were checked by Student t test. Because the m-m ratio often violated distributional assumptions, the arcsine (or angular) transformation was applied to the m-m ratio before subjecting the data to statistical testing.19 All the statistical analyses were performed with SPSS 8.0 (SSPS) at a significance level of \(P < .05\).
RESULTS

The intraobserver method error for all variables was found to be less than 5% of the variance for the entire sample.

Descriptive statistics are summarized in Table 1. A significant difference was observed for the maxillary length, which was distinctly larger in the ancient skulls (Fig 2). Although modern humans showed a smaller mandible, this difference was not significant (Fig 3). Finally, the m-m ratio was significantly smaller in modern humans as in the ancient skulls (Fig 4).

DISCUSSION

The skull and mandible were separate in the ancient sample, so the skull was placed with the occipital foramen on the table and the mandible was placed and oriented to the maxilla so that the dentition seemed to best fit. The lack of information about the original occlusion of the ancient skulls was the primary reason to omit any angular measurements. In fact, because of the aforementioned reasons, angular measurements are seldom considered in anthropological studies on skulls.

In the anthropological literature, nothing is known about the m-m ratio: During cranial measurements, the two jaws are evaluated independently of one another. The fact that the maxillary base was shorter in recent individuals is in accordance with the hypothesis that only two factors generally influence the two skeletal bases: the development of the dentition and functional occlusion. However, the maxilla is surrounded by many bony elements and must integrate different functional influences, whereas the mandible may be confronted with fewer conflicting demands and thus be more ready to reflect changing masticatory conditions. Also, the various components of the mandible are subjected to different functions, which is why there is no uniform relation of their size, shape, or position to one another. From an embryologic point of view, there appears to be a basis for the independence of these developmental units.

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Mandible</th>
<th>Maxilla</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Skull</td>
<td>135.6</td>
<td>8.3</td>
<td>99.9</td>
</tr>
<tr>
<td>Human</td>
<td>122.2</td>
<td>7.1</td>
<td>83.6*</td>
</tr>
</tbody>
</table>

* = significant differences between the groups calculated by t test.
Another limitation of this study was that the sex distribution was unknown for the skulls. However, sex has a definite effect on size, as well as proportion of the mandible and maxilla.

CONCLUSION

The lengths of the maxillary and mandibular base of ancient skulls and modern humans were assessed on lateral cephalograms. Due to a significantly shorter maxillary base in the modern sample, the m-m ratio was significantly lower in the same group, suggesting that growth of the skull is strongly modulated by the functional matrix, within which a morphologic unit develops.

REFERENCES


