A simple assessment for the vertical Proportion of the face in Japanese adults

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We investigated the vertical relation between the skeletal and alveolar components of the Japanese face using a simple assessment of vertical proportions of the face. We analyzed 114 lateral cephalometric radiographs of subjects judged to have attractive profiles. Subjects were selected who had upper and lower lips within the soft tissue E-line. They were divided into five groups based on FMA. The principal measurement items used in this analysis were the N-Me line, the S-Go line, the distance of Me perpendicular to the palatal plane, the distance from Ar to Go, and the FMA. We used the ratio of S-Go to N-Me to assess the skeletal component and the ratio of Ar-Go to the distance of Me perpendicular to the palatal plane to assess the alveolar component. We also investigated how FMA correlates with these two components.

We found that the ratio of the distance of Ar-Go to the distance of Me perpendicular to the palatal plane was correlated with FMA and with the ratio of S-Go to N-Me in all groups. The most acceptable ratio of the alveolar component occurred for an FMA between 25 and 32 degrees.

For an FMA between 25 and 32 degrees, 72% was the best ratio of for the alveolar component in order to present was best good balance in the profile. These findings suggest that we can use both FMA and the ratio of the distance of Ar-Go to the distance of Me perpendicular to palatal plane when determining individualized treatment targets. (J Osaka Dent Univ 2009; 43: 157–161)

Key words: Vertical assessment; Cephalometric analysis; Ratio of Ar-Go to the distance of Me perpendicular to the palatal plane

INTRODUCTION

To perform an adequate diagnosis and develop a good treatment plan, it is necessary to evaluate horizontal as well as vertical relations of the dentofacial complex. The facial height ratio from the Jarabak analysis and the mandibular plane angle (FMA) are both commonly used to evaluate vertical components of the dentofacial complex in orthodontic treatment. However, these measurement points do not allow accurate evaluation in the alveolar aspects of the mandible other than to determine changes after treatment. Therefore, we used the distance of the perpendicular line drawn from the menton to the palatal plane as the anterior alveolar height, and the distance from the articularare (Ar) to gonion (Go) as the posterior alveolar height. We evaluated the ratio of these two alveolar heights, and applied this new analysis method in clinical orthodontic practice. The purpose of this study was to determine the relationship of the alveolar height ratio, the facial height ratio, and FMA, and to evaluate the clinical usefulness of this new analysis.

MATERIALS AND METHODS

Materials

We selected the lateral cephalograms of 800 subjects (621 males and 179 females) with a mean age of 24 years from the records of Osaka Dental University. All radiographs were taken with the lips in light contact and the teeth in occlusion, and were
traced by one investigator.

**Subjects**
We used the E-line for each tracing to select 114 subjects who we deemed to have a beautiful profile (23 males and 91 females with a mean age of 24 years) from the 800 subjects. Subjects were selected who had both lips either on or within the E-line, had a Class I molar relationship with normal over-bite and over-jet, and had never received orthodontic treatment. After tracing the 114 radiographs, the subjects were divided into five groups based on the FMA: 24.0 to 25.9 degrees for Group 1, 26.0 to 27.9 degrees for Group 2, 28.0 to 29.9 degrees for Group 3, 30.0 to 31.9 degrees for Group 4, and 32.0 to 33.9 degrees for Group 5.

**Methods**
Measurement landmarks and lines
We used the following landmarks (Fig. 1) and lines (Fig. 2). S: Sella turcica (geometric center of the pituitary fossa), N: Nasion (most anterior point on the frontonasal suture in the midsagittal plane), Or: Orbitale (lowest point of the inferior rim of the orbit), Po: Porion (most superior point of the external auditory meatus), ANS: Anterior nasal spine (anterior tip of the sharp bony process of the maxilla), PNS: Posterior nasal spine (posterior spine of the palatine bone constituting the hard palate), Me: Menton (lowest point on the symphyseal shadow of the mandible), Mt: Mandibular tangent (point tangent to the lower border of the mandible on a line through the menton), Go: Gonion (a point on the curvature of the angle of the mandible located by bisecting the angle formed by lines tangent to the posterior ramus and the inferior border of the mandible), Ar: Articulare (junction of the posterior border of the ramus and the inferior border of the posterior cranial base), UL: Most prominent point of the upper lip, and LL: Most prominent point of the lower lip.

The following cephalometric reference lines were used for assessment of the vertical proportions of the face (Fig. 2): FH plane: Line from Po to Or, Palatal plane: Line from ANS to PNS, Mandibular plane: Line from Me to Mt, E-line: Line from the tip of the nose to the soft tissue pogonion.

**Measurement items**
The following measurements were used in this
study (Fig. 3). Angular measurement (degrees): FMA. Linear measurements (mm): AFH: Anterior facial height (distance from N to Me), PFH: Posterior facial height (distance from S to Go), AAH: Anterior alveolar height (distance from Me perpendicular to palatal plane), PAH: Posterior alveolar height (distance from Ar to Go). Facial height ratio: PFH divided by AFH (distance from S-Go divided by the distance from N-Me), Alveolar height ratio: PAH divided by AAH (distance from Ar-Go divided by the distance from Me perpendicular to the palatal plane). Means and standard deviations for all measurements were determined using statistical software (Statview 5, SAS Institute Co., Cary, NC, USA).

RESULTS

Table 1 shows the mean values and standard deviations for each group. Table 2 shows the statistical results we obtained and the significance values for seven variables. FMA negatively correlated with both the facial height ratio and the alveolar height ratio (p<0.05). There was positive correlation between the facial height ratio and alveolar height ratio.

Discussion

To perform an adequate diagnosis and a good treatment plan, it is necessary to evaluate not only horizontal, but also vertical relationships for the dentofacial complex. 4 For the final treatment goal, Kambara et al. 5 concluded that 2–3 mm is a desirable distance from the pogonion to the NB line, and that about 6 mm is a desirable distance from L1 to the NB line. They recommended that orthodontists use the Holdaway ratio, which is based on the distance from the pogonion to the NB line, as a criterion for positioning the mandibular incisors. They also found that the vertical position of the mandibular incisors affects the facial profile, and that their vertical position should be near or on the Xistion line. 6

There have been various studies on the use of different vertical assessments based on lateral cephalometry. In orthodontic treatment, both FMA 2,3 and the facial height ratio used in the Jarabak analysis 1 have commonly been used. The Jarabak analysis, based on Bjork analysis, has been modi-

Table 1 Mean values and standard deviations for each group

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFH (mm)</td>
<td>129.4 (8.1)</td>
</tr>
<tr>
<td>PFH (mm)</td>
<td>85.2 (4.8)</td>
</tr>
<tr>
<td>Facial height ratio</td>
<td>65.8 (2.1)</td>
</tr>
<tr>
<td>AAH (mm)</td>
<td>70.9 (4.0)</td>
</tr>
<tr>
<td>PAH (mm)</td>
<td>51.4 (3.5)</td>
</tr>
<tr>
<td>Alveolar height ratio</td>
<td>72.2 (3.8)</td>
</tr>
<tr>
<td>FMA (degrees)</td>
<td>28.2 (2.0)</td>
</tr>
</tbody>
</table>

Table 2 Correlation matrix

<table>
<thead>
<tr>
<th>FMA</th>
<th>Facial height ratio</th>
<th>Alveolar height ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>FMA</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Facial height ratio</td>
<td>-0.45</td>
<td>1.00</td>
</tr>
<tr>
<td>Alveolar height ratio</td>
<td>-0.43</td>
<td>0.60</td>
</tr>
</tbody>
</table>

p<0.01 (n=114)
fied and incorporated as a part of The Tweed, Steiner\textsuperscript{9,10} and Ricketts analyses,\textsuperscript{10,11} as well as others.\textsuperscript{12} The main features of this method are that it can be divided into skeletal and denture components, and growth direction can be analysed in detail by the skeletal component. It is recognized as an optimal cephalometric analysis for tracing craniofacial skeletal growth.

However, measurements used in the Jarabak analysis do not allow accurate evaluation in the alveolar region of the mandible which is expected to change after treatment. Therefore, we applied a simple, new assessment for the vertical ratios of alveolar height. To simplify the analysis, we used the distance of the perpendicular line drawn from the menton to the palatal plane as the anterior alveolar height, and the distance from Ar to Go as the posterior alveolar height. We then defined the ratio of these two values as the alveolar height (AH) ratio. In this study, we attempted to determine whether this new method of analysis correlated with FMA, and whether it was a useful parameter for clinical assessment.

**Relationship between FMA and the AH Ratio**

Our subjects had an average FMA of 28.2°, which is close to the mean for Japanese with normal occlusion. We found a strong negative correlation between FMA and the AH ratio ($-0.45$). This indicated that the AH ratio, like FMA, is useful for vertical assessment of the face.

**Relationships between the Jarabak analysis and the AH ratio**

Okamoto\textsuperscript{13} et al. studied the cephalometric evaluation of craniofacial skeletal growth using the Jarabak analysis.\textsuperscript{1} They traced growth changes in the craniofacial skeleton from childhood to adolescence in 15 boys and 14 girls between 10 and 15 years of age using Jarabak analysis, taking cephalometric radiographs once a year for six years. They found that the Japanese craniofacial growth pattern either had a slight inclination from the straight downward type or tended to the counterclockwise growth type.

When we applied a simple assessment for the vertical proportions of the face, we found an average facial height ratio of 65.8\%, which was close to the mean value for Japanese determined by Jarabak analysis. A strong positive correlation (0.60) was found between the facial height ratio and the AH ratio, indicating that the AH ratio has a strong correlation with the vertical proportions of the face. In addition, we evaluated the growth direction of the dentofacial complex using the values for the facial height ratio obtained from Jarabak analysis. Jarabak reported that a facial height ratio of less than 60\% indicates a clockwise growth type, 62-65\% indicates a straight downward type, and greater than 65\% indicates a counterclockwise growth type. Roth\textsuperscript{14,15} further examined this analysis and concluded that a ratio of 54-58\% indicates a clockwise growth type, 59-63\% indicates a neutral type, and 64-80\% indicates a counterclockwise growth type. Because subjects with normal occlusion and excellent facial profiles were selected for this study, they were in the counterclockwise division of Jarabak and Roth assessments. Therefore, we concluded that two important factors for an excellent facial profile are the distance from the pogonion to the NB line and a counterclockwise growth type of the face.

**Conclusion**

We developed a simple assessment to evaluate the vertical skeletal and alveolar components of the vertical proportions of the face using the AH ratio (ratio of Ar-Go to the distance of Me perpendicular to the palatal plane). A strong correlation was observed between the skeletal ratio and the AH ratio. An AH ratio of about 72\% is desirable when FMA is between 25 and 32 degrees. We concluded that the AH ratio is a useful, easy, and effective diagnostic method in orthodontic treatment. Further study is necessary to evaluate the AH ratios of different types of vertical malocclusions.

**REFERENCES**


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