Original Article

Can Cephalometric Indices and Subjective Evaluation Be Consistent for Facial Asymmetry?

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Abstract: The purpose of this study was to investigate the relationship between the subjective evaluation of facial asymmetry and seven cephalometric indices. Ten orthodontists subjectively evaluated the frontal photographs of 100 subjects and categorized them into three categories, ie, category I—symmetrical view; category II—a little asymmetry not requiring treatment; and category III—marked asymmetry requiring treatment. Seven indices that were used to evaluate facial asymmetry were determined using frontal cephalographs of these patients. Interobserver agreement was assessed using Cohen's kappa statistic. Agreement among the observers for category III was higher than for categories I and II. To define the characteristics of each category, the cephalometric indices, which at least eight observers agreed on, were compared between the categories. No differences were found in any of the indices between categories I and II. Five indices showed differences between category III and the other categories. Among them, the distance of Me from the vertical reference line was the most relevant index for the subjective evaluation of facial asymmetry. When a discrepancy is found between skeletal measurements and a subjective evaluation, the influence of soft tissue structures should be considered in facial asymmetry. (*Angle Orthod* 2005;75:651–655.)

Key Words: Face; Asymmetry; Subjective evaluation; Cephalograph

INTRODUCTION

The recovery of facial symmetry is an essential aim of orthodontic treatment or orthognathic surgery and is usually planned on the basis of measurements from posteroanterior (PA) cephalographs. Treatment results are objectively assessed with reference to various cephalometric indices. Conversely, a patient's decision for treatment and a patient's satisfaction with the results are subjectively determined depending on perceptive assessment.[1] This discrepancy may occasionally cause differences between the patient and clinician.

Although cephalometric measurement addresses skeletal asymmetry,[2–4] a subjective evaluation may be performed on the basis of soft tissue features including an outline of the face.[5–8] Soft tissue features are quantified by measuring frontal facial photographs, and the relationship of these measurements with cephalometric measurements has been reported.[8] However, there are few reports regarding the relationship between a subjective assessment and cephalometric indices, and this relationship has not been well described. It is unknown whether skeletal asymmetry, which is determined by cephalometric measurement, is consistent with the subjective evaluation of facial asymmetry.

In this study, we investigated the relationship between the subjective evaluation of facial asymmetry

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and seven cephalometric indices, which are generally used for symmetry assessment together with the degree of agreement between the orthodontists' evaluations.

MATERIALS AND METHODS

One hundred subjects were selected consecutively from patients who visited our hospital to receive orthodontic treatment in 2000 using the following criteria:

1. Patients had permanent dentition after IIIC in terms of Hellman's dental age.
2. No congenital abnormalities were seen in the maxillofacial region.
3. No prior surgery or injury had occurred involving the maxilla or mandible.
4. Standardized facial photographs and cephalographs taken before treatment showed sufficient quality for evaluation.

The subjects consisted of 69 female subjects and 31 male subjects who ranged in age from 12 to 53 years with a mean age of 22.5 years.

Facial photographs were taken using a single-lens reflex Nikon FM2 camera (Nikon, Tokyo, Japan) with a distance of 1.5 m between the patients and focus using a positive 35-mm film (FUJIFILM, Tokyo, Japan). The patients were seated in an upright position on a special chair and were fixed by ear rods with the Frankfurt horizontal plane in parallel to the floor. The photographs were scanned by a Nikon SF 200 scanner (Nikon) at 600 dpi and stored in JPEG format. Cephalographs were taken with CX-150s (Shimadzu, Kyoto, Japan) in the PA projection with a distance of 2.0 m between the X-ray focus and the films. PA cephalographs were printed on films with a 1.1 magnification using a digital radiography system FCR9000C (Fuji Film Medical, Tokyo, Japan). The films were then scanned with a flatbed EPSON GT9600 scanner at 150 dpi and stored in JPEG format.

Subjective evaluation

For subjective evaluation, frontal photographs were printed out (Ipsio Color 8000, RICOH, Tokyo, Japan) with a size of 21 $\times$ 29.7 cm in 360,000 colors (Figure 1). Ten orthodontists subjectively evaluated the frontal photographs of the subjects. They were asked to classify each subject into one of the following three categories:

- Category I: patients who exhibited a good symmetrical frontal view.
- Category II: patients who exhibited a little asymmetry but who did not require treatment.
- Category III: patients who exhibited marked asymmetry and required treatment.

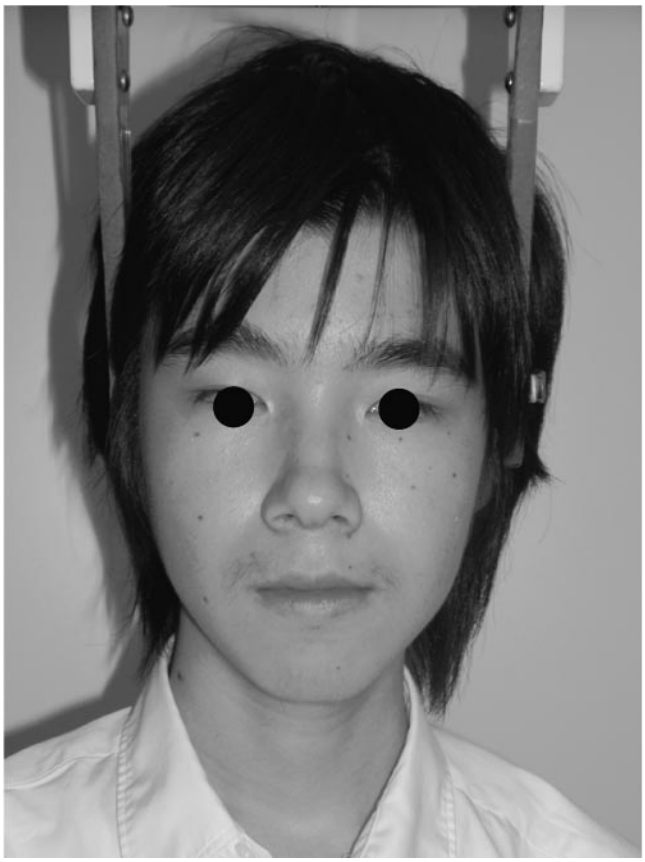

FIGURE 1. A frontal photograph used for subjective evaluation.

Cephalometric measurements

The stored PA cephalographs were analyzed with software (Winceph, Rise, Sendai, Japan) on a Windows PC. The cephalometric landmarks are presented in Figure 2. The horizontal referential line (HRL) was defined as the line connecting the Lo and Lo′, and the perpendicular line to the HRL passing through the CG was defined as the vertical referential line (VRL). The distances for Zyg, U1, L1, AG, and Me were measured from the VRL. For bilateral points, asymmetry indices were calculated according to the following formula:

$$\text{Asymmetry index (\%)} = |(R - L)/(R + L)| \times 100$$

where R is the value of the right distance and L is the value of the left distance.

In addition, the maxillomandibular midline angle was defined as the angle of the line connecting the ANS and Me to the VRL. The postural symmetry angle was defined as the difference between the Lo-AG-Zyg and Lo′-AG′-Zyg′ angles. Thus, seven indices were determined for the evaluation of the symmetry status. Five indices were compared with normal Japanese values.[9,10]

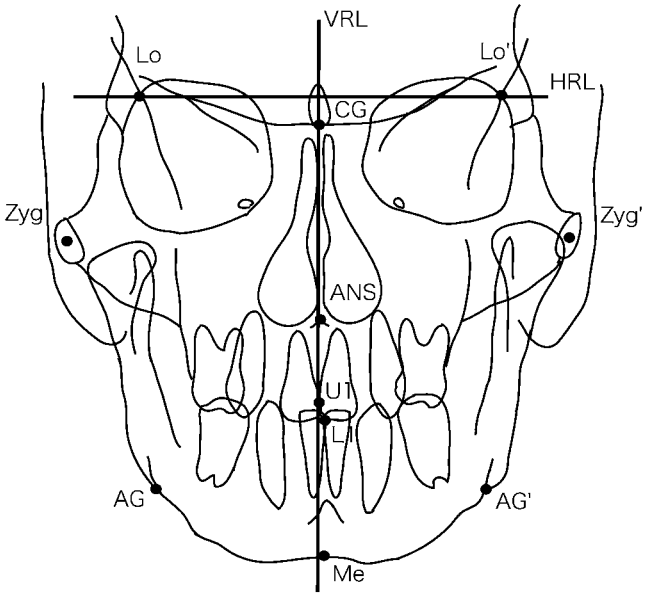

FIGURE 2. Cephalometric measurements. CG indicates crista galli; Lo and Lo′, right and left latero-orbitales; Zyg and Zyg′, right and left zygomas; ANS, anterior nasal spine; Me, menton; AG and AG′, right and left anterior notches; U1, contact point between the upper central incisors; and L1, contact point between the lower central incisors.

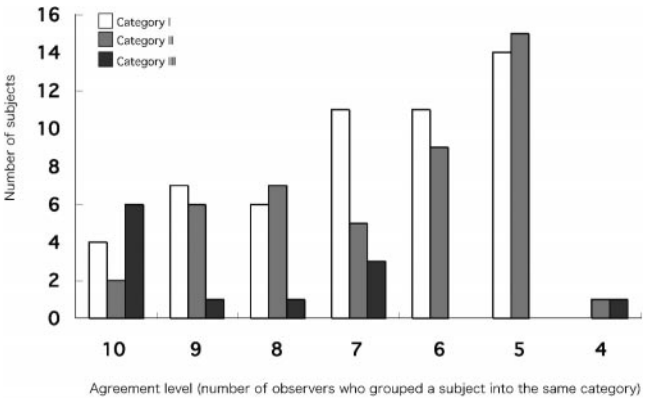

FIGURE 3. Agreement level (number of observers who grouped a subject into the same category) and the number of subjects in each category.

Statistical analysis

Tukey-Kramer statistics were used to examine the differences in measured values between the three categories. Observer agreement was evaluated using modified Cohen's kappa statistic for patient classification.[11,12]

RESULTS

Subjective evaluation

The patient distribution for each category is presented according to the number of observers who classified the patients into the same category (Figure 3). Patients classified into category I or II increased in number as the level of agreement declined, whereas they decreased in category III. The interobserver agreements (kappa values) were 0.30, 0.20, and 0.68 for categories I, II, and III, respectively. Classification into category III showed substantial agreement according to the definition by Landis and Koch,[11,12] whereas there was fair agreement for categories I and II.

To examine the characteristic features of each subjective category, patients with at least eight of 10 observers' agreement were selected, so that a total of 40 patients were chosen. They consisted of 17 patients from category I, 15 from category II, and eight from category III.

Cephalometric measurements

No differences were found in any of the indices between categories I and II (Tables 1 and 2). With the exception of three indices (asymmetry index for Zyg, Zyg′, U1 distance, and postural symmetry angle), differences were found between categories I and III and between categories II and III. For indices related to the maxilla (asymmetry index for Zyg, Zyg′, and U1 distance), no differences were found between any combination of subjective categories. For the postural symmetry angle, no significant differences were found between the three categories.

TABLE 1. Cephalometric Measurements[a]

	Category I (n = 17)		Category II (n = 15)		Category III (n = 8)	
	Mean ± SD	Median	Mean ± SD	Median	Mean ± SD	Median
Asymmetry index for Zyg, Zyg′	4.13 ± 2.61	3.12	4.60 ± 2.10	4.85	4.15 ± 2.59	4.39
Asymmetry index for AG, AG′	3.13 ± 3.37	1.90	3.96 ± 3.57	2.52	8.63 ± 5.83	11.62
U1 distance from the VRL (mm)	1.06 ± 1.03	0.80	1.12 ± 1.26	0.60	1.68 ± 1.15	1.80
L1 distance from the VRL (mm)	1.08 ± 0.81	0.80	1.61 ± 1.11	1.30	5.44 ± 3.36	5.50
Me distance from the VRL (mm)	1.21 ± 1.21	0.80	2.18 ± 1.11	2.40	7.85 ± 3.94	7.80
Maxillomandibular midline angle (°)	1.61 ± 1.75	1.35	2.71 ± 1.47	2.60	8.09 ± 3.72	8.50
Postural symmetry angle (°)	1.40 ± 1.20	1.60	0.94 ± 0.59	0.80	2.16 ± 1.46	2.10

[a] VRL indicates vertical referential line.

TABLE 2. Difference in Cephalometric Measurements Between Three Categories[a]

	Category I vs Category II	Category I vs Category III	Category II vs Category III
Asymmetry index for Zyg, Zyg′			
Asymmetry index for AG, AG′		**	**
U1 distance from the VRL			
L1 distance from the VRL		**	**
Me distance from the VRL		**	**
Maxillomandibular midline angle		**	**
Postural symmetry angle			

[a] VRL indicates vertical referential line; ** significant difference with $P < .01$ (Tukey-Kramer test).

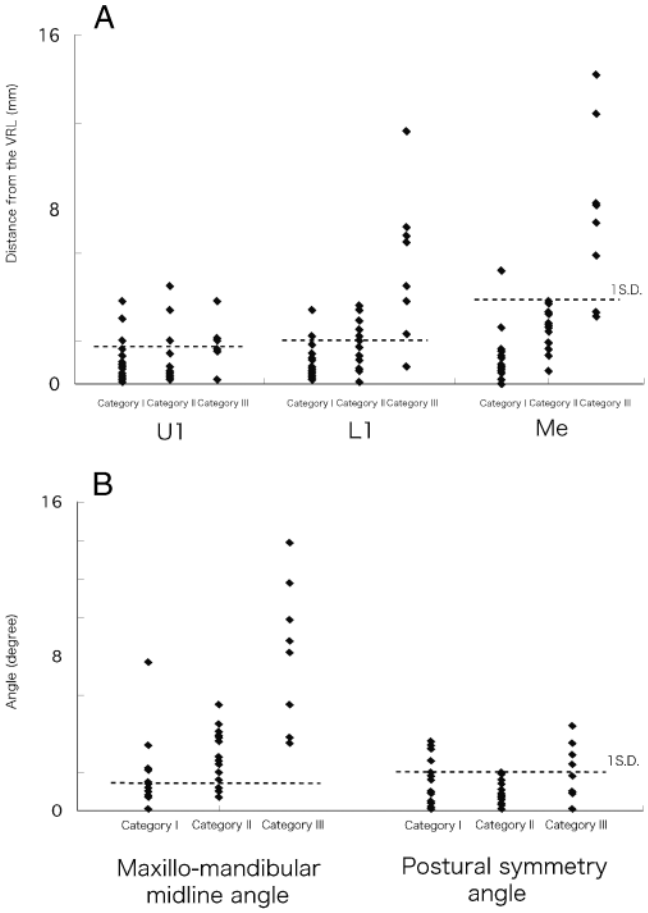

FIGURE 4. Measured values of five indices for each category. (A) U1, L1, and Me distances from the VRL. (B) Maxillomandibular midline and postural symmetry angles. The dotted lines indicate one standard deviations of Japanese normal values.[9,10]

Based on comparisons with normal Japanese values for the L1 distance, a number of subjects classified into categories I and II had values exceeding one standard deviation (1 SD), although differences were confirmed between these categories and category III (Figure 4A). For the Me distance from the VRL, only one of 32 subjects classified into category I and II was out by 1 SD, whereas two of eight belonging to category III were within 1 SD (Figure 4A). Although all eight subjects classified into category III exhibited a maxillomandibular midline angle greater than 1 SD, five (27.8%) of 17 category I subjects and 11 (73.3%) of 15 category II subjects also exhibited values exceeding 1 SD (Figure 4B). The postural symmetry angle was within 1 SD for four (50%) of eight category III subjects and all (100%) 15 category II subjects. Conversely, four of 17 subjects classified into category I exceeded 1 SD (Figure 4B).

DISCUSSION

The subjective evaluation of facial asymmetry has been investigated in relation to soft tissue features for frontal photographic measurement.[6–8] Edler et al[6] reported a high agreement for the asymmetry group requiring treatment. In their report, eight observers (four orthodontists and four oral surgeons) were asked to categorize the frontal photographs of 11 patients into three groups as in this study. The asymmetry group exhibited high agreement (kappa value = 0.77), whereas overall agreement was relatively low (kappa value = 0.46). The results of this study confirmed these observations for a large number of subjects. Category III, in which the frontal views were judged as markedly asymmetrical and in need of treatment, exhibited high agreement (kappa value = 0.68). Conversely, lower agreement ratios were observed for categories I and II. Therefore, orthodontists and oral surgeons may have a similar standard of requirement for treating facial asymmetry.

Even for people with esthetically pleasing or clinically acceptable facial symmetry, laterality can be found in almost all cephalometric indices.[3,4,13,14] Among them, indices related to the mandible show a higher degree of asymmetry[3,4,14] as for subjects with facial deformities, and the proportion of facial asymmetry is reported to be 25% to 34%.[1,15]

For patients with class III occlusion, the inferiorly located landmarks exhibit a larger deviation than the superior landmarks,[16] and the Me shows the greatest degree of deviation among the indices evaluated. Among four indices (asymmetry index for AG, AG′, L1 dis-

tance from the VRL, Me distance from the VRL, and maxillomandibular midline angle) related to the mandible, significant differences were seen between category III and the others (categories I and II) for which the subjects were evaluated as not requiring treatment. This result supports previous observations that mandibular components significantly contribute to facial asymmetry.

Considering the normal index defined as a value within 1 SD of the Japanese mean,[9,10] most subjects belonging to category III exhibited abnormal values for the Me and L1 distances and the maxillomandibular midline angle. However, a significant number of subjects who did not require treatment (categories I and II) also had abnormal values for the L1 distance and maxillomandibular midline angle. Conversely, only one subject had an abnormal Me distance from the VRL. Thus, the Me distance appeared to be the most relevant index for subjective evaluation.

The U1 distance from the VRL and postural symmetry angles did not differ between category III and the other categories. Because the U1 is a landmark related to the maxilla, these results are compatible with previous reports. However, the postural symmetry angle is determined by a landmark related to the mandible (AG: anterior notch) and is useful for the determination and follow-up of facial asymmetry for subjects with severe facial deformities.[17] In this study, no difference for this index was seen between the three categories. A possible explanation of this result is that the landmark related to this index is difficult to identify on distorted cephalographs. Changes in the vertical head position may also be related to this result. Another explanation is the effect of the interaction of soft tissue structures on subjective evaluation. Soft tissue covering the AG skeletal landmark is thicker than that of the Me. Therefore, subjective evaluation may be strongly influenced by the soft tissues status at the gonial region. Based on these results, the postural symmetry angle may not be effective for the asymmetry assessment of subjects without severe skeletal deformity.

Soft tissue structures such as the masseter muscle may compensate for skeletal asymmetry in the subject who shows skeletal laterality but is subjectively evaluated as not requiring treatment. Conversely, this study clarified the existence of subjects who exhibit no asymmetry in skeletal measurements but are subjectively judged as needing treatment. For such subjects, soft tissue laterality should be taken into account.

CONCLUSIONS

The distance of Me from the VRL is the most relevant index for the subjective evaluation of facial asymmetry. When a discrepancy is found between skeletal measurements and a subjective evaluation, the influence of soft tissue structures should be considered with regard to facial asymmetry.

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