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Facial soft tissue thickness differences among three skeletal classes in Japanese population

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ABSTRACT

Facial reconstruction is used in forensic anthropology to recreate the face from unknown human skeletal remains, and to elucidate the antemortem facial appearance. This requires accurate assessment of the skull (age, sex, ancestry, etc.) and thickness data. However, additional information is required to reconstruct the face as the information obtained from the skull is limited. Here, we aimed to examine the information from the skull that is required for accurate facial reconstruction. The human facial profile is classified into 3 shapes: straight, convex, and concave. These facial profiles facilitate recognition of individuals. The skeletal classes used in orthodontics are classified according to these 3 facial types. We have previously reported the differences between Japanese females. In the present study, we applied this classification for facial tissue measurement, compared the differences in tissue depth of each skeletal class for both sexes in the Japanese population, and elucidated the differences between the skeletal classes.

1. Introduction

The facial reconstruction technique is applied to unknown human skeletal remains to identify individuals, after evaluation of the skull. This evaluation involves the elucidation of race, sex, age, and facial profile. In addition, soft tissue data is assessed. These data differ according to the race, sex, and age (children and adults), and the evaluations are performed by a forensic anthropologist. Thereafter forensic artists perform facial reconstruction by using data collected by the forensic anthropologist. Three methods are commonly used for facial reconstruction, including sculpting, drawing, and computer-aided techniques. However, these methods are insufficient to accurately recreate the face.

However, the shape of the nose and ear region, as well as the texture (hair and color of the iris) are difficult to investigate based on information from the skull alone [1–6]. Differences in the facial features of the Japanese population have been previously reported in other studies. In the present study, we describe the differences in facial soft tissue thickness according to the skeletal features and sex, which are essential for accurate facial reconstruction. [7–10].

Several researchers have reported highly variable data for facial soft tissue thickness. Five measurement methods for measuring facial soft tissue thickness including needle puncture [11–13], ultrasonography [14–18], X-ray images [19–26], magnetic resonance imaging (MRI) [27] and computed tomography (CT) [28,29,27,30–33] have been reported. However, these methods have inherent advantages and disadvantages, which make it difficult to select an optimal method. However, in the present study, we used X-ray imaging as the relationship between the bone and soft tissue surface of the entire face can be obtained in a single image with this technique.

2. Materials and Methods

This study was approved by the Ethics Committee of the Matsumoto Dental University (No. 0171). Measurements were made using diagnostic cephalometric X-ray films (lateral view) obtained from 169 Japanese individuals (66 males [aged 18-43 years] and 103 females [aged 18-33 years]) who visited the Matsumoto Dental University Department of Orthodontics for orthodontic treatment. After informed consent was obtained, cephalometric X-ray images (a cephalogram) were acquired with a film-to-tube distance of 165 cm and rigid head fixation. The soft tissue and skeletal features were traced on acetate sheets using craniographic methods [34–36]. The images were classified into 3 skeletal classes based on the ANB angle-i.e., the position of the

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Table 1
Division of Skeletal classes.

	ANB angle $<2^{\circ} \sim 4^{\circ} <$	
concave	straight	convex
Class III	Class I	Class II

maxilla in relation to the mandible. The following points were assessed: (A) the deepest point on the line between the anterior nasal spine (ANS) and the prosthion; (B) the deepest point from the line between the infradentale (the apex of the alveolar bone between the right and left lower first incisors) and the pogonion; and (N) the nasion, (located on the suture between the frontal and nasal bones). The 3 skeletal classes were classified as follows: class I, ANB angle = 2-4°; class II, ANB angle > 4°; and class III, ANB angle < 2° (Table 1 **and** Fig. 1) [37–43].

Using a 2H retractable pencil, skeletal and soft tissue features were traced onto acetate sheets from cephalometric X-ray images. The ANB angle was then measured to identify the skeletal class and to plot the following anthropological landmarks: Or (the midpoint between the lowest point of the right and left orbital margins), Po (the highest point of the external acoustic meatus), and the Frankfort Horizontal Plane (FHP: the plane intersecting Po and Or).

After determining the FHP, the soft tissue thickness was measured at the following anthropological landmarks: (1) glabella; (2) nasion; (3) rhinion; (4) subnasale; (5) labrale superius; (6) stomion; (7) labrale inferius; (8) labiomentale; (9) pogonion; and (10) gnathion (Fig. 2) [44]. These points are perpendicular to the FHP or perpendicular to the bony surface. True measurements were recalculated after enlargement of the X-ray images by 10%. For each measurement, we calculated maximum and minimum values, range, mean, and standard deviation in each age group. One-way analysis of variance (ANOVA) was performed to assess the differences between the skeletal classes I, II, and III. Two-way ANOVA was used to compare between skeletal classes and sex. Moreover, the differences at the measurement points according to sex were compared with other Turkish [26] and Chinese [31] population studies. All the statistical analyses were performed using Graph Pad Prism® Ver. 6.

3. Results

Table 1 and Fig. 3 depict the mean thickness, range (maximum – minimum value), and standard deviation (SD) values (mm) of the Japanese male population classified according to the 3 skeletal classes, whereas Table 2 and Fig. 4 depict the corresponding female

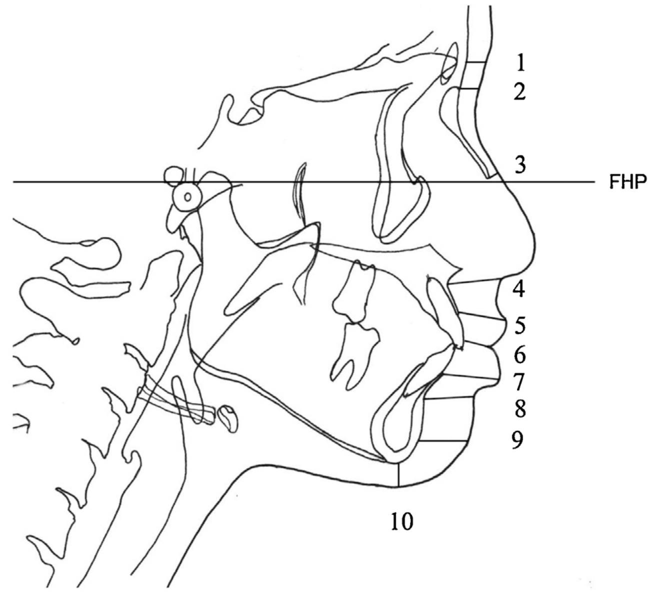

Fig. 2. Location of measurement points for facial soft tissue thickness. 1. Glabella, 2. Nasion, 3. Rhinion, 4. Subnasale, 5. Labrale superius, 6. Stomion, 7. Labrale inferius, 8. Labiomentale, 9. Pogonion, 10. Gnathion.

values. Tables 2a and 3a show comparisons among the 3 skeletal classes according to sex using one-way ANOVA, and the differences between 2 skeletal classes by the post hoc test (Tukey's multiple comparison test). Differences were observed at only the labrale inferius between skeletal classes II and III ($P < 0.05$). In the females, differences were observed at the subnasale between classes I and III ($P < 0.05$) and between classes II and III ($P < 0.01$); labrale superius between classes I and III ($P < 0.05$) and between classes II and III ($P < 0.01$); stomion between classes II and III ($P < 0.05$); labiomentale between classes I and II ($P < 0.01$) and between classes II and III ($P < 0.01$); pogonion between classes II and III ($P < 0.01$). The differences between the sexes in each skeletal class were analyzed by two-way ANOVA, as shown in Table 3. In skeletal class I differences were observed at 5 measurement points: nasion, subnasale, labrale superius, stomion and pogonion. In skeletal class II, differences were observed at the labrale superius, stomion, and gnathion. In skeletal III, differences were observed at the nasion, subnasale, labrale superius, stomion and gnathion. After comparing the data from the present study with those of the studies on the Turkish [26] and the Chinese [31] populations, we noted that the values were significantly lower in the present study compared to the other studies.

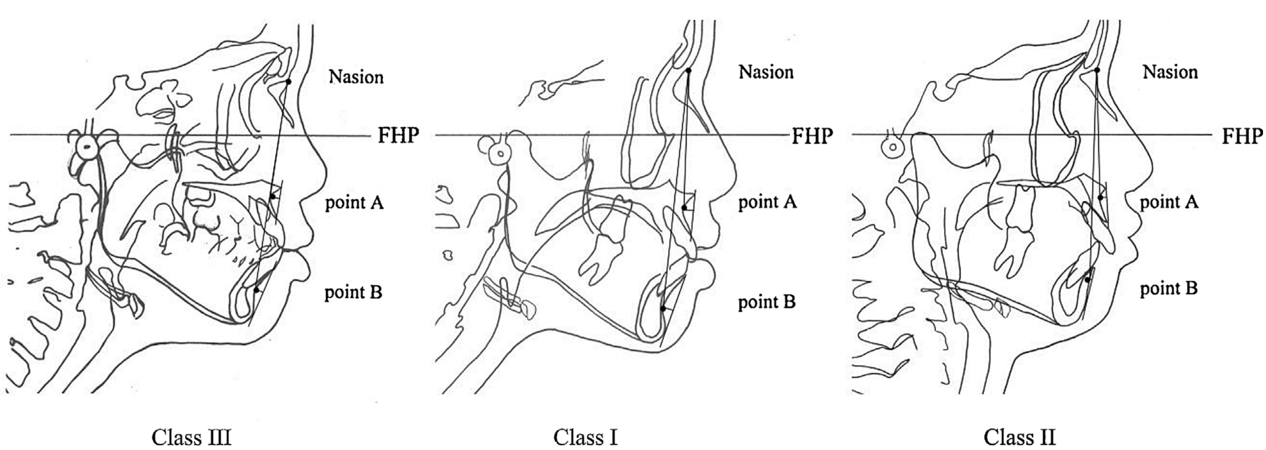

Fig. 1. Profiles of the three skeletal classes.