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Evaluation of Skeletal Ⅱ Patient's Ideal Profile by Using Computer Simulation

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The purpose of this study was to evaluate the differences in concepts of an ideal face between retrognathic patients and orthodontists, and evaluate the clinical utility of a new imaging software system. Frontal and lateral views from scanned images were captured of 11 male subjects with a retrognathic facial profile using a non-contacting three-dimensional optical surface scanner (Vivid 910 KONICA MINOLTA, JAPAN). The captured data were exported to the reverse modeling software package Rapidform 2006 RF6 (INUS Technology, Seoul, South Korea) to generate a composite whole face. Soft tissue changes were programmed into the new imaging software system and used to morph the three-dimensional images based on reference ratios. The subjects were asked to morph their own image and orthodontists morphed all of the subject images by moving 5 points set on the center of the lower face. Differences between the groups regarding the Z-coordinate values were analyzed using a Mann-Whitney U-test.

The following results were obtained.

1. The drawing simulation system utilized was found useful for clinical situations.
2. There were no significant differences between the groups in regard to the Labiale superior, Stomion, and Labiale inferior.
3. The subjects had fewer Submentale changes as compared to the orthodontists.
4. There was less Pogonion soft advancement in the subject group as compared to the orthodontists.

Our results suggest that retrognathic patients have no recognition that their chin appears to be shifted to the back as compared to normal.

Key words : non-contacting three-dimensional optical surface scanner, 3D-soft tissue change, self-image

Introduction

Among patients with adult malocclusion, those who are accompanied by dentofacial deformities often have a sense of esthetic inferiority. Accordingly, improvement of their profile is an important step to attain the final therapeutic goal. Most child patients and their parents visit orthodontists in hope of overcoming such esthetic inferiority by rearranging the teeth in a beautiful manner[1]. However, the orthodontist may not always have a clear image of the ideal profile expected by patients when designing the treatment plan, which can cause patient dissatisfaction with the post-treatment profile.

In the field of orthodontic dentistry, a variety

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of diagnostic software is used, which enables analyses of the skeletal and denture patterns, and rough simulation of the expected profile after orthodontic treatment or orthognathic surgery. However, such software has no functional setting to display an image expected by the patient following treatment. Accordingly, it is difficult for the orthodontist to design a treatment plan by taking into consideration the self image of the patient. Various methods, including drawing, silhouettes, and animation, have been employed to clarify the self image of the patient[2,3]. With those methods, subjects are asked to choose morph templates prepared in several different patterns on the basis of an average face with normal occlusion in order of preference. However, it is difficult for patients to determine their ideal profile with such methods.

In the present study, we developed a software package in cooperation with Eyes, JAPAN Co. Ltd. to depict three-dimensional (3-D) images by morphing 3-D dentofacial image data. With that software, we developed a system that is easily applicable to clinical practice to quantitatively evaluate the differences in ideal profile images by orthodontists and their patients with mandibular retrognathism among those diagnosed with dentofacial deformities.

Subjects and Methods

1. Subjects

The subjects were 11 male patients (Class II group) who visited the Department of Orthodontic Dentistry of Ohu University Hospital and diagnosed with mandibular retrognathism without severe labial inclination of the upper anterior teeth. Their dental age was IVA or older and body mass index values ranged from 18.5-25.0. The average age at the time of the first consultation was 24 years 6 months (range, 17 years 8 months to 34 years 6 months) (Table 1). For the control group, used to compare an ideal profile morph, 10 male orthodontists (Orthodontists group) qualified as certified orthodontists by the Japanese Orthodontic Society and with experience in orthodontic treatment for over 10 years were used. The present study was conducted under the approval of the Ethical Review Board of Ohu University after obtaining informed consent from the subjects.

Table 1 Summary of subjects

n=11	Mean±SD
SNA (deg)	82.16±4.69
SNB (deg)	76.00±2.72
ANB (deg)	6.08±2.93
Mandibular plane (deg)	20.34±7.43
U1 to FH (deg)	124.00±10.12
Overjet (mm)	6.50±2.69
Overbite (mm)	5.22±2.19
BMI	23.70±3.21

2. Methods

1) Preparation of bite plate for forward movement of mandible

To determine changes of the soft-tissue profile along the mid-sagittal plane, 3-D facial image data were captured at the intercuspal position and 5-mm forward position. For occlusion of mandibular forward movement, the intercuspal relationship at 5 mm forward from the intercuspal position of the mandible was captured using a George Gauge (Great Lakes, N.Y., USA)[4]. A dental cast model of the upper and lower jaw was attached to the fixer for a construction bite (FKO split postfix zeta, Dentauram, Ispringen, Germany) using the George Gauge. The bite plate was manufactured from orthodontic resin (Orth Crystal Quick Self-Curing Resin, Rocky Mountain Morita Corporation).

2) Preparation of 3-D Facial Image Data

(1) Facial morphology

Facial morphology was captured using a non-contacting 3-D optical surface scanner (Vivid

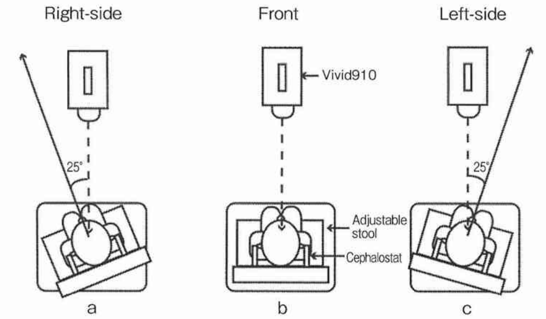


Fig. 1-A Position of patient and scanner during measurement.
Three sides for scanning.
a. Right-side scanning.
b. Front scanning.
c. Left-side scanning

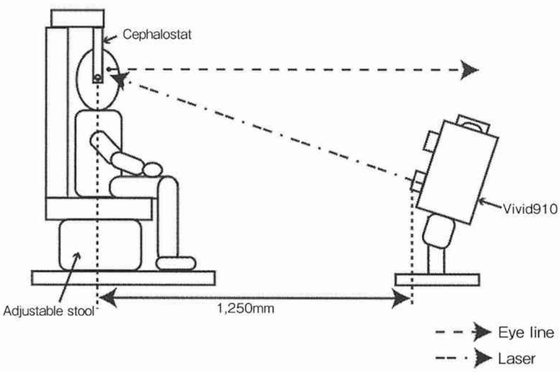


Fig. 1-B Position of patient and scanner during measurements.
The head was fixed using a cephalostat to make then FH plane parallel to the floor.

910, KONICA MINOLTA). The positioning between the scanner and subject during capture is shown in Figure 1A, B. For the Class II group, data were captured twice, at the intercuspal position and when attaching the bite plate, from the left and right sides and front of each subject. Each subject was induced with a bite plate, 5 mm forward horizontally from the intercuspal position and at the intercuspal position (Fig. 1A). For setting the reference points to superimpose the images, 8 red marking seals, each 3 mm in diameter (A-ONE label, A-One Co. Ltd.), were attached to specific points on the face (Fig. 2).

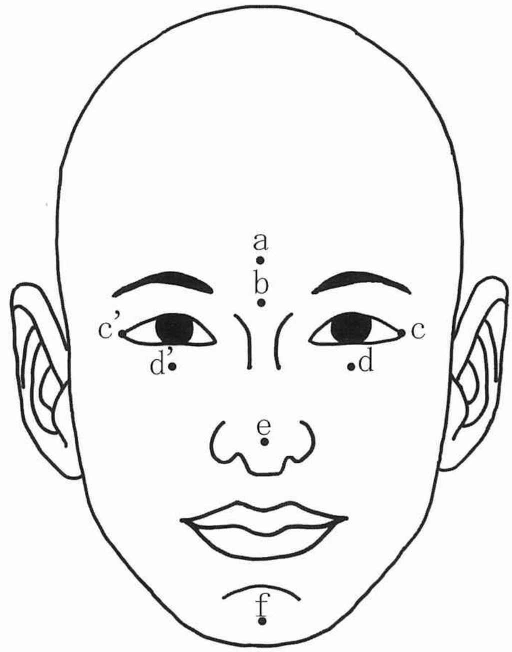


Fig. 2 Reference points for superimposition
a. G b. Ns c. Ex d. Ors e. Prn f. Pogs

The orthodontic measuring points of soft tissue were set according to Jacobson's report[5].

a) G : Glabella : The most anterior projecting point to FHV (FHV is defined as the line perpendicular to the FH plane that passes through Porion Soft(Pos). Pos is the auricular point of soft tissue that represents the superior border of the antilobium on the contour of the frontal region.

b) Ns : Nasion soft : The most retracted point to FHV on the contour of the procerus.

c) Ex, Ex' (right) : Orbitale soft : The intersection point of the upper and lower lid margins at the outer edge of the palpebral fissure.

d) Ors, Ors' (right) : Orbitale soft : The most inferior border of the orbits on the soft tissue.

e) Prn : Pronasale : The most prominent point to FHV on the contour of the procerus.

f) Pogs : Pogonion soft : The most prominent

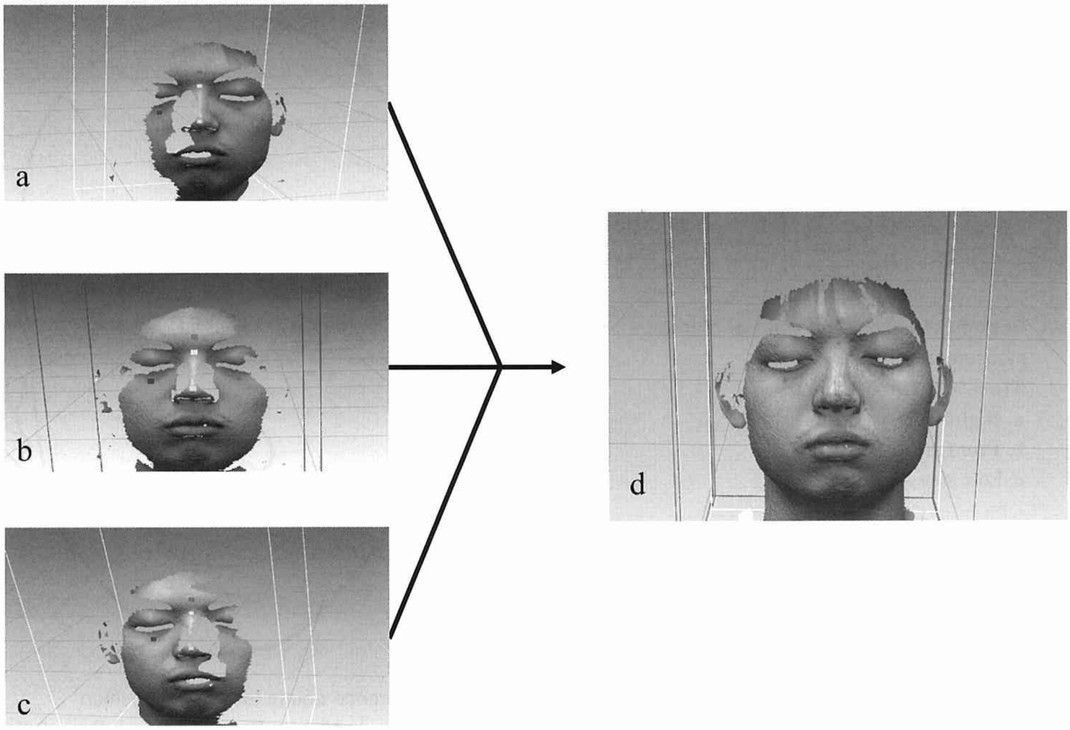


Fig. 3 Image superimposition
a, b, c. Representative images obtained by scanning from 3 directions.
d. Representative superimposed image.

point to FHV on the contour of the chin on the soft tissue.

The distance between the sensor lens of the scanner and ear rod of the cephalostat was set at 1250 mm (Fig. 1B). The Class II subjects sat on an adjustable stool (Yoshida Dental Trade Distribution Co., Ltd). While lightly inserting the ear rods of the cephalostat into the bilateral external auditory foramen, the head position was set to make the FH plane parallel with the floor (Fig. 1B) [6]. An accessory medium-range lens was used, with the lens position finely adjusted to display the face at the center. The subjects were instructed to close their eyes to avoid the adverse effects of irradiation from the device.

(2) Imaging of captured data

Aggregate 3-D facial images were made of the phases, which consisted of polygons with 0.68-mm line segments. Data at 640 x 480 pixels were captured every scan as colored images with distance data at each point on the object surface. The captured polygon data were formulated in a 3-D manner using a Polygon Editing Tool (KONICA MINOLTA), then exported to a Rapid Form 2006 (RF6) (INUS Technology Inc., Seoul, South Korea).

(3) Image superimposition

To improve the precision of the superimposed images in 3 directions (right and left sides, and front), marking seals on the face were used for rough positioning. Next, using the automatic superimpose function of the RF6, the precision was improved by hand (Fig. 3). After superimposition, the data were exported to the system and accumulated.

(4) Setting of characteristic points

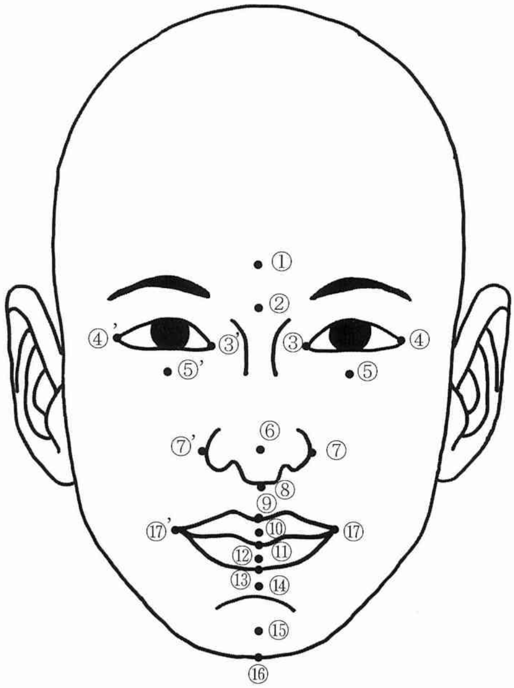


Fig. 4 Characteristic points on 3-D facial image
①G ②Ns ③En, En' (right) ④Ex, Ex' (right) ⑤Or, Or'(right) ⑥Prn ⑦Al, Al' (right) ⑧Sn ⑨Vs ⑩Ls ⑪Stm ⑫Li ⑬Vi ⑭Sb ⑮Pogs ⑯Mes ⑰ Ch, Ch' (right).

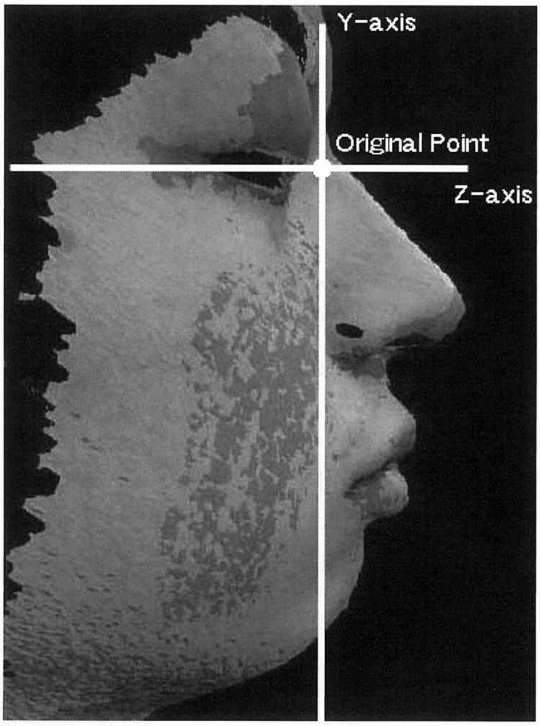


Fig. 5 Setting of Z axis for scanning
The X, Y, and Z axes were determined after setting the characteristic points.

On the facial image superimposed by the RF6, no coordinate information for characteristic points is included. Accordingly, the user can set the coordinate information to specify the site by visually plotting the characteristic points. We designated 22 characteristic points (Fig. 4).

①G : Glabella : The most anterior projecting point to FHV on the contour of the frontal region.

②Ns : Nasion soft : The most retracted point to FHV on the contour of the procerus.

③En, En'(right) : Endognathion : The intersection point of the upper and lower lid margins at the inner edge of the palpebral fissure.

④Ex, Ex' (right) : Exognathion : The intersection point of the upper and lower lid margins at the outer edge of the palpebral fissure.

⑤Ors, Ors' (right) : Orbitale soft : The most inferior border of the orbits on the soft tissue.

⑥Prn : Pronasale : The most projecting point to FHV on the contour of the procerus.

⑦Al, Al' (right) : Alale : The most projecting point to the outside of the nose wing.

⑧Sn : Subnasale : The deepest point on the contour of nasolabial border.

⑨Vs : Vermillion border superior : The upper lip-vermillion lip border.

⑩Ls : Labiale superior : The most projecting point to FHV on the contour of the upper lip.

⑪Stm : Stomion : The most anterior point on the contact site of the upper and lower lips.

⑫Li : Labiale inferior : The most projecting point to FHV on the contour of the lower lip.

⑬Vi : Vermillion border inferior : The lower lip-vermillion lip border.

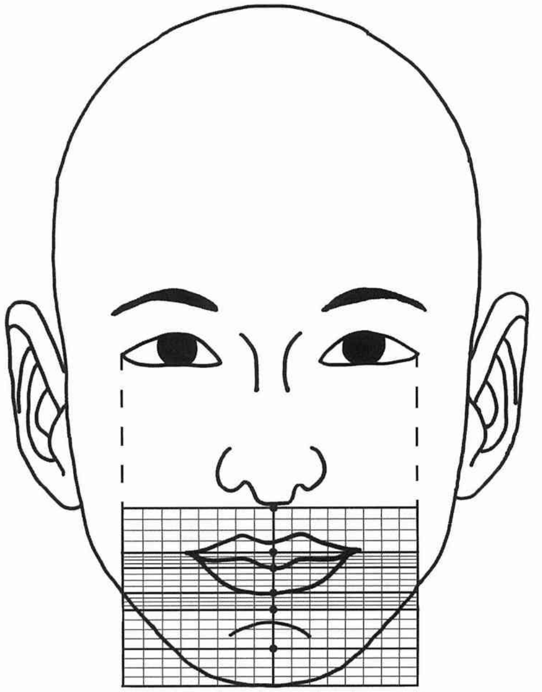


Fig. 6 Schematic diagram of a morphon
The morphon was prepared by drawing quadrilaterals on the basis of 7 characteristic points on the lower face.

⑭Sb : Submentale : The deepest point of the lower lip, the mentolabial sulcus. If the deepest point cannot be obtained, the part equivalent to the upper mental muscle, B point, and root apex of the central incisor of mandible on the lower lip-chin contour.

⑮Pogs : Pogonion soft : The most projecting point to FHV on the mental contour of the soft tissue.

⑯Mes : Menton soft : The most inferior point of the chin of the soft tissue.

⑰Ch, Ch' (right) : Chelion : The intersection at the outer edge of the upper and lower vermilion border in the angle of the mouth.

(5) Setting of 3-D coordinate axis for morphing

The 3-D coordinate axis was set as shown in Figure 5. After setting the above-mentioned characteristic points to standardize the direction of movement of the movable points, the Z axis was rotated to a position parallel to the FH plane around the point of origin. At this time, the X, Y, and Z axes rotated while maintaining their perpendicular intersection .

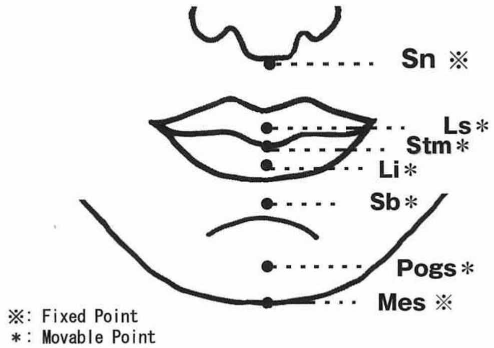


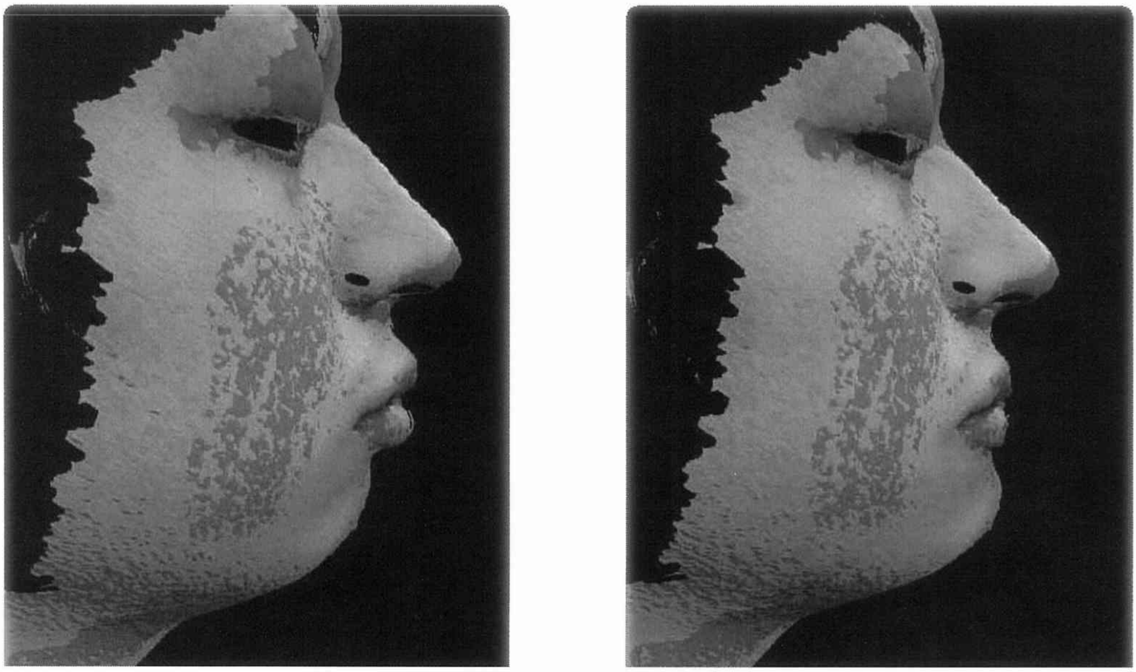
Fig. 7 Movable and fixed points
Of 7 characteristics points,
※indicates a fixed point and *a movable point.

(6) Setting of morphon

After setting the coordinate axes, lines passing through the 7 characteristic points (Subnasale, Lip superior stomion, Lip inferior, Submetale, Soft tissue Pog, and Soft tissue Menton) on the midline of the lower face and parallel to the X axis, quadrilaterals surrounded by lines passing through the bilateral external canthus points and parallel to the Y axis were set. The morph grid was set with 12 divided quadrilaterals using the outer frame of the quadrilaterals as a morphon. The morph grid was divided into 8 horizontal segments and 4 vertical segments. The difference between the morph volumes at the intercuspal position and 5-mm forward position was determined at each angle point (Fig. 6)[7]. After accumulating facial images on which characteristic points and morph grids were set in the system database, the morph volume at each angle point was calculated and automatically averaged.

(7) Task

For morphing, the right profile image was



a. Before b. After

Fig. 8 Facial images before and after drawing

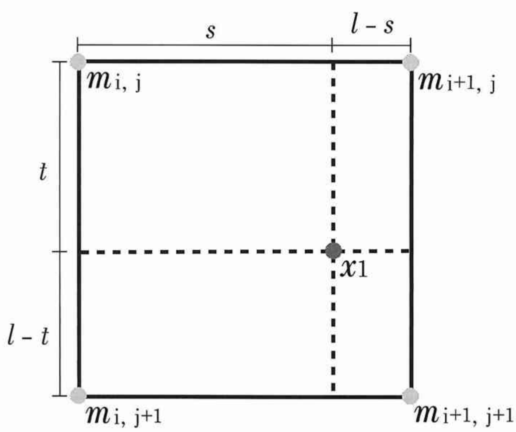


Fig. 9 Summary of bilinear interpolation

displayed on the monitor. Of 7 characteristic points on the facial midline, ①Sn and ⑦Mes were fixed points, whereas ②Ls, ③Stm, ④Li, ⑤Sb and ⑥Pogs were movable points (Fig. 7). Morphing was obtained by moving the movable points on the profile images in an anteroposterior direction. By rotating the image, the profile could be drawn while confirming the morph from every direction. The image around the movable point morphed continuously, with the point as a vertex (Fig. 8). The Class II group morphed their self profile until they considered it to be ideal, after which the Orthodontist group morphed all the images of the Class II group to what they considered to be ideal images. No time limit was given and drawing was continued until the subjects obtained the desired profile.

・ Correction of soft tissue image morph

When forward movement of a movable point was required by morph manipulation on the monitor, the morph volume at each vertex around the movable points was determined by the following calculation. The provisional morph x 1 of v was calculated on the basis of the morph ($m_{i,j}$, $m_{i+1,j}$, $m_{i,j+1}$, $m_{i+1,j+1}$) at the 4 measuring points in the quadrilateral area including v by using the following bilinear interpolation :

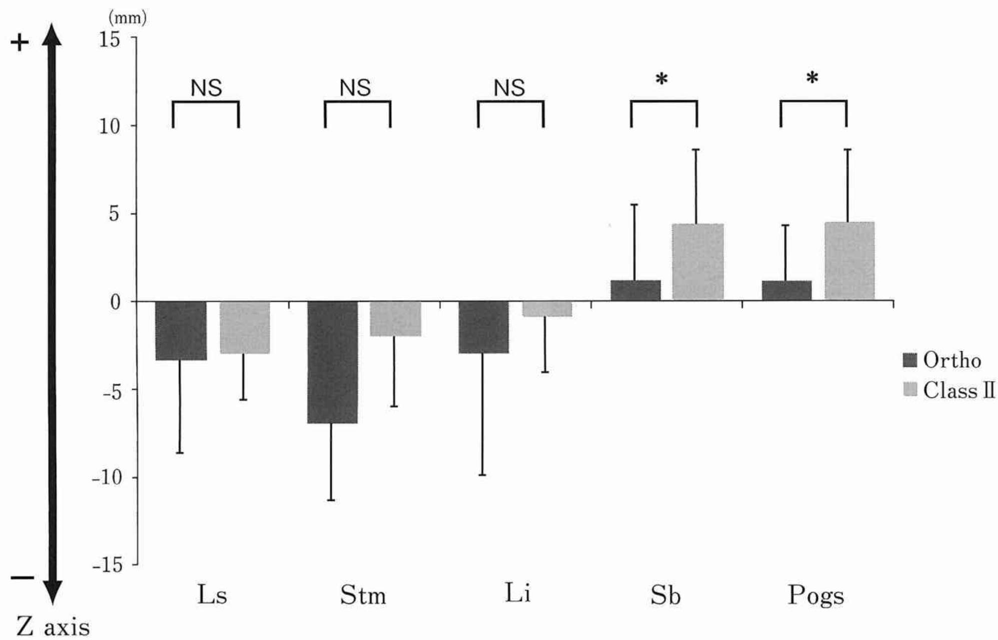


Fig. 10 Comparison of morph amount at movable
+ Morph toward anterior of face. — Morph toward posterior of face.

Table 2 Comparisons of morph amount at movable points (mm)

	Ls	S.D.	Stm	SD	Li	SD	Sb	SD	Pogs	SD
Class II (n=11)	−3.33	5.36	−6.90	4.31	−2.99	6.90	1.18	4.31	1.19	3.22
Orthodontist (n=110)	−3.00	2.50	−2.01	4.05	−0.89	3.17	4.40	4.12	4.48	4.10
	NS	—	NS	—	NS	—	*	—	*	—

* : $p<0.05$
NS : not significant

$$X1=(1-s)(1-t)m_{i,j}+S(1-t)m_{i+1,j}+(1-s)tm_{i,j+1}+stm_{i+1,j+1} \text{ (Fig. 9)}$$

The provisional morph x1 obtained was multiplied by the coefficient obtained from 5 mm of forward movement volume, M, at the control point to obtain X2, as follows :

$$X2 = S(M+D)+X1$$

When the absolute value of the denominator is close to zero, the coefficient diverges and produces spikes on the image. To prevent such a phenomenon from occurring, correction was made by adding D to the denominator of the coefficient. As a result of this correction, the morph amount becomes less than the designated amount even in areas close to the measuring point. The spike could be inhibited by bringing out the control point more than the actual morph amount. At the upper and lower ends of the morphon, displacement was nil, as the fixed points Sn and Me were immovable. The morph region was connected uninterruptedly with the outer region. h expressed the value of the X axis in the morph region. On the midline, h=0. At both margins of the face, h =-1 or h=1. As the morphology of the surface of a human face can be regarded as approximately spheroidal, h=1.0 on the midline serves as a weighted function. That was multiplied with cos, which made h closer to 0 as it became distant from the midline, as follows :

$$X3 = X2 \cos(\pi h/2)$$

(8) Data analysis

The morph amounts at the movable points after profile drawing were compared between the Class II and Orthodontist groups. For statistical analysis, a Mann-Whitney U-test was used with SPSS 17.0 J (SPSS, Tokyo).

Results

1) A simulated image drawing system in which a 3-D image was morphed in an anteroposterior direction at will was established for clinical application.

2) The following results were obtained by making changes on the 3-D profile images to draw the ideal profile image in the Class II group (Fig 10, Table 2).

(a) At the characteristic points Ls, Stm, and Li, no significant differences were observed between the Class II and Orthodontist groups.

(b) At Submentale, the anterior morph was larger in the Orthodontist group (4.40±4.12mm) than the Class II group (1.18±4.31mm) ($p<0.05$).

(c) At Pogs, the anterior morph was larger in the Orthodontist group (4.48±4.10 vs. 1.19±3.22 mm) ($p<0.05$).

Discussion

It has been reported that the mouth greatly affects the impression and appeal of a human profile[8], thus orthodontic treatment is considered to play a great role in facial appearance. For oral and maxillofacial surgeons, as well as reconstructive surgeons formation of an appealing profile and esthetic standards are based on their experience and training as specialists. However, it was reported that their conclusions did not always agree with those of patients or the general public[9].

A variety of studies have analyzed the preferred facial image of orthodontic patients. Hershon *et al*[10]. divided profile models into 4 vertical segments, then asked subjects to reproduce their own image, as well as an ideal image using a profile simulating apparatus that exhibited the prognathism and retrognathism of each segment. Giddon *et al*[1,10,11,12]. also studied the recognition of ones own profile and profiles chosen by subjects. From their results, they created animated profile morphs from averaged profile images, and then evaluated their admissibility and recognizability by the subjects. Ioi *et al*[3]. produced averaged profiles of 30 Japanese male and female subjects with normal occlusion, and then prepared silhouette images in which the chin was morphed in an anteroposterior manner. They then presented 11 template images to the subjects and asked them evaluate and rank them in order of preference.

Burcal *et al*[13]. studied recognition of anterior-posterior positional changes of the lower face following simulation surgery and reported that dentists paid attention to the position of the jaw, whereas subjects without dental training paid attention to the positions of the lips, which demonstrated differences in profile evaluation preferences. In a previous study performed by our department, Suginome[14] pointed that there were differences in profile evaluation criteria between specialists and the general public, and that the criteria varied even among the specialists depending on their experience and knowledge. Moreover, Taguchi[15] presented profile linear drawings of profiles with maxillary and mandibular prognathism to subjects, and determined the visual evoked potentials and event-related evoked potentials for perceptions of abnormality. As a result of their analysis, they noted that the sense of discomfort was more difficult to recognize for maxillary prognathism than mandibular prognathism in the profile evaluation. These findings demonstrated that there are differences in viewpoints for evaluating ideal profiles between orthodontists and non-trained subjects including patients, though the ideal profile image of the latter may be closer to an average face. Furthermore, Ioi[3] reported that Japanese subjects generally favored a profile with mandibular retrusion and suggested that there might be racial differences in regard to an ideal profile. However, those subjects only evaluated morphed images presented as silhouettes, linear drawings, and photos, while the ideal profile that the subjects themselves embraced in particular was not investigated. In the present study, we prepared 3-D images and morphed images of the subjects to enable them to draw their ideal self profile.

The non-contacting 3-D optical surface scanner used in the present study has been reported to be extremely precise, with a margin of error within 1.0 mm when measuring the whole face[16,17]. Furthermore, it is minimally invasive, and enables quick and easy measurements[6]. As for the direction of laser irradiation from the scanner, we performed scanning from 3 directions, right, left, and front, with the results used to prepare 3-D images of the whole face, so as to make up for the deficit of image data for areas of close to parallel to the skin surface, as well as around the nose and face counter by undercutting.

Since the size and position of each part of the face varies in each person, a calculated average morph amount cannot be applied to other subjects. Accordingly, 384 quadrilaterals constructed on the basis of characteristic points designated on the lower face of the images were set in a mesh pattern. By aligning 425 angle points of the quadrilaterals in the image of each patient and expanding or shrinking the quadrilaterals, a morphed image with the same ratio of soft tissue movement was made so as to exclude the effects of individual differences.

In the present study, the Class II group had less forward morph of the chin than the Orthodontist group, which suggests that the former group had less recognition of posterior positioning of the chin. Susami *et al*[16]. conducted an epidemiological survey regarding malocclusion in Japanese and found that the incidence of maxillary prognathism was 5.18%, which was higher than that of crossbite (3.86%). However, orthodontic patients reported that crossbite was more frequent than maxillary prognathism. Thus, it was considered that mandibular retrognathism was less recognized than mandibular prognathism. Meanwhile, the present Orthodontist group drew the chin in a more anterior position than the Class II group, indicating that they had more awareness of retrognathism. Orthodontists generally receive specialized education regarding criteria for a standard profile with an orthodontic definition, such as E-line[19] and Z-angle[20]. Accordingly, we speculated that the Orthodontist group in our study drew the images based on certain learned criteria.

The profile is an important factor when deciding orthodontic treatment and an effective strategy cannot be determined without a profile evaluation during the process of diagnosis. On the other hand, it is considered that the general public and orthodontic patients rarely consider their profile in daily life. Thus, we speculated that it is very difficult for them to evaluate and draw a self profile. In a future study, it will be necessary to construct a system in which the profile morph as well as a frontal morph can be displayed on a desktop to assist the subjects in understanding their own face image in 3-D terms.

Conclusion

1. The morph drawing system for 3-D facial image data developed in the present study enables orthodontic surgeons to better understand the ideal profile image of their patients.

2. The present system was able to quantitatively evaluate differences in ideal face profiles between non-trained subjects and orthodontists.

3. Our results indicate that the non-trained subjects had a lower recognition of the posterior positioning of the mandible, while the orthodontists had a high recognition of retrusion of the chin.

We concluded that the present drawing system can play an important role in obtaining informed consent from patients, as it is able to clarify differences in the expected profile between patients and orthodontists.

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References

1) Giddon, D. B. : Orthodontic applications of psychological and perceptual studies of facial esthetics. Semin. Orthod. **1** ; 82–93 1995.
2) Kitay, D., Begole, E. A., Evans, C. A., Giddon, D. B. : Computer-animated comparison of self-perception with actual profiles of orthodontic and nonorthodontic subjects. Int. J. Adult. Orthod. Craniofac. **14** ; 125–133 1999.
3) Ioi, H., Nakata, S., Nakashima, A., AL. Counts. : Influence of facial convexity on facial attractiveness in Japanese. Orthod. Craniofac. Res. **10** ; 181–186 2007.
4) George, P. T. : A new instrument for functional appliance bite registration. JCO **116** ; 721–724 1992.
5) Jacobson, A. : Facial analysis in two and three dimensions. 1st Ed : 273–284 Quintessence Publishing IL 1985.
6) Nakagawa, K., Terada, K., Inami, Y., Carmen-Elena, G., Morita, S., Hanada, K. : A study on the characteristics in the three-dimensional facial measurement using with the optical surface scanner. Niigata Dent **31** ; 147–152 2001.
7) Hijioka, H. : Three-Dimensional Analysis of Facial Morphology of Patients with Mandibular Prognathism Undergoing Sagittal Splitting Ramus Osteotomy. Jpn. J. Jaw Deform. **8** ; 157–169 1998.
8) Terry, R., Davis, J. S. : Components of facial attractiveness. Percept. Mot. Skills **24** ; 918 1976.
9) Giddon, D. B. : Through the looking glasses of physicians, dentists and patients. Perspect. Bio. Med. **26** ; 451–458 1983.
10) Hershon, L. E., Giddon, D. B. : Determinants of facial profile self-perception. Am. J. Orthod. **78** ; 279–295 1980.
11) Hier, L. A. Evans, C. A., BeGole, E. A., Giddon, D. B. : Comparison of preferences in lip position using computer animated imaging. Angle Orthod. **69** ; 231–238 1999.
12) Giddon, D., B. Sconzo, R., Kinchen, J. A., Evans, C. A. : Quantitative comparison of computerized discrete and animated profile preferences. Angle Orthod. **66** ; 441–448 1996.
13) Burcal, R. G. Laskin, D. M. : Recognition of profile change after simulated orthognathic surgery. J. Oral. Maxillofac. Surg. **45** ; 666–670 1987.
14) Suginome, K. : Study on a Change of the Event Related Potentials in Estimation of facial Morphology. Ohu Univ. Dent. J. **26** ; 1–14 1999.
15) Taguchi, D. : Event-related Potentials Evoked by the Assessment of Soft-tissue Lateral Profiles of Human Face. Ohu Univ. Dent. J. **28** ; 189–198 2001.
16) Kusnoto, B., Evans, C. A. : Reliability of a 3D surface laser scanner for orthodontic applications. Am. J. Orthod. **122** ; 342–348 2002.
17) Kau, C. H., Richmond, S., Zhurov, A., Knox, J., Chestnutt, I., Hartles. F., Playle, R. : Reliability of measuring facial morphology with a 3-dimensional laser scanning system. Am. J. Orthod. **128** ; 424–430 2005.
18) Susami, R., Asai, Y., Hirose, K., Hosoi, T. : The prevalence of malocclusion in Japanese school children Part I Total frequency. Orthod. Waves

30；221-229　1971.
19) Ricketts, R. M.：Esthetics, environment and the law of lip relation. Am. J. Orthod.　**54**；272-89　1968.
20) Merrifield, L. L.：The profile line as an aid in critically evaluating facial esthetics. Am. J. Orthod.　**52**；804-822　1996.

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