Adult Dentition in Relation to the Palate and the Cranium
－Reference from the head length and the head breadth－

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Abstract : The purpose of this study was to elucidate the relation of dentition to the palate and the cranium in Japanese adults to serve as fundamental material for considering the morphology of dental arch well fitted to each person.

In 168 Japanese male adults with no history of orthodontic treatment (mean age of 25 years and 5 months), the dental arch length and width, basal arch length and width, palate depth and volume as well as biometric head length and breadth were measured using a set of dental casts. From the determined values thus obtained, the correlative coefficient was calculated and tested for comparison.

The results of this study reveal as follows :

1. The maxillary arch length and the width of inter- 1 st molars tended to become larger with more deepened palate, indicating a tendency of larger volumes of the palate.
2. The larger the head length was, the larger the width of inter-maxillary 1 st molars became.
3. The larger the head breadth was, the larger the width of inter- 1 st molars of both arches became.
4. The maxillary protrusion tended to have a larger head length as compared with the mandibular protrusion.

From the results mentioned above, the dentition was revealed to closely relate to the palate and the cranial size, and it was thus suggested that not only the harmonized size of the tooth and alveolar base but also the cranial size should be considered when the teeth are aligned.

Key words : Dentition, Cranial morphology, Head length-breadth index, Japanese adult

Introduction

In patients with malocclusion who attend to receive an orthodontic treatment, deformities may be observed in the dental arch and cranium. As a factor probably affecting the morphology of dental arch, oral habits such as mouth respiration, thumb sucking and tongue protruding habit are well known but a sleeping habit in a favorable position such as prone lying is also listed as an environmental factor affecting the morphologies of dental arch and cranium[1,2].

In a study of the Caucasian in the United

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States of America, it was revealed that a relationship exists between arch and cranial morphologies and the dental arch of dolicho-cephalic type is narrowed and that of brach-ycephalic type is widened[3]. In Japanese, on the other hand, no such study has been so far performed though a relation of the mor-phology of dental arch to that of cranium was suggested[4]. It is thus still unclear to be also true even in Japanese, most of whom are said to have a cranial morphology of brachycephalic type dissimilar to Caucasian in the USA.

Though a high palate may be observed in patients suffered from maxillary protrusion accompanied with a narrowed maxillary dental arch, a statistical study concerning the dental arch in relation to the palatal morphology or cranial morphology is lacking and thus understood poorly. Moreover, as for the relation between the cranial morphology and malocclusion, many reports are accomplished by the concerning with the growth of the cranial base, but as for the concerning with the form of dental arch, little report occurs and isn't made clear. In order to elucidate this relationship, it seems important to consider an appropriate morphology of dental arch with less relapse after orthodontic treatment for individual patients.

The present study was therefore performed in order to elucidate a possible relationship of a dentition to a palate and a cranial size in Japanese adults.

Materials and Methods

In 168 male students in the School of Denti-stry, Iwate Medical University who had no experience of orthodontic treatment with no defect teeth and gave an informed consent
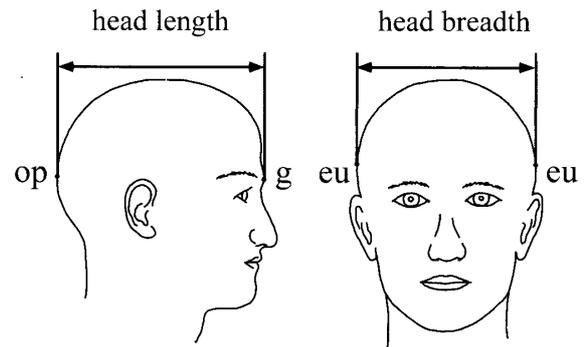

Fig. 1. Measuring sites for head length (head maximum length) and breadth (head maximum breadth).
op=opisthocranyon ; g=glabellae ; eu= euryon.

to participate in this study (mean age±S.D. : 25.4±2.3 years ; their birth places distributed widely throughout Japan), the following measurements were performed using the biometric and a set of dental casts. In the measurement of cranium, the head length between glabellae and opisthocranyon as well as the head breadth between right and left euryon were measured using a feeler meter according to Martin's method (Fig. 1)[5]. In the measurement of cast, the width and length of dental arch as well as those of alveolar base were measured using digital slide calipers of the minimum value of 0.01mm and a cast meter according to Otsubo's method[6].

In order to measure the width of dental arch except for 1 st premolars, the distances between the cusp tips of the canine, between the mesiobuccal cusp tips and between the mesiolingual cusp tips of the 1 st molars were measured (Fig. 2).

In order to further evaluate the degree of so called tapering end of dental arch, the angle of θ which is creased against the vertical line from the cusp of left 1 st molar to the right one crossed with the line from canine to the mesiobuccal cusp tip of 1 st molar (the degree of opening) was
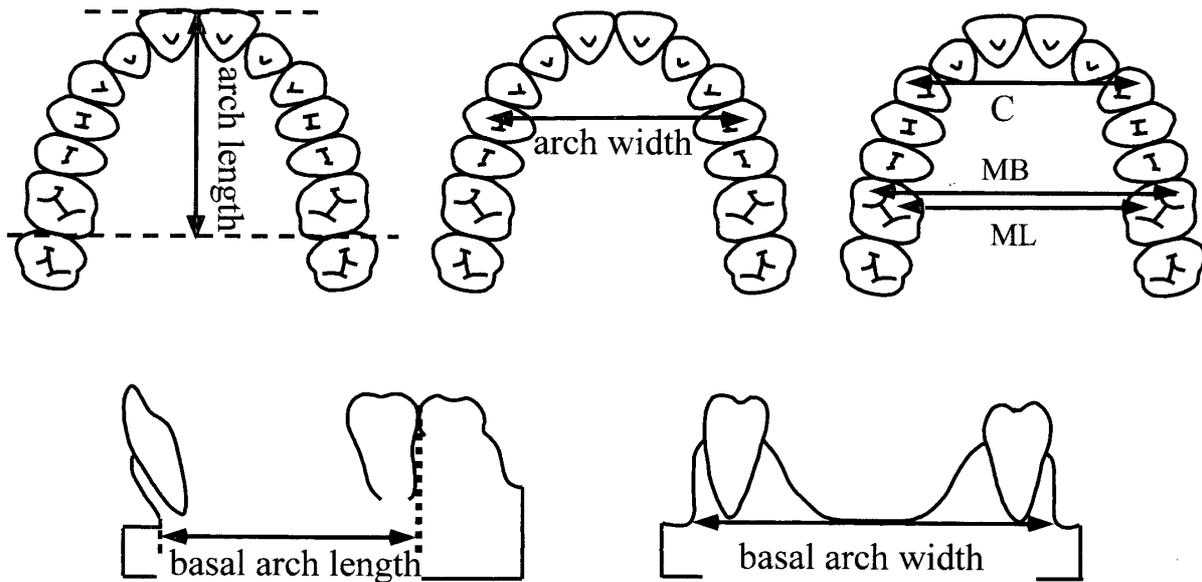
Fig. 2. Measuring sites for dental cast length and width.
C= width of inter-canine (cusp tip) ; MB=width of inter- 1 st molar (mesiobuccal cusp tip) ; ML= width of inter- 1 st molar (mesiolingual cusp tip).

determined as shown in Fig. 3.

The determination of this degree of opening was performed right and left respectively and a half of the sum of right and left values was served as the degree of opening.

As for the palatal measurement, the distance from the standardized plane(Fig. 4 -A) made by the mesiobuccal cusp tips of the right and left 1 st molars and the center point of the margin of the left central incisor to the deepest point of palate(Fig. 4 -A) as well as the area(Fig.4-B) surrounded by the surface made by the most protruded point of lingual sided teeth from 1 st molar to opposite 1 st molar and the mucous surface of palate within the anterior range from the line of distal right surface to left one were determined (Fig. 4). Incidentally, when blocked out canine in the side was remarkable, the measurement value of the canine where there are few blocked out in opposite was substituted and the measurement value when blocked out

$$\theta = asin\left(\frac{c'}{a}\right)$$
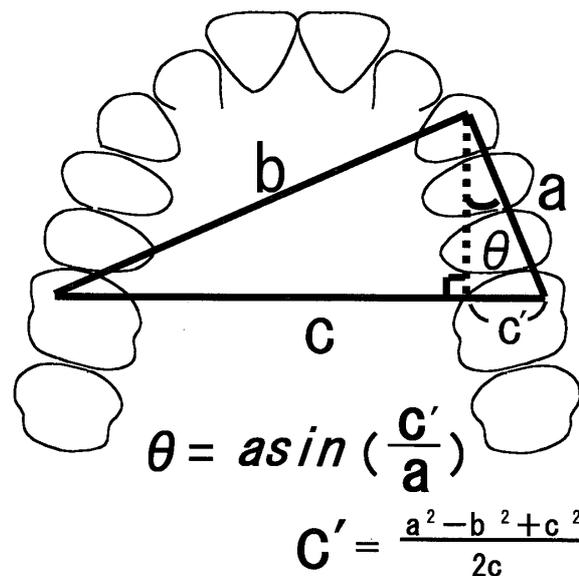
$$c' = \frac{a^2 - b^2 + c^2}{2c}$$

Fig. 3. Measuring method for the opening degree of dental arch

canine on both sides is remarkable was excluded. A three-dimensional grid pattern projection measurement method[7] (Kiisha, GRASP) was applied for the palatal measurement.

These measurements were performed on three occasions at different days respectively to calculate the mean values. In order to minimize a possible variation
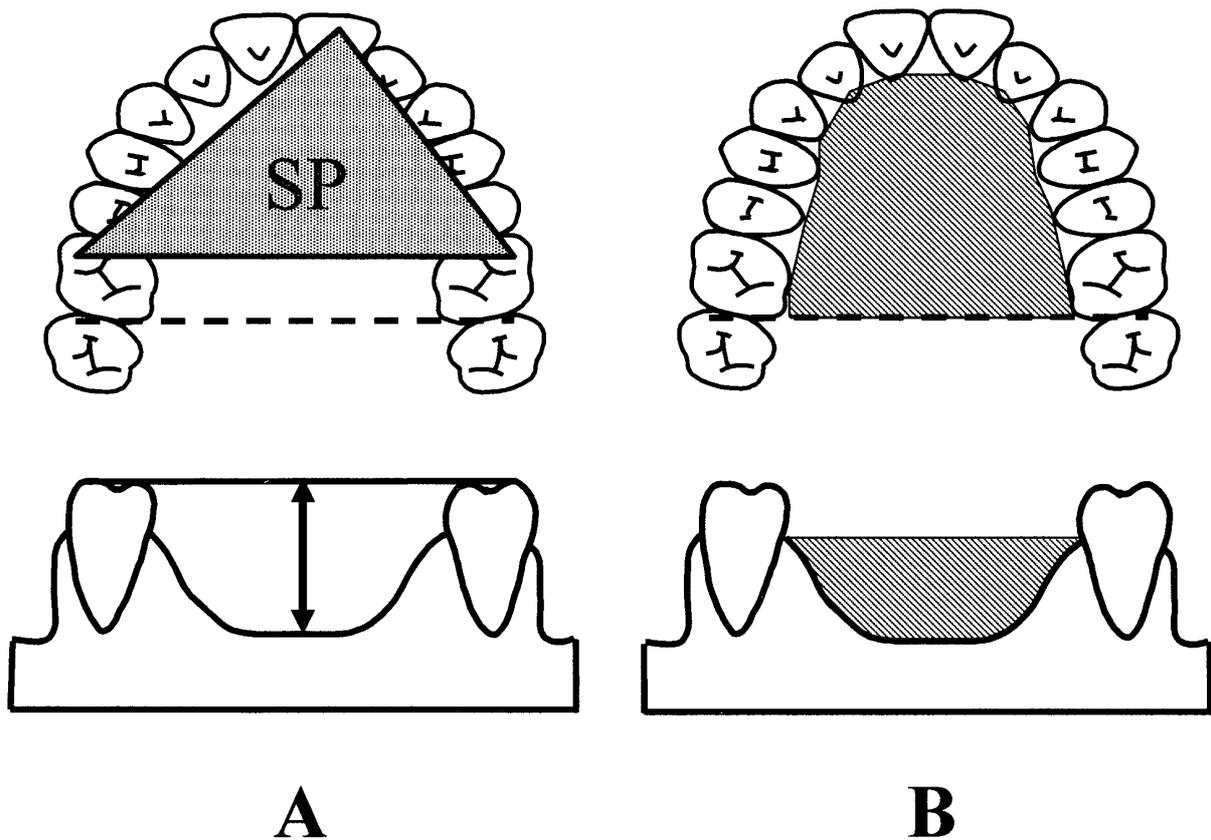
A   **B**

Fig. 4. Measurement of palatal depth and volume.
SP = standardized plane ; A = palatal depth ; B = palatal volume.

caused by different observers, the measurements were made by N.S. alone. Those casts that were taken from persons previously experienced any orthodontic treatments or having a defect tooth were excluded.

For the purpose of evaluation of cranial morphologic properties, the head length-breadth index being a ratio calculated by dividing the head breadth by the length was obtained and the incidence in different categories classified by the size of index was further calculated. A part of thus obtained values were submitted to Student's t test after confirmation of the regularity and equal partition in order to evaluate a possible significant difference in the mean values. In addition, Pearson's correlative coefficient was calculated followed by

assessment by z-test in order to clarify mutual relation between different sites of measurement. Further not only the evaluation of malocclusion according to Susami et al's definition of malocclusion[8] was performed from the dental casts from subjects enrolled in this study but also a relation of malocclusion to the head length-breadth index was examined.

Result

1. Intraobserver errors

Intraobserver errors were 0.6mm (0.3%) and 0.5mm (0.3%) for the head length and breadth respectively. Furthermore, the value was 0.1-0.29mm (0.3-0.7%) for the width of maxillary and mandibular dental arches as well as the basal arch width, 0.16-0.24mm (0.5%-0.8%) for the length, 0.1mm (0.4%) and 108.4mm³ (1%) for

Table 1. Measurement results

Measurement items	Number	Mean	S.D.
Head length (mm)	168	191.3	6.3
Head breadth (mm)	168	162.2	5.2
Head length-breadth index (breadth/length×100)	168	84.8	3.7
Maxillary arch width (mm)	133	44.2	3.1
Mandibular arch width (mm)	137	35.5	2.6
Width of inter-maxillary canines (mm)	127	35.9	2.1
Width of inter-mandibular canines (mm)	138	27.4	2.4
Width of inter-maxillary 1 st molars (mesiobuccal cusp tip) (mm)	120	55.4	3.0
Width of inter-mandibular 1 st molars (mesiobuccal cusp tip) (mm)	120	47.5	3.2
Maxillary basal arch width (mm)	135	47.9	3.1
Mandibular basal arch width (mm)	138	41.5	2.2
Maxillary arch length (mm)	126	37.9	2.5
Mandibular arch length (mm)	119	33.6	2.3
Maxillary basal arch length (mm)	126	31.4	2.1
Mandibular basal arch length (mm)	119	31.0	2.3
Opening degree of maxillary dental arch (°)	119	26.4	3.5
Opening degree of mandibular dental arch (°)	120	28.4	4.4
Palatal depth (mm)	127	24.5	4.1
Palatal depth/palatal width×100 (%)	119	44.4	7.2
Palatal volume (cm³)	127	9.48	2.69

the palatal depth and volume respectively.

These errors were all 1% or below being too minimal to affect the statistical analysis. In addition, intraobserver errors were calculated using the formula below[9] :

Intraobserver errors $= (\Sigma d^2/ 2 N)^{1/2}$ (d = difference between 1 st and 2 nd determined values, N : number of samples examined)

2. Result of measurements

The determined values are shown in Table 1. The determined degree of opening for dental arch was $26.4 \pm 13.5°$ (mean±S.D.) for mandible and $28.4 \pm 4.4°$ for maxilla with a larger trend of the former at a significant level of 1% by t-test.

3. Incidence in different categories of the head length-breadth index (Fig. 5)

Categories of the head length-breadth index in relation to the incidence are shown
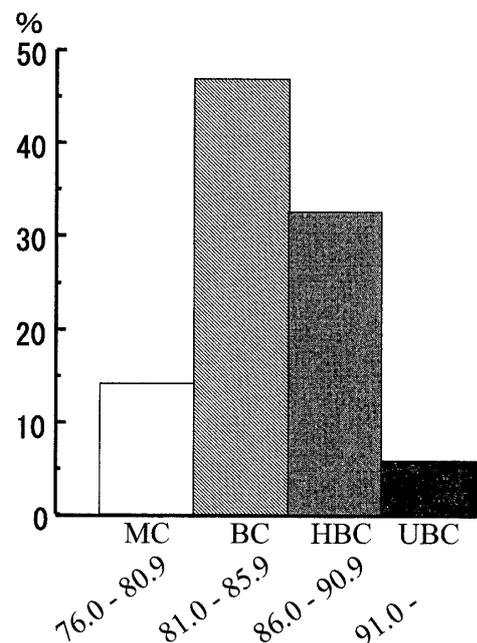

Fig. 5. Categories of head length-breadth index and Incidences.
MC=mesocephaly ; BC=brachycephaly ;
HBC=hyperbrachycephaly ;
UBC=ultrabrachycephaly.

in figure. The classification of head form is accomplished by the head length-breadth index as shown in figure. In this report, a brachycephaly (BC) was most frequently

Table 2. Correlation of individual dentition parameters to the palatal morphology and the cranial size

Independent variable	Dependent variable	z-test
Head length	Maxillary basal arch length & width	*
	Width of inter-maxillary 1 st molars (mesiobuccal cusp tip)	*
Head breadth	Width of inter-1 st molars of both arches (mesiobuccal cusp tip)	*
Opening degree of maxillary dental arch	Maxillary arch length (−)	**
	Mandibular arch length (−)	*
	Maxillo-mandibular basal arch length (−)	**
	Width of inter-1 st molars of both arches (mesiobuccal cusp tip)	**
	Mandibular arch width/length	**
	Maxillary basal arch width/length	**
	Mandibular basal arch width/length	*
	Opening degree of mandibular dental arch	**
	Palatal volume	*
Opening degree of mandibular dental arch	Maxillo-mandibular arch length (−)	**
	Maxillary basal arch length (−)	*
	Mandibular basal arch length (−)	**
	Width of inter-mandibular canines (−)	**
	Width of inter-1 st molars of both arches (meisolingual cusp tip)	**
	Width of inter-maxillary 1 st molars (mesiobuccal cusp tip)	*
	Width of inter-mandibular 1 st molars (mesiobuccal cusp tip)	**
	Maxillo-mandibular arch width/length	**
	Mandibular basal arch width/length	**
	Palatal depth (−)	**
	Palatal depth/width (−)	**
Palatal depth	Maxillary arch length	*
	Width of inter-maxillary 1 st molars (mesiobuccal cusp tip)	*
	Palatal volume	**
Palatal depth/width	Maxillary arch width (−)	*
	Palatal volume	**
Palatal volume	Maxillo-mandibular arch length & width	**
	Width of inter-maxillary 1 st molars (mesiobuccal cusp tip)	**

* P<0.05 ; ** P<0.01, by a z-test.

encountered in 47.2% followed by hyperbrachycephaly (HBC), mesocephaly (MC) and ultrabrachycephaly (UBC) in due order.

4. Correlation between individual items

When the correlative coefficient was next calculated from the determined values and assessment of the coefficient was made by z-test, a significant negative correlation was confirmed between the opening degree of mandibular and maxillary dental arches, its length and the length of alveolar base.

Furthermore, the width between maxillary 1 st molars tended to become larger with increased head length and breadth, indicating a tendency of deepened palate. In the palate, the length of dental arch, the width of dental arch between 1 st molars as well as the palatal volume tended

Table 3. Head length-breadth index by difference occlusion categories

Classification of occlusion	Number of subjects examined	%	Head length-breadth index	S.D.
Normal occlusion	66	39.3	85.0	3.7
Maxillary protrusion	45	26.7	83.9	3.2
Crowding	28	16.7	85.4	3.4
Mandibular protrusion	21	12.5	86.3	4.7
Maxillo-mandibular protrusion	2	1.2	87.1	0.4
Others	6	3.6	81.9	3.5

to be larger with more deepened palate. Furthermore, the width and length of dental arch, the width of dental arch between 1 st molars and the opening angle of maxillary dental arch tended to be augmented with larger volumes of the palate (Table 2).

5. Head length-breadth index by difference occlusion categories.

The evaluation of malocclusion thus performed revealed normal occlusion in 39.3% and among those of malocclusion, maxillary protrusion was encountered most frequently in 26.7% followed by crowding in 16.7%, mandibular protrusion in 12.5%, others in 3.6% and maxillary and mandibular protrusion in 1.2% (Table 3).

Discussion

1. Three-dimensional measuring apparatus

As an approach to measure the substance morphology cubically, three-dimensional measurements of contact and non-contact type are well known[10-13]. The contact type generates the axial value through a contact of probe with the site of measurement by means of three-dimensional measuring apparatus of contact type composed of touch probe and scale[10-13].

This apparatus is capable of measuring at high accuracy, however, several problems are presented including that it rather takes a long time for measurement or that a lot of sites for measurement are necessary to correct the contact site of probe when the shape of dentition cast as a whole is required.

The three-dimensional measuring method of non-contact type was designed to solve these criticized points and among them, a light interruption method with irradiation of laser as a representative of optical manipulations[13-20], a pattern projection method taken while moving a striped pattern[7, 21] and moiré topography[22, 23] are especially known. In the high accuracy three-dimensional measuring system developed in our laboratory (GRASP : GRAting projection System for Profiling), a pattern is projected to the subject for measurement. It is designated as a pattern projection method with special properties, that is, all three-dimensional morphologies can be measured at the same time and the time required for imaging the strips generated following the pattern projection is as short as approximately 0.5 sec allowing a successful measurement of the substance up to several tens mm to 1 m on all sides with high accuracy of approximately 0.2%[7, 21].

By means of this system, it was suggested that not only the dentition but also the palatal depth and volume could be measured

in a short time with high accuracy. This high accuracy and shortened time required for measurements provided by this method are considered to be requisites for activation of three-dimensional measuring systems in the clinical and investigational fields.

2. Quantitative analysis on the morphology of dental arch

As for an attempt to quantitatively analyze by numerically expressed morphology of dental arch, a parabola, chinning curve, ellipse, biquadratic polynomial expression and conic curve techniques have been reported[10]. Among them, Iwabayashi[10] stated that a biquadratic polynomial expression is most suitable for the analysis of dental arch morphology. Since the biquadratic polynomial expression is often affected by the size of dental arch, Ohtani[24] emphasized that Log F values calculated from the coefficients of biquadratic and quadratic terms in the biquadratic polynomial expression is most effective when one wants to compare the morphology of dental arch by excluding a large influence.

From a study that compared the morphology of dental arch between varied races with different physiques by utilizing this Log F values, it was reported that Caucasian generally have a relative pinnacled shape and Japanese have a rectangular shape[25]. However, its clinical application seems to be slightly difficult because the Log F value is calculated in a complicated manner, the morphology of dental arch is hardly imaged from the numerical values dissimilar to the case of angle, and the evaluation on the symmetry of dental arch is also less practicable. In this study, therefore, a method utilizing the angle as the degree of opening which is easily calculated and provides a simply imaged shape of dental arch was devised.

As a result, the degree of opening was revealed to be larger in the mandibular dental arch as compared with the maxillary dental arch, suggesting a strong trend of tapering or pinnacling of dental arch in the former. This can be considered to be a rationale of the differed morphologies between upper and lower arch wire of edgewise appliance used in the orthodontic treatment and is well in agreement with the report by Iida et al.[25] stating that the dental arch of maxilla tends to be rectangular and that of mandible to be pinnacled from Log F values in the biquadratic polynomial expression.

From this study, it was suggested that the opening degree of dental arch shows a significant positive correlation between upper and lower teeth and harmonization of upper and lower dental arches is thus necessary.

It is also well coincident with a report stating that a significant positive correlation exists between maxillary and mandibular arch morphologies studied in Japanese with normal occlusion by means of Log F values in the biquadratic polynomial expression[13]. Based on these evidences mentioned above, the opening degree of dental arch seems to have a possibility of utilizing as a quantitative expression of arch morphology as dose with Log F values in biquadratic polynomial expression, though it hardly expresses a complicated shape such as those having labial dislocation at a low site of incisor and further to evaluate the symmetry of dental arch by measuring

Table 4. Width to length ratio of dental arch and alveolar base

| Items of width to length ratio	Number	Mean (%)	S.D.	Wilcoxon's signed rank test
Arch width/length×100				
Maxilla	125	116.9	9.6	
Mandible	119	105.9	8.9	***
Basal arch width/basal arch length×100				
Maxilla	126	153.0	12.9	
Mandible	119	134.6	9.4	***

*** $P < 0.001$, by a Wilcoxon's signed rank test.

the degree of opening right and left separately.

In addition, this method is considered to be a manipulation with which a busy clinician can use at hand because the degree of opening can be calculated easily through direct measurement of the cast by slide calipers.

For other simple approaches which can estimate the morphology of dental arch quantitatively, a calculation of the width to length ratio of dental arch or alveolar base is also considered. These values are considered, however, to be reduced when a narrowing tendency is evident in the dental arch or alveolar base. The result of calculation on these ratios is shown in Table 4.

When Wilcoxon's signed rank order test was performed on these ratios, the width to length ratios of the dental arch and of alveolar base were found to show a significant small and tendency of narrow in the mandible rather than in the maxilla. In addition, a significant positive correlation was observed between maxilla and mandible when z-test was performed in order to examine a possible correlation of these ratios ($P < 0.001$).

As shown in Table 2, a significantly positive correlation was also noted in the opening degree of dental arch between the two portions. From these results mentioned
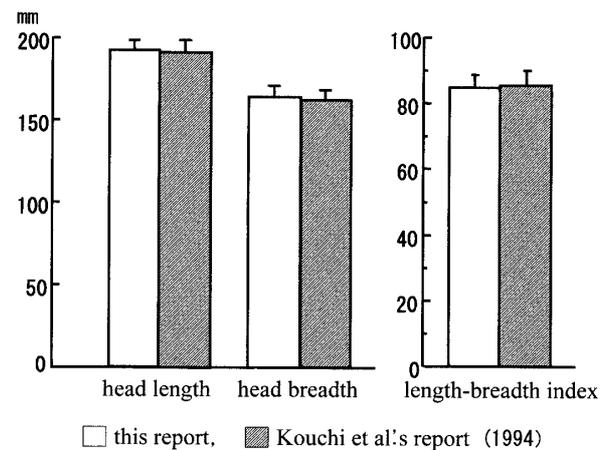
Fig. 6. Comparison of head length, head breadth and length-breadth index.

above, the method to calculate the width to length ratio was suggested to be convenient with a trend almost similar to that of Log F values in biquadratic polynomial expression or of the opening degree of dental arch, though a complicated morphology is hardly expressed.

3. Comparison with previous reports

As for the head length and breadth as well as the length-breadth index, the head length was slightly larger in the present report but no difference was observed in the head breadth and head length-breadth index as compared with those reported in a study on the general population (217 males, mean age of 22.7 years) performed by Kouchi et al. in 1994[26] (Fig. 6).

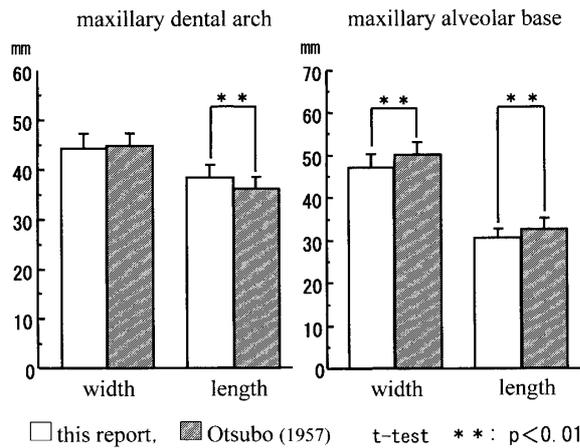Concerning the dental arch and alveolar

maxillary dental arch   maxillary alveolar base

□ this report, ▨ Otsubo (1957)   t-test   * * : p<0.01

Fig. 7. Comparison of maxillary dental arch in relation to alveolar base.

□ this report, ▨ Otsubo(1957)   t-test   * : p<0.05 * * : p<0.01

Fig. 8. Comparison of mandibular dental arch in relation to alveolar base.

base in the maxilla, the arch length was larger and both arch width and length tended to be smaller in this study as compared with the corresponding values in adult volunteers with normal occlusion reported by Otsubo[27] in 1957.

In the mandible, on the other hand, the arch width tended to be smaller and the length to be larger in this study. These findings suggested that both maxillary and mandibular dental arch tend to be anteroposteriorly long with a narrowed width in the present report. As for tendency of difference in the maxillary dental arch and the maxillary basal arch than those of Otsubo's data[27], it seemed that this result was influenced by the difference of the normal occlusion group and the general group which contains mal-occlusion (Fig. 7). About mandibular dental arch , inter-canine width, and inter-1 st molar width which are shown in figures 8 and 9 were also resulted in similar tendency due to the same reason.

4. A dentition in relation to a cranial morphology

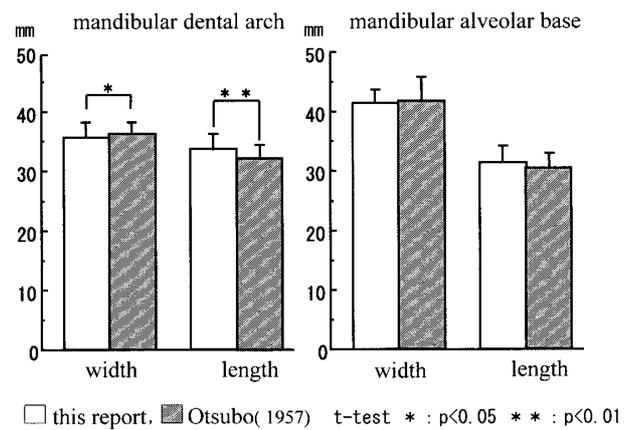It has been conventionally stated that an orthodontic treatment may be hardly

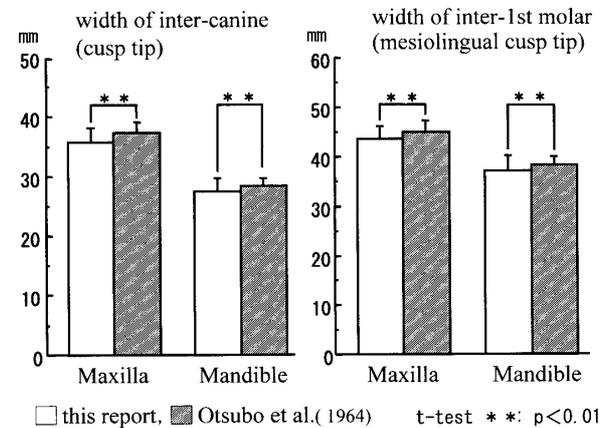□ this report, ▨ Otsubo et al.(1964)   t-test * *: p<0.01

Fig. 9. Comparison of the width of dental arch.

considered to be of practical therapeutic target even though being of ideal one if the morphology of dental arch fails to fit rationally to the person concerned, considering its relationship to the patient's occlusion materials or its surrounding structural components such as bones[28].

As the detailed example, markedly extended distance between canines of mandibular dental arch is said to have a poor long-term stability and an easy trend of relapsing an irregular dental morphology[29].

For this reason, it seems necessary to know the mandibular bone around the dental arch in relation to the cranium previously when the morphology of dental

arch with long-term stability and good compatibility for individual persons is considered.

Concerning the dentition in relation to the cranial morphology, Graber[3] stated that the dental arch tends to be narrowed in persons with a dolichocephalic tendency and to be widened in those with a brachycephalic tendency.

On the other hand, Hisajima[4] suggested that a deviated or distorted dental arch related to the distorted cranial morphology in Japanese. As an environmental factor which may affect the cranial morphology, a possible relation of sleeping in a prone position during infantile period is suggested. Masuda et al.[30] reported that an early improvement of habitual sleeping manner such as prone lying was effective to improve the facial asymmetry.

However, the cranial morphology differs between Caucasian and Japanese, and Japanese examined in the present study had a brachycephaly most frequently in 47.2%, hyperbrachycephaly in 32.7%, mesocephaly in 14.3% and ultrabrachycephaly in 6.0%, while Caucasian had a mesocephaly distributed in 52.6%, brachycephaly in 31.6% and dolichocephaly in 15.6%, indicating a trend of brachycephaly in the former[31].

In previous reports, however, it still remained unclear as for how this difference in the type of head by different races affects the relation of dentition to the cranial morphology. Since no persons with a type of dolichocephaly was included in the present study, it failed to demonstrate the relation of a dolichocephalic type as reported in Caucasian to the tendency of narrowed dental arch observed but the width of dental arch between 1 st molars was suggested to relate to the
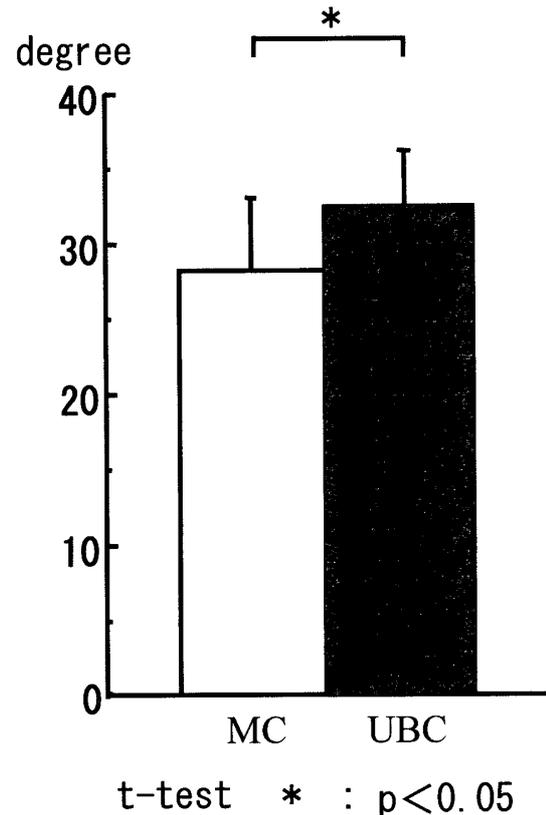

Fig. 10. Comparison of opening angle of maxillary dental arch between mesocephaly and ultrabracycephaly.
MC = mesocephaly ;
UBC = ultrabrachycephaly.

head length and breadth.

Namely, the dental arch tended to be wider with the augmented size of head but no correlation between anterior and posterior lengths of dental arch. In order to classify whether or not a difference in the dental morphology is generated according to the difference in the type of head, therefore, each measurement item was compared by different categories of head type.

As shown in Fig. 10, it was observed that a mesocephaly tended to have a smaller opening angle of maxillary dental arch as compared to a ultrabrachycephaly.

According to Kouchi[32], on the other hand, a brachycephalization in response to augmented head breadth was found to be

Table 5

Measurement items of head	Maxillary protrusion			Mandibular protrusion			t-test
	Number	Mean	S.D.	Number	Mean	S.D.	
Head length (mm)	45	192.9	5.4	21	188.4	6.1	**
Head breadth (mm)	45	161.8	4.6	21	162.4	5.1	n.s.
Head length-breadth index	45	83.9	3.1	21	86.3	4.7	*

* $P < 0.05$; ** $P < 0.01$, by a t-test.

prevailed in Japanese male students during the period from 1910 to 1980.

As for this brachycephalization, it is still unclear whether or not it is limited in Japanese or prevailed in other countries or districts[33]. These findings including present results suggest a possibility of generating a chronological difference in the morphological properties of maxillary dentition in various races worldwide but this possibility still remains to be further studied.

5. Cranial morphology in relation to malocclusion

A lot of reports have been presented concerning the relation of cranial morphology to malocclusion, especially concerning a possible involvement of cranial base.

Susami[34] and Sugawara et al.[35] stated that the skeletal Class III group has a tendency to have a smaller length of the anterior cranial base as compared with that of Class I.

From growth changes in the maxillo-facial cranium determined by lateral cephalometric radiographs in male patients with skeletal mandibular protrusion during adolescent growth period, Sakamoto et al.[36] stated that the growth amount of posterior cranial base was significantly small in a the skeletal Class III group than in Class I group. Sai et al.[37]

suggested a possible involvement of largely increased mandibular length (Cd-Gn) and contrarily minimally increased length of the posterior cranial base (S-Ba) in the relapse of reversed occlusion of front teeth in the skeletal Class III group. In addition, some reports have suggested a possible relation of patients with malocclusion of skeletal Class III group to the cranial base angle (NSBa)[38, 39].

However, no report to be listed specially is available as for an involvement of the head length- breadth index which expresses the cranial morphological properties.

In order to clarify this point, therefore, not only the evaluation of malocclusion according to Susami et al's the definition of malocclusion was performed from the dental casts from subjects enrolled in this study but also a relation of malocclusion to the head length-breadth index was examined (Table. 3). Among the classification of malocclusion thus performed, maxillary protrusion was encountered most frequently followed by crowding, mandibular protrusion, others and maxillary and mandibular protrusion.

When a multi-comparison test was performed after calculation of the head length-breadth index by different types of malocclusion, the index for reversed occlusion was 86.3 with a significantly larger trend as compared with maxillary protrusion (83.9, $p < 0.05$), suggesting a

brachycephalic trend with malocclusion.

When the head length and breadth were further compared between those with maxillary protrusion and those with reversed occlusion, no significant difference was observed in the breadth but a significantly smaller trend was observed with mandibular protrusion than in those with maxillary protrusion (p < 0.01), suggesting a possible involvement of the head length in the appearance of malocclusions such as mandibular protrusion or maxillary protrusion (Table. 5).

No similar report is elsewhere available to support these findings, however, a possible relation of a smaller trend of anterior cranial base and a reduced trend of posterior cranial basic growth in the skeletal Class Ⅲ group as compared to the Class Ⅰ group is also considered[34-36] as mentioned previously.

As for the reason of relating the cranial morphology to malocclusion, it has been discussed from the influence of cranial morphology on the proximal and distal positioning relation of maxillary and mandibular bones or its size[36, 40, 41]. Among them, a relation of the shortened anterior cranial base to the minimized and retrograded maxilla often observed in the skeletal Class Ⅲ group was estimated[40, 41].

Since the posterior cranial base in the skeletal Class III group tended to show a poor growth as compared with Class I, the anterior positioning of mandible was stated to be probably caused by the reduced mandibular fossa or even reduced amount of posterior mandibular displacement[36]. Since it was suggested that the length of maxillary base tended to become large with the increased head length from the present

results, it may conclusively affect the proximal-distal positioning of upper and lower dental arches, further leading to the occurrence of malocclusion.

From the results mentioned above, it was revealed that the dentition have a tendency to relate to the palate and the cranial size and thus suggested that not only the harmonized teeth with the size of alveolar base but also the cranial morphology should be considered when teeth are aligned. A further examination is needed to concern the relation of dentition to cranial morphology from the standpoint of dental relapse after orthodontic treatment. Future studies to validate the corresponding standard dentition patterns of cranial size would be helpful to align the teeth individually.

Conclusion

In order to serve as a basic material for considering the morphology of dental arch which is best fitted to individual persons, the dentition was examined in relation to the palate and the cranium from the dental cast and biological aspect in 168 male Japanese adults (mean age of 25 years and 5 months) with the following results :

1. The maxillary arch length and the width of inter- 1 st molars tended to become larger with more deepened palate, indicating a tendency of larger volumes of the palate.

2. With the augmented head length, the width of dentition in the maxillary 1 st molars became larger.

3. The larger the head breadth was, the larger the width of inter- 1 st molars in both arches became.

4. Maxillary protrusion was observed to have an increasing trend in the head length as compared with the case of mandibular

protrusion.

These results mentioned above indicated a possible relation of dentition to the palate and the size of cranium and suggested that not only the harmonization of teeth involved and alveolar base but also the cranial size should be examined when teeth are aligned.

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成人の歯列と口蓋および頭蓋形態との関連について
－第1報　頭長と頭幅との関係－

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抄録：本研究の目的は，各個人に適した歯列弓形態を考えるための基礎資料として，日本人成人における歯列と口蓋および頭蓋との関連性を明らかにすることである。

　矯正治療経験のない日本人成人男子168名（平均年齢25歳5か月）を対象に，歯列模型から歯列弓の幅径と長径，歯槽基底部の幅径と長径，口蓋の深さと容積，生体から頭長および頭幅を計測した．得られた計測値については，*Pearson* の相関係数を算出し，さらに相関係数の検定を行って比較検討した。

　結果は以下の通りであった。

1．上顎歯列弓長径と第一大臼歯部の歯列の幅が大きいほど，口蓋が深く，容積が大きい傾向が認められた。

2．頭長が大きいほど，上顎第一大臼歯部の歯列の幅が大きい傾向が認められた。

3．頭幅が大きいほど，上下顎第一大臼歯部の歯列の幅が大きい傾向が認められた。

4．上顎前突は反対咬合より頭長が大きい傾向が認められた。

　以上のことから，歯列は口蓋の形態および頭蓋の大きさと関連があることが示され，歯を排列する際には，歯と歯槽基底部の大きさの調和を考慮するだけでなく，頭蓋の大きさも考慮する必要性が示唆された。

キーワード：歯列，頭蓋形態，頭長幅指数，日本人成人