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Original Article

The Relation between Tooth Shape Ratio and Incisor Arrangement in Japanese Children

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Abstract

To investigate whether the relationship between tooth shape ratio and incisor arrangement proposed by Peck *et al.* in 1972 was applicable to Japanese children, we compared two groups, one with normal permanent dentition and another with crowded permanent dentition, using chronologically constructed plaster dentition models. Tooth shape ratio was obtained by dividing the incisor mesio-distal width by the labio-lingual width and then multiplying the result by 100. The results revealed a significant difference in the coronal mesio-distal diameter of the incisors between the two groups, but the other items showed no significant differences, suggesting no clear relationship between tooth shape ratio and incisor arrangement. That was, our results suggest that there is no clear relationship between tooth shape ratio of the mandibular incisors and arrangement of the permanent incisors in Japanese children.

Key words: Crowding—Tooth shape ratio—Mandibular incisor—Japanese children

Introduction

Some studies have suggested a relationship between tooth size and crowded dentition[3–6,8–11,15,17]. In 1972, Peck *et al.*[12,13] recognized that naturally well-aligned mandibular incisors possess distinctive dimensional characteristics; these teeth are significantly smaller mesio-distally and significantly larger labio-lingually, when compared with average population tooth dimensions. Investigating the relationship between occurrence of mandibular anterior tooth crowding and tooth shape ratio, Peck *et al.*[12,13] reported that ideal incisor arrangement occurred when the tooth shape ratio of the mesio-distal diameter to labio-lingual diameter was 88–92 in the central incisor, and 90–95 in the lateral incisor. Shah *et al.*[14] recently reported that mandibular incisor crowding was not predictable from mandibular incisor morphology in white people. Tsai[18] reported that the labio-lingual diameter of the second deciduous molars was significantly larger in primary dentition anterior tooth crowding cases in Taiwanese children. Furthermore, Bernabe *et al.*[1,2] reported that, although the sum of the tooth width of the anterior or all of the teeth in both the maxillary and mandibular dentitions was larger in a crowded dentition group, no

clinical significant differences were noted; they also found that, although the mesio-distal diameter of the first molars was involved in the occurrence of arch length discrepancy, their labio-lingual diameter was not involved in Peruvian people. Regarding the relationship between incisor morphology and occurrence of crowded dentition, Sugiura[16] reported that, although the mesio-distal diameter of the lateral incisors was involved, their labio-lingual diameter was not. However, there have been no reports on the relationship between ratio of incisor mesio-distal diameter to labio-lingual diameter and the occurrence of crowded dentition in Japanese patients. Therefore, the purpose of this study was to investigate the relationship between incisor tooth shape ratio and occurrence of crowded dentition in Japanese children.

Materials and Methods

1. Study materials

1) Selection of study materials

Mandibular dentition models were used in this study. These models were serially constructed from 40 Japanese pediatric patients at our department at 2-month intervals over an approximately 18 years period, starting from the age of 3 years. Informed consent was obtained from the patients and their guardians. All the patients were clinically diagnosed as having normal dentition at the time the first impression was taken in 1972. None of them received orthodontic treatment during the course of the study, and none showed premature loss of deciduous or permanent teeth due to trauma or dental caries. At the final examination, 27 patients showed normal permanent incisor dentition, and 13 patients showed crowded permanent incisor dentition. Because the number of cases was little, the difference by sex was not taken into consideration.

2) Selection of models for observation

Chronologically constructed mandibular dentition models were prepared from a total of 40 patients. Among these, those collected in the period immediately before deciduous central incisor dislodgment (deciduous dentition period) and the completion period of incisor eruption (mixed dentition period) were selected as models for observation.

2. Study methods

1) Standardization of models

Standardization of models is necessary to compare models collected chronologically. The models in this study were standardized according to the criteria established in a series of studies conducted at our department[7,19]. In the maxillary models, the reference plane was set to pass through 3 points: the central point of the incisive papilla and the lowest bilateral second deciduous molar lingo-cervical points. Each model's basal plane was adjusted parallel to the reference plane while maintaining a constant distance. After the maxillo-mandibular models were occluded in the maximum intercuspal position, each mandibular model's basal plane was set parallel to the maxillary model's basal plane while maintaining a constant distance between the maxillo-mandibular model's basal planes. Furthermore, from 6 months prior to maxillary second deciduous molar dislodgment, the reference points in the bilateral second deciduous molars were shifted to the lowest bilateral first molar lingo-cervical points according to the method by Kubodera *et al.*[7] During the shifting of these reference points, the reference planes for before and after the shift was adjusted for compliance.

2) Measurement methods

Obtaining at least two measurements in the same site using a digital caliper (NSK Co.), a third measurement was performed when a measurement error was larger than 0.5 mm.

3) Observation items

(1) Coronal mesio-distal diameter of mandibular permanent incisors (MD)

The maximum coronal mesio-distal diameter of the permanent incisors was measured (Fig. 1).

(2) Coronal labio-lingual diameter of mandibular permanent incisor (LL)

The maximum coronal labio-lingual diam-

eter of the permanent incisors was measured (Fig. 1).

(3) Inter-deciduous canine width in mandible

Distance between the bilateral deciduous canine apexes was measured.

(4) Expansion rate of inter-deciduous canine width

Inter-deciduous canine width during the mixed dentition period was divided by that during the deciduous dentition period, and then multiplied by 100.

(5) Increase in inter-deciduous canine width

The difference between the inter-deciduous canine width during the mixed dentition period and that in the deciduous dentition period was calculated.

(6) Tooth shape ratio of permanent incisors

The coronal mesio-distal diameter of the permanent incisors was divided by the labio-lingual diameter, and then multiplied by 100.

4) Statistical analysis

A Student's *t*-test was performed on the coronal mesio-distal and labio-lingual diameters of the permanent incisors, the tooth shape ratio of the permanent incisors, and the expansion rate and amount of the inter-deciduous canine width between the normal and crowded dentition groups. To investigate which items among the coronal mesio-distal and labio-lingual diameters and tooth shape ratio of the permanent incisors most influenced expansion rate and increase in inter-deciduous canine width, correlation coefficients were calculated and compared.

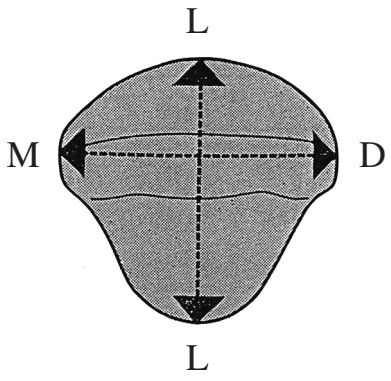

Fig. 1 A mandibular central incisor showing the mesio-distal (MD) and labio-lingual (LL) crown diameters

Results

The mean coronal mesio-distal diameters of both the central and lateral incisors were significantly larger in the crowded dentition group than in the normal dentition group ($p<0.01$), and the mean difference was 0.28 mm in the central incisor, and 0.31 mm in the lateral incisor. The mean coronal labio-lingual diameter of the central incisor was significantly larger in the crowded dentition group than in the normal dentition group ($p<0.05$), and that of the lateral incisor was larger in the crowded dentition group, although no significant difference was noted. The mean difference was 0.28 mm in the central incisor, and 0.20 mm in the lateral incisor. However, the tooth shape ratio of the permanent central incisors was larger in the normal dentition group, and that of the permanent lateral incisors was larger in the crowded dentition group, although no significant differences were found (Table 1). The frequency graph of the tooth shape ratio of the permanent incisors showed a normal distribution in both the normal and crowded dentition

Table 1 Crown dimensions and tooth shape ratio (mean)

	MD length (mm)			LL length (mm)			MD/LL×100 (%)	
	Central		Lateral	Central		Lateral	Central	Lateral
Normal	5.26	**	5.90	5.45	*	5.66	97.32	105.10
		**						
Crowding	5.54		6.21	5.73		5.86	97.17	106.59

**: $p<0.01$, *: $p<0.05$

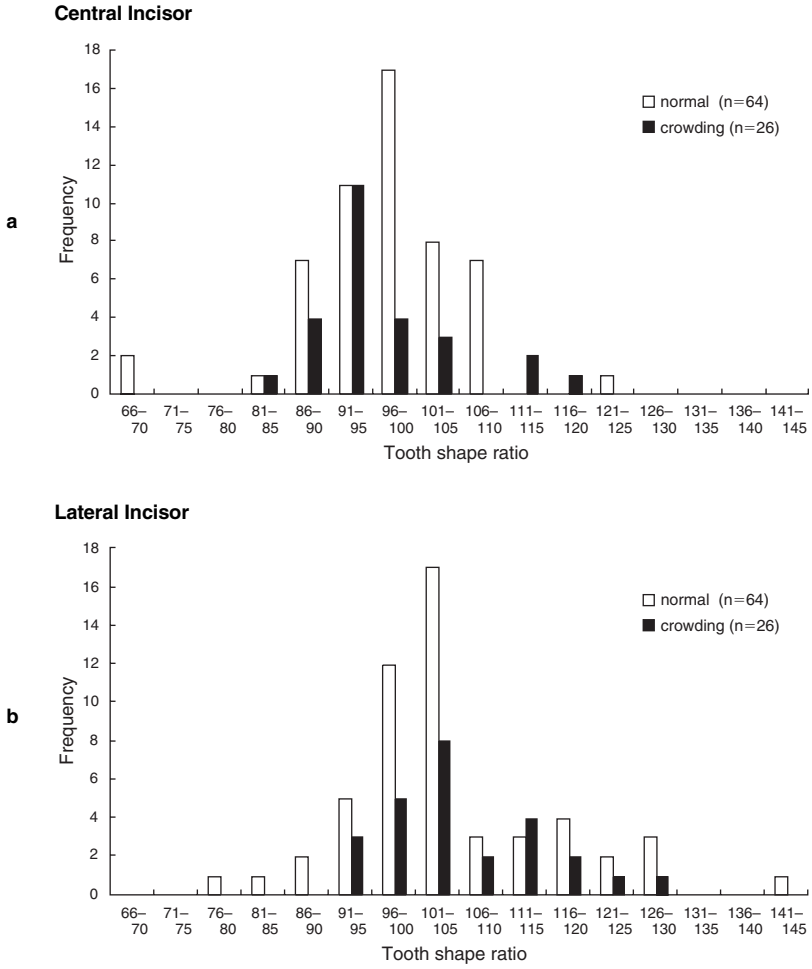

Fig. 2

groups (Fig. 2-a,b).

Increase and expansion rate in inter-deciduous canine width were larger in the crowded dentition group than in the normal dentition group, although no significant differences were detected. The mean difference in width increase was 0.63 mm (Table 2). Furthermore, comparing correlations between the coronal mesio-distal and labio-lingual diameters and tooth shape ratio of the permanent incisors, the correlation coefficient between the coronal mesio-distal diameter of the central incisors and the increase in inter-deciduous canine width in the crowded dentition group was 0.46, showing the largest value, as indicated in Table 3-a,b, and the correlation coefficient between the coronal labio-lingual diameter of the lateral incisors and the expansion rate and increase in inter-deciduous canine width in the normal dentition group was −0.51 and −0.49, respectively, showing negative correlations.

Table 2 Changes of intercanine arch width (mean)

	Rate	Amount
Normal	113.1%	3.25 mm
Crowding	116.4%	3.88 mm

Rate: The rate of increase intercanine arch width
Amount: The amount of increase intercanine arch width

Table 3

a: Correlations coefficients (normal)

	Tooth shape ratio		Mesio-distal length		Labio-lingual length	
	Rate	Amount	Rate	Amount	Rate	Amount
Central incisor	0.30	0.32	0.08	0.11	−0.28	−0.28
Lateral incisor	0.41	0.40	−0.08	−0.06	−0.51	−0.49

b: Correlations coefficients (crowding)

	Tooth shape ratio		Mesio-distal length		Labio-lingual length	
	Rate	Amount	Rate	Amount	Rate	Amount
Central incisor	−0.02	−0.04	0.35	0.46	0.23	0.31
Lateral incisor	−0.19	−0.19	0.39	0.43	0.31	0.33

Discussion

1. Coronal mesio-distal diameter

The coronal mesio-distal diameter of the mandibular central and lateral incisors was significantly larger in the crowded dentition group than in the normal dentition group. This result was in accordance with that reported by Sugiura[16], also from our department. We consider the coronal mesio-distal diameter to be the most probable cause of crowded dentition.

2. Coronal labio-lingual diameter

No significant difference in the coronal labio-lingual diameter of the mandibular central or lateral incisors was noted between the crowded and normal dentition groups. This result was also in accordance with that reported by Sugiura[16]. We consider the correlation between the coronal labio-lingual diameter and the occurrence of crowded dentition to be low.

3. Tooth shape ratio

Although Peck *et al.*[12,13] reported that normal dentition occurred when the tooth shape ratio was 88–92 in the central incisor, and 90–95 in the lateral incisor, the ratio was 97.32 in the central incisor and 105.10 in the lateral incisor in the normal dentition group in this study. We believe that this was because the coronal mesio-distal diameter in our models was larger than that in the materials used by Peck *et al.*[12,13], compared with the labio-lingual diameter. Furthermore, no significant difference in tooth shape ratio between the normal and crowded dentition groups was found. This suggests that this ratio cannot be considered a factor in the occurrence of crowding dentition in Japanese children.

4. Expansion rate and increase of inter-deciduous canine width

The increase in expansion rate and width of the inter-deciduous canine were larger in the crowded dentition group, although no significant difference was noted. The increase in inter-deciduous canine width in the crowded dentition group was larger than that in the normal dentition group by 0.63 mm, on average. However, the mean sum of the coronal mesio-distal diameters in the crowded dentition group was larger than that in the normal dentition group by 1.18 mm. Therefore, we believe that, even if the inter-deciduous canine width becomes larger, the sum of the coronal mesio-distal diameters will still be much larger, resulting crowded dentition.

In terms of the relationship between the coronal mesio-distal and labio-lingual diameters and tooth shape ratio of the permanent

incisors, the correlation coefficient between the coronal mesio-distal diameter of the central incisor and increase in inter-deciduous canine width in the crowded dentition group was 0.46. The correlation coefficient between the coronal labio-lingual diameter of the lateral incisor and expansion rate and width increase in the inter-deciduous canines in the normal dentition group was −0.51 and −0.49, respectively. This showed that, when the coronal mesio-distal diameter of the central incisor was larger, the increase in inter-deciduous canine width was also larger in the crowded dentition group, whereas when the labio-lingual diameter of the lateral incisor was larger, the expansion rate and width increase in the inter-deciduous canine was smaller in the normal dentition group.

Conclusion

Our results suggest that there is no clear relationship between tooth shape ratio of the mandibular incisors and arrangement of the permanent incisors in Japanese children.

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