– ORIGINAL ARTICLE –

A study on the anterior ratio in patients showing mandibular prognathism

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Abstract : Purpose: The purpose of this study was to evaluate the efficacy of the anterior ratio for appropriate occlusal relation using measurements of mesiodistal crown widths.

Materials and Methods: The subjects included 202 patients (71 males and 131 females) with skeletal Class III, referred to the Orthodontic clinic of Niigata University Medical and Dental Hospital, and considered to be candidates for surgical treatments. The following cases were excluded from the subjects used in this study: those who had any missing teeth, congenital defects, prosthesis, interproximal fillings and differential mesiodistal crown widths of more than 0.5 ㎜ between the left and right anterior teeth including microdont and/or peg teeth. A diagnostic cast of each patient taken before treatment was used to measure the mesiodistal crown widths of the anterior teeth on the maxilla and mandible. These values were then measured using a vernier caliper with an accuracy of 1/20 ㎜. Measurement values were taken using the mean score calculated based on two sets of measurements taken on separate days. An anterior ratio was calculated using this formula: Anterior ratio (%) = (mesiodistal crown widths of anterior teeth on mandible) /(mesiodistal crown widths of anterior teeth on maxilla) x 100

Results and Discussion: Results showed a difference between males and females in mesiodistal crown widths on the upper central incisors, upper and lower canines and lower lateral incisors, respectively. Measurement data is as follows (males and females, respectively) ; upper central incisors; 8.77 ± 0.45 and 8.50 ± 0.49, upper lateral incisors; 7.27 ± 0.60 and 7.18 ± 0.61, upper canines; 8.23 ± 0.53 and 7.89 ± 0.46, lower central incisors; 5.51 ± 0.35 and 5.45 ± 0.40, lower lateral incisors; 6.17 ± 0.39 and 6.05 ± 0.41, lower canines; 7.22 ± 0.45 and 6.86 ± 0.46. The anterior ratio also showed a difference between males and females. These were 77.92 ± 2.36% and 77.93 ± 2.63% in males and females, respectively. The present data were smaller than those in similar reports as to patients with skeletal Class III, and were analogous to the data for patients with normal occlusion.

These results suggest that even cases with antero-posterior dentofacial anomaly due to overgrowth of the mandible mostly have balanced mesiodistal crown widths of the upper and lower anteriors.

抄録：本研究は，骨格性下顎前突症を有する患者の歯冠近遠心幅径を計測し，適切な咬合関係の確立に関与する anterior ratio について検討することを目的とした。

資料と方法：新潟大学医歯学総合病院矯正歯科診療室を受診し，骨格性下顎前突と診断され，上下顎前歯部に欠損，補綴物，隣接面充填物がなく，矮小歯を含めて左右側の歯冠近遠心幅径の差が 0.5 ㎜以上ある症例を除いた 202 名（女性 131 名，男性 71 名）の歯列石膏模型を資料とした。計測は資料とした模型について上下顎 6 前歯の歯冠近遠心幅径を，1/20 ㎜の副尺付きのノギスを用いて行った。計測は日を変えて 2 回行い，その平均値を測定値とした。得られた測定値から anterior ratio（=（下顎 6 前歯の歯冠近遠心幅径の総和）／（上顎 6 前歯の歯冠近遠心幅径の総和）× 100）を算出した。

結果と結論：測定した歯冠近遠心幅径（単位；㎜）は，上顎中切歯が男性 8.77 ± 0.45 で女性 8.50 ±

0.49，上顎側切歯が男性 7.27 ± 0.60 で女性 7.18 ± 0.61，上顎犬歯が男性 8.23 ± 0.53 で女性 7.89 ± 0.46，下顎中切歯が男性 5.51 ± 0.35 で女性 5.45 ± 0.40，下顎側切歯が男性 6.17 ± 0.39 で女性 6.05 ± 0.41，下顎犬歯が男性 7.22 ± 0.45 で女性 6.86 ± 0.46，上顎中切歯，上下顎犬歯と下顎側切歯について危険率５％未満で男女差を認めた。また，anterior ratio は，男性が 77.92 ± 2.36％で女性が 77.93 ± 2.63％であった。今回算出した骨格性下顎前突患者の anterior ratio は，反対咬合者について調べた過去の報告と比べて小さい値を示し，正常者に近似していた。

以上の結果から，下顎骨過成長による上下顎骨の前後的不調和を示す症例でも，上下顎の前歯の歯冠近遠心幅径は調和がとれている場合の多いことが示された。

I. Introduction

It is of great importance for orthodontic treatment to understand correlation between teeth, dental arch, and basal bones. Understanding this interaction concisely, allows a precise diagnosis and treatment. Morphological changes in teeth, maxilla and mandible in successive periods have been often described as a mode of dietary life or evolutionary[1-3]. The softer dietary foods we take, the less functional properties of mastication become, which leads to reduction in the size of the mandible[1-3]. On the other hand, other reports have stated that there is no relation between consistency of food and developments of the maxilla and mandible[4]. Furthermore, recent studies show that the maxilla, mandible and alveolar bone have probably increased in size as time has passed[4].

Teeth size as well as mesiodistal crown widths both on deciduous and permanent teeth varied as larger[5-8] or smaller over the ages[9-12]. Moreover, there is a difference in mesiodistal crown widths based on the tooth order[13, 14]. However, both the changes in teeth size and crown width with age still remain unclear.

It's a key role for maintaining the occlusal stability and the smooth jaw movements after orthodontic treatment to attain the symmetrical dental arch forms as well as the intermaxillary relation. Especially, mesiodistal crown widths on the maxilla and mandible contribute to improvement of the occlusion through orthodontic procedure. If there is disharmony in mesiodistal crown widths on the maxilla and/or mandible, adjustment of the interproximal grinding will be needed to improve intercuspations. The anterior ratio[15] (%) (= (Sum of mesiodistal crown widths of anterior teeth on mandible)/(Sum of mesiodistal crown widths of anterior teeth on maxilla) x 100) is a valuable index for determining whether the mesiodistal crown widths of the upper and lower anteriors are proportional or not.

Surgical-orthodontic patients with intermaxillary anomaly have inadequate occlusion due to imbalanced anterior-posterior growth of the maxilla and mandible. It is important for achieving suitable occlusion after surgery to determine whether anterior ratio or mesiodistal crown widths of the anteriors show specific values in patients with skeletal discrepancy. Further, crown widths appear to change over twenty years due to one's dietary life or other surroundings. This study was undertaken to evaluate the precise anterior ratio of patients diagnosed as skeletal Class III malocclusion by measurements of mesiodistal crown width.

II. Materials and Methods

The subjects comprised 202 patients (71 males and 131 females, mean age; 18.5 years old and 19.1 years old, respectively) referred to the Orthodontic clinic of Niigata University Medical and Dental Hospital from October 1998 to September 2004. These patients were diagnosed as Class III malocclusion and considered to be candidates for surgical treatment. The following cases were excluded from the subjects used; those which had any missing teeth, congenital defects, prosthesis, and differential crown widths of more than 0.5mm compared to the left and right anterior teeth, including peg teeth. A diagnostic cast of each patient taken before treatment was used to measure the mesiodistal crown widths of the upper and lower anterior teeth (Table 1).

These values were measured using vernier caliper with an accuracy of 1/20mm. The measurements were taken twice on different days and the values were taken based on the mean score. The skewness and the kurtosis indicating the aspects of distribution were calculated based on data obtained.

The anterior ratio was calculated by using the following formula:

The anterior ratio (%) = (Sum of mesiodistal crown widths of anterior teeth on mandible)/ (Sum of mesiodistal crown widths of anterior teeth on maxilla) x100.

The mean value, standard deviation, skewness and kurtosis were evaluated separately by gender. Statistical comparisons between males and females for each dependent variable measured were performed using t-test for statistical significance.

Ⅲ. Results

The results of descriptive statistics and t-test are showed in Table 2 and Table 3, and the values of the measurements are showed in Fig. 1 through 6.

The mean value and the standard deviation of each mesiodistal crown width for males and females were 8.77 ± 0.45mm and 8.50 ± 0.49mm on upper central incisors, 7.27 ± 0.60mm and 7.18 ± 0.61mm on upper lateral incisors, 8.23 ± 0.53mm and 7.89 ± 0.46mm on upper canines, 5.51 ± 0.35mm and 5.45 ± 0.40mm on lower central incisors, 6.17 ± 0.39mm and 6.05 ± 0.41mm on lower lateral incisors, 7.22 ± 0.45mm and 6.86 ± 0.46mm on lower canines, respectively (Table 2). The skewness and kurtosis of each tooth for males and females were -0.31 and -0.25, -0.06 and -0.15 on upper central incisors, -0.69 and 1.41, 0.11 and -0.07 on upper lateral incisors, -0.33 and 0.05, 0.21 and 0.15 on upper canine, -0.130 and 0.15, 0.27 and 0.65 on lower central incisors, -0.32 and 1.41, -0.20 and -0.01 on lower lateral incisors, -0.39 and 1.29, -0.10 and 0.85 on lower canines, respectively (Table 2) (Fig. 1-6).

A statistically significant difference in mesiodistal crown widths on the upper central incisors, upper and lower canines ($P<0.01$) and lower lateral incisors ($P<0.05$) was founded between males and females.

The mean value and standard deviation of the anterior ratio showed 77.92 ± 2.36% and 77.93 ± 2.63% for males and females, respectively (Table 3). No significance with respect to the anterior ratio was present between males and females.

The skewness was showed as 0.26 and 0.28, and the kurtosis was displayed as 0.20 and 0.30 for males and females, respectively (Table 3) (Fig. 7).

Table 1 Sex and age distributions of the subjects (n=202)

Age	~ 14	15 ~ 17	18 ~ 20	21 ~ 23	24 ~ 26	27 ~ 29	30 ~ 32	33 ~ 35	36 ~	Total
Male	13	31	9	5	6	2	1	2	2	71
Female	28	42	23	12	10	6	5	3	2	131

Table 2 The descriptive statistic values of mesiodistal crown width

	Maxillary central incisors**		Maxillary lateral incisors		Maxillary canines**		Mandibular central incisors		Mandibular lateral incisors*		Mandibular canines**	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Mean	8.77	8.50	7.27	7.18	8.23	7.89	5.51	5.45	6.17	6.05	7.22	6.86
SD	0.45	0.49	0.60	0.61	0.53	0.46	0.35	0.40	0.39	0.41	0.45	0.46
Skewness	-0.31	-0.06	-0.69	0.11	-0.33	0.21	-0.13	0.27	-0.32	-0.20	-0.39	-0.10
Kurtosis	-0.25	-0.15	1.41	-0.07	0.05	0.15	0.15	0.65	1.41	-0.01	1.29	0.85

Unit: mm

**P < .01
* P < .05

Table 3 The descriptive statistic values of anterior ratio

	Sum of 6 maxillary anterior teeth (mm)		Sum of 6 mandibular anterior teeth (mm)		Anterior ratio (%)	
	Male	Female	Male	Female	Male	Female
Mean	48.56	47.13	37.81	36.72	77.92	77.93
SD	2.61	2.46	1.95	2.17	2.36	2.63
Skewness	-0.45	0.09	-0.47	-0.16	0.26	0.20
Kurtosis	-0.12	-0.10	1.18	-0.20	0.28	0.30

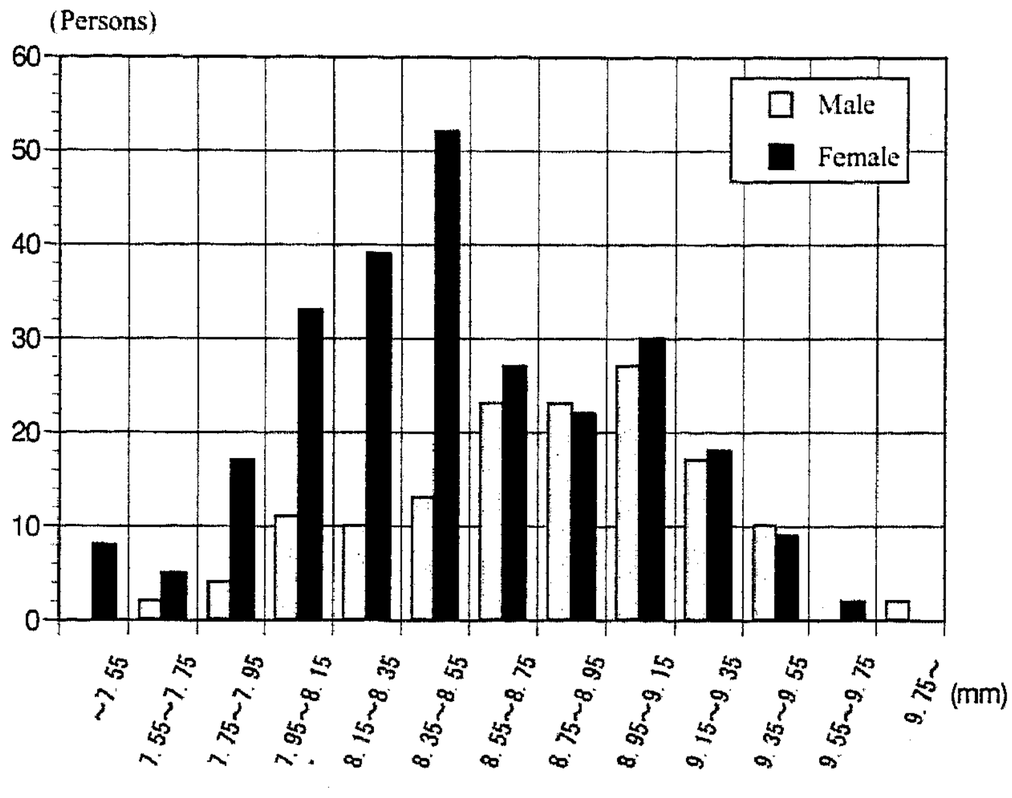

Fig. 1 Distribution of mesiodistal crown widths of maxillary central incisors

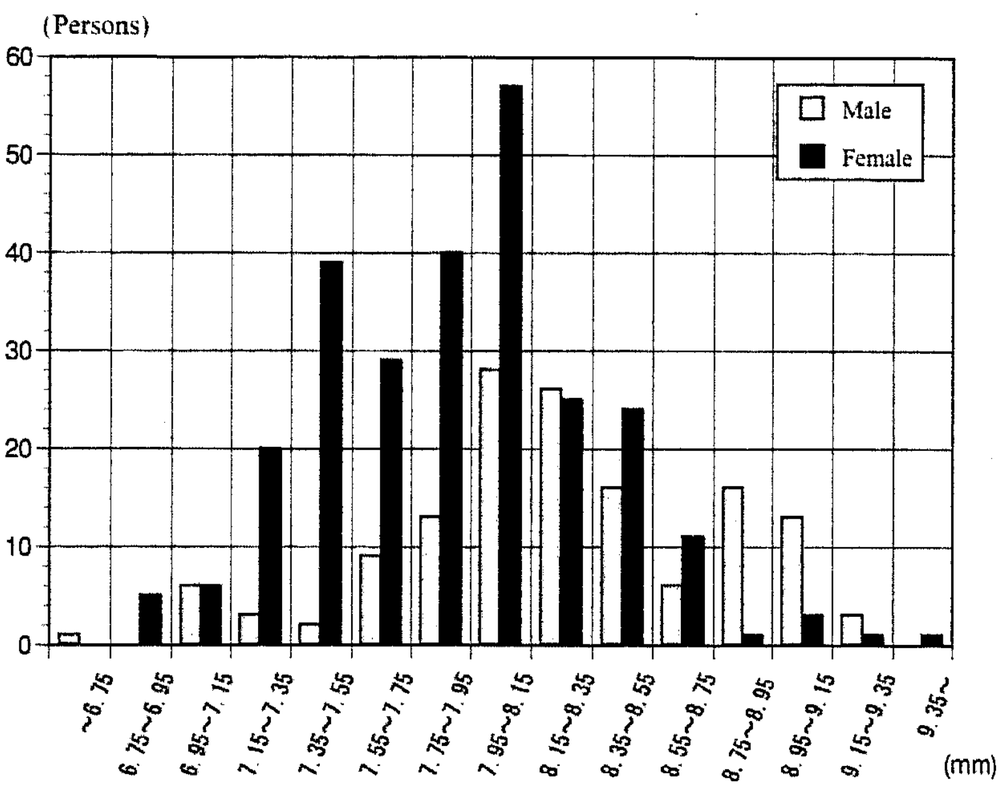

Fig. 3 Distribution of mesiodistal crown widths of maxillary canines

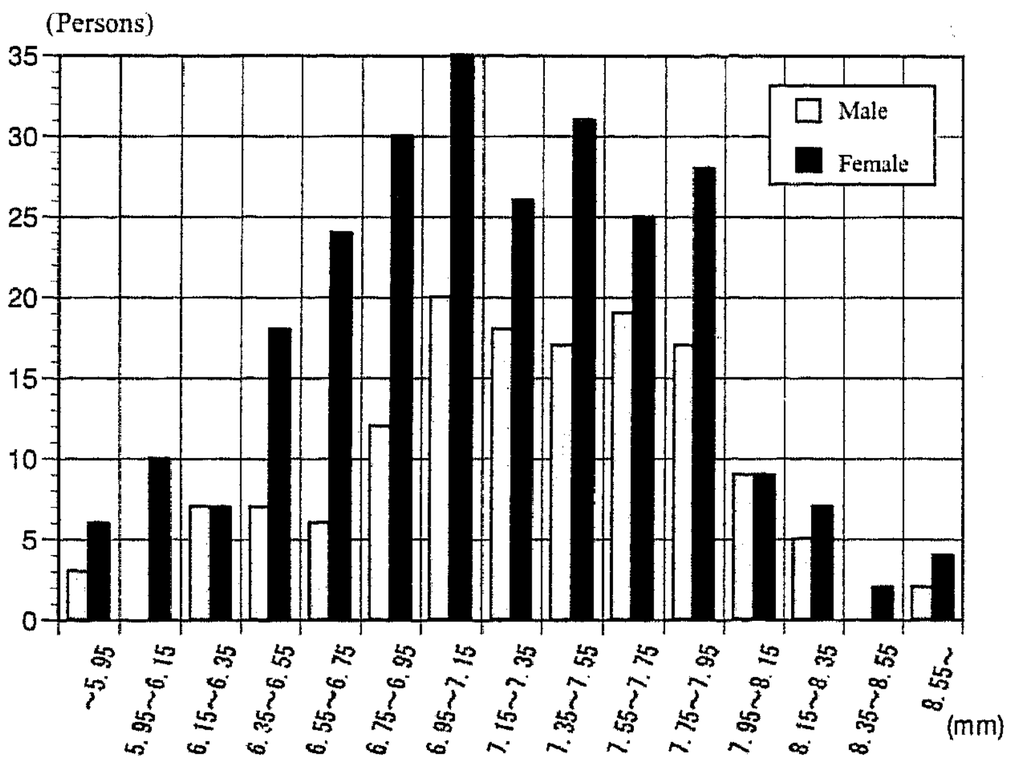

Fig. 2 Distribution of mesiodistal crown widths of maxillary lateral incisors

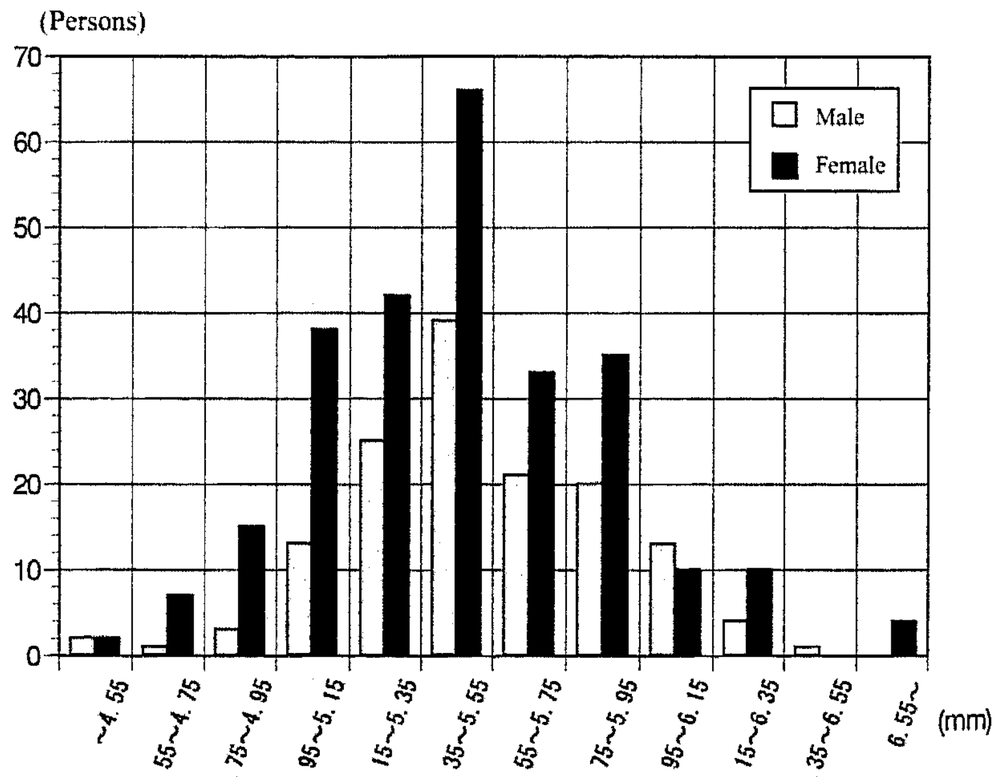

Fig. 4 Distribution of mesiodistal crown widths of mandibular central incisors

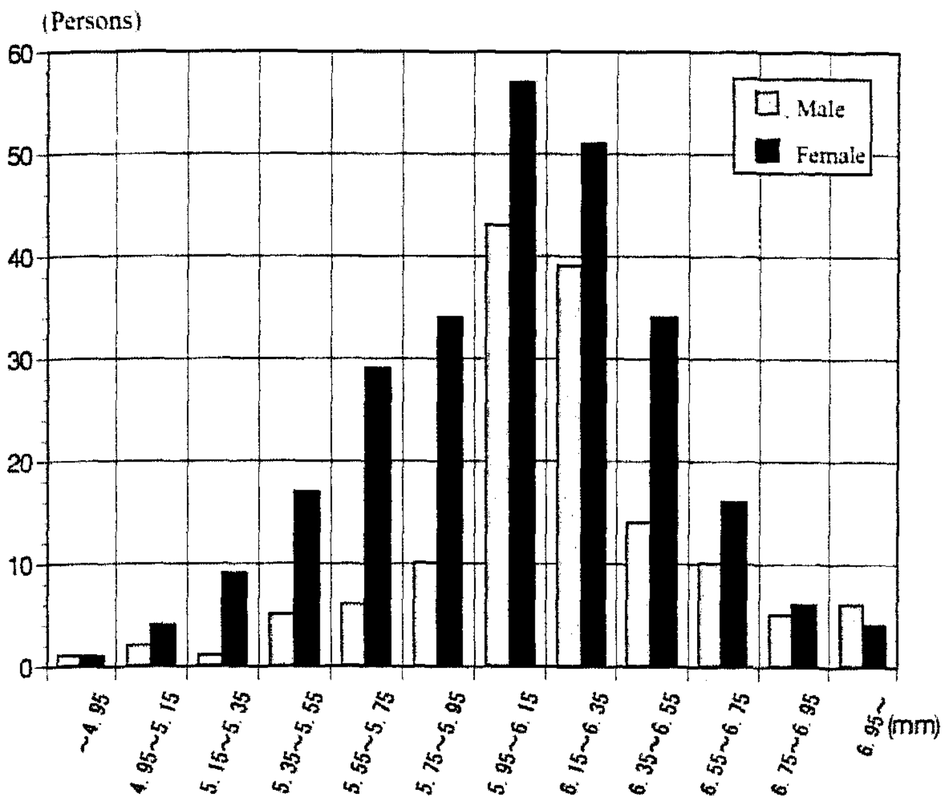

Fig. 5 Distribution of mesiodistal crown widths of mandibular lateral incisors

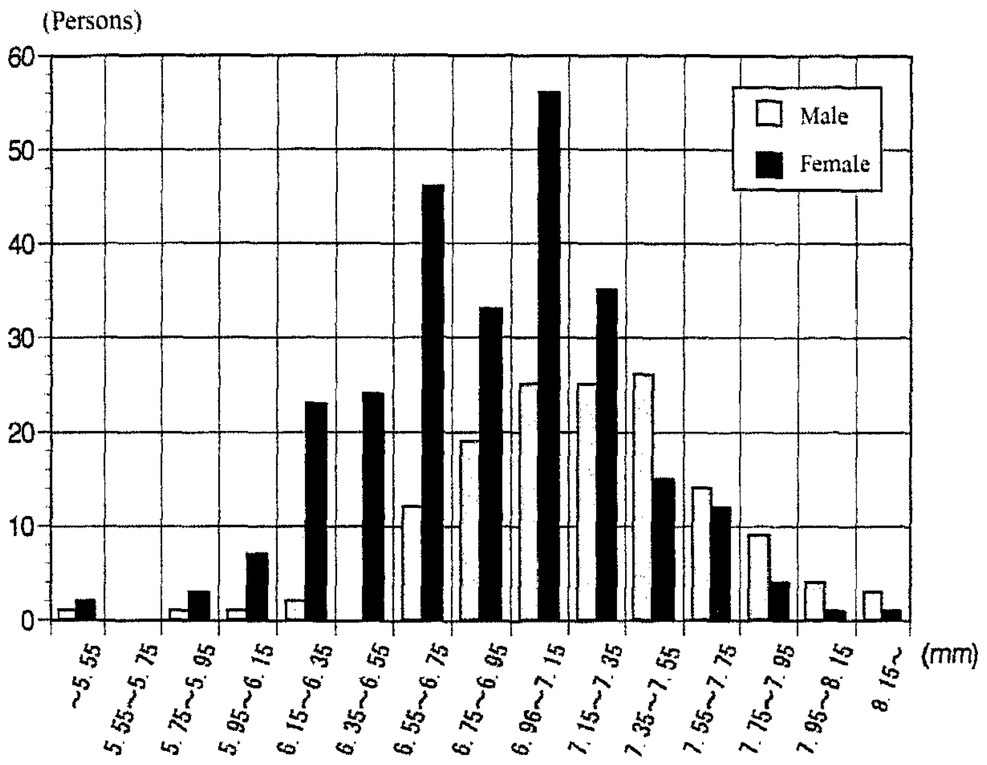

Fig. 6 Distribution of mesiodistal crown widths of mandibular canines

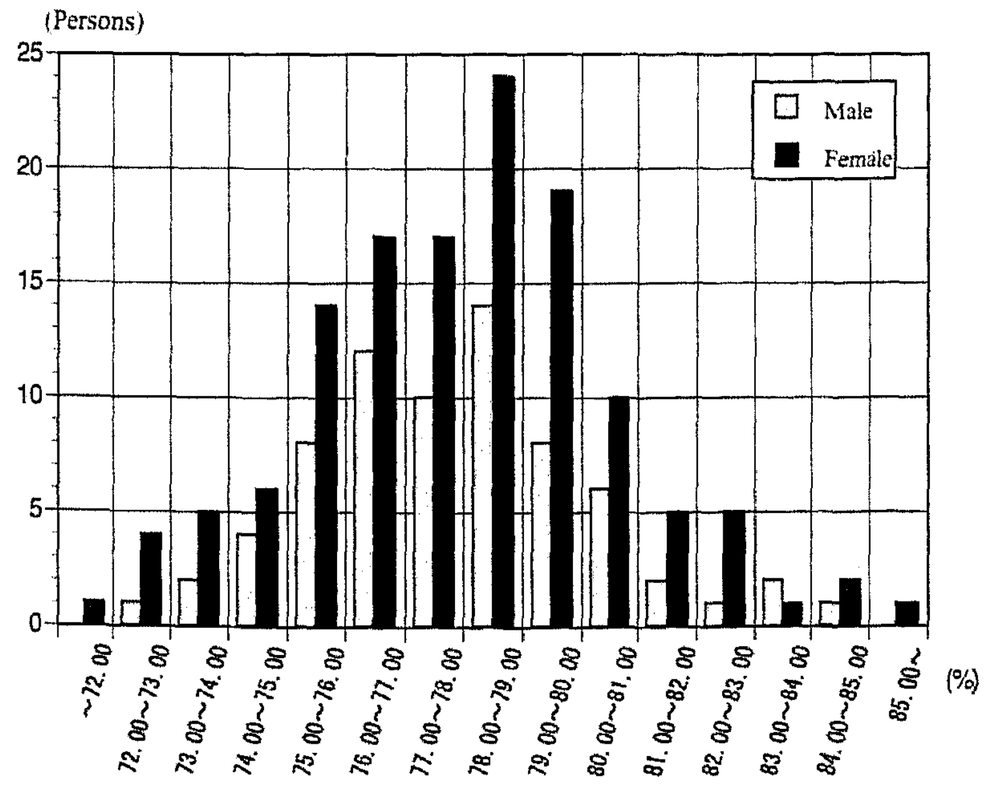

Fig. 7 Distribution of anterior ratios

Ⅳ. Discussion

1. The mesiodistal crown width

The alteration of anterior ratio is related to the mesiodistal crown widths because of the anterior ratio derived from the values of upper and lower mesiodistal crown widths on the anterior teeth. Distribution of mesiodistal crown widths of the anterior teeth on the maxilla and mandible were evaluated using the mean value, standard deviation, skewness and kurtosis. In terms of the kurtosis, these results exceeded 1.0 on the upper and lower lateral incisors and lower canines, but this value guides the conditions required for statistics, with absolute values of less than 1.5. Furthermore, these data were distributed in a linear manner when normal probability paper (Fig. 8 and 9), and showed an almost normal distribution. The standard deviation of mesiodistal crown widths of the upper and lower anteriors had a range from 0.35 to 0.60 which was almost analogous to those (0.20-0.77) in other reports[7, 10, 11, 16-21] (Table 4). This finding suggests that the subjects used in this study were almost the same ones compared to the previous studies.

2. The difference in mesiodistal crown widths among sex, age, and region (Table 4)

In this study, statistically significant differences in mesiodistal crown widths of the upper central incisors, upper canines, lower lateral incisors, and lower canines were found between males and females. In addition respective values for males showed larger than those for females. Endo[17] using, subjects with normal occlusion and Akiyama et al.[20] investigating on the general population showed that the sizes of all six anterior teeth were larger in males than in females. Endo[19] investigated subjects with reversed occlusion and concluded that there was a statistical difference in the upper anteriors and the lower canine between males and females. Kubota et al.[10] using subjects with normal occlusion also obtained the similar results. Moreover, in terms of the cases with crowding, Kubota et al.[10] reported that the size of the upper central incisors and lower anterior teeth were larger in males than in females. According to the other report using the general population[22], the sizes of the upper and lower central incisors and lateral incisors for males showed larger values than those for females.

Table 4 Comparison with other studies on mesiodistal crown widths Mean ± Standard Deviation(mm)

	Year of publication	Subject	Maxillary central incisors	Maxillary lateral incisors	Maxillary canines	Mandibular central incisors	Mandibular lateral incisors	Mandibular canines
Male								
Present study	2005	Mandibular prognathism	8.77 ± 0.45	7.27 ± 0.60	8.23 ± 0.53	5.51 ± 0.35	6.17 ± 0.39	7.22 ± 0.45
Otsubo [16]	1957	Normal occlusion	8.59 ± 0.54	7.08 ± 0.77	8.04 ± 0.40	5.44 ± 0.43	6.03 ± 0.54	7.11 ± 0.42
Yamauchi et al. [18]	1965	Normal occlusion	8.52 ± 0.43	7.04 ± 0.56	7.94 ± 0.39	5.45 ± 0.29	6.06 ± 0.36	7.01 ± 0.34
Endo [17]	1970	Normal occlusion	8.78 ± 0.46	7.36 ± 0.66	8.25 ± 0.36	5.56 ± 0.37	6.20 ± 0.36	7.19 ± 0.37
Kubota et al. [10]	1991	Normal occlusion	8.64 ± 0.39	7.16 ± 0.41	8.23 ± 0.31	5.50 ± 0.35	6.08 ± 0.35	7.14 ± 0.40
Nagaoka et al. [7]	1993	Normal occlusion	8.55 ± 0.48	7.00 ± 0.54	7.91 ± 0.41	5.44 ± 0.42	5.94 ± 0.41	7.00 ± 0.44
Endo et al. [19]	1971	Reversed occlusion	8.90 ± 0.44	7.42 ± 0.61	8.29 ± 0.49	5.70 ± 0.34	6.34 ± 0.35	7.46 ± 0.44
Kubota et al. [10]	1971	Crowding	9.12 ± 0.50	7.55 ± 0.59	8.33 ± 0.56	5.83 ± 0.35	6.40 ± 0.36	7.24 ± 0.39
Akiyama et al. [20]	1991	General population	8.63 ± 0.54	7.09 ± 0.63	8.04 ± 0.49	5.44 ± 0.37	6.04 ± 0.41	7.01 ± 0.43
Nakano et al. [11]	1993	General population	9.11 ± 0.64	8.55 ± 0.43	7.89 ± 0.45	5.86 ± 0.42	6.52 ± 0.45	7.52 ± 0.43
Sumi et al. [21]	1985	Okinawa	8.93 ± 0.43	7.59 ± 0.56	8.31 ± 0.50	5.74 ± 0.28	6.33 ± 0.41	7.35 ± 0.38
		Nagasaki	8.95 ± 0.58	8.52 ± 0.45	7.55 ± 0.49	5.70 ± 0.41	6.33 ± 0.46	7.37 ± 0.43
Akiyama et al. [20]	1991	Akita	8.72 ± 0.55	7.18 ± 0.63	8.11 ± 0.48	5.46 ± 0.37	6.10 ± 0.43	7.08 ± 0.45
		Tanegashima	8.43 ± 0.50	6.97 ± 0.62	7.97 ± 0.44	5.30 ± 0.36	5.92 ± 0.39	6.96 ± 0.34
		Tsushima	8.77 ± 0.60	7.22 ± 0.61	8.02 ± 0.59	5.54 ± 0.39	6.16 ± 0.41	7.01 ± 0.49
		Okinawa	8.64 ± 0.49	7.03 ± 0.65	8.06 ± 0.48	5.49 ± 0.35	6.02 ± 0.40	6.99 ± 0.44
Female								
Present study	2005	Mandibular prognathism	8.50 ± 0.49	7.18 ± 0.61	7.89 ± 0.46	5.45 ± 0.40	6.05 ± 0.41	6.86 ± 0.46
Otsubo [16]	1957	Normal occlusion	8.24 ± 0.41	6.64 ± 0.60	7.65 ± 0.39	5.19 ± 0.36	5.81 ± 0.39	6.58 ± 0.38
Yamauchi et al. [18]	1965	Normal occlusion	8.17 ± 0.41	6.60 ± 0.51	7.59 ± 0.41	5.18 ± 0.32	5.83 ± 0.36	6.61 ± 0.42
Endo [17]	1970	Normal occlusion	8.33 ± 0.45	6.91 ± 0.62	7.89 ± 0.40	5.36 ± 0.40	5.97 ± 0.41	6.75 ± 0.39
Kubota et al. [10]	1991	Normal occlusion	8.38 ± 0.46	6.92 ± 0.35	7.93 ± 0.55	5.40 ± 0.28	5.94 ± 0.32	6.69 ± 0.39
Nagaoka et al. [7]	1993	Normal occlusion	7.96 ± 0.46	6.61 ± 0.55	7.53 ± 0.43	5.10 ± 0.32	5.64 ± 0.37	6.41 ± 0.41
Endo et al. [19]	1971	Reversed occlusion	8.56 ± 0.53	7.02 ± 0.73	7.83 ± 0.39	5.63 ± 0.38	6.18 ± 0.35	6.98 ± 0.53
Kubota et al. [10]	1971	Crowding	8.95 ± 0.47	7.46 ± 0.50	8.14 ± 0.46	5.62 ± 0.31	6.26 ± 0.32	7.00 ± 0.40
Akiyama et al. [20]	1991	General population	8.43 ± 0.51	6.90 ± 0.64	7.75 ± 0.39	5.37 ± 0.20	5.98 ± 0.36	6.64 ± 0.34
Nakano et al. [11]	1993	General population	8.83 ± 0.53	7.41 ± 0.69	8.09 ± 0.40	5.71 ± 0.33	6.34 ± 0.37	7.05 ± 0.37
Sumi et al. [21]	1985	Okinawa	8.81 ± 0.39	7.25 ± 0.50	8.10 ± 0.32	5.68 ± 0.30	6.19 ± 0.31	6.99 ± 0.27
		Nagasaki	8.52 ± 0.45	7.08 ± 0.57	7.89 ± 0.41	5.38 ± 0.30	6.02 ± 0.33	6.91 ± 0.35
Akiyama et al. [20]	1991	Akita	8.44 ± 0.48	6.89 ± 0.64	7.84 ± 0.37	5.38 ± 0.31	6.03 ± 0.34	6.67 ± 0.32
		Tanegashima	8.32 ± 0.55	6.82 ± 0.78	7.70 ± 0.38	5.25 ± 0.35	5.88 ± 0.40	6.62 ± 0.33
		Tsushima	8.48 ± 0.57	6.97 ± 0.57	7.67 ± 0.42	5.42 ± 0.32	6.00 ± 0.34	6.60 ± 0.34
		Okinawa	8.48 ± 0.49	6.93 ± 0.56	7.74 ± 0.40	5.43 ± 0.30	5.99 ± 0.36	6.64 ± 0.37

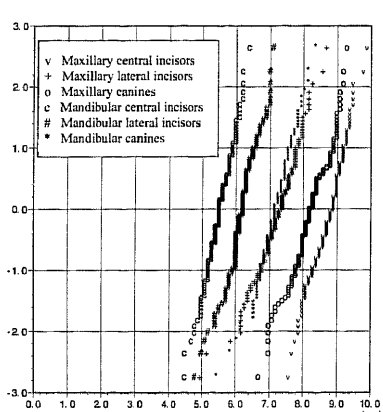

Fig. 8 Normal probability distribution of mesiodistal crown widths (Male)

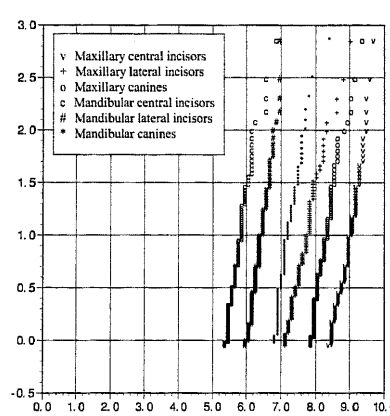

Fig. 9 Normal probability distribution of mesiodistal crown widths (Female)

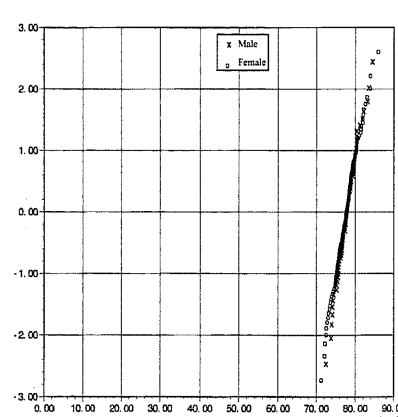

Fig. 10 Normal probability distribution of anterior ratio

Studies about tooth devolution have been published widely. In accordance with the theory of terminal reduction[23], many researchers have explained that human teeth tend to diminish in size over time. In comparison with the data from the general population in the 1990's[11, 20], the present data showed intermediate values of those findings except for the upper canines in males. In addition, compared with normal occlusion groups in the 1990's, of crown widths, we obtained almost the same values or slightly larger, except for the upper canines in females, than those reported by Kubota et al. (1991) [10] and Nagaoka et al. (1993) [7]. On the other hand, compared with the data of the subjects with reversed occlusion, the finding in this study showed that all the values in males were smaller than those of Endo et al. (1971) [19]. For females the present data were smaller than those of other studies, except for the upper lateral incisors and upper canines.

As the issues of both character and size in teeth depend on ethnicity, many relevant studies have been performed not only in dentistry but also in anthropology. Both size and its phenotype of teeth have a strong relation with ethnicity. There have been many reports published about the issue on regional differences in sizes and phenotypes of teeth in odontology as well as in anthropology. In Japanese, regional differences in dental size and morphology have been carried out from dental or anthropological points of view. In comparison with the report on regional differences in crown widths between Okinawa and Nagasaki (Sumi et al., 1985 [21]), our results for males showed that the values of mesiodistal crown widths were smaller except for the upper canines. The present data for upper canines fall in the middle of the data for Okinawa and Nagasaki. All the values for females obtained in this study except for the lower canine existed in the middle of both regions, while the values for the lower canine showed smaller than those of the two regions. Compared with this similar study[20] performed in Akita, Tanegashima, Tsushima, and Okinawa, our results were highly analogous to the values in Tsushima with the exception of the upper and lower canines.

In conclusion, the results obtained in this study show that teeth are larger than those of the subjects with normal occlusion and are almost the same as those for the general population. In terms of chronological transition, mesiodistal crown widths of anterior teeth obtained in this study were larger than those of 40-50 years ago in males and females, and the gender difference in mesiodistal crown widths probably tends to decrease.

3. The anterior ratio (Table 5)

The skewness and the kurtosis of the anterior ratio in this study were 0.26 and 0.20, 0.28 and 0.30 in males and females, respectively. Since the total sum of the skewness and the kurtosis on the upper and lower anterior teeth showed -0.47 to 0.09, -0.20 to 1.18, the anterior ratio calculated showed highly normal distribution. In fact, the anterior ratios were aligned on normal probability paper and seemed to fall into a straight line. This suggests that more accurate values of fit index were obtained using anterior ratio compared to calculating only mesiodistal crown widths (Fig. 10).

The anterior ratio is an important index in association with occlusion in the upper and lower anterior teeth; that is, the anterior ratio is helpful in determining whether adequate overbite and overjet, or Class I canine relation are achieved, and is useful for attaining smooth movements of the jaw. On the other hand, the anterior ratio is highly dependent upon its regional characteristics. For instance, there are the difference between the European and the Japanese in the anterior ratio in terms of development, acquired deformities or condition of teeth. The Europeans have mostly Chisel-shaped incisors, but the Japanese have mostly shovel-shaped incisors. Therefore, the data obtained suggest that it may be useful for future clinical diagnosis and treatment to investigate the regional differences in teeth phenotypes.

Previous studies have reported that an anterior ratio obtained from patients having suitable occlusion showed 78.3 ± 2.01 (male; 78.9 ± 2.02, female; 77.8 ± 1.95) (Matsumoto et al.)[24] and 78.09 ± 2.19 (Motohashi et al.)[25]. Our results, 77.92 ± 2.36 for males and 77.93 ± 2.63 for females, were close to the previous data, indicating that the anterior ratio measured was almost proportional in spite of anteroposterior skeletal discrepancy. However, there has been still few study made on the anterior ratio for the Japanese. Therefore, using other studies on measurements of mesiodistal crown width[7,10,11,16-21,24,25], we calculated the anterior

Table 5 Comparison with other reports on anterior ratio

	Year of publication	Subject	Sum of 6 anterior teeth (mm)		Anterior ratio Mean ± SD(%)	Sum of 6 anterior teeth (mm)		Anterior ratio Mean ± SD(%)
			Maxilla	Mandible		Maxilla	Mandible	
			Male			Female		
Present study	2005	Mandibular prognathism	48.56	37.81	77.92 ± 2.36	47.13	36.72	77.93 ± 2.63
Matsumoto et al.[24]	1971	Normal occlusion			78.9 ± 2.02			77.8 ± 1.95
Otsubo[16]	1957	Normal occlusion	23.71	18.58	78.36	22.53	17.58	78.03
Yamauchi et al.[18]	1965	Normal occlusion	23.50	18.52	78.81	22.36	17.62	78.80
Endo[17]	1965	Normal occlusion	24.39	18.95	77.70	23.13	18.08	78.17
Kubota et al.[10]	1991	Normal occlusion	24.03	18.72	77.90	23.23	18.03	77.62
Nagaoka et al.[7]	1993	Normal occlusion	23.46	18.38	78.35	22.10	17.15	77.60
Endo et al.[19]	1971	Reversed occlusion	24.61	19.50	79.24	23.41	18.79	80.26
Kubota et al.[10]	1971	Crowding	25.00	19.47	77.88	24.55	18.88	76.90
Akiyama et al.[20]	1991	General population	23.76	18.49	77.82	23.08	17.99	77.95
Nakano et al.[11]	1993	General population	25.55	19.90	77.89	24.33	19.10	78.50
Sumi et al.[21]	1985	Okinawa	24.83	19.42	78.21	24.16	18.86	78.06
		Nagasaki	25.02	19.40	77.54	23.49	18.31	77.95
Akiyama et al.[20]	1991	Akita	24.01	18.64	77.63	23.17	18.08	78.03
		Tanegashima	23.37	18.18	77.79	22.84	17.75	77.71
		Tsushima	24.01	18.71	77.93	23.12	18.02	77.94
		Okinawa	23.73	18.50	77.96	23.15	18.06	78.01
		Males and females combined						
Matsumoto et al.[24]	1971	Normal occlusion			78.3 ± 2.01			
Motohashi et al.[25]	1971	Normal occlusion			78.09 ± 2.19			
Bolton[15]	1962	Normal occlusion			77.2 ± 1.65			
Kayukawa[26]	1956	Normal occlusion	23.91	18.30	76.54			
		Reversed occlusion	23.66	18.67	78.91			

ratio for each study, and then compared them with our results obtained. As a result, all the anterior ratio obtained from Otsubo (1957)[16], Yamauchi et al.(1965)[18] and Endo (1970)[17], were larger than the present data (-0.22 to 0.89 and 0.10 to 0.87 for males and females, respectively). Compared to the data obtained from Kubota et al.(1991)[10] and Nagaoka et al.(1993)[7] in 1990's, our results showed intermediate values in male and larger values in female in 0.31 to 0.33. On the other hand, the present anterior ratio showed larger in 1.38 than that obtained in Kayukawa (1956) [26] 's study using in mixed-up group in males and females. Above all, in comparison with normal groups, the male data obtained were almost similar to normal groups and there was no relationship in chronological terms, while there was a difference in the females; the data for females were smaller in the 1950'S to 1970's, but became larger since the 1990's. On the other hand, Kayukawa (1956)[26], Endo et al.(1971)[19] and Kubota et al.(1991)[10] investigated the anterior ratios for the cases with crowding, reversed occlusion and maxillary protrusion. Our data were larger than the crowding group, while they were smaller than in the reversed occlusion and maxillary protrusion.

The anterior ratio depends on several factors including morphological anomaly of teeth, such as macrodont or microdont, congenitally missing teeth or congenital defects. In comparison with the anterior ratio among normal and malocclusion groups, the frequency of occurrence of these varieties might be considered, because this study excluded the above parameters has been no evidence that patients with malocclusion have more teeth anomaly and congenital defects than the normal population. Therefore, further

studies concerning the relationship between the tooth morphology and occlusion may be needed to establish a more ideal occlusion provided with orthodontic treatment.

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