

Tooth Size of the Early Modern Population from the Oterayama Site Compared with That of the Recent Japanese*

By

Hajime SAKURA

Department of Anthropology, National Science Museum, Tokyo

Abstract Mesio-distal and labio-/bucco-lingual crown diameters were measured on the teeth of Early Modern age (beginning of the Edo period), which were unearthed from the Oterayama burial site near Tokyo. Measurement data which were possibly decreased by advanced tooth attrition were carefully excluded from the sample. The mean tooth diameters of the Oterayama population were compared with those of recent Japanese, with the view of examining secular changes in tooth size. The results showed that the tooth diameters of Oterayama tended to be smaller particularly in the posterior teeth than those of recent Japanese. But significant differences were found only in the mesio-distal diameters of upper and lower premolars, and in the bucco-lingual diameter of lower second premolar.

Introduction

It has been generally accepted that the morphological characteristics of the teeth, especially of the tooth crowns, are largely determined by genetic factors, and are highly stable against environmental influences. In this sense, it is expected that the average tooth size of Japanese has not changed markedly through historic ages, at least within the last several hundreds of years, when the Japanese people have retained certain hereditary identity, without noticeable evolution or racial admixture.

However, there is a possibility that some minute changes have occurred in Japanese tooth size even in modern times, caused mainly by changes in environmental factors. Some authors have claimed such changes to be in fact the case. For instance, recently HANIHARA (1985) noted enlargement of the size of tooth crowns of Japanese, during periods from the Jomon to the modern, particularly after the Early Modern, Edo period. But the reality and features of the historical changes in Japanese tooth size still remain to be confirmed by more reliable measurement data.

This study is aimed to present precise data of tooth size on an Early Modern Japanese population and to compare them with those of recent Japanese, for examining the changes in modern ages among Japanese.

* Part of this study was preliminarily presented at the 39th Joint Meeting of the Anthropological Society of Nippon and the Japanese Society of Ethnology, held in Tsukuba, 1985 (SAKURA, 1986).

Materials and Methods

Present material

The material used for the sample of the Early Modern Japanese is a dental population unearthed from the Oterayama (Temple Hill) burial site in Tsurugashima Town, Saitama Prefecture, situated at some 30 km northwest of Tokyo. As mentioned in my previous paper (SAKURA, 1985a), the historic age of these teeth is most likely the early Edo period (ca. 17c.). General descriptions of the bones and teeth from this site appeared in another publication (SAKURA, 1985b).

The number of teeth available for measurement is 459, belonging to 41 individuals, mostly of unknown sex. The other 8 teeth were not included among the sample, because all the measurements of them were possibly affected by certain degree of attrition, which will be mentioned below.

Method of tooth measurement and analysis

Mesio-distal and labio-/bucco-lingual crown diameters were measured on each tooth, according to FUJITA's (1949) method, using a small sliding vernier caliper, which was specially designed for measuring teeth. Means and standard deviations were calculated from the measurements for all the 32 kinds of permanent teeth of Oterayama, and then, those of right and left sides were combined by averaging them, for the convenience of comparison with the data of other populations. Significant difference of each mean from that of another population was tested as if the sample size was the total number of right and left teeth, though the degree of freedom of the sample could be over-estimated because of the inter-side correlation.

Excluding tooth measurements affected by attrition

It is very important to reject wrong tooth measurements from the data for exact comparisons of tooth size among populations. Dental attrition as a cause of wrong measurements should be taken into consideration especially for populations of old ages. The interstitial attrition may directly affect the mesio-distal diameter of tooth crown, but if this condition is present, it can easily be recognized. The vertical attrition, ordinarily seen in most teeth in function, also can cause the decrease of tooth crown diameters in some cases when it is advanced to a certain extent.

Presence and amount of the decrease are different by the tooth kind and the degree of attrition. Formerly, I estimated the relationship between the amount of decrease of tooth diameters and the BROCA's degree of dental attrition in each tooth type, from the ordinary forms of Japanese teeth (SAKURA, 1970). It is presented here in Table 1.

According to the table, mesio-distal diameters of all tooth types, except lower canine, with third or more degree of attrition, mesio-distal diameter of lower canine with fourth degree of attrition, and bucco-lingual diameters of lower premolar and molar with fourth degree of attrition, are possibly affected by an amount of decrease not negligible. Therefore, such measurement data were excluded from the Oterayama sample.

Table 1. Estimated decrease of tooth crown diameters by attrition (in mm).

Degree of Attrition (BROCA)	MDD				LLD/BLD			
	1	2	3	4	1	2	3	4
Tooth Type								
I Upper	—	—	+	0.8–1.0	—	—	—	—
Lower	—	—	0.5	1.2–1.5	—	—	—	—
C Upper	—	—	+	0.8–1.7	—	—	—	—
Lower	—	—	—	0.5–1.0	—	—	—	—
P Upper	—	—	+	0.8–2.0	—	—	—	—
Lower	—	—	+	0.8–2.0	—	—	—	0.7–1.0
M Upper	—	—	+	0.8–1.0	—	—	—	—
Lower	—	—	0.5	1.0–1.2	—	—	—	+

+ : Small decrease present.

Data of recent Japanese for comparison

FUJITA (1957) gave the mean dimensions of Japanese teeth in his text-book of dental anatomy, but presented no sample sizes nor standard deviations.

For the purpose of comparison with the Oterayama tooth size, two sources of data of recent Japanese were used as the most reliable ones in respect to sample size and measuring technique.

OZAKI (1960) calculated the reduction index of the teeth using his measurement data, which were taken decades ago on a large number of extracted teeth from cadavers. Recently, the original data were published in another paper (OZAKI *et al.*, 1987), and became available for use as a standard of the tooth size of recent Japanese. The values of both sides in each tooth kind were combined by the present author as in the case of Oterayama teeth.

Another source of data of Japanese tooth size, except for third molars, was given by YAMADA *et al.* (1986). These data were taken from casts, and presented in parts separately in earlier papers by YAMADA (1977) and KOGISO (1982).

Results and Comparison

The means and standard deviations of tooth crown diameters of Oterayama are shown in Table 2, comparing with those of recent Japanese by OZAKI *et al.* The comparisons are visualized in the form of deviation profiles in Fig. 1, which also includes the data by YAMADA *et al.*

As seen in Fig. 1, the mean dimensions of anterior teeth of Oterayama are intermediate between those of the males and females, or close to those of the females, of recent Japanese, in both mesio-distal and labio-lingual diameters. It can be said, therefore, that no size differences are found in anterior teeth between Oterayama and recent Japanese, since the Oterayama population may consist of males and females.

Table 2. Tooth measurements of Oterayama and recent Japanese.
(in mm, both sides combined)

	Oterayama (present study)			Recent Japanese (OZAKI <i>et al.</i> , 1987)					
	<i>N</i>	<i>M</i>	S.D.	<i>N</i>	<i>M</i>	S.D.	<i>N</i>	<i>M</i>	S.D.
MDD									
Maxillary									
I1	26	8.39	0.48	497	8.49	0.54	70	8.17	0.63
I2	23	6.82	0.58	497	6.96	0.67	70	6.68	0.82
C	29	7.88	0.46	363	7.95	0.44	47	7.85	0.41
P1	28	6.97	0.31	569	7.29	0.44	72	7.25	0.39
P2	31	6.64	0.35	567	6.87	0.46	72	6.85	0.47
M1	34	10.18	0.52	490	10.45	0.59	54	10.28	0.57
M2	32	9.31	0.60	460	9.67	0.61	50	9.53	0.59
M3	13	8.34	0.73	275	8.80	0.89	19	8.73	0.80
Mandibular									
I1	6	5.35	0.17	414	5.51	0.38	60	5.47	0.46
I2	9	5.90	0.24	447	6.15	0.40	65	6.05	0.39
C	21	6.89	0.42	355	7.09	0.42	57	6.79	0.35
P1	29	6.78	0.36	544	7.12	0.42	84	7.07	0.36
P2	35	6.92	0.32	539	7.29	0.44	83	7.23	0.39
M1	43	11.10	0.54	303	11.54	0.59	28	11.33	0.48
M2	40	10.66	0.72	279	11.22	0.62	24	10.92	0.64
M3	23	9.63	1.64	208	10.67	0.93	10	10.62	1.50
LLD/BLD									
Maxillary									
I1	17	7.29	0.78	524	7.24	0.42	79	7.02	0.44
I2	16	6.32	0.49	524	6.49	0.54	79	6.15	0.51
C	23	8.36	0.54	366	8.59	0.55	50	8.21	0.46
P1	29	9.26	0.67	580	9.45	0.53	73	9.21	0.55
P2	32	9.10	0.57	578	9.33	0.60	73	9.15	0.56
M1	36	11.31	0.56	498	11.65	0.55	53	11.20	0.62
M2	36	11.22	0.93	467	11.78	0.68	48	11.18	0.63
M3	12	10.62	0.54	273	10.83	1.00	19	10.56	0.92
Mandibular									
I1	10	5.69	0.25	504	5.89	0.42	68	5.71	0.28
I2	11	6.24	0.33	521	6.41	0.41	73	6.28	0.32
C	16	7.87	0.66	361	8.13	0.49	58	7.63	0.42
P1	28	7.64	0.63	561	7.94	0.52	86	7.68	0.48
P2	36	7.99	0.55	558	8.36	0.53	86	8.19	0.49
M1	46	10.58	0.50	313	10.81	0.57	27	10.46	0.63
M2	39	10.06	0.54	290	10.43	0.55	23	10.05	0.54
M3	21	9.69	0.46	216	10.12	0.76	10	9.90	1.14

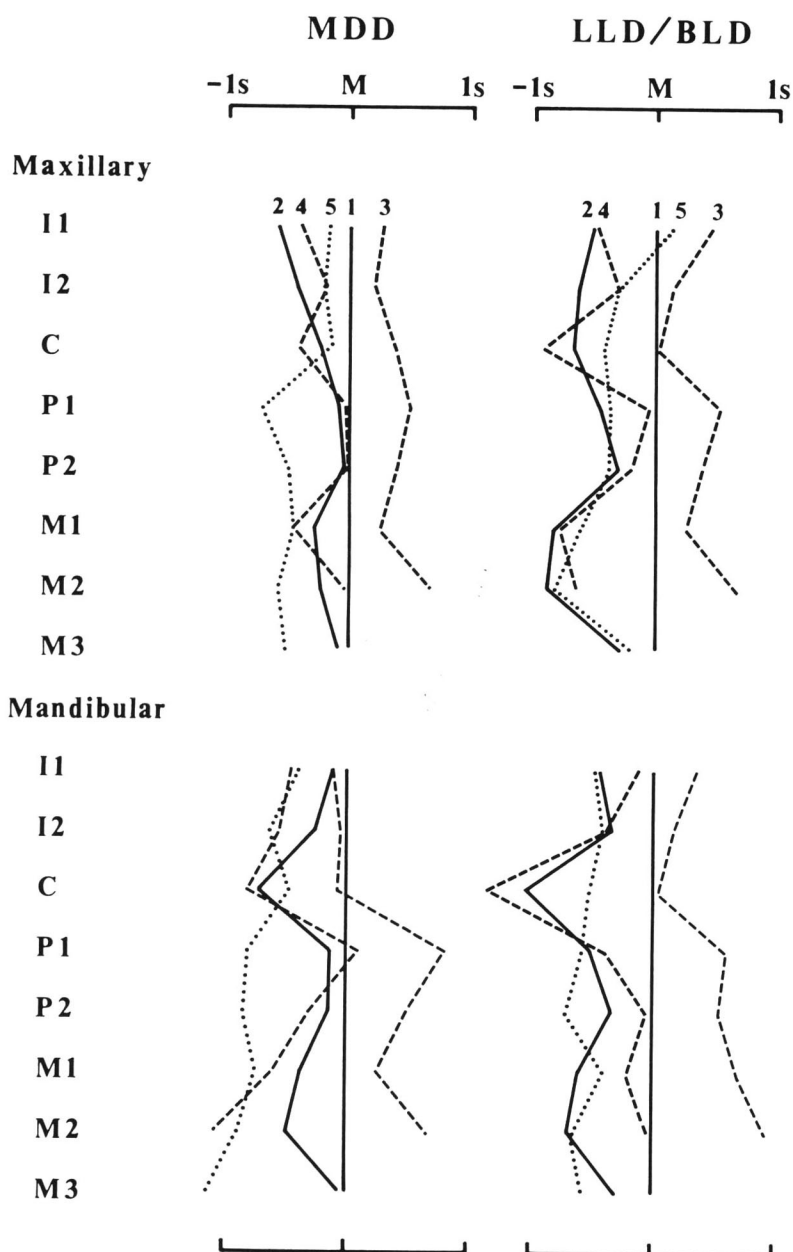


Fig. 1. Deviation profiles of mean tooth measurements from the means (M) of, and by the standard deviations (s) of, OZAKI *et al.* (1987), male. Populations: 1, 2, males and females of OZAKI *et al.* (recent Japanese, both sides combined); 3, 4, males and females of YAMADA *et al.*, 1986 (recent Japanese, taken from casts); 5, Oterayama (both sides combined).

In bucco-lingual diameters of posterior teeth except lower second premolar, condition is almost the same as in the anterior teeth. On the contrary, in mesio-distal diameters of posterior teeth, most Oterayama means are smaller than the respective means of recent Japanese females from either of the sources.

From the results of statistical test, significant differences are found between the Oterayama and the recent Japanese female (OZAKI *et al.*) teeth in the mesio-distal diameters of upper first premolar ($p < 0.005$), upper second premolar ($p < 0.05$), lower first and second premolars ($p < 0.001$), and in the bucco-lingual diameter of lower second premolar ($p < 0.05$). All the differences found in molars are not significant statistically.

Discussion and Conclusion

The difference of tooth size found between Oterayama and recent Japanese may represent the change in Japanese dentition from the Early Modern to recent ages. If it is true, the cause of the change is a problem difficult to be solved.

Changes in physique of a population during a relatively short period of historical time are usually called "secular change" or "microevolution". But the latter term may be inappropriate, unless genetic change has really occurred. Environmental changes, such as changes in nutritional status, are more likely to be the main cause of these physical changes.

HANIHARA (1985) suggested that the tooth size of Japanese changed in parallel with the body size, and that the size changes of tooth crowns are almost completely consistent with those of stature during the last hundred years. But the comparison of Oterayama and recent teeth in this study suggests that the changes are not consistent even within the tooth dimensions. Some tooth diameters, namely the mesio-distal crown diameters of premolars, may have changed apparently, but others may have remained unchanged.

This phenomenon is possibly explained by the supposition that different tooth characters may differ in stability against the influence of environmental factors.

Acknowledgements

I wish to express my thanks to Mr. Minoru SAITO of the Educational Committee of Tsurugashima Town, for his kind cooperation with the study of Oterayama remains, to Mr. Shuichiro NARASAKI, for his help in elaborate preparation of the material. I am also indebted to Drs. Bin YAMAGUCHI and Yuji MIZOGUCHI of the Department of Anthropology, National Science Museum, Tokyo, for their valuable advice on this paper, and to Miss Akiko NAKATSUKA, for her assistance in completing the manuscript.

References

- FUJITA, T., 1949. Über das Messungsstandard der Zähne. *J. Anthrop. Soc. Nippon*, **61**: 27–32, 42. (in Japanese with German summary)
- FUJITA, T., 1957. *Ha no Kaibogaku* (Dental Anatomy), 3rd ed. 130+16 pp. Tokyo, Kanehara. (in Japanese)
- HANIHARA, K., 1985. Secular changes in size of Japanese tooth crowns (Abstract). *J. Anthrop. Soc. Nippon*, **93** (2): 212.
- KOGISO, T., 1982. A morphological study of sexual dimorphism in human masticatory apparatus. *Aichi-Gakuin J. Dent. Sci.*, **20**: 229–267.
- OZAKI, T., 1960. The reduction index of the Japanese teeth. *Acta Anat. Nippon.*, **35**: 563–577. (in Japanese with English summary)
- OZAKI, T., T. SATAKE & E. KANAZAWA, 1987. Morphological significance of root length variability in comparison with other crown dimensions. I. Basic statistics and difference. *J. Nihon Univ. Sch. Dent.*, **29** (4): 233–240.
- SAKURA, H., 1970. Historical changes in the dental morphology of Japanese. (oral communication, Symposium “Dental Anthropology”, 24th Joint Meeting of Anthropological Society of Nippon and Japanese Society of Ethnology, held in Kurume)
- SAKURA, H., 1985a. Low incidence of dental caries among a rural population in the Early Modern age unearthed from Oterayama site. *Bull. Natn. Sci. Mus., Tokyo, Ser. D*, **11**: 1–5.
- SAKURA, H., 1985b. Human bones and teeth unearthed from Oterayama site. In: (Tsurugashima Town Educational Committee, ed.) *Oterayama Site: Report of the Excavation and Research*: Pp. 241–262, pls. 48–60. Tsurugashima. (in Japanese)
- SAKURA, H., 1986. Dental remains of Early Modern age unearthed from Oterayama burial site. *J. Anthrop. Soc. Nippon*, **94** (2): 244.
- YAMADA, H., 1977. Factor analysis of human teeth, dental arch and palate. *Aichi-Gakuin J. Dent. Sci.*, **15**: 267–287.
- YAMADA, H., T. KOGISO & J.-Y. LIAO, 1986. Correlation matrices for the mesiodistal and buccolingual crown diameters of the Japanese and Chinese permanent teeth. *J. Anthrop. Soc. Nippon*, **94** (4): 473–479.

