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Temporal Changes in Corpus Thickness of the Japanese Mandibles

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Abstract Thickness of the lateral mandibular corpus was compared among the several chronological Japanese populations. It was suggested that the corpus thickness reduced markedly in the early modern and modern populations compared to their ancestral conditions. This morphological change is probably one of the consequences of mandibular underdevelopment due to a diminished chewing stress.
Key words: Mandible, Mandiblular reduction, Masticatory function, Japanese.

The growth of the human jaw bone is thought to be affected significantly from masticatory habitats. As indicated from animal experiments and other evidences (Watt and Williams, 1951; Moore, 1965; Bovier and Hylander, 1981; Corruccini and Beecher, 1982; Ito *et al.*, 1982; Kikuta, 1985; Kaifu, 1997; Larsen, 1997: 226–244), underdevelopment occur in the jaw bone when chewing stress diminishes significantly because of insufficient stimulation for proper bone growth. Detailed investigation on the effect of this underdevelopment on the jaw morphology is important because it probably leads to a clearer understanding of the etiology of malocclusion, one of the most serious oral problems in modern societies. Comparative studies between ancient and modern human jaw bones provide important and essential information for this research purpose.

Kaifu (1997) investigated the temporal change pattern in mandibular morphology of the Japanese and found that the mandibles of the early modern Edo and modern populations were markedly reduced compared to those of their ancestral populations. In the formers' mandibles, the overall breadth measurements showed marked narrowing, and significant dimensional reduction occurred in the regions of the major masticatory muscle attachments such as the gonial angle and coronoid process. In the course of this study, it was felt that the basal corpus thickness of the Japanese mandibles also exhibited the same pattern of reduction. In order to test this previous observation, in the present study, the mandibular corpus thickness is measured and compared among several chronological Japanese populations.

Materials and Methods

The samples used here are Japanese skeletal remains from the Jomon, Kofun,

Kamakura, Muromachi, and Edo periods as well as skeletons of the modern Japanese from the dissecting rooms. The Jomon people are prehistoric hunter-gatherer-fishers of Japan (ca. 12,000–2,300 BP). The Kofun period defined here is the combined period of the protohistoric and early historic era (ca. AD 300–AD 1,185). The Kamakura and Muromachi periods correspond to the early and later medieval era, respectively (AD 1,185–1,333, and ca. AD 1,333–1,600). The Edo period corresponds to the early modern era (AD 1600–1868). All the above samples are from the Kanto region (east-central Japan). The provenance of the modern Japanese sample was based on the documented legal domiciles.

The material selection criteria are same as those adopted in the previous study (Kaifu, 1997). In the previous study, only adult males with the mandibular third molar(s) erupted were used because female sample sizes were too small. Also, the specimens with alveolar resorption due to antemortem tooth loss were excluded if the resorptive changes of the bone were judged to have significantly affected the original morphology of the mandibles.

The corpus thickness was measured by the author to an accuracy of 0.1 mm using a digital sliding caliper (Mitutoyo, Japan). The measurement method is as follows: The two arms of the instrument are spread to the distance of about 3 cm. The movable arm of the caliper was first set on the buccal corporal surface below the midpoint of the mandibular first molar having the shaft of the instrument positioned below to the corpus. The movable arm is adjusted to become tangent to the superior lateral torus and marginal torus (in cases where the superior lateral torus is ill-defined and the mid-corporal surface is somewhat hollowed relative to its upper and lower regions, the arm was set to become tangent to the buccal alveolar margin and marginal torus). Then the fixed arm is drew until it touches a point somewhere on the lingual corporal surface and the thickness in this situation is read.

In addition to the above samples, the data for the five chronological populations (Jomon, Yayoi, Kofun, Muromachi, and Edo periods) from Yamaguchi, Fukuoka, and Saga Prefectures in western Japan published by Department of Anatomy, Kyushu University (1988) was used. There is good evidence that the Yayoi population (ca. 300 BC–AD 300) from this region, called NK-Y region hereafter, was largely composed of immigrant from the Asian continent or their offspring (e.g. Nakahashi, 1993; Matsumura, 1994). They are called "immigrant Yayoi" because of this. The mandibular corpus thickness is measured at the level of the mental foramen in this published data set (Martin No. 69(3)).

Results

Table 1 and Figure 1 show the descriptive statistics and the results of statistical comparisons using the least significant difference (LSD) (Sokal and Rohlf, 1995) for the samples from the Kanto. The mandibular corpora of the Kofun and Kamakura

Table 1. Descriptive statistics and results of statistical tests using LSD for the Kanto samples (males).

	N	Mean	S.D.	Jomon	Kofun	Kama.	Muro.	Edo
Jomon	43	14.8	1.38	—	—	—	—	—
Kofun	17	16.6	1.52	**	—	—	—	—
Kamakura	26	16.0	1.29	**		—	—	—
Muromachi	22	15.7	1.30	*			—	—
Edo	37	14.8	1.88		**	**	*	—
Modern	24	14.8	1.43		**	**	*	

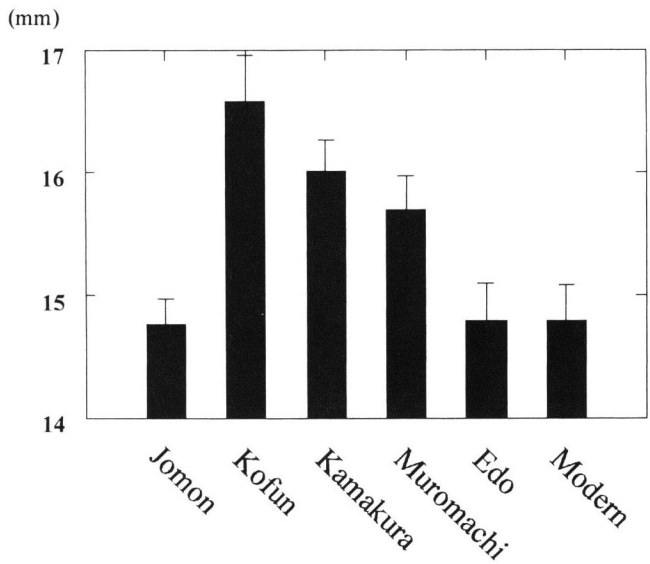

Fig. 1. Average thickness of lateral mandibular corpus for the six chronological samples from the Kanto region (males). The vertical lines indicate standard errors.

samples are thicker than the Jomon, Edo, and Modern samples. The Muromachi sample lies in between these two groups but is relatively closer to the conditions seen in the Kofun and Kamakura.

Table 2 (a and b) shows the temporal changes of the corpus thickness at the mental foramen level in the NK-Y region. In both males and females, the corpus thickness is slightly thicker in the Yayoi than in the Jomon, though the differences are not statistically significant. The tendencies observed in the periods after the Yayoi are inconsistent between the males and females. The corpus thickness is outstandingly large in the Kofun among the male samples, but it is not so in the females. The corpus thickness is reduced in the Edo male compared to the former periods but that of

Table 2a. Comparisons of corpus thickness among the populations from the NK-Y region (males).

	N	Mean	S.D.	Jomon	Yayoi	Kofun	Muro.
Jomon	8	12.8	1.39	—	—	—	—
Yayoi	157	13.4	1.55		—	—	—
Kofun	42	15.1	1.39	**	**	—	—
Muromachi	18	13.6	1.24			**	—
Edo	23	12.8	1.38			**	

Table 2b. Comparisons of corpus thickness among the populations from the NK-Y region (females).

	N	Mean	S.D.	Jomon	Yayoi	Kofun	Muro.
Jomon	9	12.2	1.56	—	—	—	—
Yayoi	106	12.8	1.36		—	—	—
Kofun	27	12.7	1.78			—	—
Muromachi	27	12.2	1.45		*		—
Edo	17	12.8	0.81				

the Edo female is comparatively large among the samples.

Discussion and Conclusions

Kaifu (1995, 1997) noted possible between population variation in the basal corpus thickness. In the present study, the corpus thickness was measured instead of the basal corpus thickness because the latter is difficult to measure and compare systematically.

Table 2 seems to support the author's previous observation that the immigrant Yayoi is larger in corpus thickness than the Jomon, though the detected differences were not statistically significant. Unfortunately, only small sample is available at present for the Jomon population in the NK-Y region. This sample size could be increased by combining with Jomon samples from the other regions if it has been ensured that there was little variation in mandibular corpus thickness among various regional Jomon populations. Though the measurements of corpus thickness for relatively large Jomon samples have been published (Kintaka, 1928; Imamichi, 1934), these published data measured by different workers can not be compared directly to the data in Table 2 because of the possible methodological differences.

Recent advances in the studies of human skeletal remains, genetics, and various other fields strongly suggest that the protohistoric and historic Japanese populations

have been formed through admixture of the native Jomon people and immigrant Yayoi people (e.g. Hanihara, 1991; Omoto & Saitou, 1997). Thus, the large corpus thickness in the Kofun and early medieval populations in the Kanto and NK-Y regions is at least partially a result of this genetic admixture.

In the previous study, I showed that the mandibles of the early modern and modern Japanese were markedly reduced compared to those of their ancestral populations (Kaifu, 1997). Several circumstantial evidence discussed in Kaifu (1997) as well as temporal change pattern of reduction in tooth wear severity in Japan (Kaifu, 1999) strongly suggest that this mandibular reduction was primarily caused by underdevelopment of the mandible due to a diminished chewing stress. Interestingly, the same pattern of temporal change, that is, a marked reduction from the early modern period onward, was observed in the present study for the mandibular corpus thickness in the male samples from the Kanto and NK-Y regions. This similarity in temporal change pattern suggests that the reduction in lateral corpus thickness is one of the consequences of mandibular underdevelopment due to diminishing chewing stress. On the other hand, however, the Edo female from the NK-Y region did not show reduction in lateral corpus thickness. This apparent contradiction has to be answered through future studies based on a larger sample.

Kanazawa and Kasai (1998) showed that cortical thickness of the lateral corpus is significantly thicker in the Jomon than in the modern Japanese mandibles. If this morphological difference also reflects mandibular underdevelopment in modern Japanese, the information presently available about possible effects of diminishing chewing stress on the Japanese mandibles is summarized as follows: (1) overall narrowing, (2) reduction in the regions of major masticatory muscle attachments, (3) reduction in the lateral corpus thickness, and (4) reduction in the cortical bone thickness.

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