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## Edge-to-Edge Bite and Tooth Wear

By

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**Abstract** Relationships between the bite forms of prehistoric Jomon people in Japan and their dental age or tooth wear were examined. It was indicated that advance of wear is essential for formation of edge-to-edge bite, which is dominantly observed in this population. In addition, it was suggested that antero-posterior occlusal relation between the maxillary and mandibular molars should be taken into consideration for studies on human bite form variation.

### Introduction

It is widely known that the edge-to-edge bite is the normal bite form in prehistoric or non-industrialized populations as opposed to the condition of modern industrialized populations in which scissor bite (or overbite) is dominant. The cause of this difference has drawn the attention of dental and anthropological researchers for more than 100 years (see reviews in BRACE, 1977; REINHARDT, 1983). Hypotheses proposed so far can be summed up as following: (1) forms of the bite are strictly genetically determined, (2) forms of the bite are strongly influenced by advance of tooth wear, and (3) others.

The first view (KLATSKY & FISHER, 1953) is not accepted by most researchers since rapid transition from edge-to-edge bite to scissor bite was observed in various recent non-industrialized populations (JONES, 1947; D'AMICO, 1958; BRACE, 1977). Adoption of western diet has been suggested to be responsible for this.

Most researchers has related edge-to-edge bite to occlusal wear (CAMPBELL, 1925; LEIGH, 1928; EMSLIE, 1952; BEGG, 1954; MOORREES, 1957; D'AMICO, 1958, 1961; FISHMAN, 1976; BABA & ETOH, 1989 and others). According to them, the edge-to-edge bite is a condition achieved through gradual occlusal modification of the subadult form by the advance of wear, although ideas on its formation process vary among researchers (LEIGH, 1928; BEGG, 1954; D'AMICO, 1958, 1961; MURPHY, 1958; HYLANDER, 1977; REINHARDT, 1983). The most important reasons of this hypothesis are: (A) presence of general rule that the edge-to-edge bite is associated with populations in which progressive tooth wear is normal, and (B) observations that subadults generally show scissor bite even in a

population in which edge-to-edge bite is normal among adult members.

Brace presented a question to the above idea citing his experiences that edge-to-edge bite were observed in individuals with slight degree of wear in several populations. He proposed a different hypothesis based on these observations (BRACE & MAHLER, 1971; BRACE, 1977).

Few authors, however, cited factual data to back up their claims and if any, the observed specimens were restricted to dental adults (FISHMAN, 1976; HYLANDER, 1977; REINHARDT, 1983). The dentition is formed through combined growth processes of jaw and tooth development. Therefore, investigation of occlusal development is important in studies of bite form variation. In this study, using prehistoric Jomon skeletal materials of Japan, developmental change of the bite form under a high tooth wear environment was investigated, through examination of interrelationships between dental age or tooth wear and the bite forms.

### Materials and Methods

**Materials:** The Jomon people are prehistoric hunter-gatherer-fishers of Japan, ranging in time from ca. 10,000 to ca. 2,000 B.P. It has been shown that the skeletal materials of the Jomon period throughout Japan so far known have basically common features, (BABA & ETOH, 1989; DODO, 1982, 1986; KAIFU 1995; MATSUMURA, 1989; MOURI, 1986, 1988; NAITO & MATSUSHITA, 1977; YAMAGUCHI, 1981, 1982, 1989). The dentition of Jomon people is characterized by edge-to-edge bite and heavy tooth wear (YAMAGUCHI, 1982 and others). SUZUKI (1969) showed that the bite form of Japanese gradually transformed to scissor bite thereafter with time.

Among Jomon skeletal collection housed in the Department of Anthropology and Prehistory, the University Museum of the University of Tokyo, 60 skulls of both sexes were selected according to the following criteria: (1) sufficiently good preservation of the jaw and teeth so that the bite form can be satisfactorily ascertained, (2) the permanent central incisors having erupted to the occlusal plane (presence of wear facet on the upper or lower central incisors by occlusion with the antagonists), (3) no more than one antemortemly lost tooth in right or left segment of upper or lower dental arch (number of antemortemly lost tooth is at most four). These materials are from various regions in Japan.

Sex of each adult specimen was determined by the present author by morphological observations of the associated pelvis and skull. The pelvis was given priority and the skull was used after the observation of the individual sexed by the pelvis.

Dental age was judged for subadult specimens according to the formation and eruption sequence of teeth figured by UBELAKER (1989).

**Material preparation:** The jaws and dentitions were carefully checked for damage, distortion, etc. Poorly reconstructed specimens were corrected if possible, and several specimens were newly reconstructed by the present author, to ascertain original state of occlusion and to measure overbite and/or overjet accurately.

**Measurements:** Overbite and overjet were measured in maximal intercuspation of the upper and lower arches (centric occlusion). In most cases, it was readily determined referring to corresponding occlusal wear facets between arches. Overbite is the fraction of the mandibular central incisor's labial crown height that is vertically overlapped by maxillary central incisor. In the case of openbite, a negative value was registered. Overjet is the distance from the labial surface of the maxillary central incisors to the labial surface of the mandibular central incisor (parallel to the occlusal plane). Negative value was recorded when the upper incisors are to lingual of the lower.

To quantify the degree of tooth wear for the upper and lower first molars (UM1 and LM1), the method of SCOTT (1979) was used. For the upper and lower central incisors (UI1 and LI1), crown heights on labial side and labio-lingual diameter of exposed dentine on the occlusal surfaces were measured along the central longitudinal axis of the teeth.

Measurements were taken by the present author with a digital sliding caliper (Mitutoyo, Japan) to an accuracy of 0.1 mm. The mean of the left and right side measurements was used for the analyses. If it was impossible to measure both sides, one side alone was used.

**Terminology:** The literature occasionally showed confusion in terminology of the bite forms. The 'edge-to-edge bite' should be defined as literally, overbite = 0 and overjet = 0 (REINHARDT, 1983). In this study, a state of overbite > 0 and overjet > 0 is labeled as 'scissor bite' not to confuse with 'overbite' which indicates a measurement item.

**Analyses:** Significant differences in the bite forms may be present between subgroups with different antero-posterior molar occlusal relations. Therefore, subsamples with Class I molar relation (the protocone of UM1 in the central fovea of LM1, N=56) and Class II molar relation (the protocone of UM1 in the anterior fovea of LM1, N=4) were analyzed separately. There were no specimens with Class III molar relation (the protocone of UM1 in the anterior fovea of LM2).

At first, relationships between bite forms and dental age or degree of wear were examined using bi-variate plot for the cases whose overbite and/or overjet was measurable. Then, to supplement small sample size in these analyses, examinations were performed including unmeasurable specimens.

## Results

The results of bi-variate plot were eventually identical between cases in which the UM1 and LM1 were used, as well as among cases in which four variables of the central incisors were used, as wear parameters. Because of this, only results for LM1 and crown height of UI1 are shown below.

### Class I

Figure 1 shows bi-variate plot of overbite and dental age for the subadult subsample (mixed sex). In all the 8 specimens, overbite and overjet (not shown) were positive, and the bite form was scissor bite.

Figure 2a and b shows bi-variate plot of overbite or overjet and degree of wear for all measurable specimens (mixed sex). Figure 2c shows interrelation between overbite and overjet for these cases. Specimens with scissor bite are present only when tooth wear is relatively slight. Among individuals with extensive wear, edge-to-edge bite is the most dominant but other forms are also present. The value of overjet may vary among cases with zero overbite, and several specimens show negative overbite and zero or negative overjet when wear is extensive.

Next, to examine sex differences, bi-variate plots of overbite and wear for male and female dental adults were conducted and shown in Fig. 3. No apparent differences can be detected from this.

Finally, to supplement small sample size of the above analyses, the bite forms were ascertained for all specimens including those whose overbite or overjet were not available and relationship between the bite forms and tooth wear was tabulated in Table 1. The tendency observed in Table 1 is consistent with the

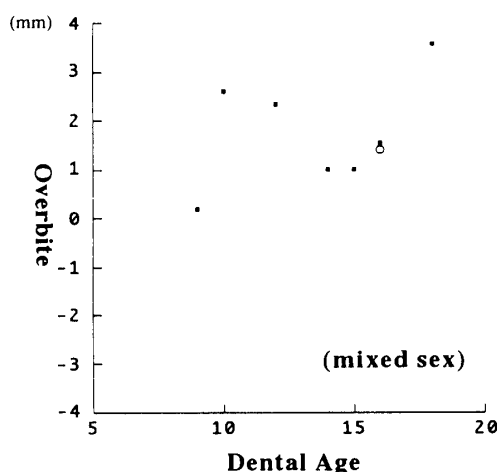


Fig. 1. Bi-variate plot of overbite and dental age (subadults). A solid rectangular indicates specimen with no antemortem tooth loss except M3, an open circle specimen with 1 or 2, and an open triangle specimens with 3 or 4 antemortem lost teeth.

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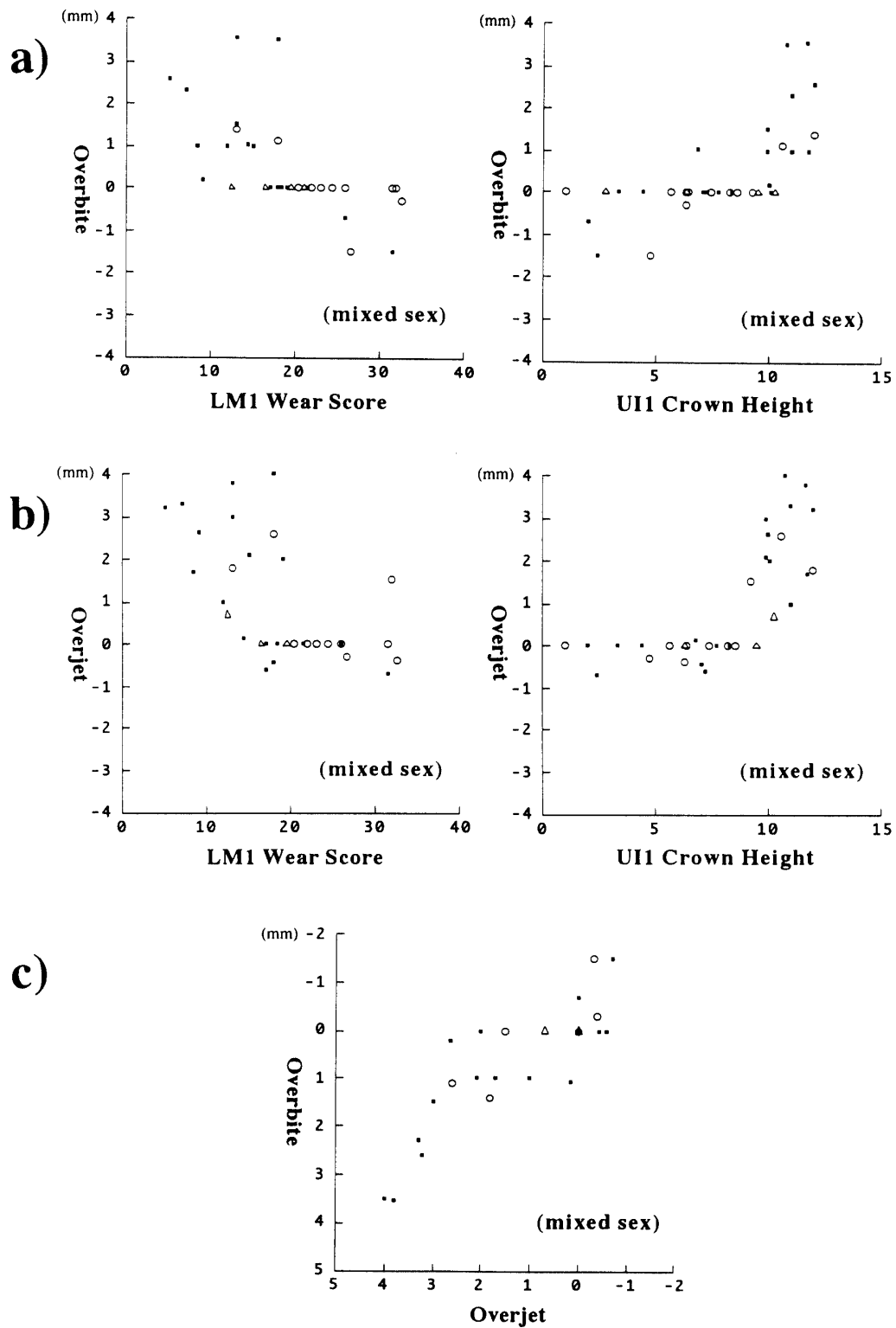


Fig. 2. Bi-variate plot of overbite or overjet and tooth wear parameters (a and b), and overbite and overjet (c), for all measurable specimens. In Fig. 2c, twelve specimens are edge-to-edge bite (overbite=0 and overjet=0). Symbols as in Fig. 1.

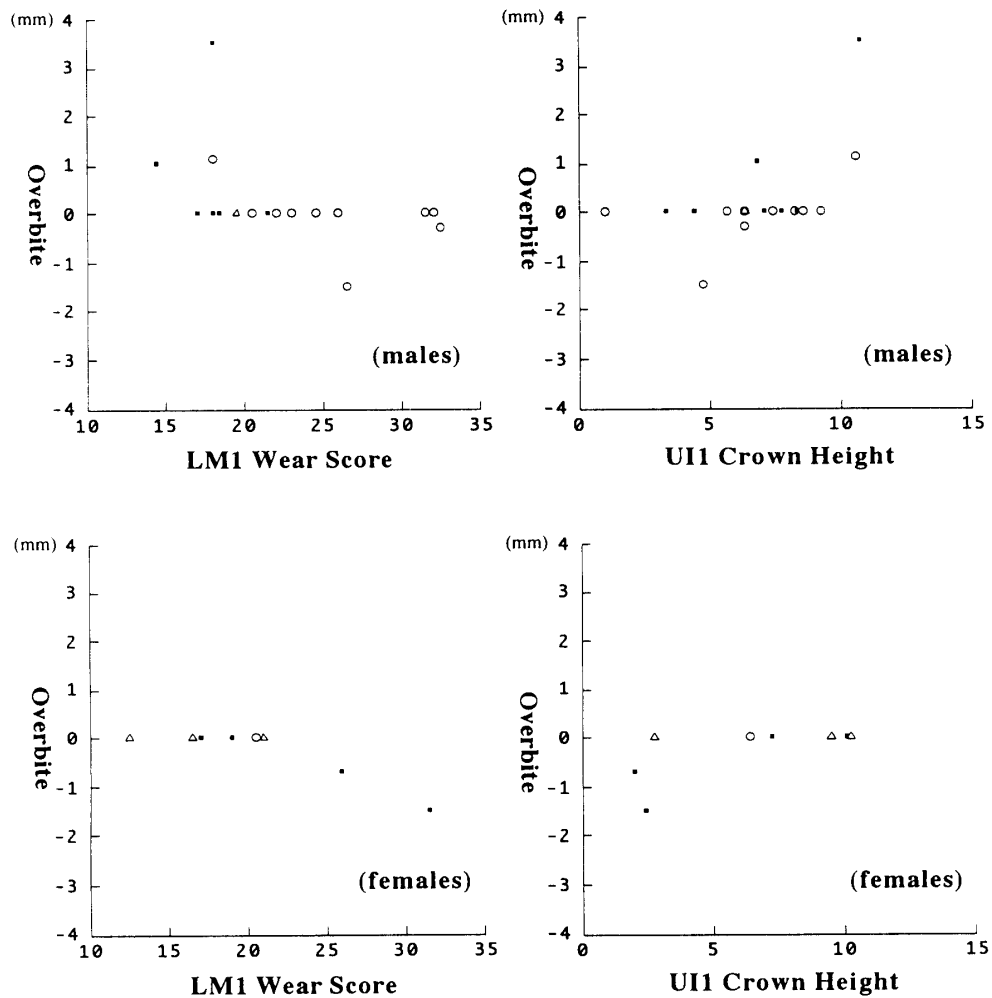


Fig. 3. Bi-variate plot of overbite and tooth wear parameters (dental adults). Symbols as in Fig. 1.

Table 1a. UI1 crown height and the bite forms. (mixed sex)

Crown height (mm)	12-11	10.9-9	8.9-7	6.9-5	4.9-3	2.9-0	Total
Overbite > 0, Overjet > 0	6	6	0	1	0	0	13
Overbite ≤ 0	0	6	12	12	5	6	41

Table 1b. LM1 wear score and the bite forms. (mixed sex)

Wear score	4-10	10.5-15	15.5-20	20.5-25	25.5-30	30.5-35	Total
Overbite > 0, Overjet > 0	4	6	3	0	0	0	13
Overbite ≤ 0	0	2	10	15	9	6	42

foregoing results.

### **Class II**

All the four specimens with Class II molar relation showed positive overbite and overjet. Among these, two are subadults (dental age of 15 and 20) and the others are dental adult males (wear score of LM1 and crown height of UI1: 14 and missing, 24.5 and 6.4 mm). Wear of the last specimen is rather progressive compared to Class I specimens with scissor bite.

## **Discussion**

While the 'edge-to-edge bite' is the most dominant form of the bite in individuals with extensive tooth wear among the Jomon people, other forms are also recognized. In contrast to the characteristic bite form of modern industrialized populations (scissor bite), the adult bite forms of the Jomon people seems to be characterized more accurately by zero or negative overbite (This may be distinguishable from typical 'openbite' observed in modern civilized populations in terms of a state of zero or negative overjet). The term 'edge-to-edge bite' is loosely used as indicating this condition hereafter.

### **Class I and Class II**

In the Class I subsample, the subadult condition of scissor bite is transformed to edge-to-edge bite unexceptionally with advance of wear. In contrast to this, it was suggested that the subadult condition of scissor bite in Class II individuals tend to be retained when wear progresses.

Although the sample size of the present study is small, it is very likely that discrepancy in the bite forms present between subgroups with different antero-posterior molar relations. Most of previous studies failed to take this into consideration. In the present sample, distinction between Class I and Class II is clear almost unexceptionally, and intermediate forms were rare regardless of degree of wear. This probably indicates that the molar relation is not subjected to major change by tooth wear. FISHMAN (1976) reported a similar observation.

### **Class I**

Discussion hereafter is made only for the Class I subsample. In a description of occlusal development in Australian Aborigines, in which edge-to-edge bite is dominant in adults, BEGG (1954) mentioned that scissor bite is the common subadult condition. Similar observations were reported for Californian Native Americans, Norwegian Lapps, and Circum-polar people (LEIGH, 1928; SELMER-ORSEN, 1937; MOORREES, 1957). Figure 1 of this study documented the same observation in another population. In this prehistoric Japanese sample, edge-to-edge bite is achieved unexceptionally with advance of tooth wear. It is very likely that there is no sex difference in this formation process of edge-to-edge bite. Same tendency was observed by the present author in a small sample of Okhotsk people

which show extensive degree of wear and edge-to-edge bite as normal adult condition (housed in the Department of Anatomy, Sapporo Medical University School of Medicine; see ISHIDA, 1988 for related informations).

Whether this is an universal formation process of the edge-to-edge bite in various populations or not is an unsettled question, as suggested in BRACE (1977). However, at least in Jomon people, major occlusal modification must have occurred to form the edge-to-edge bite and, in all possibilities, tooth wear played an essential role for this. In the subadult subsample of the present study, the occlusal height would not increase dramatically any more because their first molars have already fully erupted. Therefore, if extensive wear had not occurred, scissor bite of subadult period would be maintained throughout their lifetime.

In addition, interrelationships between the bite forms and tooth wear was tighter when using the central incisors as the wear parameter than in the case using the first molars (Fig. 2). This probably indicates necessity of loss of incisal edge, rather than other aging factors, for formation of the edge-to-edge bite.

Finally, negative overbite is observed only in individuals with extensive degree of wear. This is probably because wear rate of the incisors increases rapidly when they lost most of their enamel by wear. In the present sample, extreme wear like complete loss of enamel usually occurred first in the incisors (the author's observation).

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