Attrition and the Edge-to-Edge Bite

An Anthropological Study

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An evaluation of overjet and attrition in skulls of aboriginal California populations, finding a strong negative correlation.

The edge-to-edge bite in humans has drawn the attention of dental and anthropological researchers for at least 90 years. A recurrent focus has been the relationship between overbite and edge-to-edge bite.

The literature has long shown confusion over apples-to-oranges comparisons between overbite and edge-to-edge bite. Overbite is a vertical attribute, but it is sometimes loosely used to indicate the horizontal relationship more correctly described as overjet. What is commonly called an edge-to-edge bite is a state of zero overjet, frequently associated with worn-down anterior teeth that have lost some of their former vertical dimension.

Most anthropological writings fail to separate the vertical dimension from the horizontal, sometimes comparing lightly worn teeth to heavily worn ones and then studying population differences between groups with disparate levels of attrition.

Normal overjet and edge-to-edge bite are often viewed as dichotomous, but recent anthropological thinking argues for a transition from positive overjet to zero overjet with high attrition levels. The highly processed constituents of modern diets contribute

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very little to tooth wear. In contrast, a more natural fare of coarser foodstuffs not only supplies more ambient grit than a refined diet, but also requires greater effort and time to chew before swallowing. Many studies have demonstrated that diet and attrition are often closely related, so that a change in one can affect the other.

The physiological development of edge-to-edge bite may be a consequence of either dietary function or heredity, or both, so explaining the progression of this condition has dental implications as well as evolutionary interpretations.

This study examines the relationship between edge-to-edge bite and attrition in a primitive population. The data suggests that attrition may have even greater import than conceded thus far.

Review of Literature

Turner, 1891, one of the earliest writers to discuss edge-to-edge bite, felt that it was not due to a forward growth of the mandible relative to the maxilla, but rather to a difference in cranial base length. Comparing 20 aboriginal Australian crania to those of Lowland Scots, Turner suggested the shorter Scot base line made the face more vertical and caused the mandible to recede, thereby containing the lower arch within the upper. The longer Australian base line produced a more prognathic maxilla and more protrusive mandible, with an edge-to-edge bite.

Keith (1928) noted that most Britons have an overbite, while their Anglo-Saxon predecessors had edge-to-edge bites. Considering this common to all primitive human races, he suggested that the difference was a matter of function, or diet, rather than form or heredity. However, he amends this: "the cause must be sought . . . in the nature of the stock as well as in the food" (Murphy, 1958).

Cameron (1934) pointed out that all British Neolithic dentitions demonstrated an edge-to-edge bite, and attributed it to mandibles with a more obtuse angle than modern Britons', which have overlapping bites. Copper Age Minorcan and Eskimo incisors also meet edge-to-edge. He asserts that edge-to-edge bite produces characteristic wear, not vice versa.

Klatsky and Fisher, 1953, maintain edge-to-edge bite is of genetic origin, characteristic of certain ethnic stocks, while overbite typifies most modern peoples. If edge-to-edge bite is hereditary, it cannot be altered much by the environment or by function.

Mattingley, 1915, felt edge-to-edge bite is natural to native Australians and the rule rather than the exception among prehistoric humans. Nevertheless, Wright responds that effects of attrition should not be ignored, and Prytz wonders whether edge-to-edge bite is not simply due to mechanical action (Philpots, 1915).

Campbell, 1925, agrees that edge-to-edge bite is found among all primitive and prehistoric races. However, he relates it to occlusal attrition, resulting in apparent shifting forward of the lower anterior teeth relative to the upper anterior teeth. The actual mechanism for the change is attritional reduction of tooth height[1] (Fig. 1).

Others remark on the significance of attrition. Leigh, 1928, connects edge-to-edge bite with advanced attrition. Box, 1940, concludes that in modern dentitions edge-to-edge occlusion is seldom achieved because of sparse occlusal attrition. Emslie, 1952, views it as the result of marked attrition in a normal occlusion. Begg,

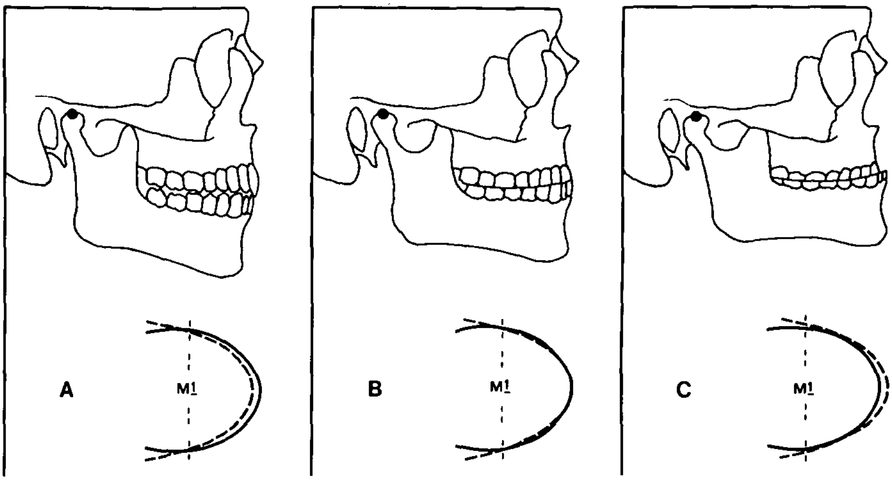

Fig. 1 Profile of an idealized adult dentition (after Bass, 1971) with: (A) no wear—shown slightly out of occlusion to show incisor overbite; (B) simulated loss of 1/3 crown height; and (C) simulated loss of 2/3 crown height. Maxillary (soild line) and mandibular (dashed line) arch outlines are shown below.

1954, 1965, 1977, discusses attrition in great depth as producing edge-to-edge bite. Lysell, 1958a, b, mentions a trend of smaller overbite with greater age and attrition.

Murphy, 1958, regards adult mandibular changes as a consequence of tooth attrition. His data suggest that life-long vertical tooth eruption makes up for attritional loss until wear exceeds the eruption rate, whereupon bony changes ensue. The condyles grow and shift, as does the mandibular angle from basal plane to ramal plane. The net result is a mandible rotating upward and forward relative to the maxilla as attrition progresses. Murphy, 1959, states that heavy attrition among Australian aborigines reduces facial height after tooth eruption lags behind the attrition rate.

Lysell, 1958b, and Begg, 1965, 1977, observed that upper incisors with heavier attrition are less procumbent than those with lighter wear. Lysell finds 12.5° less mean labial inclination of upper central incisors between a group with slightly worn teeth and another with markedly worn ones. He suggests that this is due to greater reliance on lip muscles to tear food as the incisors wear flatter.

Begg, 1965, 1977, expounds upon Lysell, 1958b, adding anterior pressure of the tongue to posterior pressure of the lips. Judging from his figure 50, Begg suggests the upper lip tips the upper incisors lingually while the tongue tips the lower incisors labially. He supposes some growth component also affects incisor inclinations.

Lysell, 1958a, measured incisor overbite and overjet in addition to incisor inclination. Overjet was measured horizontally to the nearest 0.5mm and recorded only for left and right pairs of central incisors. Both overbite and overjet were found to decrease with increased age, accompanied by increased attrition. Lysell, 1958a, Fig. 7, illustrates one individual out of 37 with a negative overjet (−0.5mm).

Begg, 1965, Fig. 51, shows an upper and lower central incisor in occlusion before and after attrition. The lower incisor appears after attrition as the more anterior tooth, indicating relative mandibular prognathism or negative overjet. However, Begg and Kesling's 1977 revised Fig. 51 ends not in negative overjet but rather in an edge-to-edge bite.

Method and Materials

Data for this study were derived from two aboriginal California archaeological populations. Fifteen individuals are from Malibu (CA-LAn-264), held by the University of California, Los Angeles, and 28 are from Cañada Verde, Santa Rosa Island (CA-131.41A), held by the Santa Barbara Museum of Natural History. These 43 individuals represent adults with relatively complete and intact dentitions that could be measured and occluded with confidence. They were selected from sample sizes of 40 and 69 for Malibu and Cañada Verde, respectively. Radiocarbon dates (UCLA #1863, 1886, 135, and 178) indicate that the two collections are roughly contemporaneous, about 800 to 1000 years old.

Occlusal Attrition

Each tooth was given an occlusal attrition score from 1 to 9 (1 being worn the least). This scale is adapted from Molnar's, 1971, range of 1-to-8 by adding a value 9, which is defined as 'non-molars very short, and multi-root molars almost or fully dehisced.'

Third molars were not evaluated because their later eruption or potential absence would skew comparisons between individuals with and without them. Thus a maximum of 28 teeth were scored for each individual.

Occlusal attrition scores were averaged for each skull to yield the following values.

Individual Attrition Score

Individual attrition scores, the mean for 21 or more teeth of an individual, were computed to the nearest 0.1 attrition value. Given that attrition increases with age and that the individual attrition score averages an entire dentition, this score was assumed to provide a rough indication of relative chronological age. Other indicators of age were not assessed.

Labial Overjet

The mean overjet of the left and right central incisors, when present; otherwise, a near approximation was made with indirect antagonist pairs by combining central and lateral incisors.

To determine overjet, pairs of mandibles and maxillae were occluded by hand to attain the best approximation of centric occlusion, based on minimal buccolingual and labiolingual play of the jaws. Postmortem arch reconstructions were rejected from this study in cases where the reconstruction could affect this position. Since greater occlusal attrition increased the range of movement around centric occlusion, overjet measurements were less replicable in severely worn dentitions.

Overjet was measured as the horizontal distance from the buccal enamel surface of a maxillary tooth to that of its mandibular antagonist, or vice versa. When there was no direct antagonist, overjet was measured from the more buccal tooth to its indirect antagonist, the tooth of the opposite jaw in mesial or distal contact.

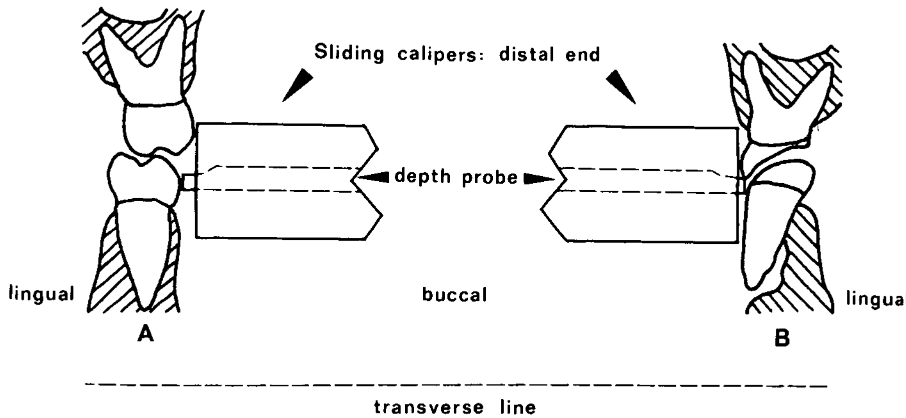

Fig. 2 Method of measuring molar overjet on unworn and worn molars.

Overjet was gauged by placing the fixed end of sliding vernier-scale calipers against the most buccal aspect of the more prominent tooth of an antagonist pair (Fig. 2A). When a tooth was very worn, overjet was measured from or to the most buccal aspect of its cemento-enamel junction (Fig. 2B). The depth probe was then extended to the more lingual antagonist to measure the horizontal distance. All overjets were recorded to the nearest 0.05mm and means averaged to the nearest 0.01mm. Overjets with positive values indicate a more prominent maxillary tooth, negative values a more prominent mandibular tooth.

Lateral Overjet

The mean overjet of left and right sides of an individual dentition, taken from the most buccal tooth of the wider arch, normally at the maxillary first molar, to its direct or indirect antagonist.

Results

Replicability

Attrition scores and overjets were tested for their ranges of replicability at the 95% confidence level. Jaws of five Malibu individuals were each positioned and measured 10 times, and the results evaluated with a chi-square variable to produce a chi-square probability distribution (Mendenhall, 1979). These tests showed replicability ranges with 95% confidence for occlusal attrition scores ±1, lateral overjet ±0.5mm and labial overjet ±0.5mm. This level of accuracy for overjet compares with Lysell, 1958a.

Correlations

Linear correlation coefficients (Pearson's r) for pairs of the variables lateral overjet, labial overjet and individual attrition are summarized below and shown in Fig. 3.

	Pearson's r		
Lateral overjet (LtO)	1.00		
Labial overjet (LbO)	0.32	1.00	
Individual attrition (IA)	−0.59	−0.51	1.00
	LtO	LbO	IA

The data were also subjected to logarithmic, exponential and power curve fits. These were never over 0.02r value greater than the linear relationships, suggesting truly linear covaria-

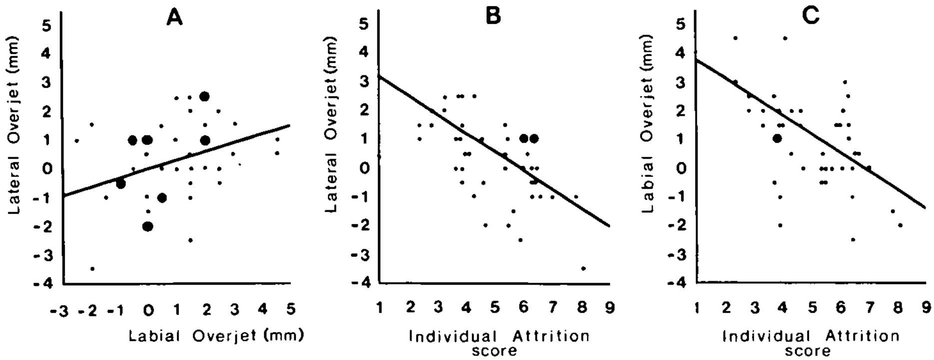

Fig. 3 Bivariate linear regressions for lateral overjet vs. labial overjet, and lateral and labial overjets vs. individual attrition score. The t-test (d.f. = 41) values are: (A) $t = 3.52$, $p < .01$; (B) $t = -9.31$, $p < .01$; (C) $t = -7.70$, $p < .01$ (after Mendenhall, 1979).

tions. Even though there was little correlation between lateral and labial overjet (Fig. 3A), they correlate appreciably better with individual attrition (Fig. 3B, C). In fact, the individual attrition correlations have virtually identical slopes, with overjet diminishing at the same rate with increased attrition.

Discussion

The data indicate that lateral and labial overjets are not only lower with increased attrition, but may actually become negative. The mandible potentially becomes the wider arch when the individual attrition score exceeds 5.9. It becomes the more anterior arch when individual attrition surpasses 6.7. It appears, then, that attrition is related to low labial overjet and a state of relative mandibular prognathism, although such correlations do not establish cause-and-effect relationships.

While the production of negative overjet with increased attrition seems unusual, it is not inconceivable for labial overjet. At least one of Lysell's, 1958a, subjects demonstrates negative labial overjet and Begg, 1965, Fig. 51, implies that same likelihood.

Although it may seem curious that lateral overjet becomes negative too, a consideration of arch form may illuminate this.

DuBrul, 1980, maintains that greater attrition reduces overjet laterally and labially, yielding an edge-to-edge bite. He also reports that the maxillary arch is elliptical, the mandibular arch parabolic. As labial overjet lessens and the mandible shifts anteriorly (Murphy, 1958) with attrition, the parabolic mandibular arch moves forward in occlusion relative to the maxillary arch. Hence the maxillary arch, which is less divergent posteriorly, is narrower in relation to the occluding anterior-shifting mandible, the arch of which is progressively wider in the posterior region. The lower half of Fig. 1 illustrates this change as seen from above.

Another observation may clarify our understanding of diminishing labial overjet. Patrick Turley (personal communication) says this change may be due simply to attrition of tooth height.

To demonstrate, Fig. 1 starts with an ideal, unworn adult dentition with normal overbite. A constant pivot point (represented by a large dot) is established at the most superior aspect of the temporomandibular fossa. Next, 1/3 crown-height attrition, approximating individual attrition score 5.5, is simulated for both arches and the mandible pivots into an edge-to-edge relationship. Finally, 2/3 crown-height attrition is simulated, approximating individual attrition score 7.0, and the mandible pivots into a state of negative labial overjet or relative prognathism.

The profiles in Fig. 1 have not been altered in any way except for reductions of tooth height. Thus, even without changing the mandible's shape (Murphy, 1958) simulated attrition can produce edge-to-edge bite or even negative overjet. Unfortunately, models cannot account for the normal compensatory eruption noted by Begg, 1954, 1965, 1977, and Murphy, 1958-59, although the simulated reductions in facial height with increased wear seem consistent with Murphy, 1959. Nor do the drawings allow for procumbent incisors (Lysell, 1958b; Begg, 1965, 1977). Notwithstanding these shortcomings, pivoting the mandible upward on its arc provides a simple explanation of overjet changes with attrition.

Conclusion

It appears that the incisor relationship changes from one of positive overjet to edge-to-edge bite as occlusal attrition progresses. This study posits a continuation of the process, culminating in negative labial overjet, which could be described as relative mandibular prognathism.

Greater wear is associated with negative overjet laterally as well as labially, possibly due to different geometrical shapes of the upper and lower arches.

A certain percentage of most modern populations displays a class III malocclusion (negative overjet of upper and lower incisors). Many archaeological populations seem to have a much higher incidence of this relationship that may not be genetic. The fact that this incidence is correlated with individual attrition score suggests the possibility of a relationship to age (Patrick Turley, personal communication).

Genetics plays a considerable role in producing a certain frequency (3 to 6%) of edge-to-edge bites, but its increased incidence with greater age cannot be explained genetically (Patrick Turly, personal communication).

Yet it is equally apparent that attrition may not be the only force involved. The wide variation seen in Fig. 3 suggests the strong possibility of other factors at work even in these populations. We have not adequately addressed the roles played by procumbent incisor changes or continuous tooth eruption, among others. No doubt a number of other forces have varying degrees of impact on incisal bite and considerably more remains to be learned in resolving the nature of such occlusal changes.

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