

A Curve Symbol on the Maxillary First (Third) Premolar (P³) in Hominins



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Abstract

The degree of curvature of the maxillary first premolars when viewed from the occlusal plane was examined. Curvature at the transition between the buccal and adjacent surfaces is a known characteristic of left-right differences. In general, the curvature characteristics of the teeth of modern humans are more acute in the mesial than in the distal. However, this characteristic appears reversed only in the maxillary first premolars. This study investigated when and how the maxillary first premolars reverse curvature emerged in human evolution. The results showed that the occurrence of reversal curvature in the maxillary first premolars was caused by the weakening of the buccal ridge and the shift of this ridge to the distal, as well as the development of the distobuccal area of tooth crown, which has occurred since the time of the present. The P³ curvature seen in modern humans is thought to be a fairly new trait acquired during human evolution

Keywords: Maxillary first (third) premolar; Curve symbol; Reversal curvature; Hominins

Introduction

Accurate recognition of tooth morphology is a matter of great importance in the fields of dental anatomy, anthropology, forensic odontology, and archaeology. Generally, tooth differentiation is done by (1) tooth type, (2) maxilla or mandible, (3) rank within a tooth type, and (4) left or right. Mühlreiter [1,2] focused on the morphological characteristics of the teeth and identified three important features for differentiating right and left teeth: angular, curvature, and root characteristics. This is called Mühlreiter's triad in tooth differentiation. When viewed from the incisal or occlusal plane, Mühlreiter describes the curvature feature as a line connecting the mesial and distal corners that intersects at an angle to the buccolingual axis and slopes toward the distolingual direction. Nelson [3] describes the distal contact as being more lingual than the mesial contact, with the apex of the buccal ridge is slightly more mesial than that of the lingual ridge. Fujita [4] also stated that the degree of curvature at the transition between the buccal and adjacent surfaces is always more acute mesially than distally.

Although each researcher has a different way of describing the left-right difference of the teeth, the meaning of the curvature feature is the same. This feature is called curvature feature

or curve symbol. However, this method cannot accurately differentiate in the maxillary first premolar (P³), especially in modern humans. This is because the curvature features of this tooth appear in the opposite pattern. That is, the degree of curvature at the transition between the buccal and adjacent surfaces is always more acute on the distal side than on the mesial side. The previous authors did not describe any cause for the P³-specific character. In this study, the author will examine when and how this phenomenon of reverse curvature has occurred in the course of human evolution.

Materials and Methods

Materials used in this study include photographs taken from upper third premolars (P³s) of several primates (*Macaque fuscata* in Cercopithecinae and *Pan troglodytes* in Homininae) [5], and photocopies from papers already published for fossil hominins. The author drew sketch drawings of them. The fossil hominins used are *Ar. kadabba* (ASK-VP-3/400) [6], *Au. Africanus* (Stw 252) [7], *H. erectus* (PA67)[8], *H. heidelbergensis* (AT-4325) [9], *H. Neanderthalensis* (OR-1) [10], Early *H. sapiens* (DX 42) [11], and Modern *H. sapiens* (present study).

The photograph was taken from the occlusal plane so that the optical axis of the camera is aligned with the crown axis of the premolar. The primate skull materials were housed at the Primate Research Institute, Faculty of Science, Kyoto University. The cast model of modern humans was from the collection of Aichi-Gakuin University.

Identification of P³

Figure 1 shows a modern Japanese maxillary first premolar viewed from the occlusal plane. The mesiobuccal curvature is loose and the distobuccal curvature is acute. The tooth does not show the conventional signs of curvature, but rather the reverse curvature.

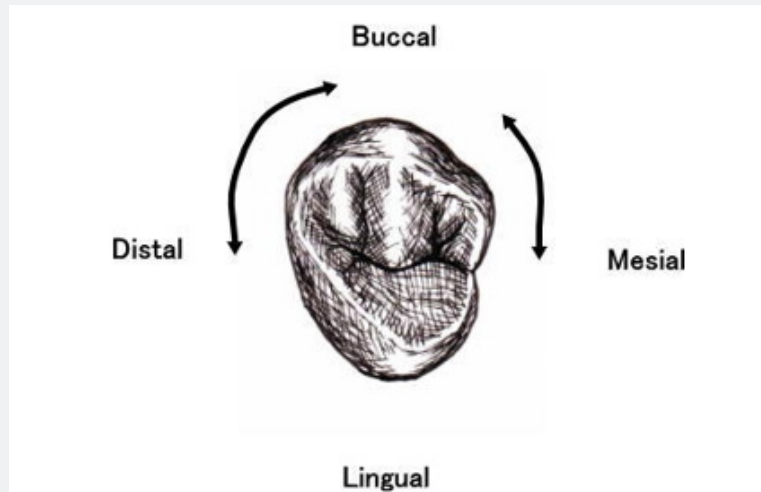


Figure 1: Reverse curvature sign of the maxillary first premolar in a modern human.

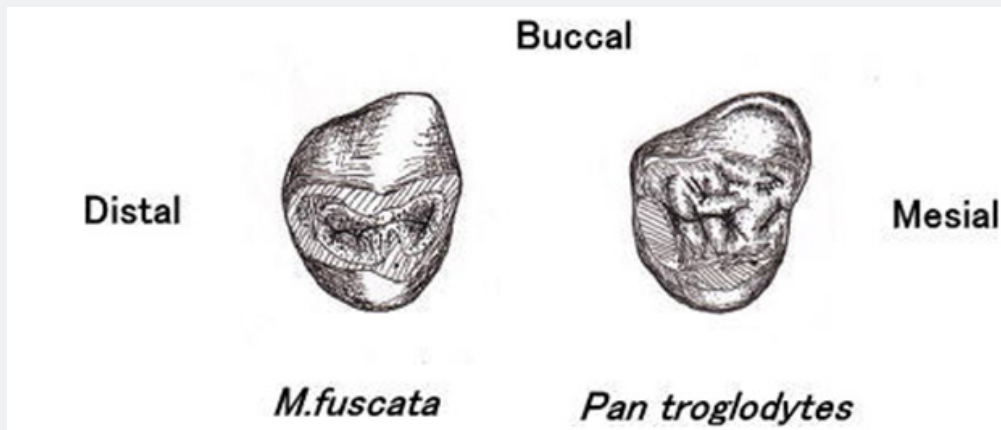


Figure 2: Maxillary third premolars (P³s) of *Macaque fuscata* (left) and *Pan troglodytes* (right).

Curvature of maxillary third premolars in non-human primates

The Figure 2 is a sketch of P³ of a Japanese monkey (*Macaque fuscata*) and a chimpanzee (*Pan troglodytes*) viewed from the occlusal plane. The P³s of the Japanese macaque and chimpanzee have a strongly developed ridge running from the buccal cusp tip to the mesiobuccal portion, which protrudes strongly outward at

the base and has a pronounced degree of curvature. In contrast, the distobuccal curvature is less pronounced. This phenomenon is the same curvature characteristic of almost all teeth in the human dentition except for P³. In the P³ of Japanese monkeys and chimpanzee, there are two buccal roots, and the development of the mesiobuccal root is particularly strong, resulting in a strong outward convexity of the curvature.

Occurrence of the reverse curvature symptom

The Figure 3 shows the degree of curvature of the transition between the buccal and adjacent surfaces of the maxillary first premolar. In fossil hominins, P³ of *Ar. kadabba* [6] (5.8-5.2 million years ago) from Ethiopia (Figure 3a) showed a well-projected mesiobuccal area and a sharp curvature like chimpanzees. In P³ (Stw 252) of *Au. africanus* (estimated to be about 2.8-2.3 million years ago), the curvature was almost equal and symmetrical mesiodistally. The buccal ridge, which runs down the middle of the buccal surface, protrudes well outward, and the general outline as seen from the occlusal surface is strongly convex and curved (Figure 3b). The crown outline of *Paranthropus* (SK 24) is also similar to that of *Au. africanus*, although two buccal roots are

present on SK 24 [12]. The P³ of *H. erectus* [8], which lived in China about 1.5 million years ago, has a strongly outward projecting buccal ridge mesial to median of the crown and a strongly curved outline (Figure 3c). A similar P³ morphology is also seen in Weidenreich [12]. The P³ morphology of *H. heidelbergensis* [9], an ancient form of *H. sapiens* from 500,000 years ago, shows conventional curvature with strong bulging (Figure 3d). The curvature of *H. neanderthalensis* [10], which lived in Europe and the Far East from about 200,000 to 40,000 years ago, also had the customary strong curvature and developed buccal ridges (Figure 3e). By early *H. sapiens* from southern China [11], with an estimated age of more than 80,000 years and up to 120,000 years ago, the buccal curvature of P³ is becoming less prominent and the crown outline is becoming more symmetrical (Figure 3f). Modern *H. sapiens* (present study) shows a less prominent buccal curvature and a more symmetrical crown outline (Figure 3g).

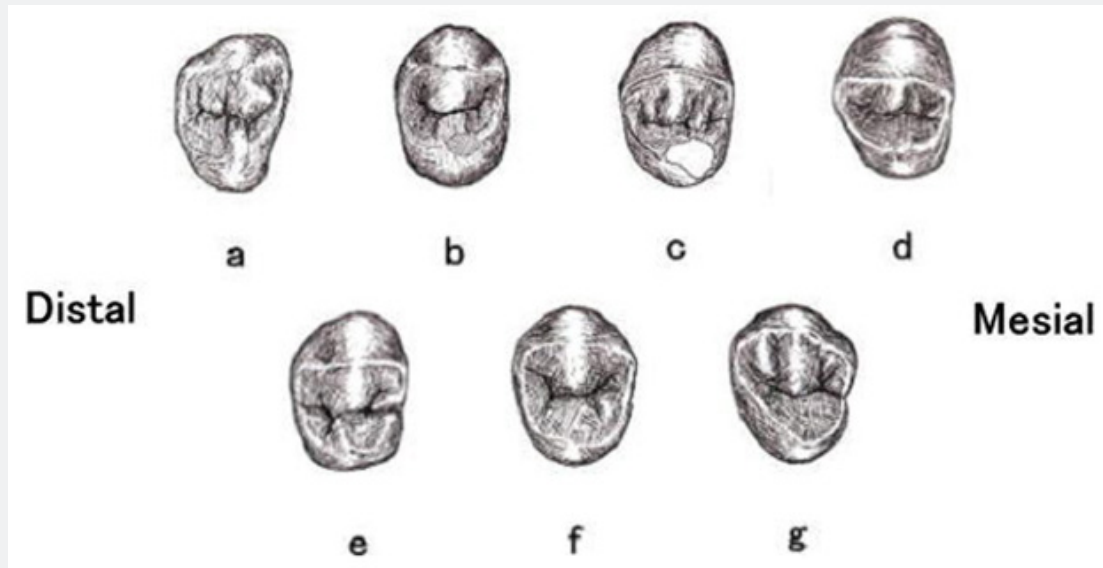


Figure 3: shows P³s of hominins viewed from the occlusal plane.

a: *Ar. kadabba* (ASK-VP-3/400)[6] (reverse), b: *Au. africanus* (Stw 252) [7], c: *H. erectus* (PA67)[8], d: *H. heidelbergensis* (AT-4325)[9], e: *H. neanderthalensis* (OR-1) [10] (reverse), f: Early *H. sapiens* (DX 42) [11], g: Modern *H. sapiens* (present study).

Furthermore, in modern *H. sapiens*, the buccal projection is less prominent and the distobuccal curvature is relatively stronger than the mesiobuccal curvature, forming a symptom of reverse curvature (Figure 3g). The P³ curvature seen in modern humans is thought to be a fairly new trait acquired during human evolution.

Factors showing signs of reverse deformity only in P³

The location of P³ at the inflection point of the dental arch is thought to be responsible for the reverse curvature sign in modern humans. This is discussed in detail below. The maxillary dental arch of chimpanzees is elongated and U-shaped, with the left and right molars nearly parallel or slightly narrowed distally, while the shape of the human dental arch is semi-elliptical. The

two taxa have been shown to have different dental arch shapes [13]. As can be seen from Figures 2 and 3, the P³s of chimpanzees and hominids from *Ardipithecus kadabba* to Neanderthal are characterized by a strong mesial transitional curvature between the buccal and adjacent surfaces, and a loose distal curvature. The signs of curvature of P³ are similar to those of chimpanzees, and pre-*H. sapiens*. Thus, there is no relationship between the shape of the dental arch and the state of the curvature at P³.

There is another view of the usual curvature of P³. When a degenerative trend appears in tooth morphology, the teeth become smaller in size, rounded in shape, and degenerate from the distal portion of the tooth crown [14,15]. This concept is

generally applicable to most tooth groups. If so, why is it that only P³ does not exhibit the usual sign of curvature? In the premolar group, the degeneration or loss of tooth number occurs in the mesial direction phylogenetically. Most primitive mammals had four premolars in one half of the jaw, but the tooth number has been reduced to three in New World monkeys and two in Old World monkeys and Hominoidea [5,16,17]. This is why the first and second premolars in humans are called third and fourth premolars in non-human primates. Thus, the missing in the premolars may have occurred from the mesial direction. Even with this idea, however, it is difficult to understand why tooth degeneration begins on the distal side in premolar. It is also difficult to understand why P³ degenerated distally until Neanderthal man, but has not degenerated distally since *H. sapiens*, where has developed and protruded distobuccally. The phenomenon of signs of reverse folding that began in *H. sapiens* may be related to the weakening of the buccal ridge and the shift of this ridge to the distal, as well as the development of the distobuccal area of tooth crown. Therefore, the reverse curvature of P³ is not related to the phylogenesis of the premolars.

Conclusion

In general, the curvature characteristics of the teeth are more acute mesially than distally. However, only in P³, this characteristic appears in the opposite direction in modern humans. This study investigated when and how the P³ reverse curvature emerged in human evolution. The results showed that the occurrence of the tooth reversal curvature was caused by the weakening of the buccal ridge and the shift of this ridge to the distal, as well as the development of the distobuccal area of tooth crown, which has occurred since the time of the present *H. sapiens*.

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