# Brief Communication: Rotation of the Maxillary Premolars: Evidence in Support of Premolar Morphogenetic Field

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***ABSTRACT:*** The presence of an individual tooth, axially rotated within the maxillary and/or mandibular dental arcade is not an uncommon occurrence in the human dentition. Far rarer is the axial rotation of two or more adjacent teeth, rotated together as a "unit" within the dental arcade. Two rare cases are presented here, each case possessing a maxillary P3-P4 unit that has been axially rotated. This event is in and of itself interesting and important, yet it also potentially provides support for the concept of a "premolar" morphogenetic field. *Dental Anthropology* 2006;19(3):70-73.

Dental morphological variation can be considered to fall within two broad categories: (1) those that involve major deviations from the basic dental blueprint and (2) those that involve minor, subtle variations in crown and/or root morphology (Hillson, 1996; Scott and Turner, 1997). Included within the first category are such dental anomalies as supernumerary teeth (polygenesis or polydontia), missing one or more teeth (agenesis or hypodontia), fusion of adjacent teeth, transposition of teeth, rotation of teeth, malposition of teeth, deviations from the "normative" crown morphology (*e.g.*, conical lateral incisors, 3-cusped upper premolars, "mulberry" molars) and other sundry anomalies. The second category of dental variation includes minor variations in secondary cusps, fissure patterns, marginal ridges, supernumerary roots, and so forth (Scott and Turner, 1997:3). Many of the dental anomalies in the first category involve developmental errors in the number and/or positions of individual tooth germs or tooth morphogenic fields. However, the existence of dental morphogenic fields has been debated (Henderson and Greene, 1975). Evidence illustrating an extremely rare form of dental rotation, as well as supporting the presence of a premolar morphogenic field is discussed below.

## SPECIMENS

Within the skeletal collection of the American Museum of Natural History, New York, are two specimens displaying a unique rotation of a maxillary P3-P4 unit.

### CASE 1: AMNH 99.1/1395

The first case consists of well-preserved maxillary and mandibular dental arches of a specimen from the collection of Marquesas Island crania collected by H. L. Shapiro during the Templeton Crocker Pacific Expedition in 1934 or possibly during his participation in the B. P. Bishop Museum Tuamotu Expedition in 1929. This specimen possesses a unique dental anomaly in which both the maxillary left P3 and P4 were mesially rotated 90º, as a unit (Figs. 1-2). Crown morphology of the premolars is completely normal. Also evident in the specimen's dentition is moderate shoveling of the central and lateral incisors, as well as a small expression of Carabelli's trait on the first maxillary molars. No other dental anomaly was noted.

### CASE 2: AMNH 99/8478

The second case consists of well-preserved maxillary and mandibular dental arches of a specimen from the collection of Cañon del Muerto, Arizona crania collected by Earl H. Morris during an American Museum of Natural History expedition in 1923 and 1924. This specimen also possesses a unique dental anomaly in which both the maxillary right P3 and P4 were distally rotated ~80º, as a unit (Figs. 3-4). However, unlike the P4 of the AMNH 99.1/1395 specimen, the P4 of this specimen appears to have distally rotated an additional 180º. Crown morphology of the premolars is normal otherwise, though with a relatively large carious lesion on the distal surface on the P4 crown and root. Also evident in the specimen's dentition is shoveling of the central incisors, as well as the medial rotation of the central incisors. No other dental anomaly was noted.

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**Fig. 1**. Occlusal view of AMNH 99.1/1395 maxillary dentition.


**Fig. 2**. Close-up view of left maxillary premolars of AMNH 99.1/1395.

## DISCUSSION

Minor-to-pronounced axial rotation has been noted of individual teeth of the maxillary and mandibular dental arcade. The direction of this axial rotation can be either mesial or distal. Winging and counter-winging, either unilateral or bilateral, of the maxillary central incisors, seen predominantly in Native American Indians, is one example of a minor rotation of a tooth (Dahlberg, 1963; Escobar *et al*., 1976). More pronounced axial rotation of an individual tooth typically involves a 90 to 180 degree rotation (Lui, 1980; Tay, 1968; van Nievelt and Smith, 1997). Normally, these cases of extreme axial rotation are also characterized by either unilateral or bilateral rotation of individual teeth.

However, the rare cases discussed above represent an even smaller sub-category of dental rotation, an occurrence where two adjacent teeth are rotated as a "unit" within the dental arcade. This type of dental rotation, to the author's knowledge, has not been documented or reported in the literature. These cases each possess a maxillary P3-P4 unit that has been either medially or distally rotated, an event in and of itself very interesting and important. Yet, these examples of P3-P4 unit rotation also potentially support the concept of a premolar morphogenic field.

Butler (1937; 1939) presented the concept that the gradients in mammalian dentition was due to morphogenic fields. He proposed that each tooth germ in the maxilla or mandible possessed the same genetic information, which would allow any single tooth germ to develop into any type of tooth. It was only the tooth germ's position in the maxilla or mandible that determined what type of tooth the tooth germ would ultimately develop into, directed by some field substance or morphogen (Scott and Turner, 1997). Butler hypothesized three morphogenic fields, namely incisor, canine and molar, and variations within each field were due to "pattern genes" operating at a secondary level on different tooth germs within a morphological field (Butler, 1937, 1939; Scott and Turner, 1997:82).

Butler's morphogenic field theory was applied to humans by Dahlberg (1945). In addition to Butler's three morphogenic dental fields, Dahlberg defined a fourth, "premolar" dental field. Dahlberg's separation of premolars from the molar morphogenic field into its own field, resulting in the definition of four morphogenic dental fields, nicely corresponded to the four morphological classes of teeth present in humans. Debate currently exists as to whether premolars should be distinguished as a dental field, separate from the molar field (Scott and Turner, 1997; Suarez and Williams, 1973; Townsend and Brown, 1981). Many dental anthropologists argue that premolars are an anterior extension of the molar dental field, while others note crown and root morphology that support the existence of a distinct premolar dental field (Scott and Turner, 1997:84-85; Wood and Engleman, 1988; Wood *et al*., 1988). Scott and Turner (1997:85) state, "To summarize, the evidence is equivocal regarding a separate premolar field…."

These cases with their rotated maxillary P3-P4 units and perfectly formed premolar and molar crowns tentatively support the existence of a separate premolar morphogenic field, making the evidence slightly less equivocal.

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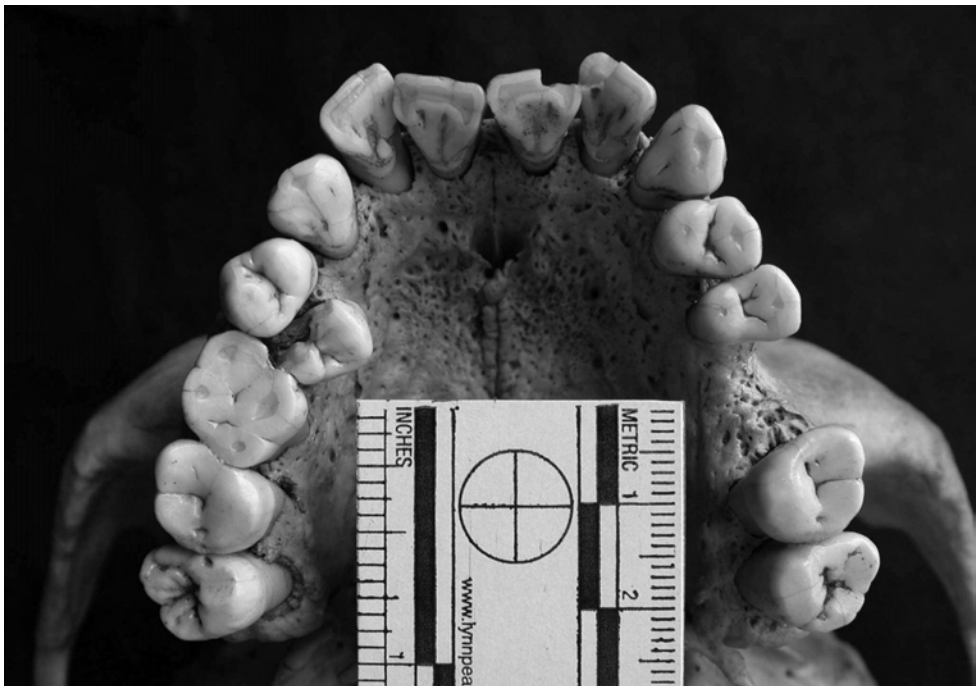


**Fig. 3**. Occlusal view of AMNH 99/8478 maxillary dentition.

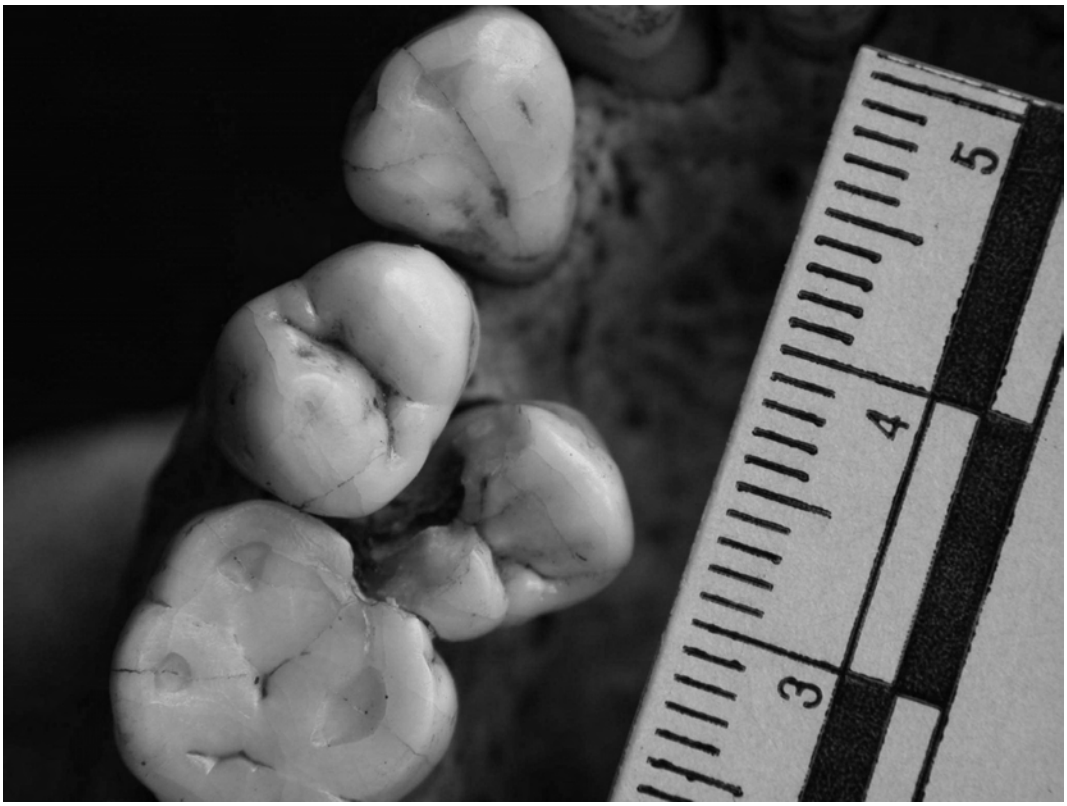


**Fig. 4**. Close-up view of right maxillary premolars of AMNH 99/8478.

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