Canine transposition in prehistoric Pakistan: Bronze Age and Iron Age case reports

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This report describes two prehistoric cases of maxillary canine–first premolar transposition (Mx.C.P1) from the Bronze and Iron ages of South Asia. Recent developments regarding the analysis and interpretation of maxillary transpositions have increased interest in this subject among clinical practitioners and biological anthropologists. Peck and colleagues recently reported on anomalies of tooth number and size associated with malpositioned maxillary canine teeth.[1,2] A provocative review paper on transposition of teeth by Chattopadhyay and Srinivas reports a high rate of bilateral tooth transposition among the inhabitants of Karnataka, South India.[3] Current surveys of the literature on canine transpositions note a "surprisingly" high prevalence among Asian Indian populations.[4,5] Finally, Nelson recently presented a persuasive argument for the genetic etiology of Mx.C.P1 transposition in prehistoric skeletal remains from Santa Cruz Island, off the California coast.[6] These publications call attention to transposition prevalence and associated dental conditions, provide more robust prevalence data for areas of the world where transpositions are not well documented, address controversial issues regarding etiology, and document high rates of canine transposition, possibly due to inbreeding, in prehistoric Native Americans.

The purposes of this report are: (1) to provide

Abstract

This report documents two prehistoric cases of canine–first premolar transposition (Mx.C.P1) from the Indo-Pakistan subcontinent. Recent discussion of the etiology of canine transposition and reports of high prevalence for the condition in modern India accentuate the significance of the ancient cases reported there. Case 1 is from the Iron Age site of Sarai Khola in northern Pakistan (1000 BC). The specimen, an adult female, 25 to 30 years of age at death, exhibits unilateral Mx.C.P1 transposition on the left side. The condition is associated with a barrel-shaped maxillary left third molar in an otherwise normal and healthy maxillary dental arch. Case 2 is from the Bronze Age urban site of Harappa (2500 BC), an important center of the Indus Valley Civilization. In this specimen, an adult female, transposition is bilateral, resulting in displacement of premolars and large diastemata between the maxillary lateral incisors and first premolars. Bilateral agenesis of maxillary third molars and rotation of maxillary and mandibular teeth occur with transposition in this specimen. In neither case are the lateral incisors reduced in size, peg-shaped, or congenitally absent. This report of Mx.C.P1 transposition in prehistoric times is significant because it provides historical documentation for the female predilection of the trait and establishes its co-occurrence with specific dental variants, such as agenesis, reduction, and rotation of teeth.

Key Words

Dental anthropology • Canine transposition • Dental paleopathology • Bronze Age • Iron Age • India • Pakistan

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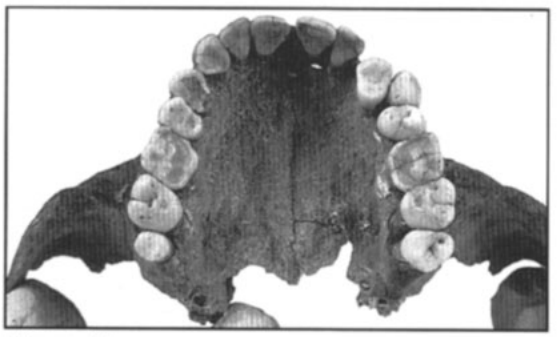

Figure 1A

Figure 1B

Figure 1A-B
A. Occlusal view of SKH 1 maxillary dentition. Note transpositon of left canine and first premolar and the barrel shape of the right third molar. - 18.
B. Left lateral view of SKH 1, maxilla and mandible in occlusion. The transposed left canine (23) is strikingly prominent.

Figure 2A

Figure 2B

Figure 2C

Figure 2A-D
A. Occlusal view of H87 / 145 / 156a maxillary dental arch. Note large diastemata, asymmetry of premolar displacement, carious crown of the right canine, and agenesis of third molars (18 / 28). (Neg. no. R157f8)
B. Superior lateral view of right maxilla showing relationship of first premolar and canine roots and remnant of the carious canine crown. (Neg. no. R164f7)
C. Occlusal view of mandibular dental arch. Note rotation of 34 (LP_1), crowding of lower incisors, and presence of third molars (38/48, Neg. no. R157f7).
D. Left lateral view of maxilla and mandible in occlusion. Note mesial rotation of lower first premolar (33) and position of canine crown. (Neg. no. R158f10).

further evidence of maxillary canine–first premolar transposition in prehistoric human skeletal remains of the Old World, thereby providing a 5000-year antiquity for the condition in South Asia, (2) to discuss the expression of transposition in these cases, and (3) to consider the meaning and significance of anatomical features associated with transposition. The classification of maxillary tooth transpositions recommended by Peck and Peck is used in this report.[7]

Case 1

SKH 1 (female, 25-30 years)

The first case consists of the well-preserved maxillary and mandibular dental arches of a specimen derived from a cemetery site known as Sarai Khola, located approximately 33 km northwest of Islamabad in northern Pakistan. Discovered in 1967, the site was excavated by the Government of Pakistan, Department of Archaeology, under the direction of M.A. Halim. Four periods were recognized archaeologically, with the cemetery (Period III) dated to between 1000 and 270 years BC. The skeletal biology of the Sarai Khola skeletal series has been described by Wolfram Bernhard,[8,9] and the dental anthropology of 36 specimens was analyzed by Lukacs.[10,11] One of the 20 (5%) well-preserved maxillae in the Sarai Khola skeletal series exhibits canine transposition.

All maxillary and mandibular teeth are present and well preserved in this individual. The mandible was fixed in articulation with the cranium

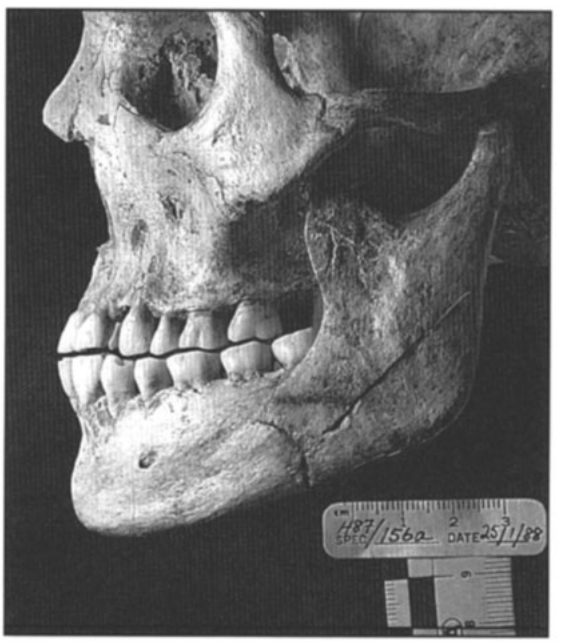

Figure 2D

with adhesive by the excavators and had to be removed so that the occlusal surfaces of the teeth could be studied. This procedure caused slight damage to the crown of 11 (RI^1), but it is the only postmortem damage sustained by the teeth of the specimen. (The ISO/FDI two-digit tooth numbering system is used as the tooth identification method throughout the report, with anthropological notation following in parenthesis.)

The transposition is unilateral (left side) and results in significant mesial displacement of the

left first premolar and slight distal displacement of the second premolar (Figure 1A-B). A small diastema between the left maxillary lateral incisor and the rotated buccal aspect of the first premolar is evident along the alveolar margin. Maxillary third molars and lateral incisors are present. Although dental agenesis was not observed in this specimen, 18 (RM^3) is reduced in size and barrel-shaped (maximum crown diameter = 6.5 mm); the crown is small in comparison with 17 (RM^2). The antimere, 28 (LM^3), is of normal size and morphology (refer to Table 1 for crown dimensions). One large carious lesion is present in the central fossa of the occlusal surface of 18 (LM_3), but the maxillary canines and premolars are free from caries.

In general, this specimen has healthy dental arches. Dental crowding is absent from the anterior dentition of the mandible and pathological lesions are absent from this specimen, which also lacks evidence of gross enamel hypoplasia, dental calculus, antemortem tooth loss, alveolar recession, and dental abscesses. Enamel chip scars are present in two teeth—26 (LM^1) and 45 (RP_2)—indicating either extremely tough food, or more likely, foreign inclusions or contaminants in the diet.

Table 1
Odontometric data for specimens with maxillary canine–first premolar transposition (in mm)

	Case 1: SKH 1				Case 2: H87 / 145 / 156a			
	Left		Right		Left		Right	
	MD	BL	MD	BL	MD	BL	MD	BL
Maxilla								
I1	8.0	6.5	—	6.7	9.6	6.9	9.2	6.7
I2	6.4	6.1	6.6	6.2	7.1	6.8	7.5	6.4
C	7.2	7.2	7.3	7.6	7.7	7.7	—	—
P1	7.0	9.2	7.1	9.2	—	—	6.7	9.0
P2	6.6	9.6	6.6	9.5	6.8	9.2	7.0	9.3
M1	9.4	10.9	9.5	10.6	10.1	11.6	10.2	11.5
M2	9.0	10.9	9.3	10.6	9.6	11.1	9.6	11.2
M3	8.0	10.1	5.5	6.5	—	—	—	—
Mandible								
I1	5.4	5.6	5.5	5.6	5.7	6.0	5.6	5.9
I2	6.9	5.8	6.5	5.9	6.1	6.3	6.2	6.3
C	6.7		6.7	7.2	6.5	7.4	6.6	7.2
P1	6.1	7.7	6.5	7.7	6.8	7.2	6.8	7.6
P2	6.7	8.3	6.1	7.7	7.5	8.5	7.7	9.1
M1	10.9	10.1	10.2	10.2	11.5	10.8	11.7	10.8
M2	9.2	9.5	9.5	9.5	10.5	10.2	10.8	10.3
M3	9.3	9.1	9.3	9.1	10.5	9.9	10.7	9.8

Case 2

H87 / 145 / 156a (female, 25-29 years)

This specimen comes from the archaeological site of Harappa, a large urban center of the Indus Valley Civilization which dates to the third millennium BC. Cemetery excavations at Harappa were conducted in 1987 and 1988 by the University of California—Harappa Expedition, conceived and initially directed by George F. Dales Jr. Preliminary results of the first two seasons of fieldwork were published in 1990 and include discussion of the site's history, archaeology, faunal remains, and bioanthropology.[12] More than 90 partial and complete human skeletons were recovered from the cemetery and, in addition to a synthetic overview of these remains by Hemphill, Lukacs, and Kennedy,[13] analyses of skeletal trauma,[14] chemical evaluations of diagenesis and paleodiet,[15-16] and dental pathology[17,18] have appeared in the literature.

One of the best-preserved skeletons from the cemetery, specimen number H87 / 145 / 156a exhibits a pristinely preserved dentition (Figure 2A-B). All 16 mandibular teeth are present and show minimal wear. The maxillary dental arch lacks 25 (LP^4), loss of which was clearly postmortem, as the alveolus is deep and unresorbed. Congenital absence of maxillary third molars is bilateral, an observation determined on-site from field radiographs of the maxilla. While canine transposition in this specimen is bilateral, expression of the condition is clearly asymmetric. The right side displays significant displacement of first and second premolars; the buccal aspect of 14 (RP^1) is displaced mesially, while the buccal aspect of 15 (RP^2) is displaced to a greater degree distally. The postmortem loss of 24 (LP^1) prohibits interpreting crown position of this tooth, but orientation of the alveolus suggests lingual displacement with the buccal aspect rotated mesially 50° to 60°. By contrast, 25 (LP^2) is unaffected by the transposed canine.

In this individual, transposition resulted in large diastemata distal to the maxillary lateral incisors. While not directly or causally related to the occurrence of transposition, associated phenomena exhibited in the dentition of this individual include: carious destruction of right canine crown, bilateral rotation of maxillary lat-

eral incisors, crowded lower incisors, and mesial rotation of 34 (LP_1). These conditions are discussed in sequence.

The entire crown of 13 (RC) has been destroyed by caries. The locus of initial caries development cannot be determined. The interdental embrasure between premolars and canine may have served to entrap food, predisposing the tooth to caries. However, none of the premolars in this specimen are carious, and generally canines have very low caries rates. While the lower incisors appear displaced due to crowding, the rotation of upper lateral incisors is not due to crowding. However, the absence of maxillary canines from their normal position may partly explain the free rotation of maxillary lateral incisors. Finally, 34 (LP_1) is rotated (buccal aspect mesially) nearly 90° from its normal anatomical position and crowding is not a causal factor in the rotation of this tooth (see Figure 2C).

Discussion

This report provides the first documentation of maxillary canine–first premolar transposition (Mx.C.P1) in prehistoric populations of South Asia and possibly the entire Old World. An antiquity for canine transposition of 5000 years is established for South Asia, an age comparable to that reported for New World cases by Nelson.[6]

The long history of dental transpositions in an area of the world where recent reports show an unusually high prevalence of transpositions is of more than passing interest. This is especially so since dental anomalies co-occurring with Mx.C.P1 transposition have been documented in prehistoric times: reduced or barrel-shaped maxillary third molars at Sarai Khola (SKH 1), and bilateral agenesis of maxillary third molars at Harappa (H87 / 145 / 156a). These findings reaffirm the covariation of Mx.C.P1 with tooth agenesis and size-reduction observed by Peck and colleagues among contemporary clinical samples.[2] By contrast, reduced or peg-shaped maxillary lateral incisors, while commonly associated with Mx.C.P1 in the Karnataka sample from South India, were not observed in either prehistoric case from Pakistan.[3] The association of specific dental anomalies with Mx.C.P1 transposition provides crucial clues that may ultimately help to decipher the etiology of this enigmatic trait. Furthermore, the cases reported

here suggest that the female bias in expression of the condition noted by Peck and Peck[7] may have a long history among South Asians.

Dental anthropologists and paleopathologists are encouraged to report cases of dental transposition in prehistoric human skeletal series so that clinical research can be placed in historical perspective. While many skeletal series are of small size and will yield high prevalence rates for Mx.C.P1 transposition, the adoption of a paleoepidemiological approach to dental transposition is required if the goal is to understand the evolutionary origins and significance of this dental anomaly. Epidemiological analysis of large skeletal collections from different ecological and cultural contexts may yield important clues to the etiology of dental transposition. Anthropological data on canine transposition, when integrated and interpreted in conjunction with clinical data, will significantly enhance understanding of this intriguing condition. Investigators are therefore encouraged to report the sample size of skeletal collections in which canine transposition is observed and details of associated morphology and pathology.

Acknowledgments

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