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Evidence of dental anomalies from prehistoric Eastern Sudan: two cases from the Mesolithic graveyard UA 50*

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Abstract

Dental anomalies in humans are rare developmental alterations involving the normal number, morphology, size, eruption, and position of one or more teeth in primary or permanent dentitions. To date, the etiology of these anomalies is still yet to be fully understood, since they are caused by interactions between genetic, epigenetic, and environmental factors. However, familiarity is considered to play an important role in their onset. In this paper, we report two new cases of dental anomalies recorded in two adult skeletal individuals from the Mesolithic graveyard UA 50 (Eastern Sudan, 5th millennium BCE). The mature male from Grave 3 shows bilateral supernumerary mandibular premolars. The two additional teeth erupted on the lingual side of the mandibula between the fourth premolars and the first molars. The young adult female from Grave 1 shows the retention of the deciduous mandibular right canine, the intra vitam loss of both mandibular central incisors, and the transmigration of the right mandibular canine with the impaction of the left one. Both mandibles were subject to gross morphological analysis and cone-beam computed tomography (CBCT) 3D volumetric measures. Evidence of dental anomalies in past populations is still scanty and, as far as we know, the reported cases are the oldest dental anomalies so far recorded in prehistoric Sudanese populations.

Keywords: supernumerary premolars; deciduous canine retention; canine impaction; canine transmigration; prehistoric Eastern Sudan

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Introduction

Tooth eruption is a complex process during which a tooth germ moves from its developmental position in the alveolar crypt and it reaches the functional position in the oral cavity (1). Any alteration or interruption occurred during this process can result in dental anomalies, which are deviations from the normal morphology, size, shape, number, position, and degree of development of one or several teeth (2, 3). These anomalies can occur in both primary and permanent dentitions.

The etiology of dental anomalies is yet to be fully understood since odontogenesis involves the interaction between genetic, epigenetic, and environmental factors (4, 5). In general, dental anomalies can result from a combination of intrinsic factors, such as familiarity, metabolic dysfunction, or mutations, and extrinsic factors, such as physical trauma, nutritional deficiencies, stress, cultural habits, or environmental conditions (6, 7).

Although dental anomalies have been detailed in the clinical literature and their prevalence and distribution in the permanent dentition of modern Sudanese orthodontic patients have been carefully investigated (8), to date, scanty evidence from Sudanese archaeological populations are reported. This paper offers an opportunity to highlight that dental anomalies have also affected past populations (9).

This contribution reports two cases of dental anomalies from the Mesolithic graveyard UA 50, in Eastern Sudan, dated to the 5th millennium BCE.

Materials and methods

Since 2015, the investigations of the Italian Archaeological Expedition to Eastern Sudan (IAEES) in the Mesolithic graveyard UA 50, located in the flat area of the Khor Marmadeb, between the Gash and the Atbara rivers, in the Kassala region, have returned 28 graves dating to the 5th millennium BCE and related to the Malawiya Group culture (10) (Figure 1).

Single graves are 82% of the sample (N=23), while 2 double graves and 3 multiple graves (hosting respectively 3, 4, and 7 individuals) were recorded, for a total of 41 skeletal individuals, all placed in a contracted position on the left or right side. Given the bad preservation of the human bones, the dental analysis was carried out only for 16 individuals, two of whom showed dental anomalies in the lower dentition.

The sex of the individuals was estimated based on the observation of the morphological features

of the skull and pelvis (11). The age at death was estimated using dental wear stages (12) and degenerative changes of the auricular surface and pubic symphysis (13, 14).

The first individual (Grave 3) is a 40-45-year-old male. Only 25-50% of the skeleton is preserved. No pathological conditions were recorded.

All the maxillary teeth are preserved as isolated teeth except for the left lateral incisor, both the left premolars and the left first and second molars, which were lost post-mortem. The post-mortem fractured mandible with 15 teeth is preserved. The anterior region of the mandible is badly damaged. For the right side, the first molar, the fourth premolar, a supernumerary premolar, and the canine are fully preserved in place, while the third premolar and the incisors are still in place, but their crowns are not preserved. The presence of the alveolar socket of the third molar shows that the tooth was lost post-mortem. For the left side, only the third molar, the third premolar, the canine, and the lateral incisor are fully preserved in place. The first molar, the fourth premolar, and a supernumerary premolar are seriously damaged by a severe carious lesion involving the crown of the three teeth, but only their roots are still recognizable. The central incisor is in still place but its crown is not preserved. Both the mandibular second molars were lost *intra vitam*.

The second individual (Grave 1) is a 20-25-year-old female. The preservation of the skeleton is ca 50%. No pathological conditions were recorded.

All the maxillary teeth except the central incisors are preserved, as isolated teeth. In the mandibula, all posterior teeth (from the third premolars to the third molars) are present as isolated teeth, and only the anterior portion of the mandible is preserved with 6 teeth – the right first premolar, the right deciduous canine retained, the lateral incisors and both permanent canines – still in place. The right permanent canine has not erupted and is completely included in the mandibular corpus, close to the mandibular symphysis; the left canine is impacted.

The description and differential diagnosis of the anomalies were performed by morphological observation and radiographic techniques. Both specimens were measured with a 3D Accuitomo 170 cone-beam computed tomography unit (J. Morita Corp.) with a pixel size of 0.125 mm and a slice thickness and interval of 0.5 mm at the Radmedica SRL Dental Radiology Laboratory in Rome, Italy. The software J. Morita i-Dixel 2.0 (J. Morita Corp.) and ImageJ 1.53s (National Institutes of Health, USA) were used for image post-processing.

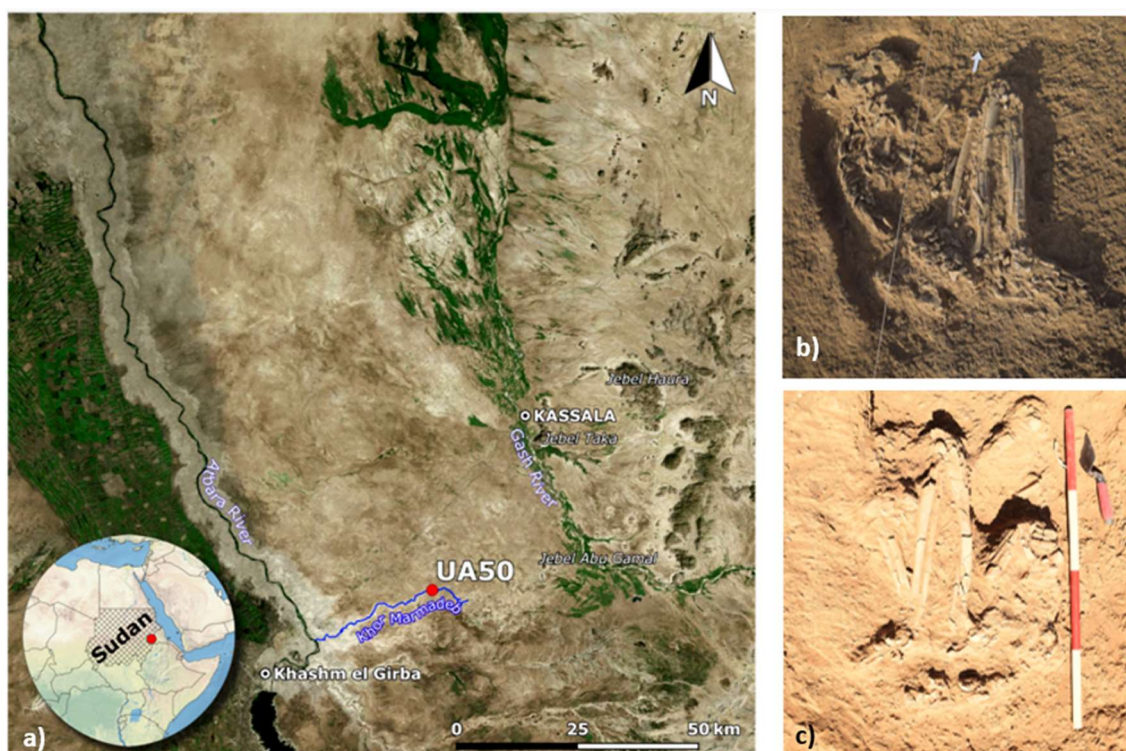


Figure 1. Left panel: a) image courtesy of Stefano Costanzo showing the area of Khor Marmadeb where the site UA50 is located. Image created with QGIS 3.4 (QGIS Development Team, 2019) using public domain satellite imagery datasets retrieved through the QGIS plugin QuickMapServices (NextGIS, 2019). Upper right panel: b) Grave 1 (Female, 20-25) with the individual in a contracted position on the left side. Lower right panel: c) Grave 3 (Male, 40-45), with the individual in a contracted position on the right side.

Results

Grave 3 (Male, 40-45)

The individual shows the bilateral occurrence of a supplementary mandibular premolar, which erupted on the lingual side of the mandible, between the fourth premolar and the first molar, in close contact with both teeth. On the right side, where the crowns of the first molar, the fourth premolar, and the supernumerary tooth are preserved, the additional tooth resembles a permanent premolar in both size and shape (Figure 2b). The CBCT examination showed the tooth has an independent root. Unlike the other teeth, this tooth is not worn, as it has never reached the occlusal plane (Figure 2b, 2d). For the left hemimandible, the first molar, the fourth premolar, and a supernumerary premolar are seriously damaged by a severe carious lesion involving the crown of the three teeth, but their roots are still recognizable (Figure 2c). The CBCT examination suggests that the anomaly occurred bilaterally, showing the presence of the roots of three different teeth arranged similarly to the right

side of the mandible (Figure 2e). The root canal morphologies of the supernumerary and adjacent teeth confirm the nature of premolars.

Grave 1 (Female, 20-25)

In this female individual, the right mandibular canine has transmigrated following the type-5 category described by Mupparapu (15), as it occupies a space vertically in the midline with the long axis of the tooth crossing the midline of the mandible (Figure 3a, 3c). The root of the transmigrated canine is completely formed. The left canine is unerupted and impacts the distal aspect of the left lateral incisor (Figure 3e). As a consequence of the transmigration of the right permanent canine, the right deciduous canine is retained, and it is worn, due to its prolonged use during life (Figure 3d).

Both the mandibular central incisors are missing and the alveolar sockets are fully resorbed. These teeth might have been lost during life, as a consequence of the transmigration of the right canine. In some cases, indeed, the

transmigration of a tooth can cause the resorption of the roots of the adjacent teeth (16, 17). Anyway, the missing teeth might have been traumatically lost, or, as a possible third option, dental avulsion could be considered. Indeed, it must be taken into account that intentional incisor avulsion is a widespread cultural practice in Africa (18) and, in particular, in Sudan, this practice has been documented among human groups from the pre-Mesolithic period to the present (19). This is even more interesting when considering that the maxillary central incisors didn't preserve either. Unfortunately, we cannot know if these teeth have been lost *intra vitam* like the mandibular ones.

as supplementary, if they have a normal shape and size, or rudimentary, if they have an abnormal shape and smaller size and may be conical, tuberculate, or molariform (20, 22). Based on its position, a supernumerary tooth can be classified as mesiodens (if located in the incisor region, at the midline), paramolar (if located vestibularly, beside a molar), distomolar (if located distally of the third molar), and parapremolar (if located beside a premolar) (23). Supernumerary teeth may appear as a single tooth or multiple teeth, occurring unilaterally or bilaterally, erupted or impacted, either in the maxilla or mandible or in both. The highest incidence of supernumeraries involves single teeth, followed by double and multiple (24, 25). Supernumerary teeth can be found in almost any

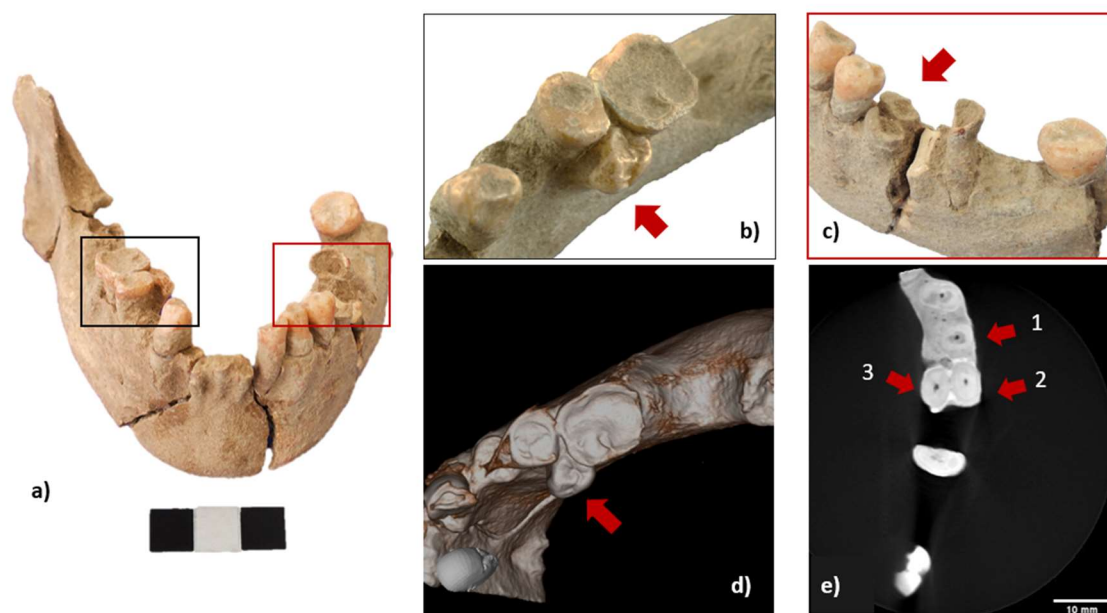


Figure 2. Grave 3 (Male, 40-45): Left panel: a): frontal/oblique view of the mandibula. Upper right panel: b) lingual view of the right mandibular premolar region with the supernumerary premolar, erupted on the lingual side of the mandibula between the fourth premolar and the first molar; c): buccal view of the left mandibular premolar region with the roots of the first molar, the fourth premolar, and a supernumerary premolar recognizable. Lower right panel: d): 3D volume rendering of the CBCT volume of the right hemimandible, occlusal view; e): axial reformatted image of the CBCT volume of the left hemimandible (slice thickness = 1mm) showing the roots of the third premolar (1) the fourth premolar (2) and the supernumerary one (3).

Discussion

Supernumerary premolars

'Supernumeraries' are defined as those teeth in addition to the expected number in a deciduous or permanent series (20, 21). Based on their morphology, supernumerary teeth can be defined

region of the dental arch. Anyway, according to clinical literature, supernumerary premolars are a rare condition: only about 8-9% of all supernumerary teeth occur in the premolar region (21). According to contemporary epidemiological studies, the prevalence of supernumerary

premolars in the general population ranges between 0.01% and 1%, with populations from the East or Africa being the most affected (21). Unlike other supernumeraries, supernumerary premolars occur more often in the mandible, where the additional teeth are generally of the supplemental type (26). Although mandibular supernumerary premolars are common, their bilateral occurrence is uncommon (20, 21, 25). Although the occurrence of supernumerary teeth is associated with syndromes or developmental anomalies such as Gardner's syndrome, cleidocranial dysplasia, and cleft lip and palate (21, 27, 28), the most widely accepted theory to explain the occurrence of supernumerary premolars is that these teeth belong to a third – post-permanent – series, developing from the localized hyperactivity of the dental lamina (21, 29, 30).

Retention of the deciduous canine

Contrary to permanent teeth, deciduous teeth undergo exfoliation. Indeed, as soon as a deciduous tooth has fully developed, root resorption is physiologically triggered by apoptosis – the programmed cell death which occurs as a controlled part of an organism's development – of cementoblasts and odontoblasts (31). In some cases, though, a deciduous tooth can be retained beyond the time of normal exfoliation. According to clinical literature, this phenomenon is related to developmental anomalies of the permanent successors, such as congenital absence, impaction, inclusion, or intra-bony migration (32, 33, 34, 35, 36, 37, 38, 39, 40).

The retention of deciduous mandibular canines is rare. Clinical evidence shows that deciduous mandibular second molars are the most frequently retained deciduous teeth, followed by the right and left maxillary canines and second molars on both sides (40).

Canine anomalies: inclusion, impaction, and transmigration

Tooth inclusion – or primary retention – refers to the failure of a normally placed and fully developed tooth before gingival emergence without a recognizable physical barrier in the eruption path (41). This anomaly is probably caused by a disturbance of the dental follicle that fails to initiate the metabolic events responsible for the eruption path (42).

Conversely, if the cessation of the eruption is due to a physical barrier in the eruption process, the tooth is defined as impacted. According to clinical

literature, the most frequently impacted permanent teeth are third molars, followed by maxillary canines (41). In particular, the prevalence of impacted canines ranges from 0.92% to 5.1%, more often in the maxillary arch (43). The most probable cause for the impaction of mandibular canines is hereditary primary tooth germ displacement, which leads to abnormal angulation of the tooth's long axis and consequently to the impaction (44).

In some cases, the failure of the eruption of permanent canines may lead to intra-bony migration. The term 'transmigration' refers to the intraosseous migration of an impacted tooth beyond the midline for more than half of its length (45, 46). Transmigration is a relatively rare developmental anomaly that starts during the early mixed dentition stage (17).

Canine transmigration occurs infrequently, with a prevalence ranging from 0.52% to 5.1% (36, 47). According to modern clinical evidence, this anomaly is observed more often in the mandible (48, 49, 50) and women are generally more affected than men (32, 49, 51). In 2002, Mupparapu classified mandibular canines transmigration into 5 different classes (15). In most cases (type I), the impacted canine is mesioangularly crossing the midline, labial or lingual to the anterior teeth, with the crown portion of the tooth crossing the midline. The least frequently occurring type is 5, with the canine positioned vertically in the midline with the long axis of the tooth crossing the midline (15).

To date, the etiology of mandibular canine transmigration is still not fully understood, but it was suggested that the occurrence of tumors, familiarity factors, and disorders of the endocrine glands can be causative factors for this anomaly (44, 52, 53). As mentioned above, canine transmigration is often associated with the retention of the deciduous canine (32, 33, 34, 35, 36) and in some cases, this anomaly can cause the resorption of the roots of the adjacent teeth (16, 54, 55).

Although the clinical literature reports numerous cases relating to the dental anomalies here described, to date, only scanty evidence of dental anomalies from archaeological populations were published. In particular, more recent cases of supernumerary premolars were recorded in archaeological populations from Southwest India, Hungary, Croatia, and Mesoamerica (56, 57, 58, 59). Even if canine impaction is frequently recorded in modern populations, archaeological cases of this anomaly are rare and involve mainly the maxillary arch (60, 61, 62). To date, the only

published archaeological cases of impacted mandibular canines come from Copper Age France and Roman period Croatia (63, 64). As far as we know, the case of canine transmigration reported in this contribution is the oldest available for Sudan, as two later archaeological cases from the same region have been recorded in two female individuals from the Late Kerma (1500-1200 BCE) and Christian period (600-800 CE) (9).

has probably not influenced the way of life of the adult male from Grave 3, the clinical picture of the young woman from Grave 1 clearly shows a deficit of occlusion in the anterior region of the dentition which may have influenced the chewing abilities of this individual. Furthermore, the unproven but probable avulsion of the lower central incisors could mean a practice already attested in the area for a long time. Ongoing detailed study of oral pathologies and

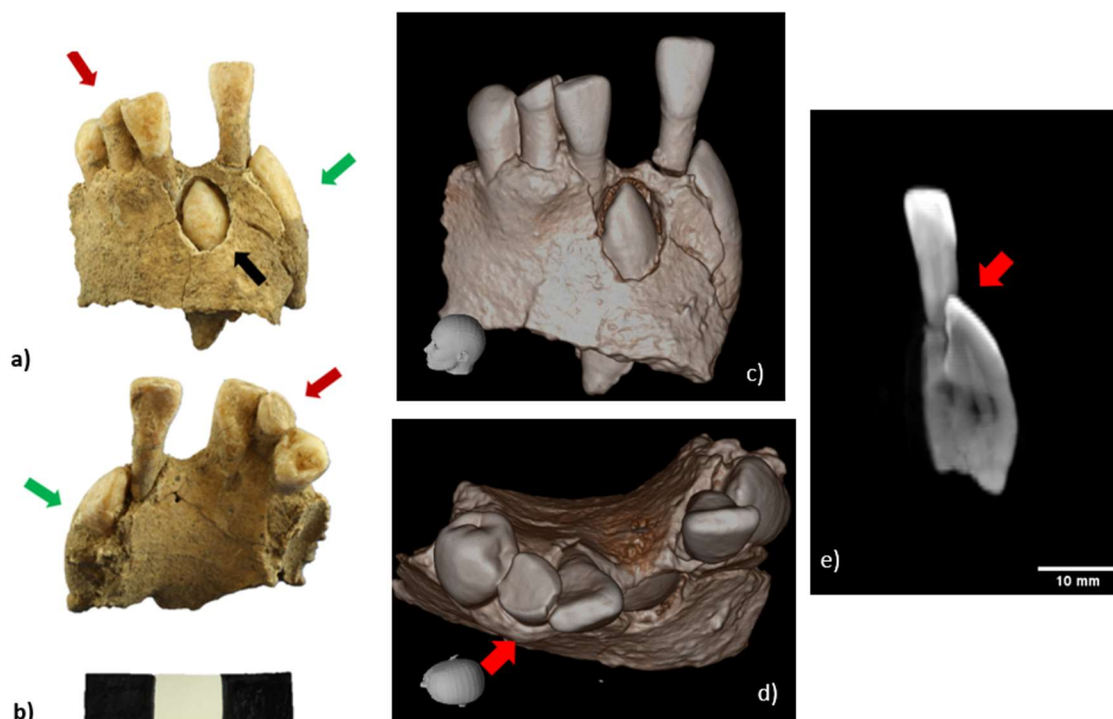


Figure 3 Grave 1 (Female, 20-25). Left panel: symphyseal (a) and lingual (b) view of the mandibular symphysis showing the left canine (green arrow), the right transmigrated canine (black arrow), and the retained deciduous canine (red arrow). Right panel: c) 3D volume rendering of the CBCT volume of the mandibular fragment, symphyseal view; d) 3D volume rendering of the CBCT volume of the mandibular fragment, occlusal view. The right deciduous canine is retained, and it is worn due to its prolonged use during life (red arrow); e) transverse reformatted image of the CBCT volume of the mandibular fragment (slice thickness = 1mm) showing the left canine impacting the distal aspect of the left lateral incisor.

Conclusion

The two dental anomalies cases reported, pertain to two adult skeletal individuals from the Mesolithic graveyard UA 50, in Eastern Sudan. On the overall presence of five adult mandibles, the observation of two cases of dental anomalies shows an unexpectedly high prevalence (40%). While the presence of supernumerary premolars

isotopic analyses on the skeletal sample from the graveyard UA 50 and other important skeletal collections from the area, provided by the investigations of the IAEES, will allow us to better understand the adaptation and mobility dynamics of the human groups who lived in Eastern Sudan during the Mesolithic-Neolithic transition.

Declaration of interest

The author declares no conflict of interest.

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