Radicular *dens invaginatus* in Late Bronze Age in Armenia

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Bull Int Assoc Paleodont. 2016;10(2):52-59.

Abstract

The purpose of this paper was to present a case of type III dens invaginatus, identified on the maxillary right second premolar. To date there have been no reports about dens invaginatus in ancient teeth from Armenia. This skull was unearthed from Quchak site (Aparan region) in Armenia. Based on archaeological findings, most of the graves of Quchak were dated to the Late Bronze Age.

Keywords: dens invaginatus; premolar; Armenia

Introduction

Dens invaginatus known also as dens in dente from the literature is a developmental anomaly resulting from invagination of enamel organ into the dental papilla, beginning at the crown and sometimes extending into the root before calcification occurs (1-3). It commonly occurs in maxillary permanent lateral incisors followed by the maxillary central incisors, premolars, canines and less often in the molars (2). The defects may vary in size and shape from a loop like, pear-shaped or slightly radiolucent structure to a severe form resembling a “tooth within a tooth” (4). This kind of malformation was first described by ‘Ploquet’ in 1794 in whale’s tooth (5).

Over the last few decades, several theories have been proposed to explain the aetiology of this malformation but it is still unclear: growth pressure of dental arch resulting in buckling of enamel organ (6); Kronfeld (7) suggested that it results from a focal failure of growth of internal enamel epithelium; Rushton (8) proposed that the invagination is a result of rapid and aggressive proliferation of a part of internal enamel epithelium invading the dental papilla; Oehlers (9) considered that distortion of the enamel organ during tooth development and subsequent protrusion of a part of the enamel organ will lead to the formation of an enamel-lined channel ending at the cingulum or occasionally at the incisal tip; the ‘twin-theorie’ suggested a fusion of two tooth-germs (10); infection was considered to be responsible for the malformation (11); Gustafson and Sundbergdiscussed (12) trauma as a causative factor; genetic factor cannot be excluded (13, 14); it may result from a deep infolding of foramen caecum during tooth development which in some cases may result in a second apical foramen (15); ectomesenchymal signaling system between dental papilla and the internal enamel epithelium can affect tooth morphogenesis (16); these signals have specific roles such as tooth morphogenesis and the folding of enamel organ (17).

Materials and Methods

The Quchak site is a burial site, which includes at least 10 individuals (excavations 1987, 2011). Their individual ages ranged from 15 to 55 years old. While the attempt to completely register burials and grave goods from Quchak is currently in progress, nearly all burials were accompanied by Late Bronze Age ceramics. The burials were made in burial chambers, the walls of which were made of slabs. The human skeleton, analyzed for this article, was excavated by archaeologist Levon Petrosyan. The individual was buried in a stone box, oriented on an east-west axis.

Sex and age at death of the individual were determined according to standard osteological methods. Measurements were taken as outlined in Alexseev (18). The results are shown in Table 1. Non-metric traits have been recorded for skull (19) and dentition (20, 21, 22) in order to allow future comparisons with findings from other sites of Armenia. In addition to the gross visual examination of the congenital anomaly and X-ray have been applied.

Most commonly used classification was proposed by Oehlers in 1957. He described the anomaly occurring in three forms (coronal invaginations) (Figure 1): Type I - an enamel-lined minor form occurring within the confines of the crown not extending beyond the cemento-enamel junction; Type II - an enamel-lined form which invades the root but remains confined as a blind sac. It may or may not communicate with the dental pulp; Type IIIA - a form which penetrates through the root and communicates laterally with the periodontal ligament space through a pseudo-foramen. There is usually no communication with the pulp, which lies compressed within the root; Type IIIB - a form which penetrates through the root and perforating at the apical area through a pseudoforamen. The invagination may be completely lined by enamel, but frequently cementum will be found lining the invagination. In 1958, Oehlers also described the radicular form of invagination. This type is rare and is thought to arise secondary to a proliferation of Hertwig’s root sheath and radiographically, the affected tooth demonstrates an enlargement of the root (23).

Schulze and Brand (24) proposed a more detailed classification, including invaginations starting at the incisal edge or the top of the crown and also describing dysmorphic root configuration.

The prevelance of each type of invagination was reported by Ridell et al. (25) with Type I being the most common (79%) whilst Type II (15%) and III (5%) less frequently observed. Present case was Classified as Oehler’s Type IIIA dens invaginatus resembling last diagram in Figure 1.

The nature and variety of the dental anomalies present in ancient populations should help us to understand the origin, development, and possible aetiology of such anomalies. The aim of this report is to examine, via X-ray, the anatomy of a maxillary right second premolar with type 3 dens invaginatus.

l	Maximum cranial length	185
8	Maximum cranial breadth	134
l7	Cranial height	133
5	Cranial base length	102
9	Minimum frontal breadth	94
12	Occipital breadth	109.9
29	Frontal chord	102.2
30	Parietal chord	116.5
31	Occipital chord	103
43	Upper facial breadth	101
48	Upper facial height	66
60	Maxillary alveolar length	52
61	Maxillo-alveolar breadth	61.5
62	Palatal length	41
63	Palatal breadth	31.1
55	Nasal height	51
54	Nasal breadth	25.5?
51	Orbital breadth	40.8
51a	Orbital breadth	37
52	Orbital height	36
8:1	Cranial index	72.44
17:1	Height-length index	71.892
17:8	Height-breadth index	99.26
9:8	Fronto-transverse index	70.15
54:55	Nasal index	50.0
52:51	Orbital index (mf)	88.24
52:51a	Orbital index (d)	90.69
63:62	Palatal index	75.86

Table 1. Some anthropometric measurements in mm (code numbers according Martin (18)).

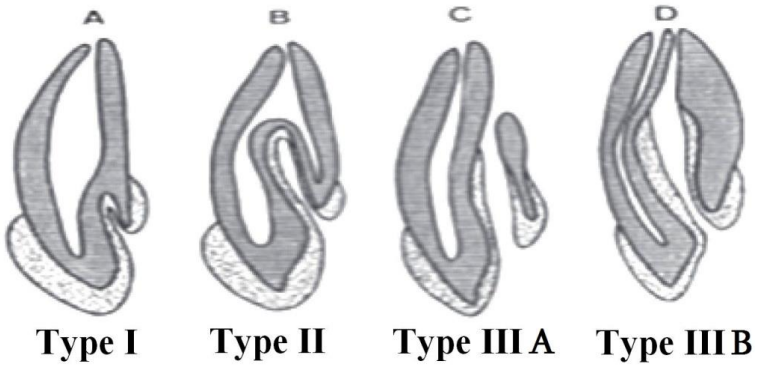

Figure 1. Oehler's classification of dens invaginatus (coronal types)

Results

The female individual of a Late Bronze Age, burial 39/3, from Quchak site was approximately 20-29 years of age at death. Unintentional cranial deformation (cradle deformation: sagittal flattening) was found in female. The flattened surface thus slopes to the top above the lambda. This pressure would have to be exerted downward and forward, unless the head and the whole body were pressed up against a forward-sloping board of pad. This flattening is a deformation that could have been effected by the infant lying on the back with the head resting on the occiput. Thus, cradle deformation is heavily influenced by infant sleep position, and constant supine positioning is a frequent cause of deformation during infancy (26).

The following measurements (mm) were recorded from the skull (Table 1): cranial length, 185; cranial breadth, 137.5; cranial height 133, frontal breadth, 94; occipital breadth, 109,9; frontal chord, 102.2; parietal chord, 116.5; occipital chord, 103; alveolar arch length, 52; alveolar arch breadth, 61.5; palatal length, 41; palatal breadth, 31.1; nasal height, 51; nasal breadth, 25.5; orbit height, 40.8; orbit height, 36. The following traits were presence: foramina zygomaticofacialia, stenocrotaphia, processus frontalis squamae temporalis, os epiptericum, os postsquamosum, os wormii suturae lambdoidea, sutura palatina transversa (∏-shaped), sutura incisive, foramen pterygospinosum, canalis craniopharyngeus, foramina spinosum, manifestatio vertebrae occipitalis, foramina mentalia.

Teeth of the individual of the Quchak are characterised by hypocone UM2, hypodontia of M3 (Figure 1). Two measurements, faciolingual (maxilla: M1 6 мм, M2 6.6 мм /right/; maxilla: P1 7.5mm; P2 6mm; M1 6.5mm; M2 6 мм /left/) diameter and mesiodistal (maxilla: M1 8мм, M2 7мм, /right/; maxilla: P1 4 mm; P2 3.9mm; M1 7.8мм, M2 7.2мм /left/) diameter were taken for each M as described by Zubov (22).

Examination revealed slight cuspal anomaly in the jaw right second premolar. A diagnosis was established of dens invaginatus. According to the Oehlers system (9, 27), the tooth was classified as a Type IIIA dens invaginatus. A radiograph with files in the root canals was obtained (Figure 2). Unfortunately there is post-mortem loss of the upper two right central incisors and the premolars. We do not have any information about the root morphology P2 due to the post-mortem loss. The tooth had a single root, and no evidence of infection was noted. Furthermore, present anatomical evidence of not deep pit. Examination revealed slight pits and with left side of second premolar (Figure 3). A female shows evidence of a brain abscess (Figure 4) that is consistent with a diagnosis of tuberculosis (28). The infection has produced a smooth walled cloaca with the appearance of an accessory foramen that passes through the masto-occipital suture.

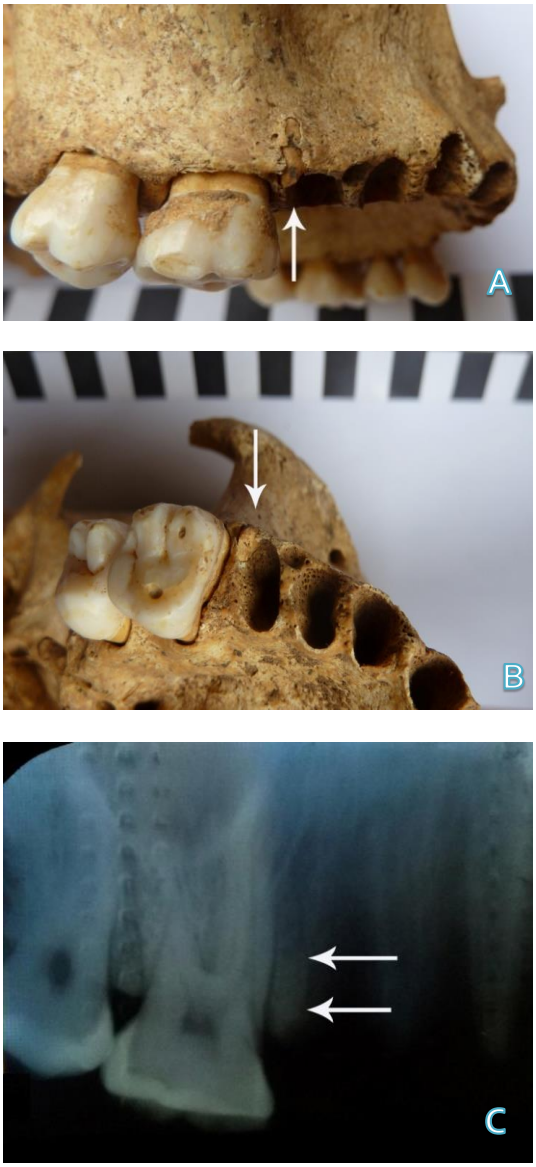

Figure 2. Maxillary right second premolar with type 3 dens invaginatus (A-C).

On the left parietal of cranium there is a small osteoma, located in the near the sagittal suture. It is circular in shape (6.5×6 mm diameter) and slightly protruding (less than 1 mm). There are no differences between the surface of the osteoma and that of the surrounding bone. Cranium exhibits hyperostosis in both auditory canals (Figure 5).

Calculus was recorded on the teeth of individual. The most severely affected teeth were the molars (M1). As shown in Figure 3, enamel hypoplasia weakly appears linearly on the enamel surface (P1, P2).

Figure 3. Slight pits with left side of second premolar. (A-B).

Discussion

Generally, dens invaginatus is thought to be rare, but a report by Hallet showed that the prevalence of dens invaginatus can be as high as 49.62% of individuals and 32.34% of examined teeth (29), suggesting that dens invaginatus may occur more often than other developmental anomalies. A study by Thongudomporn et al. (30) found that dens invaginatus was the most prevalent dental anomaly among 111 orthodontic patients, while Uslu et al. (31) reported tooth agenesis as the most common (21.6%), followed by dens evaginatus (6.2%), dens invaginatus (5.0%), pulp stones (4.2%), and impaction (2.9%).

Figure 4. Evidence of a brain abscess. (A-B).

Figure 5. Auditory hyperostosis.

Although there have been many studies reporting the prevalence of dens invaginatus, few reported studies have been conducted on ancient teeth (32). Keleş et al. (33) reported of maxillary third molar with type 2 dens invaginatus in Perge (2nd and 3rd century AD). Shi et al. (34) scanned 517 permanent teeth with a micro CT to examine the prevalence and types of dens invaginatus in an ancient Chinese population. They reported a 31.34% (21 of 67) prevalence of dens invaginatus in maxillary lateral incisors. The invaginated lingual fossa (Type I) occurred most frequently (84%), followed by radicular grooves (Type II; 16%), while Type III and Type IV were not found. This report presents case of dens invaginatus in permanent maxillary left second premolar. Maxillary lateral premolar (or incisor) are the teeth most susceptible to invaginations.Type IIIa presents as a deep fissuring of the tooth that exits on the lateral surface of the root.

Stress markers on teeth are not very common. Enamel hypoplasia is one such marker. The female survived not strong metabolic stress during the early childhood (35). Metabolic stress is strongest during the transition from the diet based on the sterile breast milk to the diet rich with microorganisms. The diet of consisted of low cariogenic food. High intakes of proteins and fats result in an alkaline plaque (36) consisting of undissolved mineral salts. When this mineralized matter is not removed through cleaning it accumulates to form visible accretions on the tooth or root surface.

Artificial cranial modification is performed during infancy or early childhood while the cranial bones remain malleable. The skull of a young female (20-29 years) from Quchak burial 39/3 shows signs of cradle deformation. Cradle deformation is heavily influenced by infant sleep position, and constant supine positioning is a frequent cause of deformation during infancy. Regarding unintentional skull deformation, it can be observed that cradle deformation was detected in 22.9% of individuals from Armenia in Late Bronze Age and Early Iron Age (26).

The left parietal bone displays a button osteoma. An osteoma (or also known as button osteoma) is a benign, slow-growing tumor which occurs almost exclusively in the skull (37, 38). Osteomas most commonly occur on the frontal and the parietal bones in approximately 35% of the population (38, 39). Aufderheide and Rodriguez-Martin (37) report that button osteoma occur more in males, Eshed et al. (40) account that females are more frequently affected, and Sewell et al. (39) only mention that the sex distribution is controversial.

Presence and features of auditory hyperostosis were investigated in individual of Quchak. The etiology of ear hyperostosis has been related to external factors such as a continued cold water exposure (41, 42) or infections (41). On the other hand, some authors (43-46) related this pathology to genetic factors, using it as a non-metrical trait to establish genetic distances. The author are in agreement with Hrdlička (43) and believe that auditory hyperostoses, and those of cranium from Quchak in particular, are the result of an external factor that stimulates a genetic predisposition.

This female also has an abscesses on the occipital bone. It a serious, life-threatening disease and remains a potentially fatal entity (47). The earliest reference to brain abscesses can be attributed to Hippocrates in 460 B.C. when he recognized a syndrome of purulent otonhea and fever associated with cerebral symptoms. Hippocrates considered the infection to be secondary to the brain abscess. Brain abscess is caused by inflammation and collection of infected material, coming from local (ear infection, dental abscess, infection of the mastoid air cells of the temporal bone, epidural abscess) infectious sources, within the brain tissue. Tuberculosis also can produce brain abscesses. Scheidel (48) points out that high rates of tuberculosis have an increased impact on death rates and especially causes a high mortality amongst young adults.

Conclusion

A case of dens invaginatus was found on a maxillary left second premolar. This skull was unearthed in Quchak site (Armenia). To understand the origin, frequency, and tendencies of invagination it is proposed that similar studies on further ancient human skeletal populations be conducted.

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