Eurasian Journal of Anthropology Euras J Anthropol 4(2):45−50, 2013

A micro computed tomography examination of dens invaginatus type 2 in an approximately 2000 year-old maxillary molar tooth—a case report

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Received September 3, 2013
Accepted December 28, 2013

Abstract

A case of dens invaginatus was found on a maxillary molar. This tooth was unearthed from a grave complex in Perge, one of the major cities of the province of Pamphilia in Southern Anatolia. Based on archaeological findings, most of the graves of Perge were dated to the 2nd and 3rd century AD. A commercially available high-resolution micro-computed tomography (SkyScan 1172; Bruker-microCT, Kontich, Belgium) was used to scan the tooth. From the visual analysis of the three-dimensional micro CT reconstruction, the invagination lumen has a coronal entrance. Communication between pulp and invagination lumen was not detected. In the micro CT images, it is apparent that the density of the enamel around the invagination is less than the coronal enamel. Micro CT analysis showed that the invaginated ancient tooth shares the same anatomical and morphological features as modern dentition. However, to understand the origin, frequency, and tendencies of invagination it is proposed that similar studies on further ancient human skeletal populations be conducted.

Keywords: *dens invaginatus, dental anomaly, micro-computed tomography*

Introduction

Dens invaginatus, also called dens in dente, gestant odontoma, and dilated compound odontoma, is commonly known as a structural malformation that occurs before the calcification of the tooth from the enamel and dentin to the pulp (Keles and Cakici, 2010; Alani and Bishop, 2008). The prevalence rate of dens invaginatus in populations varies from 0.04% to 26.1% (Alani and Bishop, 2008; Hovland and Block, 1977), and occurrences of dens invaginatus in posterior teeth contribute a very small percentage (Bansal et al., 2010; Shi et al., 2013). This malformation is characterized by a deep enamel-like tissue lined pit that extends to varying depths into the underlying

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ISSN: 2166-7411

dentin and sometimes extends periodontal ligament space through a pseudo-foramen (Keles and Cakici, 2010).

The classification of dens invaginatus by Oehlers' is the most widely accepted (Oehlers, 1957). He described three types: Type 1—the invagination involves only the crown and does not extend to the cemento-enamel junction, and the enamel is lined as a minor form; Type 2—The invagination enamel lined form extends from the cemento-enamel junction to the root. It may or may not interconnect with the pulp cavity; Type 3—the invagination occurs in the root and sometimes may cause a second foramen as it penetrates and perforates at the root apex.

Radiographic and modeling techniques have been used to study the internal configuration of human teeth. However, these techniques may be invasive and inadequate because they are based on two-dimensional analyses and therefore cannot precisely reflect the total morphology of the tooth being studied (Fan et al., 2008). Micro CT has been applied to evaluate root canal variations of modern (Fan et al., 2008; Gu, 2011) and ancient dentition (Versiani et al., 2011; Shi et al., 2013) because of its high resolution and non-destructive method of examining specimens.

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 micro CT, the structure and the anatomy of a ca. 2000 year-old maxillary third molar with type 2 dens invaginatus

Material and methods

Perge was one of the prominent cities of the province of Pamphilia in Southern Anatolia, Turkey. It is situated 11 km to the north of the Mediterranean coast and 25 km east of modern Antalya (ancient Attelia). The specimen studied was unearthed from the western necropolis, which is one of the three necropolises at Perge (Abbasoğlu, 2001).

The tooth discussed in this paper was unearthed in the third chamber of a four chambered grave complex (M6). Skeletal remains had been scattered in the chamber tomb by treasure hunters in ancient times. An MNI (minimum number of individuals) of at least forty-six was determined for the third chamber tomb. The tooth evaluated in this paper was broken post-mortemly. For this reason, it is not possible to determine which skeleton it belonged to. Likewise, the determination of the sex of the individual to whom the tooth belonged cannot be made.

Micro CT examination

A commercially available high-resolution Skyscan 1172 micro CT system (SkyScan 1172; Bruker-microCT, Kontich, Belgium) was used to scan the tooth. The X-ray tube was operated at 85 kV and 118 μA using a 0.5 mm Al+Cu filter with a resolution of 13.68 μm pixels. The tooth was scanned for 60 minutes. The resulting two-dimensional images (8 bit TIFF) were used to reconstruct axial cross-sections. The raw data set was then reconstructed into images using NRecon v.1.6.3, CTAn v.1.12 and CT Vol v.2.2.1 software (Bruker-microCT).

Results

A total of 831 molar teeth, of which 192 belong ARE third molars, have been analyzed and only one of them exhibited the invagination. The frequency is 0.52% among third molars and 0.12% among molars.

The micro CT images show that the invagination lumen has a coronal entrance. In addition, although the lumen is surrounded by enamel, the lumen exceeds the enamel

and reaches up to its dentine in some levels of invagination. Although the invagination affects the shape of the pulpal tissue, a communication between the pulp and invagination lumen was not detected. The invagination lumen exceeds the enamel in the apical section of the invagination and extends to the dentine (Figure 1).

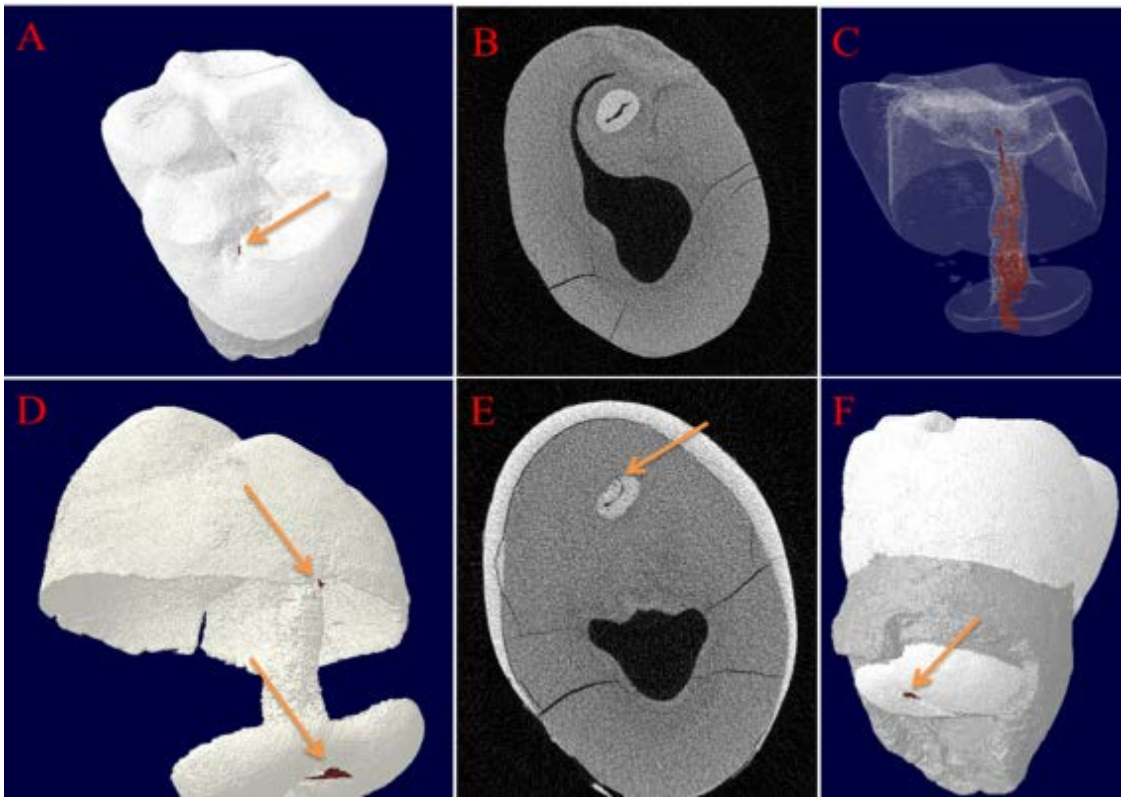

Fig. 1: The invaginatus lumen has a coronal entrance (A), the lumen affects the shape of the pulp (B), the anatomy of the lumen (C), the lumen exceeds the enamel and reaches up to its dentine in some levels of invagination (D, E, F)

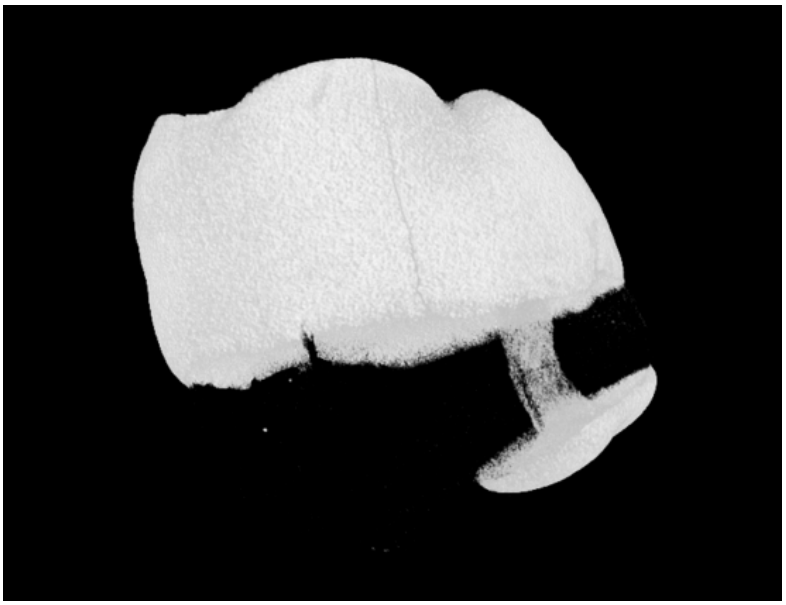

Fig. 2: The density of some sections of the enamel around the invagination is less than the normal enamel of the tooth.

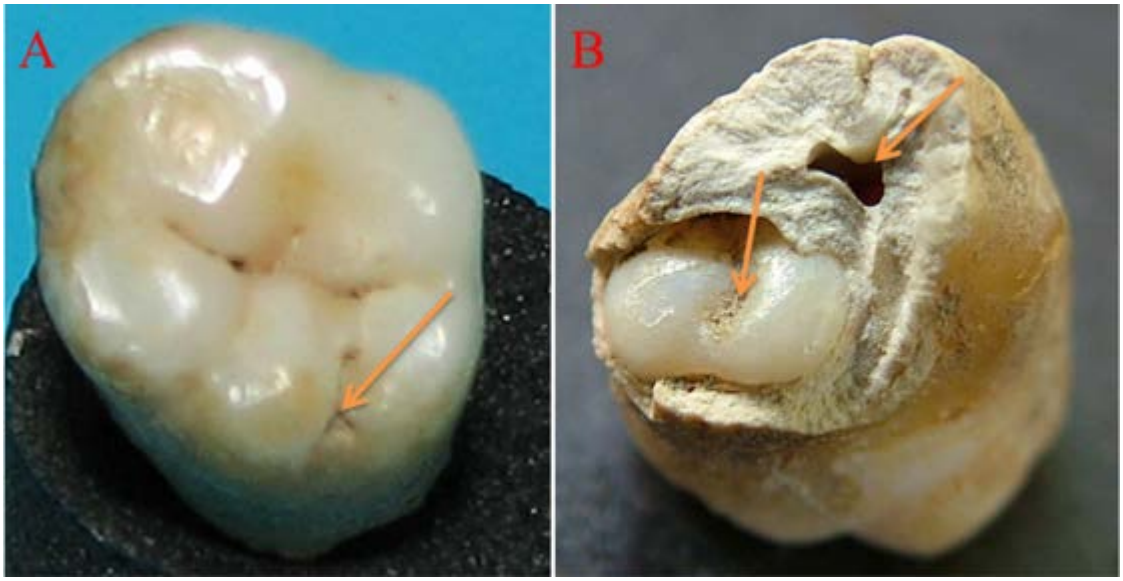

Fig. 3: The coronal entrance of the lumen (A), the pulp space (B), the lumen exceeds the enamel in the apical section of the invagination (B).

In the micro CT images, it is apparent that the density of some sections of the enamel around the invagination is less than the normal enamel of the tooth (Figure 2). Although some variations were found in the crown morphology of the tooth by visual examination, there were no apparent signs to indicate that the tooth had an invagination. We do not have any information about the root morphology due to the breakage (Figure 3).

Discussion

Today, the prevalence of dens invaginatus in maxillary molar teeth is quite rare (Alani and Bishop, 2008; Hovland and Block, 1977). The frequency of dens invaginatus for molar teeth in Perge is similar to the low figures of published frequencies (see Alani and Bishop, 2008; Hovland and Block, 1977). In dens invaginatus the appearance of the crown may vary, ranging from normal to more unusual forms such as a greater labio-lingual or mesio buccal diameter, a peg-shaped, barrel-shaped, or conical shaped crown. These may also be associated with a dens evaginatus or a palatal groove (Goncalves et al., 2002; Bishop and Alani, 2008). Although some variations were found in the morphology of the crown of the tooth during visual examination, there were no apparent signs to indicate that the tooth had an invagination. The presence of the fifth tubercle on the crown of the tooth, as well as the distinctness of the location of that tubercle could not be compared due to the lack of an antimere. Often the entrance to the invagination is difficult to locate and the use of magnification can help with identification (Keles and Cakici, 2010). In this case report, a connection between the invagination and outer surface of the tooth was not macroscopically apparent, but the micro CT images show however that the invaginatus lumen has a coronal entrance.

The micro CT images indicate that the invagination exceeds the enamel surrounding the lumen of the invagination, and reaches up to dentine. It is also known that the invagination lumen passes into the dentine from the enamel whereby bacteria, by reaching the dentine tubules, can cause pulpal necrosis (Alani and Bishop, 2008; Kramer, 1953).

From the visual analysis of the three-dimensional micro CT reconstruction it can be observed that the enamel around the lumen has less density when compared with the enamel of the tooth. Beynon (1982) has reported the presence of hypomineralized enamel at the base of the invagination. In addition, Morfis (1993) has described an alteration in the chemical structure of the enamel of the invagination. The study reports the absence of magnesium, but increased phosphate and calcium ions compared to the normal coronal enamel.

Dental anthropological studies suggest that human dentition has evolved both in its size and shape (Scott and Turner, 1997). Previous research on dental remains has demonstrated that the size of the dentition decreases with age, the number of tubercles decreases, and the complex morphology of the dentition becomes more simple (Scott and Turner, 1997; Brace and Mahler, 2005). Reductions in both size and in morphological complexity have proceeded farthest where cultural change has occurred most rapidly (Brace and Mahler, 2005). Although there is some information about crown morphology and dental tissues (Brace and Mahler, 2005), only one available study sheds light on the prevalent types and nature of dens invaginatus in ancient populations. Shi et al. (2013) 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 0% prevalence of dens invaginatus in posterior teeth.

This case report presents a ca. 2000-year-old maxillary third molar with type 2 dens invaginatus and the nature of this invagination. However, to understand the origin, tendencies, and frequency of this anomaly studies on additional ancient human remains are needed in order for them to be considered at population level.

Micro CT analysis has shown that the invaginated ancient tooth has the same anatomical and morphological features as modern dentition with this anomaly. However, the origin and the frequency of this kind of anomaly can only be truly evaluated if studies on skeletal remains are conducted at a population level, or with succeeding populations.

Acknowledgement

We would like to thank the site director of Perge, Prof. Dr. Haluk Abbasoğlu, for granting permission to analyze the Perge skeletons. We would also like to thank Assoc. Sedef Çokay Kepçe, and Assistant. Prof. Aşkım Özdizbay for their hospitality during the analysis, as well as Benjamin Irvine for his help during the editorial process. The authors deny any conflicts of interest.

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