Denticles. A literature review

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ABSTRACT

Denticles are pulp degenerations in the form of calcified deposits of mineral salts, usually found in molars and lower incisors, as well as in impacted teeth and deciduous molars. Denticles may come in various sizes, from microscopic particles to larger mass that almost obliterate the pulp chamber and are visible only on X-ray images. Denticles form as a result of chronic inflammatory lesions, but may also be caused by injuries and conservative treatment. They are most frequently found in necrotic foci. Denticles may cause problems for root canal treatment, as their presence might make it difficult to obtain proper access to the pulp chamber bottom and the canal orifices. There is also the increased risk of bending or breaking the endodontic instruments. Sometimes, denticles fill the entire space of the tooth chamber and pushing the pulp to the edges of the chamber. Denticles can cause pain due to the pressure on the nerves and blood vessels supplying the internal tissue of the tooth. The presence of large denticles might eventually lead to necrosis of the pulp. Denticles accompany certain diseases, such as dentin dysplasia, odontodysplasia or Albright hereditary dystrophy. **Key wards:** teeth, denticles,

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LITERATURE REVIEW

The tooth pulp is a dentin-forming tissue. Initially, the pulp is responsible for the formation of the primary dentin, and in the fully formed tooth for the formation of secondary dentin. Denticles may be caused by fibroblasts by differentiation of secondary fibroblasts into cells producing hard tissue [1]. Also, the aging of the organism reduces the size of the tooth chamber due to the formation of the tertiary dentin and dental pulp atrophy. It starts with the apoptosis of odontoblasts and fibroblasts, and the accumulation of hydroxyapatite crystals. This is accompanies by the reduction of the perfusion due to the narrowing of the apical foramina caused by cement depositions. Furthermore, the number and diameter of nerve fibers is reduced and the blood vessels become calcified. Dental pulp inflammation also causes deposits of impaired secondary dentin and the formation of denticles or deposits of mineral salts, either loose or connected to hard tissue, called denticles or pulp stones [1,2,3]. Pulp stones also accompany a number of diseases, among others: end-stage renal failure, dental dysplasia, Ehlers-Danlos syndrome, Ellis-van Creveld syndrome, dentinogenesis imperfecta, van der Woude syndrome or Marfan syndrome. A correlation has been determined between the presence of denticles and the enamel pearls, taurodontism, dilaceratio and crooked roots [5]. Komorowska and Bany report that physiological or pathological stimuli to the pulp may result in the formation of increased mineralization sites usually referred to as denticles. Various reasons of the formation of increased mineralization sites in the pulp have been reported [6].

There is a number of classifications of denticles. One of the most popular classifications is based on the structure of denticles. According to Kmieć, the following types are distinguished:

- genuine denticles - highly shaped
- alleged denticles - low formed [4].

A characteristic feature of genuine denticles is their similarity to dentin [4]. They have more or less regular dentinal tubules extending from the Tomes fibers. They are usually found around the apical foramina, but are less frequent than alleged denticles [2]. According to Bargholz, all genuine denticles are anomalies related to the protrusion of dentine structures into chamber [1]. Bargholz defines genuine denticles as anomalies related to the invagination caused by the protrusion of the dentine structures into the chamber. Furthermore, Bargholz writes that the total protrusion may take the form of dens invaginatus. This claim is supported by numerous authors of English-speaking reports. According to White, the invagination in the crown is formed due to the incorrect protrusion of the enamel organ into the dental papilla, which results in the formation of a fold of the hard tissues of the tooth, lined with enamel. The final form of the defect may be the dentinoma, most frequently located in the incisors [7]. However, according to Allen, dentinoma is a very rare condition [8]. Furthermore, Cuevas-Nunez reports that the nature of the dentinoma remains largely unknown. Dentinoma is probably the effect of an epithelio-mesenchymal interaction during the tooth development [9]. The enamel lining the invagination of the crown is usually thin, deficient and often does not form at all. The invagination of the root develops as a result of the protrusion of the Hertwig epithelial root sheath and is most frequently found in mandibular first premolars and second molars. In most cases, tooth in tooth does not give any clinical symptoms. The crown morphology is usually normal, sometimes a sulcus forms on the incisal margin, or a particularly deep and wide *foramen cecum* with prominent lingual cusp [7,10].

The structure of alleged denticles is not similar to dentine. Alleged denticles consist usually of concentric running lines of calcification, with dead or calcified pulp cells in the central parts. The calcifying clots in the dental pulp blood vessels might also result in the formation of alleged denticles [2].

Another classification of denticles is based on their position with respect to dentin. In terms of the ratio of pulp stones to the dentin wall, the following types of denticles are distinguished:

- free denticles (interstitial denticles) - surrounded completely by the pulp,
- adjacent denticles (parietal denticles) - partially connected to the dentin,
- intradentinal denticles (intratissular denticles) - fused with canal wall and completely surrounded by dentin [2].

In terms of dimensions, the denticles are classified as:

- compact denticles - visible on an X-ray image,
- scattered denticles - not visible on X-ray image and detected by histopathological examination [11].

Furthermore, Bargholz also distinguishes:

- fibrous denticles - formed from the remains of the epithelial cells of the Hertwig epithelial root sheath, with odontoblasts arranged concentrically around,
- radial denticles - reticulin fibers surround the denticle, penetrate its structure and connect with the surrounding tissue,
- lamellar denticles - with loose connection of individual dentin layers. They are connected to the pulp blood vessels, often located in the center of the pulp stone [1].

The main cause of formation of the pulp stones is difficult to determine. Pulp stones often appear in teeth that appear normal in every respect [2]. According to Barańska-Gachowska, denticles might form in the course of chronic pulp

inflammation and after conservative treatment [2]. A large number of histopathological tests confirm that the presence of pulp stones is not necessarily related to the pathological symptoms of the pulp. The formation of pulp stones is affected by a number of factors and the exact cause remains unclear [1]. The Department Of Histology of the Jagiellonian University Medical College examined the ultrastructure of the denticle using electron microscopy. In the denticle, collagen fibers were observed, both individual and in bundles following different directions. The collagen fibers were not arranged uniformly and did not run perpendicular to dentinal tubules. Such arranged results in the less compacted tissue of the tubular space as compared to normal dentin. The authors hypothesized that the structure and the formation of the denticle were determined by the disorder of the layout and arrangement of collagen fibers in the tooth bud [12].

One of the factors contributing to the formation of calcium deposits that build up pulp stones is the necrosis of pulp cells induced by external stimuli, usually mechanical ones. Excessive masticatory load, occlusal trauma and parafunctions favor the formation of denticles. The concentric formation of denticles of teeth with broken crown was confirmed in 50% of examined patients [1].

The calcium deposits in the pulp are also caused by thermal injuries. Those injuries lead to the necrosis of tissues that are surrounded by the pulp to encapsulate and calcify in order to separate the necrotic tissue from healthy tissue [1].

Other causes of pulp stones include the dispersed mineralization in the pulp tissue. It consists in dispersed calcification in the form of mineral deposits along the blood vessels and collagen fibers [1].

Increased pulp mineralization was also observed in teeth affected by decay. The deeper the tooth decay, the larger size and number of pulp stones [1].

The reduction of blood supply to the pulp as a result of surgical procedures is also reported as a cause of formation of denticles [8].

In their study, Gao and Yang wrote that the bone morphogenetic protein (BMP) that belongs to the transforming growth factor family, is able to induce the growth of bone and cartilage if transplanted into tissue other than bone tissue. It also plays a significant role not only in bone formation, but also in the differentiation of normal tissues with tooth buds. BMP can play an important role in the epithelio-mesenchymal interactions during the tooth development. The disruptions in the BMP expression may lead to the formation of odontogenic tumors, including denticles [13].

Galler et al. in their study of the impact of the TWIST1 transcription factor in the pulp homeostasis in mice showed that TWIST1 inhibited the RUNX2 factor responsible for intensifying the mineralization process. They also observed that TWIST1 acted in protective capacity, preventing the formation of denticles [14].

Pulp stones usually form without symptoms and are detected by chance on X-ray images. On the X-ray image, a denticle might appear as a tooth set in another tooth, hence the name "tooth in tooth" [15]. Denticles may form in the vicinity of nerve fibers which, when pressed by the developing denticle, can induce spontaneous dental pain imitating trigeminal neuralgia or dental pulp inflammation. The diagnosis is posted on the basis of the X-ray image on which isolated shading is visible, after excluding other possible causes [2].

On the X-ray image, denticles take the form of round or oval shades in the tooth cavity. Digital radiography provides high quality images [16]. Denticles vary in size, from microscopic particles not visible on traditional X-ray images, to well-visible with 2-3 mm diameter [17]. Calcifications smaller than 200 μm in diameter are not visible on an X-ray image [5]. Denticles are structures that take various shapes, capable of absorbing X-rays similarly to dentin [3]. The size and number of pulp stones increase with age. Interestingly, denticles can form not only in erupted deciduous and permanent teeth, but also in unerupted teeth [2]. Ingrid Różyło-Kalinowska showed an X-ray image of the denticle of tooth 17. Różyło-Kalinowska pointed out that the image can be interpreted as either a denticle, an artifact, dental calculus deposits, enamel pearl or internal resorption foci. Therefore, X-ray is unable to provide an unequivocal clinical diagnosis [18]. The Chair and Department of Orthodontics of the Pomeranian Medical University conducted a study on the frequency and location of denticles on dental panoramic radiographs. The presence of pulp stones was found on 51.5% of examined images. On the majority of images, denticles were found only in pulp chambers, usually in molars with restoration. First molars were the location of over 50% of denticles. In 91.6% of examined patients, the pulp stones were observed in multirooted teeth. The studies indicate that the most frequent location of denticles are multirooted teeth, mainly the first molars with restorations [19].

Clinical management of denticles is difficult. Where pain is present, it will involve the removal of the pulp with the denticle [2]. One of the methods of eliminating denticles from the tooth cavity is with ultrasounds. Clinical trials show, however, that piezoelectric method is more efficient. The terminal of the piezoelectric device is applied to the side edge of the denticle and round motion is performed until the pulp stone is loosened. The denticle may also be filed from the root canal, provided that the entire length of the file fits along the denticle [20]. Also, the denticle may be broken off with a dental chisel or excavator. After the extraction, root canal treatment can be performed

using any method.

Dentists and other doctors often cooperate in the process of diagnosing and treating patients with denticles. The joint diagnostics is applied to the elimination of foci of inflammation and paroxysmal pain of the head and the bony face of unclear etiology. In his report, Łukomski described a case where a neurologist referred to dental consultation a 45-year-old patient with a diagnosed left trigeminal neuralgia. The patients complained on paroxysmal pain in the mandible and the jaw, occurring at various times during the day and night; the pain was radiating and had uniform intensity, and receded without intervention. The patient had suffered from the pains for 9 months. The X-ray examination indicated the presence of a denticle in the cavity of tooth 38 that was the direct cause of the recurring pain. The pulp stones located in the vicinity of nerve fibers press the fibers, thus inducing spontaneous pain similar to acute pulpitis or trigeminal neuralgia [21]. Krupiński indicates that one of the key errors related to denticles is the incorrect diagnosis. This error occurs frequently with pain in teeth without restorations and/or dental caries. In the case reported by the author, the patient with the denticle consulted with laryngologist (suspected otitis media) and neurologist (suspected trigeminal neuralgia) [22].

In conclusion, it should be pointed out that the presence of denticles might make impossible the appropriate dental management, often causing a break of the dental instrument in the cavity or the canal, incomplete filling of the root canal, pushing the material outside the apex of dens, or perforation of the cavity or the root. Teeth with denticles are a major issue in the dental practice. The increasing accuracy of the imaging diagnostics of the masticatory system enables early detection of denticles and their location in the pulp, and thus the appropriate clinical management.

Conflicts of interest

The authors declare no conflict of interest in this work.

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