

ORIGINAL PAPER

Radiological and microscopic aspects of the denticles

V. DEVA¹⁾, L. MOGOANTĂ²⁾, H. MANOLEA¹⁾, OANA-ADINA PANCĂ³⁾,
MIHAELA VĂTU⁴⁾, MARIA VĂTĂMAN⁵⁾

¹⁾Department of Morphology and Semiology of Stomatognathic System,
Faculty of Dental Medicine

²⁾Department of Histology, Faculty of Medicine
University of Medicine and Pharmacy of Craiova

³⁾Department of Technology of Mobile and Mobilizable Prosthetics,
Faculty of Dental Medicine and Pharmacy,
"Ovidius" University, Constanța

⁴⁾Department of Dental Prosthetics, Faculty of Dental Medicine,
University of Medicine and Pharmacy of Craiova

⁵⁾Department of Endodontics, Faculty of Dental Medicine,
"Gr. T. Popa" University of Medicine and Pharmacy, Iassy

Abstract

In this paper we have realized a study on 43 patients on which the retro-alveolar radiological exam has shown the existence of a calcareous structure within the pulp chamber having in view a better knowledge of this structure and its etiology, way of forming and pathological implications. For 16 of the patients the radiological exam was supplemented by a microscopic examination. Radiologically, the denticles were noticed more often in the pulp chamber of the molars. The examination of the histological samples has evidenced aspects such as the size, shape and structure of the denticles. The concentric disposition of the tissue elements shows that in the formation of a denticle there is a "center" around which a conjunctive substance avid of calcium salts is deposited. The microscopic aspects noticed on large denticles allowed us to sustain the hypothesis that in a large pulp chamber many denticles form simultaneously and grow up and merge generating a large-sized unique calcareous structure.

Keywords: denticles, dental pulp, mineralization centers, histological modifications.

☞ Introduction

The denticles represent masses of calcified conjunctive tissue present on the level of the pulp chamber of the teeth. From the point of view of their histology and way of formation, on the level of the dental pulp there were described two types of calcified formations: the pulp denticles and the denticles.

The pulp denticles represent calcified masses which appear in the dental pulp more frequently in the vicinity of the apical foramen. They have a microscopic and biochemical structure similar to the dentin, the calcium/phosphorus ratio being identical. Additionally they present dentinal tubules, formed by the odontoblasts that border the denticle at the exterior. The pulp denticles can be unique or multiple in any tooth, can form in several teeth and can even appear in all the teeth of an individual [1].

The denticles (also known as false denticles) appear as concentric layers of calcified tissue which realizes around an originating point, which can be represented by a fascicle of collagen fibers, a calcified vascular thrombus, necrotic cells etc [2]. These calcified formations do not present dentinal tubules and do not have odontoblasts on their periphery. The incidence of the denticles rises with the age and their

symptomatology is poor, if they do not create pressure on the vessels or the nervous fibers. We are convinced though that these formations act as a foreign body in the pulp chamber and they induce an unspecific symptomatology which, because of its low intensity, is not taken into account by the patient or the dentist. Thus, their discovery is in most of the cases accidental, mainly on histological preparations rather than radiological studies, as it seems that only a small amount of the denticles are big enough to be evidenced on the radiography. With the hope of a better knowledge on these structures, on their way of formation and their pathological implications, we have made a study on a batch of 43 patients which have seen the dentist for various diseases of the odontium or of the periodontium on which the radiological examination has shown the existence of a calcareous structure within the pulp chamber. The radiological exam was completed by a microscopic examination where a tooth had the indication of extraction.

☞ Material and methods

There have been studied 52 retro-alveolar radiographies realized on patients aged 29 to 72 years and with various symptomatology. On clinical

examination, six patients presented profound cavity lesions without subjective symptomatology or with a minimal symptomatology, four patients presented voluminous obturations with marginal adaptations more or less correct, 10 patients presented acute pulp manifestations, 19 patients presented for 2nd and 3rd degree accentuated dental mobility. In four cases the denticles were accidentally discovered when the indication of radiography was for a nearby tooth.

The histological study was performed on a number of 16 teeth which had radiologically shown calcareous images on the level of the pulp chamber and which required extraction because of very advanced pathological processes (chronic marginal periodontitis or periapical lesions).

Immediately after the extraction, the teeth have been put into a 10% neutral formalin fixing solution for 10 days at room temperature and eventually have been decalcified using a 10% trichloroacetic acid solution for 21 days. After the decalcification, the teeth have been washed in running water for 24 hours in order to eliminate the excess of acid in the dental structures and they have eventually enclosed into histological paraffin. We used the Shandon AS 325 paraffin microtome to get serial 5- μ m slices which were eventually colored with Hematoxylin–Eosin and with the trichromic with green of light (the Goldner–Szeckely technique).

Results

Radiological study

As it can be noticed below in the figures, in order to be distinguished on the radiography, the denticles must have large enough sizes and also a certain concentration of mineral salts. It is obvious that the small-sized denticles or the ones at their early stages of development cannot be radiologically evidenced, and thus a statistic done on a radiological study has a high degree of relativeness. The formation of a denticle is a complex morphological process which necessitates a certain amount of time. This is why the denticles can appear on patients of various ages. In our study we have noticed that the incidence of the denticles rises with the age, most of the patients carrying denticles (almost 90%) being over 40 years old.

The etiological pathogenic mechanism which determines the formation of these structures is unclear for now. In our study we have noticed that the denticles can appear on the level of teeth with normal appearance, without any lesion on the level of the odontium or of the periodontium (Figure 1) or, on the contrary, they appear on teeth with cavity lesions or affected by different degrees of periodontitis (Figures 2–4).

In the first case we consider that the denticles appear because of some occlusal troubles which led to the apparition of some occlusal pressures distinctive as direction and strength, mechanical aspects which had also repercussions onto the dental pulp, determining a reaction response, materialized into the formation of denticles. The apparition of some denticles on the level of the teeth affected by cavity processes, pulpitis or by

periodontitis can be explained by the chronic inflammatory process which propagates on the level of the pulp chamber.

In the cases we have studied, the denticles have been noticed most often in the pulp chamber, as there is here a larger space which allows the development of such structures that would become visible on the retro-alveolar dental radiography (Figures 2 and 3).

It is obvious that the denticles can develop in the radicular channel too, but in case the denticle develops in the radicular channel it appears as a small calcification which deforms or not the radicular channel, a diffuse calcification being difficult to differentiate.

Most of the cases of large-sized denticles were found in devitalized teeth following cavity processes which evolved towards septic necrosis and fewer cases on vital teeth with profound cavity processes or with periodontitis. Yet it is certain that their formation and development initially took place within a living pulp, without knowing exactly how and at what degree the pulpal tissue was affected at the moment when the mineralization process started.

It is known that the denticles can appear at all teeth. In our study, in over 70% of the cases the denticles were evidenced on the level of the maxillary and mandibular molars. We consider that the more frequent presence on this level is due both to the larger pulpal chambers and to the stronger occlusal pressures in this area. Also, on this level the cavity lesions and the periodontitis are more frequent.

Histological study

The examination of the histological preparations obtained from the biological pieces collected following the extractions allowed us to evidence some interesting aspects concerning the size, shape and structure of the denticles, and to issue hypotheses on their way of formation. On the histological slices the denticles appeared as conjunctive calcified formations with inhomogeneous structure, of round or oval shape, with neat contour, well delimited from the rest of the pulpal structure or from the layer of odontoblasts and dentine. Others had an elongated shape and irregular contour. In some areas where the denticles had been in direct contact with the odontoblasts, these cells had a “defense reaction” synthesizing and depositing dentine towards the pulpal chamber (Figures 5 and 6).

Most of the denticles appeared as being formed of concentric layers of calcified conjunctive tissue, with rare conjunctive cells within them (Figure 5). The concentric disposition of the tissular elements denotes the fact that in the formation of a denticle there is a “center” which forms a conjunctive substance avid of calcium salts. We consider that this “center” can be represented by some pulpal fibroblasts which have metaplasied becoming similar to the osteoblasts or by other proteinaceous elements which calcify (cell or fiber remainders). Within the structure of other denticles the calcified conjunctive tissue had a reticular disposition, as if the calcification had realized along some conjunctive fibers. We did not identify the presence of conjunctive cells within these structures (Figure 7).

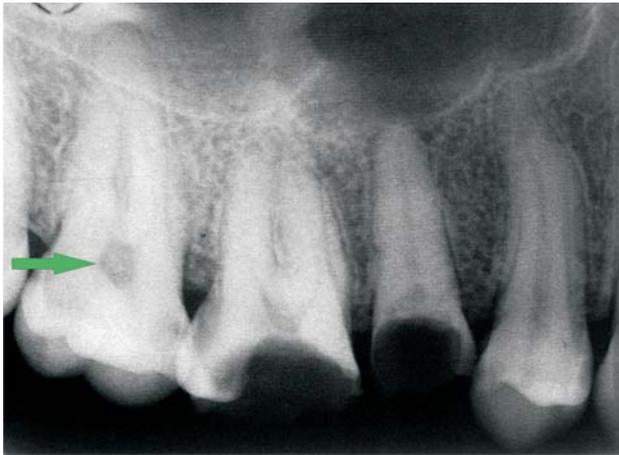


Figure 1 – Retro-alveolar radiography of a 29-years-old patient. It is noticed the presence of a small-sized denticle situated on the level of the pulp chamber of the 2.7 molar, without noticing the presence of associated cavity or periodontal lesions



Figure 2 – Retro-alveolar radiography of a 38-years old patient, with maintained vitality on the level of the 3.6 and 3.7 molars, but with chronic marginal periodontitis and a proximal cavity lesion on the distal surface of the 3.6, it is noticed the existence of some denticles which are being formed in the pulp chambers

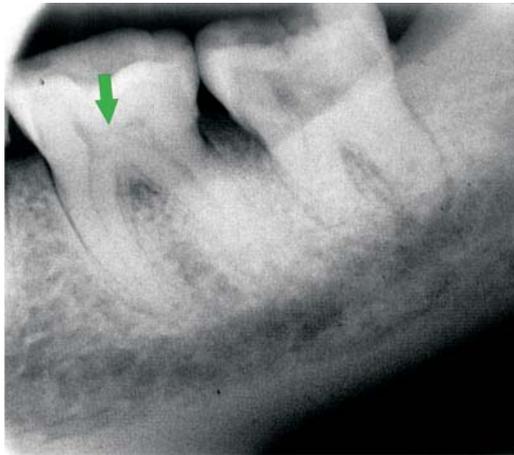


Figure 3 – Retro-alveolar radiography of a 58-years old patient in which it is evidenced a well-grown denticle which occupies almost half the pulp chamber of the 4.7 molar; it is also noticed a diffuse demineralization area between the 4.7 and 4.8 molars

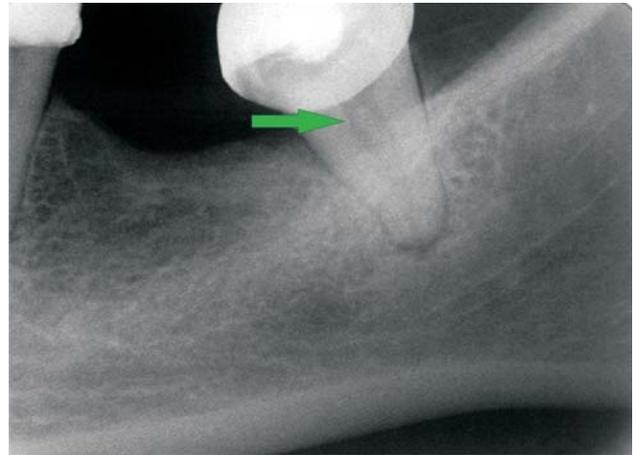


Figure 4 – Retro-alveolar radiography of a 42-year-old patient with a large-sized denticle on the level of the 3.8 molar. It is also noticed the existence of a profound cavity process which seems to have evolved under the metallic covering crown which determined the apparition of a periapical lesion

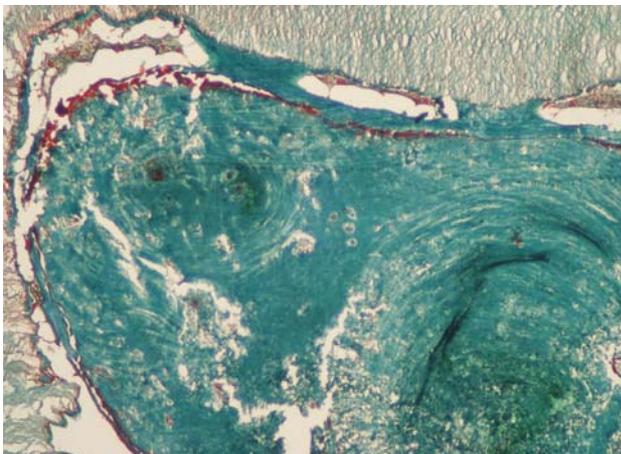


Figure 5 – Microscopic image of a large-sized denticle present in the pulp chamber of a molar. It is noticed the presence of two mineralization centers around which the conjunctive tissue disposes concentrically (Trichromic GS staining, $\times 100$)

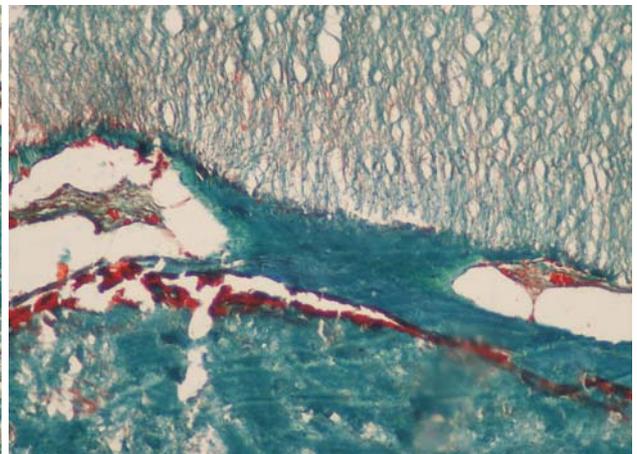


Figure 6 – Detail of the previous picture, from the joint area between the denticle and the coronal odontoblasts (Trichromic GS staining, $\times 200$)

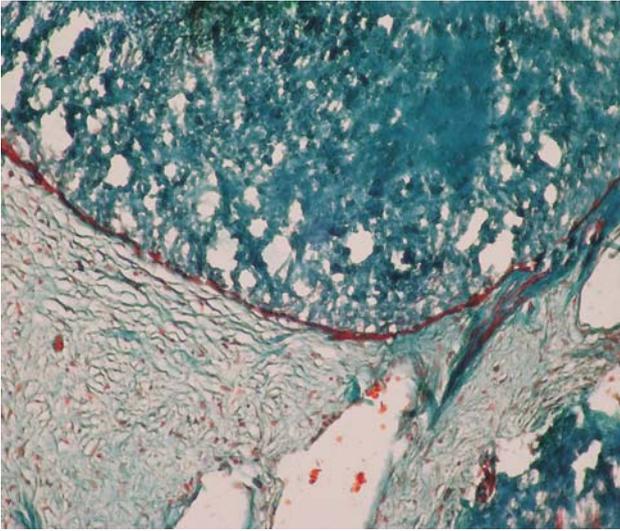


Figure 7 – Large-sized denticle with reticular disposition of the calcified conjunctive matrix (Trichromic GS staining, $\times 200$)

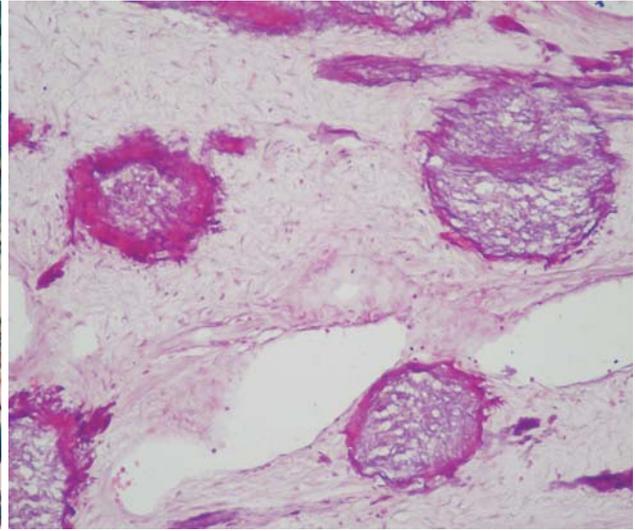


Figure 8 – General microscopic view of a pulp chamber from a molar, in which is noticed the presence of several denticles of various shapes, sizes and structures (H-E staining, $\times 40$)

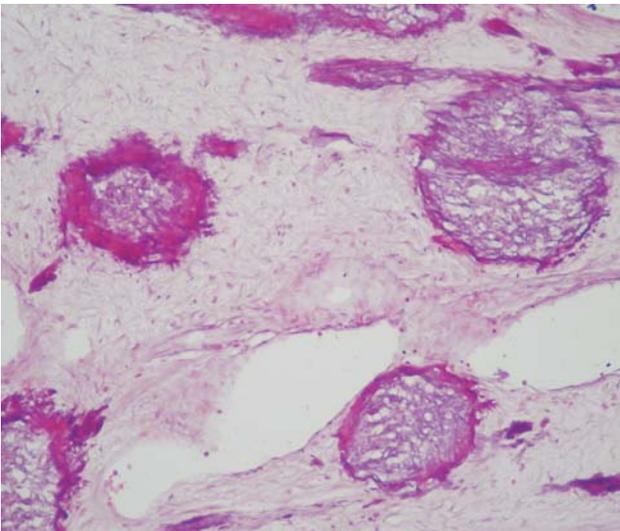


Figure 9 – Detail of the previous picture (H-E staining, $\times 100$)

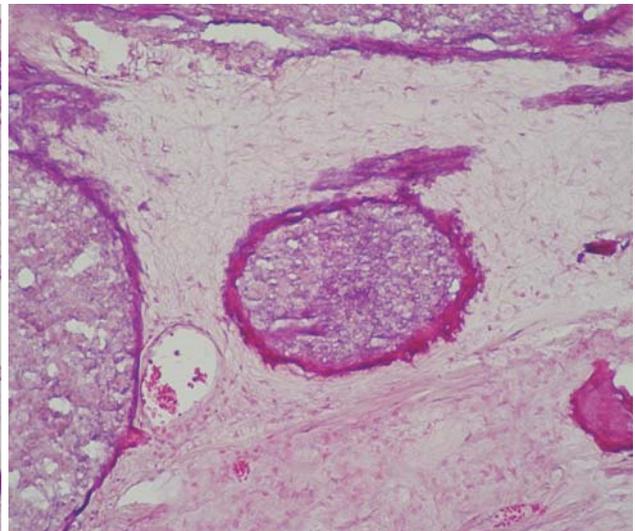


Figure 10 – Histological aspect of two denticles of various sizes and structures, identified on the level of a premolar (H-E staining, $\times 100$)

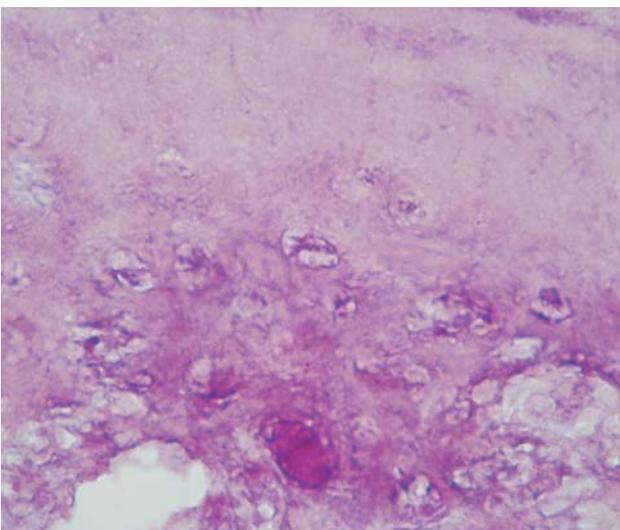


Figure 11 – Conjunctive cells with an aspect similar to osteoblasts, non-homogenous disseminated in the calcified structure of a denticle (H-E staining, $\times 400$)

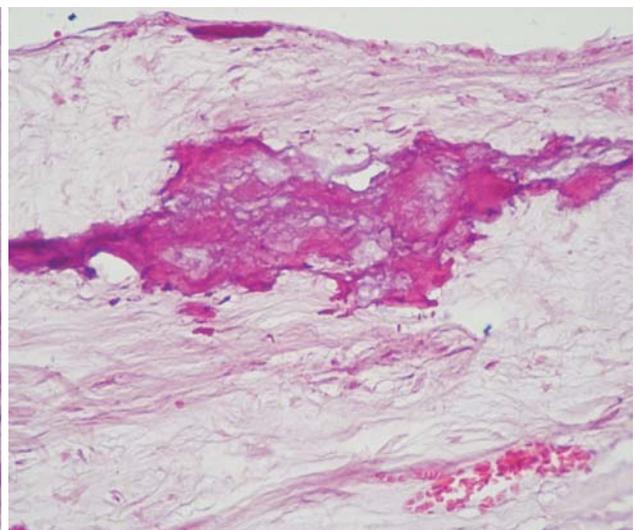


Figure 12 – Denticle with irregular contour, associated with a high quantity of collagen fibers in the adjacent pulp tissue (H-E staining, $\times 200$)

Although the radiologic images did not identify but one denticle within the pulp chamber of a tooth, the microscopic study allowed us to evidence the presence of more denticles within the pulp of the same tooth, sometimes with different histological aspects, which leads to the conclusion that the etiologic and pathogenic factors which are at the base of the formation of denticles are multiple (Figures 8 and 9).

The sizes of the denticles were also very varied, from a few micrometers to 2–3 mm. The largest denticles were observed on the level of the molars, on persons with chronic periodontitis (Figure 10). This histological aspect can be explained by the fact that the molars have the largest pulp chambers and; besides the occlusal traumas are bigger here than on other teeth.

We do not exclude here the importance of the periodontal disease relating to the formation and development of the denticles. The difference between the radiological image and the microscopic examination can be explained by the fact that some small-sized denticles, under 1 mm, cannot be visualized on the simple radiography or they have a small content of mineral salts and thus they cannot be differentiated from the structures of the tooth. As it can be seen in the Figure 5, the large-sized denticles, which occupy the entire pulpal chamber, present more mineralization “centers” around which the pulpal fundamental substance disposes concentrically. In other words, in a pulpal chamber many denticles form concomitantly, develop and join together generating a large-sized unique calcareous structure. The cells present within the structure of the denticles had medium sizes, poor, acidophil, inhomogeneous cytoplasm, and the nucleus appeared round, normochromic, sometimes with nuclear pycnosis. The cells appeared disposed within a cavity of the calcified fundamental substance, similar to the osteoblasts. Contrary to the osteoblasts which have a relatively homogeneous and ordered disposition, these “denticleic cells” were very rare and with a totally disordered disposition (Figure 11).

☒ Discussions

The denticles are abnormal calcified conjunctive formations present within the radicular channel or the pulpal chamber. According to some studies, these calcified conjunctive structures have a calcium/phosphorus ratio similar to that of the dentine. The denticles can appear without obvious causes, being discovered mostly accidentally following a radiological examination. Yet, most of the time, their apparition is determined by a series of general or local factors. Some authors claim that gout, avitaminosis, metabolic disorders, renal lithiasis etc. determine the apparition of denticles on all teeth [3]. Recently, Edds AC *et al.* (2005) demonstrated by a radiological study the increase in frequency of pulpal denticles on patients with cardiovascular diseases and even proposed the use of dental radiographies in the screening of these diseases [4]. Traumatism constitute another etiological factor, frequently incriminated in the apparition of the denticles, especially if an increase of the mobility of the

tooth had taken place before [3]. The local factors which can determine the apparition of the denticles are represented by pathological processes which evolve slowly in the vicinity of the pulpal chamber, constituting a chronic irritating spina for the pulpal conjunctive tissue. Among these we can mention cavity lesions with slow evolution or the cavity relapses under large obturations, most frequently metallic. In our study these local lesions represented the most frequent pathological modifications associated with the radiological diagnosis of the denticles. The increased incidence of denticles associated to cavity lesions is often cited in the literature [3].

The chronic marginal periodontitis represent another source of chronic irritation for the dental pulp, especially for the radicular pulp, which can contribute to the apparition of the denticles. The lack of space for growth makes a denticle in the radicular area, more often, not to grow to the necessary maturity to be differentiated from the hard structures around it and evidenced on the radiography, being discovered only on the microscopic examination following the extraction. Besides, the histological study of the pulpal tissue of the periodontitis teeth evidences more frequently the apparition of lesions of diffuse-calcification-type rather than of denticles-type. The occlusal traumas determine the apparition of great forces which frequently induce mineralization of the coronal pulpal tissue which can also be translated as denticles [6].

Subay RK *et al.* (2001) proved through a histopathological study the apparition of denticles after the application of orthodontic extrusive forces to almost 20% of the interested teeth [7].

Micro-polytraumatism, various medicinal substances applied in the treatment of the pulpal-dentinal lesion or those applied in periodontal bags are other factors which can contribute to the apparition of pulpal denticles [8].

The presence of the denticles is more rarely mentioned in scientific papers. Statistics realized by radiological studies have shown, despite their very large variations (between 4% and 20%), the much more frequent presence of the denticles on the level of molars, comparing to the rest of the groups of teeth [9, 10].

Although they do not have a characteristic symptomatology, we consider that the denticles can determine irritations of the nervous terminations present in the dental pulp generating more or less intense pain, or can determine local structural modifications by compressing the blood vessels. Yet in all the cases in which we noticed the presence of the denticles the painful symptoms could not be linked exclusively to their presence, but mainly to other associated pathological manifestations: profound cavity lesions, acute or chronic pulpitis, and chronic marginal periodontitis of various degrees. The denticles present, apart from the inorganic main component, also an organic matrix. Studies of immune-histo-chemistry have identified the presence of type-1 collagen on the level of the denticles, this being the main component of this matrix, and also the presence in high quantities of the osteopontin with distinctive role in the formation of this matrix [11].

The etiopathogenic mechanisms are not fully understood not even nowadays. Most of the authors show that these calcifications take place around an originating point, a “center” which can be represented by a fascicle of collagen fibers, calcified vascular thrombus necrotic cells [2].

Because of the fact that the denticles appear within a conjunctive structure with multiple reactional possibilities, we consider that their conjunctive matrix results due to some cell syntheses. The fact that the conjunctive cells within the denticles have microscopic aspects similar to the osteoblasts, we consider that the fibroblasts in the dental pulp, as the result of the action of some mechanical, infectious, or vascular factors, transform into cells similar to the osteoblasts which secrete a fundamental substance similar to the ossein.

Most of the cases of large-sized denticles were found in devitalized teeth following cavity processes which evolved towards septic necrosis and fewer cases on vital teeth with profound cavity processes or with periodontitis. Yet it is certain that their formation and development initially took place within a living pulp, without knowing exactly how and at what degree the pulpal tissue was affected at the moment when the mineralization process started [12].

Recent researches have incriminated as a factor which initiates these calcium deposits a small bacteria – *Nanobacterium sanguineum* – which has the possibility to form around itself, a real “mineral carcass” [13].

The growth-in-size mechanism is also less known. According to some authors [12], a denticle does not start from a single point of mineralization, but it is formed by the joining of several smaller formations [14]. This idea is also supported by the microscopic images taken by us, which show that within the pulp chamber many denticles can coexist with different microscopic aspects, and being in different stages of formation, growth and maturation.

☒ Conclusions

The denticles are abnormal, calcified conjunctive formations present more often in the pulp chamber, especially on the level of the molars, as there is a larger space which allows the development of such structures, yet also in the radicular channel. On the microscopic examination, most of the denticles appeared as being formed of concentric layers of calcified conjunctive tissue, with rare conjunctive cells within them. The concentric disposition of the tissue elements proves that in the formation of a denticle there is a “center” which forms a conjunctive substance avid of calcium salts.

Corresponding author

Virgil Deva, Associate Professor, MD, PhD, Department of Morphology and Semiology of the Stomatognathic System, University of Medicine and Pharmacy, 2–4 Petru Rareș Street, 200 349 Craiova, Romania; Phone +40251–524 442, E-mail: virgil_dv@yahoo.com

Received: February 8th, 2007

Accepted: February 20th, 2007

In addition to the radiological examination where we have seen only a denticle in the pulp chamber, the microscopic examination allowed us to evidence the presence of more denticles within the pulp of the same tooth, sometimes with different histological aspects, which leads to the conclusion that there are multiple etiologic and pathogenic factors which are at the basis of the formation of the denticles.

The growth mechanism of the denticles is less known at the moment, yet we consider that the large-sized denticles which occupy the whole pulp chamber present many “centers” of mineralization around which the fundamental pulp substance deposits concentrically, which leads to the idea that in a pulp chamber many denticles form simultaneously and eventually grow up and merge generating a large-sized unique calcareous structure.

References

- [1] NANJI A., *Ten Cate's Oral Histology: development, structure and function*, 6th edition, Mosby Inc., St. Louis, 2003, 215–236.
- [2] BHASKAR S. N., *Orban's Oral Histology and Embryology*, 9th edition, Mosby, St. Louis, 1980, 169–171.
- [3] CONSTANTIN I., *Patologie pulpară*, Ed. Junimea, Iași, 1981, 52–55.
- [4] EDDS A. C., WALDEN J. E., SCHEETZ J. P. et al., *Pilot study of correlation of pulp stones with cardiovascular disease*, J Endod, 2005, 31(7):504–506.
- [5] FRIED I., ERICKSON P., SCHWARTZ S., KEENAN K., *Subluxation injuries of maxillary primary anterior teeth: epidemiology and prognosis of 207 traumatized teeth*, Pediatr Dent, 1996, 18(2):145–151.
- [6] MJOR I A., *Pulp-dentin biology in restorative dentistry. Part 5: Clinical management and tissue changes associated with wear and trauma*, Quintessence Int, 2001, 32(10):771–788.
- [7] SUBAY R. K., KAYA H., TARIM B. et al., *Response of human pulpal tissue to orthodontic extrusive applications*, J Endod, 2001, 27(8):508–511.
- [8] IONITA R., SACALUS A., JIVANESCU M. et al., *Experimentarea unui preparat apicol pentru coafajul direct și indirect al pulpei dentare*, Stomatologia, 1990, 37(1):19–30.
- [9] RANJITKAR S., TAYLOR J. A., TOWNSEND G. C., *A radiographic assessment of the prevalence of pulp stones in Australians*, Aust Dent J, 2002, 47(1):36–40.
- [10] CHANDLER N. P., PITTFORD T. R., MONTEITH B. D., *Coronal pulp size in molars: a study of bitewing radiographs*, Int Endod J, 2003, 36(11):757–763.
- [11] NINOMIYA M., OHISHI M., KIDO J. et al., *Immunohistochemical localization of osteopontin in human pulp stones*, J Endod, 2001, 27(4):269–272.
- [12] VĂTAMAN MARIA, MELIAN A., PATRAȘ E., ICIM I., *Este Nanobacterium sanguineum adevărată cauză a producerii pulpoliților?* Medicina Stom, 2003, 7(Suppl 1):41–46.
- [13] CIFTCIOGLU N., MCKAY D. S., KAJANDER E. O., *Association between nanobacteria and periodontal disease*, Circulation, 2003, 108(8):e58–59.
- [14] VĂTAMAN MARIA, *Răspunsul pulpei dentare la acțiunea unor factori agresivi*, Ed. Panfilus, Iași, 2003.