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Original study

MORPHOLOGIC ANALYSIS OF APICAL RESORPTION ON HUMAN TEETH WITH PERIAPICAL LESIONS

Fabiana Vieira **Vier***; José Antônio Poli de **Figueiredo****; Antônio Adilson Soares de **Lima*****

* Assistant Professor of Endodontics at the Lutheran University of Brazil - ULBRA (Canoas/RS), Specialist and Masters in progress in Endodontics at ULBRA

** Professor of the Graduate Program in Dentistry at ULBRA (Canoas/RS), Ph.D. in Endodontics - USP/Bauru.

*** Post-graduate course in Endodontics ULBRA, Canoas, RS, Brazil.

Correspondence:
Fabiana Vieira Vier – fabianavier@ulbranet.com.br
Rua Duque de Caxias, 667. Vila Rica
São Sebastião do Caí/RS.
CEP – 95760-000.

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ABSTRACT

Objective: The aim of this study was to compare the presence and extension of cementum and dentin resorption in apexes containing different periapical pathosis. **Material and method:** 31 teeth were selected for the presence of a proliferative tissue compatible with a periapical pathology. Sections were conducted in periapical lesions which were then dyed by the HE. The periapical pathosis were classified in fibrous connective tissue, granuloma and cysts. The apical root

surfaces were submitted to SEM analysis. The external root resorption was classified in an increasing level, according to presence and extension of the resorbed area. The Qui square test at a $p<0,05$ was used as estatistical analysis. **Results:** 29,04% of the cases resulted in fibrous connective tissue, which were used as negative controls for resorption. The remaining cases were, in 81,82 %, granulomas, while 18,18 % were cysts. It was a frequent finding the presence of resorption lacunae, with a honey comb aspect. In some specimens, the resorption was spread over the area adjacent to the apical foramen, while others showed lacunae of variable sizes, in specific sites. Some specimes showed no resorption at all. **Conclusions:** There was no statistically significant differences in resorption of granulomas and fibrous connective tissue, showing a similar frequence distribution. Cysts were statistically superior to the others in terms of presence and severity of resorptions. The abscessed granuloma was statistically superior to simple granuloma, considering presence and severity of resorption. There seems to be a correlation with abscess formation and the presence of periapical external resorption.

Key words: pariapical pathology, SEM, dental resorption, cysts, granuloma.

INTRODUCTION AND REVIEW OF LITERATURE:

In cases of pulpal necrosis with periapical lesion, there are microorganisms which inhabit the whole radicular canal system[1]. The microorganisms which invade the necrotic pulpal tissue have the capacity of initiating and maintaining an inflammatory reaction, via degradation of products and toxins originating from their metabolism, resulting in periapical pathologies, as well as in resorption[2-4]. The periapical reactions may be of proliferative type – as in granulomas and cysts - and exudative – as in abscesses[1]. HOLLAND[5] *et al*. conducted histological exams of these cases where, besides evidencing the presence of bone resorption reaching the cortical, also showed an apical erosion, exposing a **bare / denude** and contaminated dentin to the periapical environment.

The periapical inflammation is briefly mentioned in the dental literature as a possible cause of radicular external resorption. The severity of resorption is proportional to the duration of the periapical inflammation[6]. Histological studies[7] had shown that the external resorption of cement and dentin is due to an activity of the granulation tissue in the area of the chronic inflammation.

Practically all teeth that exhibit apical periodontitis present apical resorption. The resorption may be minimum and practically radiographically invisible or may be so extensive so as to cause a loss of a significant quantity of the extremity of the root. All the causes of apical periodontitis lead to an apical resorption[8].

HAMMARSTROM & LINDSKOG[2] have called to attention to the fact that, contrary to the bone, which suffers resorption and apposition as part of a continuous process of remodellation, the roots of the permanent teeth are not normally resorbed. The mechanisms behind this resistance are discussed, but it seems to be an effect of the composition and structure of the mineralized tissue

and of the cells that involve it.

Two conditions must preexist so that a periapical external inflammatory resorption occurs. First, the protective layer of the root must be absent or chemically altered (i.e., the pre-cementum and the cementoblasts). Secondly, a stimulus for the clastic cells must be present. The main stimulating local factors causing the radicular resorption radicular are the excessive pressure and the presence of bacteria, i.e., inflammation usually in response to infection of the radicular canal[8].

TROPE & CHIVIAN[8] have argued that the infection stimulates an inflammatory response, resulting in a resorption of a susceptible radicular surface (without protection). Therefore, the main local cause of inflammatory radicular resorption is the inflammation associated with the injury to the protective layer of the root. Bacteria and their products may seem to attract resorptive cells. The activity of resorption in association with infection is probably increased by substances liberated by the inflammation cells in the soft neighboring tissues such as factors which activate osteoclasts and prostaglandins[2].

Studies by DELZANGLES[9], in which the apical surfaces of teeth extracted with apical lesions were examined by means of SEM, have demonstrated that teeth bearing granulomas presented centralized, systematic and extensive apical resorption in the central foramen. The resorption usually occurred in the cementum, however when the lysis was the most remarkable, the dentin was also injured. The author reports that the hard dental tissue surrounding the cyst has shown little or no resorption. In the cysts, when the resorption was present, the zones in it were disperse and resembled regions of various sizes which could be connected or not. The areas of resorption were not systematically centralized in the foramina, but were extended over the radicular surface. The occasional distribution of thin zones pathologically attacked caused by the cysts were a great contrast compared with the regularity of the due sites of the granulomas.

On the other hand, teeth without pulpar and periapical signs of inflammation showed absence of external periapical zones of resorption and the appearance of the radicular dentin was in agreement with the published anatomic and histological studies[10-11].

SHAFER, HINE & LEVY[12] reported that the majority of the teeth involved by periapical granuloma did not present any significant degree of resorption. The fact that the bone is always destroyed when a periapical granuloma develops, whereas the resorption of the tooth's root without loss of the bone rarely occurs, except in microscopic level, reveals that the bone tissue is resorbed more promptly than the dentin tissue.

BRYNOLF[13] stated that only in extreme cases, absence of resorption or extensive resorption may seem to be detected in the radiograph exam. Thus, teeth presenting periapical lesions such as granulomas and cysts may have apical external radicular resorption, without being visible in the radiograph.

The presence of apical resorptions in teeth presenting apical lesions may be the

cause of failure in the endodontic therapy, once in the lacks of resorption of the cementum, the presence of periapical bacterial biofilm may be evidenced[14-16]. A resistance in elimination of periapical biofilm by means of conventional endodontic methods and/or systemic administration of antibiotics was mentioned[14,17].

In the light of this context, the aim of the present paper is to evaluate by means of SEM, apexes presenting periapical lesions regarding the presence and extension of resorption of cementum and dentin, as well as compare the frequency of this resorption in the proliferative inflammatory lesions.

MATERIAL AND METHODS:

For the present study we have used 31 extracted human teeth, which were associated with the presence of great coronary destruction and consequent state of necrosis of the pulpar tissue, where it was possible to observe macroscopically, associated to their apexes, the presence of a proliferative tissue compatible with a periapical pathological alteration.

The samples were stored in a solution containing formaldehyde at 10%, in a time interval between 2 to 6 months.

The experiment was then divided in two parts:

1. HISTOPATHOLOGICAL ANALYSIS OF PERIAPICAL LESIONS:

The apical pathologies were carefully detached manually from the dental element and submitted to histopathological processing in the Lab *"Patologistas Reunidos"*, in Porto Alegre/RS - Brazil. The blades were then classified in dense conjunctive tissue, granulomas and periapical cysts making use of the Zeiss microscope, lenses 3,2/0,07, 10/0,22 and 40/0,65, and oculars 10 /18, at the Histological Lab of the Lutheran University of Brazil.

We have considered as dense conjunctive tissue the histological cuts where tissue fragments presenting intense deposition of collagen and numerous fibroblasts were observed. Due to the absence of inflammatory periapical lesion, these samples were used as negative control for resorption.

It was considered as granuloma every lesion composed by inflammatory infiltrated of limphoplasmocyte prevalence, as well as by intense fibroblastic population, a wealth of blood vessels, with involvement of a quantity of various collagen fibers configuring a capsule. The presence of Malassez epithelial remains characterized the epithelial form.

It was considered as periapical cyst every lesion with a layer of stratified squamous epithelium along one surface of a sufficient amount of the inflammatory tissue consisting by plasmocytes and lymphocytes to indicate that

the epithelium actually lined a cavity[18].

2. SEM OF RADICULAR APEXES:

The specimens, now without the periapical lesion associated to the apex were immersed in a solution of sodium hypochlorite at 1% of active chloride, during one week. Sequentially, the radicular apexes were sectioned with the help of a carburundum disk and hand piece. Approximately 5 - 7 mm apicals of roots bearing the lesions were kept and then stored in physiological serum.

The apexes were submitted to sequential exchanges of alcohols (70%, 90% and 99%) during five hours for each solution and then, taken to a dental sterilizer (brand BIOMATIC, ref. 302, model 424) at 60°C for 4 hours.

The radicular apexes were carefully handled with the help of tongs and glued to stubs by means of graphite added to colorless nail polish. About 20 hours were necessary for the effective drying of the glue.

The SEM was conducted in the Scanning Electronic Microscopy Lab at the Museum of Natural Sciences of the Zoobotanical Foundation of Rio Grande do Sul.

The metalization of the specimens was made with gold in the metalizer of the brand BAL - TEC, reference SCD 005. The microscope used for the experiment was the JEOL, reference JSM 5200.

After obtaining the photomicrographs, they were submitted to an observer with vast expertise in the matter. He was asked to employ the same criteria for judging the apical external resorptions:

- 0 – absence of resorption, i.e., radicular apex presenting an integral cementum surface;
- 1 – low degree of resorption – presence of small resorption in specific points of the radicular apex;
- 2 – moderate degree – presence of resorption in constant zones, in contiguous points which were inter-related or not;
- 3 – high degree – presence of wide zones of resorption, reaching practically all the apical surface of the dental element.

The degrees of resorption were arranged in tables for the statistical evaluation of the results. The statistical analysis of the results was conducted by means of the X^2 Test (Chi-Square). For the presentation of the average values, we have made use of the mode, which points to an observation of the highest frequency in the statistical treatment.

RESULTS:

1. HISTOPATHOLOGICAL EVALUATION OF THE PERIAPICAL

LESIONS:

The results of the histopathological evaluation of periapical lesions are shown in tables 1 and 2.

Tabela 1 – **Incidence of proliferative lesions X Dense conjunctive tissue**

Dense Conjunctive Tissue	9	29,04
Granulomas	18	58,06
Cysts	4	12,90
Total	31	100%

Tabela 2 – **Incidence of proliferative lesions**

Granulomas	18	81,82%
Cysts	4	18,18%
Total	22	100%

The granulomas have supported the majority of the diagnoses conducted from the microscopical exam of the histopathological blades, adding up to a total of 58,06%, whereas the cysts represented 12,9 of the total of the sample and the negative control group, dense conjunctive tissue, 29,04%.

Taking into consideration just the incidence of periapical lesions of proliferative type, the granulomas reached a total of 81,82%, whereas the cysts were present in 18,18% of the cases.

The incidence of types of granulomas found in histological blades is described in table 3.

Tabela 3 – **Incidence of types of granulomas**

Simple	10	55,56%
Abscessed	7	38,88%
Epithelialized	1	5,56%
Total	18	100%

From the samples of evaluated granulomas, 55,56% belonged to the simple type, whereas 38,88% were abscessed and 5.55% were epithelialized.

2. SEM OF THE RADICULAR APEXES:

The results of the analyses of the specimens´ degree of resorption, regarding their periapical condition, are referred to in tables 4, 5, 6 and 7.

Tabela 4 – **Qualitative Evaluation of the apical resorption X Condition of the periapical tissue**

Cond. of Periapical tissue	Degree of resorption				TOTAL	MODE*
	0	**1**	**2**	**3**		
Dense Conjunctive Tissue	8	1	-	-	9	0b
Granuloma	10	3	1	4	18	0b
Cyst	1	-	2	-	3	2a
TOTAL	19	4	3	4	30*	

* Modes followed by the same letter do not differ statistically by x^2 Test at 5% of probability

Tabela 5 – **Qualitative Evaluation of the apical resorption X Type of periapical pathology**

Type of periapical pathology	Degree of Resorption				TOTAL
	0	**1**	**2**	**3**	
Simple Granuloma	7	1	1	1	10
Abscessed Granuloma	2	2	-	3	7
Epithelialized Granuloma	1	-	-	-	1
Abscessed Cyst	-	-	-	-	0
Periapical Cyst	1	-	2	-	3
TOTAL	11	3	3	4	21*

*One specimen was disconsidered from the sample.

Tabela 6 – **Qualitative Evaluation of the apical resorption X Histopathological Condition of granulomas**

Histopathological Condition	Degree of Resorption				TOTAL	MODE*
	0	**1**	**2**	**3**		
Simple Gran./ Epithelialized	8	1	1	1	11	0b
Abscessed Granuloma	2	2	-	3	7	3a
TOTAL	10	3	1	4	18	

* Modes followed by the same letter do not differ statistically by x^2 Test at 5% of probability

Tabela 7 – **Qualitative Evaluation of the apical resorption of abscessed lesions X chronic lesions**

Condition of lesions	Degree of Resorption				TOTAL	MODE*
	0	**1**	**2**	**3**		
Abscessed Lesions	2	2	-	3	7	3^a
Chronic Lesions	9	1	3	1	14	0b
TOTAL	11	3	3	4	21*	

* Modes followed by the same letter do not differ statistically by x^2 Test at 5% of probability

The statistical results have shown that the dense conjunctive tissue and the granuloma did not differ statistically. The periapical cyst has differed statistically from the others, presenting higher values.

The statistical results reveal a significant difference in the x^2 Test among the simple and abscessed granulomas at one $p < 5$ % of probability. The same may be

said in relation to the chronic and abscessed lesions.

In the apexes of the teeth of the negative control group, i.e., the teeth corresponding to a dense conjunctive tissue no resorption site was observed, except in 1 of the 9 analyzed specimens, which presented a small resorption in determined specific points of the apical surface. In the other specimens of the same group, the photograph of the SEM highlighted a smooth apical surface, covered by an integral cementary tissue as well as some foramens (picture 1).

The apexes of the teeth with granulomas and cysts frequently showed the presence of resorption gaps. These had the appearance of honeycombs. In some specimens, the resorption appeared generalized around all the apical foramen (picture 2), whereas in others there were groups of adjoining gaps, separated by areas of non-reabsorbed cementum (picture 3). In these cases, it was possible to observe dispersed resorption zones of various sizes, which could or not be connected.

The majority of the simple granulomas presented absence of external apical resorption.

In some cases, although the cementary resorption was present in a generalized way around all the apical foramen, the latter was still integral in the point of view of anatomic conformation (picture 4).

Still in other cases, the resorption, although not generalized in all the apical surface, promoted a morphological alteration in the anatomy of the foramen (picture 5).

In this very specimen, the resorption was so severe that it was possible to visualize the dentin tubules (picture 6).

DISCUSSION:

Although the radiograph is, without any doubts, an indispensable complement for the evaluation of the presence of periapical pathologies in the involvement of structures and in the destructive extension of the process, the precise differential diagnosis between granulomas and cysts may only be made by means of the microscopical observation[19].

One important issue that must be considered in the histopathological description of cyst and granuloma, is the fact that both constitute a continuous and variable aspect of the same phenomenon – the inflammation. The literature have illustrated[4,9], that in cases of periapical lesions resulting from a pulpal infection and consequent necrosis, inflammatory tissue around the apex may cause resorption of dentin and apical cementum.

The numerous existing and quoted studies by MORAES[20], have shown that there is a proportion of approximately 60% of granulomas for 40% of cysts. This same author has also conducted an investigation of the percentages of cysts and

granulomas described by many authors in the period between 1954 to 1976, showing the great variation in the occurrence of diagnosis (6% to 54% in granulomas and 46% to 93% in cysts) of these lesions.

It the present study, we have observed the incidence of granulomas in 81,82% of the cases, and of cysts, in 18,18%. LANGELAND & BLOCK[21] stated that the discrepancy in the results of these studies may be due to the lack of standardization of the histological exams and to the surgical manipulation with loss of the cystic content and of a great part of the epithelial coating.

The great percentage of abscessed lesions presented in this study are due to the fact that the sample originated from Dental Service, which characterizes a higher incidence of acute histopathological cases.

With the result of the histopathological evaluation of the examined samples we have obtained, in 29,04% of the cases, the presence of a dense conjunctive tissue, compatible with the one of the periodontal ligament. This sample was employed as a negative control for resorption, since it was exempt from inflammatory reaction. The SEM of these specimens has resulted in the absence of resorption (picture 1), in 8 of the 9 analyzed cases. These findings corroborate with the studies by DELZANGLES[9], who reports that teeth without periapical signs of inflammation show absence of periapical external resorption zones. Just in one case of dense conjunctive tissue small gaps of cementary resorption have been observed. This very specimen was classified as degree 1 for resorption. This might be the result of a transitory resorption, which has been referred to by TRONSTAD[4] as an auto-limiting process. Once the stimulus ceases, a repair by cellular cementum occurs spontaneously. In these cases, the stimulus is minimum and lasts very little. The main ethiological factor may be the compression of the periodontal ligament caused by an increase of occlusal load.

Studies by LOMÇALI, SEN & ÇANKAYA[14] , in SEM, have observed resorption zones with gaps, frequent in the radicular surface of teeth with apical periodontitis. These findings corroborate with ours, once the aspect of the observed resorptions in the evaluated specimens were similar to honeycombs (picture 2) as was described by BOYDE & LESTER[22]. The resorption gaps seen in chronic periapical lesions may seem to resemble the Howship gaps[9].

In determined species**,** the apical external resorption associated to the presence of granulomas and periapical cysts has promoted an alteration in the anatomic configuration of the apical (picture 5). This alteration in form may also occur in the junction cementum dentin canal, as described the aforementioned author. This fact deserves relevance, once the loss of the original anatomy of the endodontist´s limit of performance may generate problems of mechanical status, i.e., failures in obtaining a good apical shoulder, what culminates in a restraining of the deficient master cone, which may result in extravasation of the filling material, either solid or cementum itself. Biological problems may also occur once these gaps of resorption may host microorganisms which do not suffer efficacious remedying through the routine endodontic treatment. Problems of mechanical and biological type such as these maybe related with the index of success of just 60%[1] of the

cases of pulpal necrosis with periapical lesion.

In the present study, dense conjunctive tissue and granulomas do not differ statistically concerning the frequency and extension of periapical external resorption. The cysts, however, differed statistically from the others, presenting higher values. Although these results have presented statistical documentation it is our hypothesis that the cysts differed statistically from the dense conjunctive tissue and granulomas, regarding the apical external resorption, due to the small number of samples of this pathology in the present study. If this number had been a little higher, maybe the results had been different. We believe that if the sample of cysts had been more significant we would be more secure to state that cysts promote more frequent resorption and in higher degrees than granulomas. Due to this, there is a need of conducting further studies in order to corroborate this fact, once DELZANGLES[9] has evidenced the absence or very little periapical external resorption associated to the samples of cysts.

In the present research, abscessed lesions have presented statistically higher degrees of resorption when compared to chronic lesions. In this case, we have brought ut the question as to the possibility of relating the presence of periapical resorption due to the condition of local extra-radicular infection and the acuteness of chronic periapical processes since the cause of exacerbation of these processes is unknown. PAIVA & ANTONIAZZI[23] and MORAES[20] attribute this fact to a lowering of the resistance of the individual, or still, to an increase in the virulence of determined microorganisms.

Concerning the condition of extra-radicular infection, KRONFELD[24] and GROSSMAN[25] have stated that, although a tooth with a granuloma may have an infected radicular canal, it usually presents sterie peri-radicular tissue: "The granuloma is not an area in which the bacteria live but in which they are destroyed". Whereas a relative sterility of the peri-radicular lesions of pulpar origin has been argued by some researchers[21], more recent studies[26] have shown that bacteria is present in the peri-radicular lesions and that its presence begins and perpetuates such lesions.

We question the fact that the apical resorption or the formation of resorption gaps would constitute in niches which would facilitate the deposing and accumulation of bacteria thus resulting in the formation of periapical bacterial biofilm. On the other hand, it might happen that, in the first place, the physical presence of the bacteria on the apical surface would occur. This situation, however, could culminate in apical resorption. The presence of activating factors for bone resorption in human peri-radicular lesions, such as components C3 of the complement[27], such as interleucina-1[28-30], and factor of tumor necrosis[29-31], once presenting the capacity of reabsorbing the bone, could also injure the dental surface.

The acuteness of periapical pathological processes might therefore be related with the presence of apical external cementum and/or dentin resorption, associated to the formation of periapical bacterial biofilm. However, this issue highlights many doubts and calls for further studies, so as to guarantee scientific reliability.

CONCLUSIONS:

According to the methodology employed in this study, it is right to conclude that:

- The resorptions found in dense conjunctive tissue and granulomas did not differ statistically, presenting a similar distribution of frequency. The cyst has differed from the others, presenting higher values of resorption.
- The abscessed granuloma was statistically superior to the simple granuloma ($p < 5$ % of probability), regarding the presence and severity of periapical external resorption. Similarly, abscessed lesions were statistically superior as compared to the chronic ones.
- There seems to be a correlation between the acuteness of periapical lesions and the presence of apical external resorption.

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Av. Prof. Lineu Prestes, 2227 - Cidade Universitária - Butantã - CEP 05508-900 - São Paulo - SP

e-Mail

ecler@siso.fo.usp.br