ABSTRACT

Introduction: Key stages in the treatment of chronic apical periodontitis (CAP) are the assessment of the status of periapical zone, effective decontamination and subsequent sealing of the root canal space.

Purpose: The aim of this article is to analyze histologic and electron microscopic results from periapical tissue examination in teeth with chronic apical periodontitis.

Material and Methods: The apices of 43 teeth (n = 43) were examined, allocated in two groups. The teeth were stored in saline solution (9% NaCl) supplemented with thymol, at 4°C. The apical portions of the roots were resected at 5 mm coronary. After resection, the apices were fixed to stands for SEM-examination. The periapical lesions (n = 24) were carefully removed with a curette from the root or the apical portion of the alveolar socket and were kept in 10% formalin solution to the preparation of histological samples.

Results and Discussion: The results of the performed SEM-examinations of the apical zones showed that in 97.6% of the teeth with radiographically diagnosed CAP, there were external resorption around the apical foramen and associated apertures of varying degrees – from the initial to the advanced stage of apical resorption. Despite the limited number of examined cases, the results obtained confirm the histology and the inaccuracy of diagnostic assumptions in some of the cases, resulting from the radiographic examination only.

Conclusion: Based on the analysis of results, the following conclusions can be drawn: that external resorption around the apical foramen is established in 97.6% of cases in the teeth with radiographically diagnosed CAP.

Key words: apical zone, chronic apical periodontitis, external apical resorption.

INTRODUCTION

Apical resorption is a biological phenomenon, characterized by processes of cement and/or dentine depletion, resulting from the physiological or pathological activity of resorptive cells, called dentoclasts (a subclass of the osteoclasts) [1, 2]. Studies have suggested that the permanent dentition is protected against physiological resorptive processes, but pathological resorption has been found in cases of trauma, orthodontic treatment, expansion of tumor or cystic formations, or has been largely the result of inflammatory processes in the pulp tissue, etc. [3]. In internal root resorption, normal or necrotic pulp tissue, transformed into granulation tissue with giant multinuclear cells resorbing the dentinal wall in the absence of the odontoblast layer and predentine, has been histologically demonstrated [4, 5]. Stopping the internal resorptive processes is likely to occur through removal of the pulp and granulation tissue, as well as interruption of the blood supply to these tissues, necessary for the development of resorbing cells.

Key stages in the treatment of chronic apical periodontitis (CAP) are the assessment of the status of periapical zone, effective decontamination and subsequent sealing of the root canal space.

MATERIAL AND METHODS

Our objective was to clarify some aspects of the findings in the apical zone of teeth with chronic apical periodontitis by applying ex vivo scanning electron microscopy (SEM) of the apical zone to detect the presence of resorption and by histological examination of the periapical lesions. To clarify the available apical resorption, the peculiarities in the apical zone in teeth with CAP and the difficulties for the treatment, a comparative ex vivo SEM-examination was performed between the apical zones of teeth extracted for CAP and intact teeth with completed root development extracted on the basis of orthodontic considerations. For this purpose, the apices of 43 teeth (n = 43) were examined, allocated in two groups: group I (n = 24) – apices with radiographically diagnosed CAP and group II (n = 19) – apices with normal radiographic periapical structures, extracted on the basis of orthodontic considerations. The teeth were stored in saline solution (9% NaCl) supplemented with thymol, at 4°C. The apical portions of the roots were resected at 5 mm coronary. After resection, the apices were fixed to stands for SEM-examination. The prepared samples were vacuum coated with gold dust in an argon medium by using JEOL JFC-1200 fine coater and examined with a scanning electron microscope (JEOL JSM-5510 SEM) at the corresponding magnifications (x 50, x 200, x 1000, x 5000).

The periapical lesions (n = 24) of group I were carefully removed with a curette from the root or the apical portion of the alveolar socket and were kept in 10% formalin solution to the preparation of histological samples. The histological samples were prepared in 4-5 µ thickness and stained with hematoxylin-eosin (HE).
RESULTS AND DISCUSSION

The results of the performed SEM-examinations of the apical zones showed that in 97.6% of the teeth with radiographically diagnosed CAP, there were external resorption around the apical foramen and associated apertures of varying degrees – from the initial (Fig. 1) to the advanced stage of apical resorption (Fig. 2, 3, 4, 5, 6). In 85.4% of the apices of the teeth with periapical lesions larger than 4 mm, there was also resorption of the foramen, related with destruction of the physiological constriction. These results are in support of the preliminary measured clinical widths of the narrowing.

Fig. 1. Scanogram of a zone with initial resorption, dimensions 100 µm x 700 µm (x 130)

Fig. 2. Scanogram of a zone with extensive resorption involving the apical foramen (x 50)

Fig. 3. Scanogram of the apical zone of a palatal root (x 50)

Fig. 4. Scanogram of the apical zone of a mesiodistal root (x 50)

Fig. 5. Scanogram of the apical zone of a distovestibular root (x 50)

In 57.1%, values of the narrowing within the range of #35–55 were measured and in 34.4% – #60–140. Only in 5 of the teeth with CAP (14.2%), 2 in group III and 3 in group IV, signs of resorption were found radiographically.
Fig. 6. Scanogram of the apical zone of the first mandibular premolar root (x 50)

Table 1. Distribution of measured widths of clinical physiological constriction by group (%)

<table>
<thead>
<tr>
<th>Grouping compared clinically measured width of the apical constriction</th>
<th>I Group</th>
<th>II Group</th>
<th>III Group</th>
<th>IV Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teeth with normal periapical tissue n=19 (100%)</td>
<td>n=9</td>
<td>n=10</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(47.4%)</td>
<td>(52.6%)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Teeth with CAP n=24 (100%)</td>
<td>n=2</td>
<td>n=1</td>
<td>n=20</td>
<td>n=12</td>
</tr>
<tr>
<td></td>
<td>(5.7%)</td>
<td>(2.8%)</td>
<td>(57.1%)</td>
<td>(34.4%)</td>
</tr>
</tbody>
</table>

The irregular, lacunary-like zones of resorption favor the existence of microorganisms (yellow arrows) – these are the areas on the outer surface of the root, which cannot be treated instrumentally (Fig. 7, 8, 9).

Based on the histologic findings, the lesions were defined as periapical granulomas or periapical cystic formations. After the performed radiographic and histologic analysis of the periapical zones, the results showed that the histological diagnosis is the only reliable diagnostic method, which is to confirm the observations of Linenberg (1964) [6, 7].

Fig. 7. Scanogram of external root resorption – SEM (magnification x 200)

In periapical granulomas, the infiltration of lymphocytes (L), plasma cells (P) and macrophages (Mph) was predominant, with or without epithelial debris coated with a collagen capsule. Neutrophils were a rare finding in these lesions L [8].

Fig. 8. Magnification of the marked zone on Fig.7 (x 1000)
Fig. 9. Magnification of the marked zone on Fig. 8 (x 5000) (the arrows indicate *E. faecalis*)

Histological sections were analyzed under magnifications x 4, x 10 and x 40 (Zeiss microscope, Germany). The results of the histological examination are presented in Table 2.

**Table 2. Distribution of samples by periapical finding**

<table>
<thead>
<tr>
<th>Teeth with CAP</th>
<th>Histological samples</th>
<th>Radiographic examination</th>
</tr>
</thead>
<tbody>
<tr>
<td>n=24 (42)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Periapical granuloma</td>
<td>n= 33</td>
<td>n= 27</td>
</tr>
<tr>
<td>Periapical cyst</td>
<td>n= 9</td>
<td>n= 15</td>
</tr>
</tbody>
</table>

Despite the limited number of examined cases, the results obtained confirm the histology and the inaccuracy of diagnostic assumptions in some of the cases, resultant from the radiographic examination only (cases 1 and 2). Both clinical cases were radiographically diagnosed as periapical granuloma. Because of the coronary loss of hard dental tissues, the teeth (n = 24) were planned for extraction. After the microscopic analysis of the histological samples, the diagnosis of **clinical cases 1 and 3** was confirmed (Fig. 10, 11, 14 and 15), while this of **clinical case 2** was rejected, where the histology was indicative for periapical cystic lesion (Fig. 12 and 13).

Fig. 10. Clinical case 1 – tooth 26 – lesion around MB root

Fig. 11. Histological sample of periapical granulomatous lesion (stained with HE)

Fig. 12. Clinical case 2 – tooth 23, periapical lesion

Fig. 13. Histological sample of periapical cystic lesion (stained with HE)
This technique of preparation, it is possible to increase the size of the main apical file, which is a prerequisite for adequate removal of the infected intracanalicular dentine and maximum removal of invaded microorganisms, in consistency with the features of the root canal system, while avoiding the increased risk of over instrumentation in the apical zone. Clinical observations have shown that the increase in the size of the file applied last in the apical zone and the extension of the set conicity/taper substantially increase the volume of solution for irrigation, enhance debris evacuation to the maximum and minimize the need of creating an apical dentine stopper. The average statistical apical treatment of the root canal with file #40 (according to ISO) and taper 0.04 has been shown to preserve hard dental tissues and provide maximum irrigation in the apical third, adequate distance between the needle and the root canal walls and a possibility for evacuation of the solution towards the orifice. This has been confirmed by a number of authors [10, 11, 12, 13, 14]. The apical level of processing and the volume that should be removed during root canal preparations in this area are the subject of much discussion [15, 8, 16, 14, 17]. Many modern machine Ni-Ti systems limit the processing area to a diameter of 250-300 $\mu$m, while avoiding the preparation in the zone of narrowing. This is due to technical considerations aiming at the creation of favorable conditions for obturation of the root canal system by applying warm condensation methods in order to avoid the extrusion of material in the case of a wider apical zone. However, biological considerations indicate otherwise [15, 16, 14, 17]. The apical narrowing and the apical foramen are areas that favor the development of microorganisms and the accumulation of bacterial biofilm that can remain mechanically and chemically untreated upon limited preparation [8]. Moreover, the natural size of the apical narrowing (typically $\geq 250-300$ $\mu$m to 600 $\mu$m) implies an extended apical preparation [18].

**CONCLUSION**

Based on the analysis of results, the following conclusions can be drawn:
- external resorption around the apical foramen is established in 97.6% of cases in the teeth with radiographically diagnosed CAP;
- in 85.4% of the apices of teeth with periapical lesions larger than 4 mm, resorption of the foramen was also observed, related with destruction of the physiological narrowing;
- in 57.1% of the ex vivo measured apices, values of the narrowing within the range of #35–55 were measured and in 34.4% – #60–140;
- no correlation was found between the radiographic diagnosis of presented apical resorption and the findings of the SEM-analysis.
REFERENCES:


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