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Outcome of orthograde endodontic retreatment – A two-year follow-up

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SUMMARY

Introduction Endodontic retreatment is a complex intervention that requires detailed analysis of possible reasons for failure, and flawless practical execution of the procedure.

Objective The aim of the study was to assess the outcome of endodontic retreatment based on clinical and radiographic criteria after a two-year observation period.

Methods Clinical study included 49 teeth indicated for endodontic retreatment based on periapical index (PAI). All teeth were divided into two groups. Group I comprised teeth without any periapical lesion (PAI score of 1 and 2) while Group II consisted of teeth with visible periapical radiolucency (PAI score of 3, 4, and 5). Endodontic retreatment was completed in two visits with inter-appointment medication of 2% chlorhexidine and calcium hydroxide for two weeks. Outcome of endodontic retreatment was evaluated 12–24 months after final obturation.

Results Endodontic retreatment was successful in 93.3% in Group I after 24 months. In Group II, successful treatment and complete healing was found in 52.9% of teeth, whereas 14.7% of teeth showed only partial healing. However, clinical symptomatology was not present in any of the cases. Considering the absence of clinical signs and subjective symptoms, retreatment was successful in 67.6% of cases where chronic periapical inflammation was present.

Conclusion Endodontic retreatment was successful in high percentage in teeth with and without periapical lesions.

Keywords: endodontic retreatment; endodontic failure; apical periodontitis

INTRODUCTION

Contemporary endodontic therapy aims to preserve functionality and aesthetics of teeth with diseased pulp and/or periapical tissue. Root canal treatment is currently one of the most efficacious dental interventions with high success rate [1–4].Endodontic treatment is affected by anatomical and morphological complexity of root canal system, diagnosis, and periradicular tissue state before the intervention. Also, equipment and materials, operator experience, and the presence of infection at the time of obturation play an important role [5,6].

In certain cases endodontic treatment may fail. One of the most common reasons is inability to eliminate microorganisms from the root canal. Some of the reasons for microorganism survival after endodontic procedure are inaccessibility to all parts of the canal system during chemo-mechanical instrumentation, or procedural errors such as root perforations, ledge formation, and transportation or separated instruments [6]. Procedural errors by themselves are not direct cause of endodontic treatment failure but indirectly they pose risk due to incomplete chemo-mechanical debridement or inadequate obturation of the root canal system [4–7]. It has been confirmed that presence of root canal infection at the time of obturation and preoperative presence of periapical lesion significantly reduce chance for successful outcome of endodontic treatment [5, 6].In addition to the persistence of intraradicular infection, some possible causes for failure of endodontic treatment are extraradicular infection in the form of actinomycosis, true cysts (in which lumen does not communicate with the apex of the root canal), foreign body reaction in the presence of cholesterol crystals or endodontic materials extruded in periapical tissue or fibrous scar tissue [8].

There is no exact definition of failure of endodontic treatment among endodontists. Many clinicians would agree that the absence of pain and other clinical symptoms, or even more precise – preservation of function of an endodontically treated tooth can be considered successful endodontic treatment [1, 9]. However, the existence of inflammatory lesion in periapical tissue that previously did not exist, its persistence or even increased size after endodontic treatment is a definite sign of failed endodontic treatment [6, 8, 9].

Radiographic evaluation of endodontic treatment is main method of monitoring outcome of the treatment [10, 11]. It is, however, limited by visual interpretation that is not objective but depends on the observer [12]. Epidemiological studies on large number of samples showed that most failures have occurred within two years of the treatment, whereas

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sometimes it takes four to five years for complete healing of bone defect [4, 7, 12–16].

Prior to retreatment it is important to consider all options in relation to the time, cost and prognosis of therapy, and to decide between nonsurgical (orthograde) retreatment, surgical retreatment, or extraction[17]. Endodontic retreatment includes removal of material from the root canal space, detection of all deficiencies, and repair of pathological or iatrogenic defects, followed by shaping and cleaning, and finally obturation[18]. Decision for retreatment is directly related to reduced percentage of success in repeated interventions [7, 12, 13, 15, 19, 20].

OBJECTIVE

The aim of this study was to assess the outcome of endodontic retreatment based on clinical and radiographic criteria during a two-year period.

METHODS

Clinical study included 37 patients and 49 teeth (28 multirooted and 21 single-rooted teeth) indicated for retreatment. Endodontic treatment was done in a period of less than one year in two cases, a period of one to five years in 17 cases, while 30 teeth were treated more than five years before diagnosis of endodontic failure. Adequate prosthetic restoration was observed in 17 teeth, five teeth no longer had definitive filling material, and 27 teeth did not have proper restoration. Retreatment was done at the Department of Restorative Dentistry and Endodontics, Faculty of Dental Medicine in Belgrade by one therapist while two therapists assessed the outcome of retreatment.

All patients were clinically and radiographically examined in order to establish diagnosis and indications for conventional retreatment. Patients also signed informed consent for voluntary participation in the clinical study. Teeth with extensive carious destruction, severe periodontal disease and patients who didn't sign the consent were excluded from the study. Teeth that had blocked canals or separated instruments were indicated for surgical retreatment.

Retreatment decision was based on detailed analysis of initial endodontic treatment failure, analysis of intraoral radiography, clinical examination of teeth and periodontal tissues, possible success of retreatment and adequate reconstruction afterwards.

Periapical tissue was assessed radiographically using periapical index (PAI) system [21]:

PAI 1 – normal periapical structure;

PAI 2 – small changes in the structure of bone not pathognomonic of apical periodontitis;

PAI 3 – changes in bone structure with mineral loss characteristic for apical periodontitis;

PAI 4 – well defined apical radiolucency characteristic for apical periodontitis, and

PAI 5 – severe periodontitis with exacerbating features and bone expansion.

Based on radiographic assessment of periapical tissue, the teeth were divided into two groups. Group I included teeth without periapical changes (PAI score of 1 and 2) where retreatment was indicated due to the poor quality of root canal filling. The teeth with visible signs of damage in periapical tissue (PAI score of 3, 4, and 5) were assigned to Group II. For the evaluation of multirooted teeth, the greatest damage of periapical tissue around roots was considered. The second parameter for analysis was the presence of clinical symptoms where Group I included teeth with no clinical symptoms (diagnosed accidentally) and Group II consisted of teeth with clinical symptoms (pain, swelling, sensitivity to bite or presence of sinus tract) (Table 1).

Endodontic retreatment was conducted according to contemporary standards of endodontic therapy. After the access cavity preparation, root canal material was removed from root canal space. Gates Glidden instruments were used to remove gutta-percha from the coronal two thirds of the canal, while Hedstrom files with copious irrigation with 1% sodium hypochlorite solution were used to remove obturation materials from the apical third. In some cases Gutasolv and Endosolv (Septodont, Saint-Maur-des-Fossés, France) were used to dissolve gutta-percha. Working length was determined using apex locator. Complete material removal and working length were also verified using X-rays. Access cavity was thoroughly examined to find missed canals. All canals were instrumented using "crown-down" technique with Gates Gliddenand K-files and K-flex hand instruments to full working length using 17% EDTA or Canal + (Septodont). After copious irrigation with 1% sodium hypochlorite solution, canals were irrigated with 10% citric acid and saline. After drying with paper points, 2% chlorhexidine (R4, Septodont) solution was placed in the canal for inter-appointment medication. The teeth were temporarily closed with glass ionomer cement (Alfagal, Galenika, Belgrade, Serbia) for two days. In the next visit, after removing medication, the canals were irrigated and suspension of calcium hydroxide was placed in the canals using lentulo spiral. The teeth were again temporarily restored with glass ionomer cement for two weeks. If symptoms still persisted, medication was repeated for two more weeks. Obturation was done using

Table 1. Distribution of teeth in relation to the presence of clinical symptoms in the group of teeth with healthy periapical tissues and the group with present periapical lesions.

Clinical symptoms		Teeth with healthy periapical tissue		Teeth with periapical lesion	
		N	%	N	%
Symptoms	Yes	0	0	9	36%
	No	15	100%	25	64%
Pain	Yes	0	0	6	24%
	No	15	100%	28	76%
Sensitivity to bite	Yes	0	0	3	12%
	No	15	100%	31	88%
Swelling	Yes	0	0	3	12%
	No	15	100%	31	88%
Sinus tract	Yes	0	0	3	12%
	No	15	100%	31	88%

lateral compaction of gutta-percha and sealer (Acroseal, Septodont). The teeth were permanently restored by sandwich technique using glass ionomer cement (Fuji VIII and Fuji IX, GC, Tokyo, Japan) and composite material (Filtek, 3M ESPE, Saint Paul, MN, USA) or they received prosthetic restoration.

Periapical X-rays were taken before, during and immediately after obturation and permanent restoration. Follow-up was scheduled for two years after retreatment. All X-rays were blind-coded and organized randomly. To avoid subjectivity, two dentists carried out the analysis. X-rays were analyzed in the light box with the use of magnification (×2). In order to minimize false-positive results, in cases of disagreement, radiographic analysis was repeated until consensus was reached.

Follow-up included the assessment of subjective symptoms (if any, before treatment) and objective signs after the retreatment, after 12 months, and two years. In the group of teeth where periapical radiolucency was present, radiographic evaluation of healing process after retreatment was done based on the following criteria [22]:

1. Unchanged – no changes in the periapical area after completion of retreatment and follow up visits;
2. Improvement – reduced radiolucency in alveolar bone with bone forming or partial repair of damaged cementum;
3. Complete healing – disappeared periapical radiolucency and bone formation, re-establishment of the lamina dura and cementum apposition (*restitutio ad integrum*), and
4. Deterioration – persistence of radiolucency and alveolar bone resorption with the same or larger lesion or dulled apex.

Table 2. Distribution of teeth in relation to periapical index (PAI) value before retreatment and on the follow-ups.

PAI	Before retreatment		After 12 months		After 24 months	
	N	%	N	%	N	%
1	8	16.3	10	20.4	22	44.9
2	7	14.3	20	40.8	15	30.6
3	16	32.7	15	30.6	7	14.3
4	12	24.5	2	4.1	1	2.0
5	6	12.2	2	4.1	4	8.2

The results were statistically analyzed using appropriate statistical tests (Man–Whitney U-test).

RESULTS

On follow-up examination after 12 months there was major improvement of apical periodontitis. PAI score of 4 was initially found in 24.5%, and after 12 months in only 4.1% of the cases. At the end of the observation period of 24 months, PAI score of 1 and 2 (successful retreatment) was observed in 44.9% (score 1) and 30.6% (score 2) of the teeth. This means that retreatment was successful in 75.5% of the cases (37 of total of 49 teeth). PAI index 3, 4, and 5 (unsuccessful retreatment) was found in 24.5% of the cases (14.3% for score 3, 2% for score 4, and 8.2% for score 5) (Table 2).

Retreatment in the group of teeth with healthy periapical tissue was successful in 93.3% of the cases after 24 months (Figures 1, 2; Table 3).Partial improvement was observed in 14.7%, and complete healing in 52.9% of the cases (Figures 3,4, 5). Statistically significant difference in treatment outcome was found between the two studied groups (U=158, Z=2.485; p=0.013). Considering the absence

Figure 1. a) Periapical radiography of the right maxillary first molar with forgotten buccal canals, b) Obturation after retreatment, c) Prosthetic reconstruction with post and metal-ceramic crown – complete healing after two years.

Figure 2. a) Periapical radiography of the left maxillary first molar with inadequate obturation and without changes in the periapical tissue, b) Obturation after retreatment, c) Complete healing after two years.

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Table 3. Outcome of repeated endodontic treatment in relation to the existence of periapical (PA) lesion.

Follow-up				Treatment outcome			Total
			Deterioration	Status quo	Improvement	Complete healing	
After 12 months	Without PA	N	0	0	0	15	15
		%	0%	0%	0%	100%	100%
	With PA	N	2	9	8	15	34
		%	5.9%	26.5%	23.5%	44.1%	100%
After 24 months	Without PA	N	1	0	0	14	15
		%	6.7%	0.05%	0%	93.3%	100%
	With PA	N	4	7	5	18	34
		%	11.8%	20.6%	14.7%	52.9%	100%

Figure 3. a) Periapical radiography of the left first and second maxillary premolars. No. 24 was sensitive to palpation and with inadequately filled root canals, No. 25 had inhomogeneous filling with periapical radiolucency, b) Obturation after retreatment, c) Complete healing after two years.

Figure 4. a) Periapical radiography of the left mandibular first molar. No. 36 was painful and swelling was present, b) Obturation after retreatment, c) Complete healing after two years.

Figure 5. a) Periapical radiography of the left mandibular first molar with short filling in the distal canal and forgotten mesial canals, b) Obturation after retreatment, c) Complete healing after two years.

of clinical signs and subjective symptoms, retreatment was successful in 67.6% of cases where chronic periapical inflammation was present.

DISCUSSION

Repeated endodontic treatment is a very interesting endodontic problem that requires complex analysis of indications and perfect practical execution of the procedure. Torabinejad et al. [23] conducted comprehensive review of literature on clinical studies that assessed success and failure of endodontic treatment in the period 1970–2004. They analyzed 31original articles and six review articles. Only a few studies had high level of evidence (level 2). Also, even though all studies examined causes of endodontic treatment failure and outcome of retreatment, they all had different design and performance [7, 8, 11, 12, 13, 15, 19, 20].

Ørstavik et al. [21] introduced PAI system for radiographic assessment of periapical status that was used in

our study. This system allows easier tracking of periapical changes and purposeful comparison of outcome of conventional endodontic retreatment in clinical studies. Radiographic evaluation is the main method to monitor outcome of endodontic treatment. It is however limited by visual interpretation, which is not an objective method and depends on the observer. Disagreement between observers in the interpretation of radiographs is very common. Therefore, "strategies of observation" increase the degree of compliance among observers, minimizing subjectivity in interpretation [24]. Another limitation is that radiography shows only two dimensions. A lesion is radiographically visible if there is significant bone destruction. This means that a lesion in reality is bigger than on a radiographic view. Bender et al. [25] indicated that changes in X-ray beam angulation might increase or reduce the size of the lesion. Furthermore, differences in exposition and conditions for X-ray developing can affect the assessment of treatment outcome. Some anatomical structures (maxillary sinus, mental foramen, inferior alveolar nerve canal, zygomatic bone...) can also make the interpretation of intraoral radiography difficult.

Cone beam computed tomography (CBCT) represents the most modern, three-dimensional diagnostic system and has been specially designed for use in maxillo-facial region. Regardless of its superiority compared to traditional two-dimensional intraoral radiography, CBCT is not yet in widespread clinical use due to its cost and significant radiation dose[26, 27].

Microbiological status of endodontically treated teeth is significantly different compared to untreated infected root canal. Gram-positive cocci, bacilli and filaments with equal distribution of facultative and obligate anaerobes *Enterococcus* and *Streptococcus*, *Actinomyces*, *Peptostreptococcus*, *Propionibacterium* (previously *Arachnia*) and *Lactobacillus* are most commonly found in endodontically treated teeth [28, 29].

Enterococcus faecalis is a microorganism that is not present in the initial periapical infection but is associated with asymptomatic, persistent endodontic infections after endodontic treatment in high percentage (24–77%) [29, 30]. *E. faecalis* has a variety of mechanisms to survive in extreme conditions, different virulence factors, potency to invade dentinal tubules and is difficult to eliminate from the canal system. Aseptic technique and intracanal medication with calcium hydroxide must be complemented with 2% chlorhexidine solution to reduce the number of microorganisms [30]. Zerella et al. [31] demonstrated that combination of chlorhexidine and calcium hydroxide was significantly more effective in retreatment compared to calcium hydroxide only. Yoldas et al. [32] conducted a clinical study in order to compare the efficiency of one-visit vs. two-visit retreatment using medication that combines calcium hydroxide and 2% chlorhexidine solution. The results showed that two-visit retreatment was more effective in reducing postoperative pain and potential flair-ups.

The results of the current study indicate that after 24 months repeated endodontic treatment was successful in 75.5% regardless of the periapical status. The criteria for evaluating success were the absence of clinical signs and symptoms and radiographical findings that show healthy periodontal tissue or minor radiolucency (PAI index ≤2). During the two-year observational period, four teeth were extracted, two because of pain, and two because of uncertain prognosis in terms of prosthetic rehabilitation plan. The reason for the treatment failure of one of the two teeth was vertical root fracture that was diagnosed during the extraction. The only case of failure after repeated therapy in teeth with previously healthy periodontal tissue could be attributed to delayed prosthetic reconstruction of more than three months and inadequate coronal seal during that period.

Our study showed that 93.3% of teeth with no signs of periapical radiolucency had successful outcome of endodontic retreatment while this percentage was 67.6% for teeth that showed signs of periapical radiolucency before retreatment. High success rate of endodontic retreatment in the current study could be explained by the fact that treatment was conducted in adequate conditions with appropriate instrumentation and medication after detailed analysis of causes of failure. The most common causes of failure were incomplete or delayed conservative or prosthetic reconstruction, inadequate occlusal relationship with other teeth, as well as individual oral hygiene. The results of our study are in agreement with results of other studies that have investigated outcomes of nonsurgical endodontic retreatment [7, 11, 13, 15, 19, 20].

Gorni and Gagliani [20] investigated the success of endodontic retreatment over a period of two years. They analyzed 452 teeth divided into two categories. The first one comprised teeth with modified anatomy where initial endodontic treatment altered morphology of the canal system. In this group retreatment was successful in 47%. In the second group, where there were no significant anatomical changes and morphology of canals was respected, success rate was 86.8% [20]. Fristad et al. [19] conducted a long-term study where they performed radiographical evaluation of 112 retreated teeth after 20–27 years. They found that asymptomatic periapical radiolucency should not be considered a failure because in 95.5% of cases they remain asymptomatic. Also many of them (especially those that were adequately restored) showed delayed healing after a prolonged period of time [19].

Friedman et al. [7, 13] conducted extensive epidemiological study in Toronto to evaluate successful outcome of repeated conventional nonsurgical endodontic treatment and factors that influence it. During the observation period of four to six years in four stages of research, they examined 126 retreated teeth and found that 81% of them had absence of periapical inflammation and signs and symptoms of periapical inflammation. They concluded that the most important factors to determine successful outcome of endodontic retreatment are the quality of canal filling, the existence of preoperative perforation, and preoperative status of periapical tissue [7, 13].

Salehrabi and Rotstein [15] assessed 4,744 non-surgically endodontically retreated teeth during an observation period of five years. They found that 89% of teeth were still present in the oral cavity while 11% were extracted. Dur-

ing the first two years, 4% of the retreated teeth underwent surgical intervention (apicoectomy). This high success rate is related to criteria that exclusively analyze survival and function of teeth and ignore radiographical findings.

CONCLUSION

Retreatment of previously endodontically treated teeth for various endodontic indications during an observation period of two years was successful in high percentage in teeth with and without clinical symptoms and radiographic signs of periapical lesion.

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Исход поновног третмана ендодонтски лечених зуба након две године

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КРАТАК САДРЖАЈ

Увод Ендодонтски ретретман је комплексна интервенција која захтева детаљну анализу индикација, односно перфектну практичну реализацију оваквог захвата.

Циљ рада Циљ овог рада је био да се на основу клиничких и радиографских критеријума процени исход поновљене ендодонтске терапије након периода од две године код пацијената са различитим ендодонтским индикацијама.

Методе рада Клиничка студија је обухватила 49 зуба индикованих за поновљени ендодонтски третман, који су на основу ПАИ (периапикални индекс) скора подељени у две групе. У прву групу су сврстани зуби без периапикалних промена (ПАИ скор 1 и 2), док су другу групу чинили зуби са видљивим знацима оштећења апексног пародонцијума (ПАИ скор 3, 4 и 5). Поновљено ендодонтско лечење подразумевало је медикацију 2% раствором хлор-хексидина и суспензијом калцијум-хидроксидом у трајању од две недеље у обе групе зуба. Исход предузете терапије процењиван је на клиниким и радиографским контролама 12–24 месеца након дефинитивне оптурације.

Резултати Поновљена ендодонтска терапија у групи зуба са здравим пародонталним ткивима након 24 месеца била је упешна у 93,3% случајева. У групи са периапикалним променама радиографски делимично побољшање забележено је у 14,7%, а потпуно излечење у 52,9% случајева. С обзиром на одсуство клиничких знакова и субјективних симптома, поновљена терапија сматрана је успешном у оба случаја, дакле у укупно 67,6% зуба код којих су постојале хроничне периапикалне лезије.

Закључак Поновљена ендодонтска терапија је била успешна у високом проценту и код зуба без изражених клиничких и радиографских симптома и са њима.

Кључне речи: ендодонтски ретретман; ендодонтски неуспех; апикални периодонтитис

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