ORIGINAL ARTICLE

Fariborz Moazami[1] DDS, MS, **Safoora Sahebi**[1] DDS, MS, **Fereshte Sobhnamayan**[2*] DDS, **Abbas Alipour**[2] DDS

Success rate of nonsurgical endodontic treatment of nonvital teeth with variable periradicular lesions

1. Associate Professor of Endodontics, Dental school, Shiraz University of Medical Sciences, Shiraz, Iran.
*2. Postgraduate Student of Endodontics, Dental school, Shiraz University of Medical Sciences, Shiraz, Iran. *Correspondence author*
E-mail: f-sobh-namayan @yahoo.com

INTRODUCTION: Bacterial infection of tooth pulp can progress into periapical diseases. Root canal treatment has been established as the best treatment. In cases of failure, nonsurgical retreatment of teeth is preferred to surgical procedure and extraction.

MATERIALS & METHODS: In this historical cohort study, 104 permanent teeth with apical lesion were treated during 2002-2008. All teeth showed radiographic evidence of periapical lesion varying in size from 1 to >10mm. A total of 55 teeth were treated with initial root canal treatment and 49 teeth required retreatment. Patients were recalled up to ≈7 years. All radiographs were taken by RSV MAC digital imaging set and long cone technique. The presence/absence of signs and symptoms and periapical index scores (PAI) were used for measuring outcome. Teeth were classified as healed (clinical/radiographic absence of signs and symptoms) or diseased (clinical/radiographic presence of signs and symptoms). The data were statistically analyzed using student t-test and Pearson chi-square or fisher's exact test.

RESULTS: The rate of complete healing for teeth with initial treatment was 89.7%, and for retreatment group was 85.7%; there was no significant difference. Size of lesions did not significantly affect the treatment outcomes. Success of tooth treatment did not reveal significant correlation with gender and number of roots.

CONCLUSION: Orthograde endodontic treatment/retreatment demonstrates favorable outcomes. Thus, nonsurgical endodontic treatment/retreatment should be considered as the first choice in teeth with large periapical lesion.

KEYWORDS: Endodontics, Periapical disease, Retreatment, Root canal therapy, Treatment outcome.

INTRODUCTION

Infection of root canal system occurs subsequent to tooth caries, surgical treatments, and trauma. The microbial flora is commonly mixed, predominantly gram-negative, anaerobic bacterium (1). The close relation between tooth pulp and periapical region allows passage of bacteria, fungi, and cell components with a path for initiating inflammatory processes in periapical regions and activating resorption in the tissues. These immunopathological mechanisms lead to formation of abscess, granuloma, and periapical cyst (2-4). Ramachandran Nair *et al.* analyzed 256 periapical lesions histologically and found that 35% were abscesses, 50% were granulomas, while only 15% were cysts; 52% of lesions had an epithelial compartment within their structures (5-7). The incidence of periapical cysts has been reported to be 15-42%. Radiographs cannot distinct periapical radiolucencies as a cyst or granuloma. The two types of periapical cysts are true and pocket cysts. True cyst has lumen with intact epithelial lining which is separate from the root apex; whereas, pocket cyst shows the lumen which is open to the root canal of the infected tooth. True cysts do not probably heal after non-surgical endodontic therapy and usually require surgical procedures (8). Some clinical studies have shown healing of large periapical lesions following simple endodontic treatments (9,10). Previously, large periapical lesions were

generally managed by surgical excision of cysts after root canal treatment of infected teeth (11); during recent years, increased knowledge of the morphology and complexity of root canal system has led to development of newer technique, instrument and materials which consequently result in improved endodontic treatment and healing of cyst and a reduced need for periapical surgery (12,13). Success rate of about 90% is reported for endodontic treatments. Although several studies still believe that treatment for teeth with periapical lesions has lower success rate (20% decrease) (14-16).

As there are no studies looking at the healing of endodontic lesions in Iran, the aim of this study was to evaluate the success rate of nonsurgical endodontic treatment/retreatment of teeth with various periapical lesions sizes.

MATERIALS & METHODS

For this historical cohort study, 104 permanent teeth of 81 patients were analyzed. All teeth had been endodontically treated during 2002-2008. Patients with endodontic-periodontal lesions, contributory systemic disease, obturation techniques other than lateral condensation, inter-appointment dressings >1 session, and follow-ups <6 months were excluded from this study. An informative form including individual, medical and dental information in addition to detailed records of previous root canal treatments was performed for each patient. Among the included teeth, 41 were single rooted, 7 were double rooted, and the remaining 56 were multiple rooted. Radiographically, all teeth showed periapical lesion with the size between 1mm to >10mm. According to patient records 41 teeth had different sign and symptoms of acute apical periodontitis *e.g.* pain, tenderness to percussion, localize or diffused swelling and also mobility. The remaining 66 teeth were symptom-free. A total of 55 teeth were root canal treated for the first time and 49 teeth were retreated (failed treatments). Radiographic examination was performed using RSV MAC digital imaging long cone technique. All teeth were treated by one endodontist in one session. Access cavity was performed and teeth were isolated with rubber dam. Working lengths

were determined using appropriate K-files (Mani, Tochigi-ken, Japan). In teeth with previous endodontic treatment, gutta-percha and sealer were removed by hand and rotary instrumentation including Gates-Glidden drills (Mani, Tochigi, Japan), heated plugger, K and H files and also ProTaper rotary system (Dentsply, Maillefer, Ballaigues, Switzerland). If needed chloroform was used as solvent. Working lengths were determined radiographically. Subsequently, root canals were instrumented with rotary files. Irrigation was performed frequently with 2.5% sodium hypochlorite (NaOCl). After drying with sterile paper points, canals were obturated with gutta-percha (Ariadent Co., Tehran, Iran) and Tubliseal (Sybron Endo, CA, USA) using cold lateral condensation method. After root canal filling, teeth were restored permanently. Patients were recalled every 4 m for up to 1 yr, and then every 12 m for about 6 yrs.

All radiographs were taken by RSV imaging set and long cone technique with standardized exposure time and no need for processing. The largest diameter of the lesions was measured with RSV imaging software. The presence or absence of signs and symptoms and also PAI scores were used for measuring the outcome.

Teeth were classified as healed when there was clinical absence of signs and symptoms and radiographic PAI score ≤2. Teeth were termed diseased in cases with clinical presence of signs and symptoms or when PAI≥3. Multi-rooted teeth were assigned the highest PAI scores of their roots. Teeth with the absence of any sign or symptoms regardless of PAI score were considered functional. Three trained observers (two endodontist and one radiologist) analyzed radiographs. PAI were assigned to each radiograph. If there was any controversy between observers the two that were similar were chosen.

The data were statistically analyzed using student t-test and Pearson chi-square or fisher's exact test, where applicable (with a preset probability of P<0.05 and considering of variance equality with Leven test). Experimental results are presented as arithmetic Mean ±SD. Normality of parameters' distribution was

***Table 1**.* Association between outcomes of treatment with independent variables

Independent variable		Outcome of treatment [N (%)]		P-value
		Healed (n=91)	Diseased (n=13)	
Gender	**Female**	65 (86.7)	10 (13.3)	0.482[1]
	Male	26 (89.7)	3 (10.3)	
Treatment	**Initial treatment**	49 (89.8)	42 (85.7)	0.602[2]
	Retreatment	6 (10.9)	7 (14.3)	
Root	**Single-rooted**	38 (92.7)	3 (7.3)	0.162[2]
	Multi-rooted	3 (84.1)	10 (15.9)	
Lesion size	**≤5mm**	60 (89.6)	7 (10.4)	0.289[1]
	>5mm	31 (83.8)	6 (16.2)	

(1) Fisher exact test, (2) chi-square test

evaluated with one sample Kolmogorov-smirnov test. For the evaluation of non linear association between frequencies of persistent disease state with prognostic factors (independent variables that P-value of association of those with disease status in Univariate analysis was less than 0.2) binary logistic regression was performed.

RESULTS

Eighty one patient, with 104 teeth (72.1% of teeth were in female patients and 72.1% in males) were evaluated in this historical cohort study with the age ranging from 8-82 years (mean=38.36, SD=13.49). Follow-up time ranged between 4 to 81 month (mean=31.92, SD=21.82). A total of 55 (52.9%) teeth underwent initial treatment and 49 (47.1%) teeth were retreated. Also, 41 teeth (39.4%) were single-rooted and 63 (60.6%) teeth were multi-rooted. Total of 67 (64.4%) teeth had lesion ≤5mm and in the remaining 37 (35.6%) teeth the lesions were ≥5mm. Ninety one teeth (87.5%) were "healed" and the other 13 (12.5%) teeth had persistent disease at the follow-up. Cumulative incidence of healing was 0.875 (95% CI: 0.811, 0.939).

Association between outcome of treatment with demographic and other independent variables were evaluated. Age of patients in healed and diseased groups were 37.57±12.88 and 43.85±16.71 years respectively; which was not statistically significant (P=0.117). Although follow-up time in healed group patients was greater than persistent group patients (32.96±22.11 mon vs. 28.62±20.14 mon), this difference was not statistically significant (P=0.562). Other associations between

outcomes of treatment with independent variables are shown in Table 1. There were no remarkable correlation between outcome of treatment with gender and previous treatment status of patients, number of roots and also lesion size.

Multilevel analysis for evaluation of association between outcome of treatment with prognostic variable (root number and age) was evaluated. There were no association between age of patients (OR=1.033; P=0.169) and number of roots (OR=2.092; P=0.293) with treatment outcome.

DISCUSSION

Unlike other studies that evaluated the success rate in all treated teeth, regardless of periapical lesions, this study focused on the success rate of teeth with periapical lesions. This may explain the difference between the various outcomes.

Several factors may influence endodontic treatment outcome, which are called outcome predictors. Radiographic outcomes have been used to indicate "success" and "failure" of endodontically treated teeth and have been compared with clinical evaluations. Since Goldman *et al.* demonstrated poor inter- and intra-observer reliability in interpretation of periapical radiographs, and in order to make more reliable criterion PAI was used to describe the status of periapical tissues (17,18).

Unfortunately, methodological problems complicate the comparison of different studies (19). Several studies have compared the success rate of teeth with and without apical periodontitis

(lesions with different size). Most quoted ≈15%-20% lower success rate for teeth with apical periodontitis (20-23). This is inconsistent with our study. Peters *et al*. had a success rate of about 75% in 115 teeth with periapical lesion; 20% lower than the cases without lesions (20). A further study found a similar pattern with 74% success rates for teeth with apical periodontitis (72 teeth) which was 15% lower than teeth with healthy periapical condition (22). Farzaneh *et al*. also showed the success rate of teeth with periapical lesion was 79% in 70 cases which is 14% lower than cases without periapical lesion (21). The current study shows a success rate of about 87%. Our study may be more reliable than other studies as the experimental procedures were performed by one operator who was a specialist; also factors not assessed in the regression analysis could thus be better controlled (relative to each other) than in retrospective studies with data pooled from a clinic. However, a greater number of teeth were included in this survey, except one other study which may result in better reliability in the treatment outcome.

In the present study, all teeth were treated in one session. Some studies believe that there is no significant difference between one-visit and two-visit endodontic treatments (10,19,23). Others advocate that using intracanal medica-ment such as calcium hydroxide between sessions especially in very large periapical lesions is beneficial, as shown in several case reports and studies (23-29). Generally, there is a great tendency among practitioners to use calcium hydroxide in canals specifically in those with periapical lesions. In this study we showed high success rate (84%) in cases with large peri-apical lesion without using calcium hydroxide as it is thought that this medicament is not always effective and its action is unreliable (30-34).

The outcome of treatments in this study did not show any correlation with size of lesion. Although there is some evidence to indicate better outcomes for cases with small lesions (≤5mm) compared to those with larger periradicular lesions after either initial treat-ments (10,23-25,35) or retreatments (4). In some studies, comparable outcomes have been reported for both small and large lesions after initial treatment (23-25,35) and retreatment (36). Soares *et al*. showed the complete resolution of large periapical lesion after 2-year follow-up (2); Caroline *et al*. also showed complete healing of large lesions (10×15mm) after 2yrs (28). Saatchi demonstrated the 12-month periapical healing of large lesion after using calcium hydroxide as an intracanal dressing (11). These case reports confirm the high probability of healing of large periapical lesions without periapical surgery, similar to our study. However, Hoskinson *et al*. suggested that there was nearly an 18% decrease in the probability of success rate with every 1mm increase in the lesion size. He also described the periapical lesion as the most significant factor affecting outcome of treatment which is not in agreement with this study (34). The better outcome in teeth with smaller lesions that is suggested in this study (though statistically insignificant) is probably due to the greater time required for a large lesion to heal, and the probability of repairing scar tissue in large lesions (10).

Whether RCT was performed as initial treatment or as retreatment did not significantly influence the outcome in this study. This finding is consistent with that of Marending *et al*. (37) and contrary to other studies like Peters *et al*., and some other investigators (20,24,38-40). There was an insignificant lower success rate for retreatments, which may be due to treatment complications. Some studies believe in impairment of healing by complications including perforation of the pulp chamber or root, broken instruments that prevent adequate cleaning, and massive extrusion of filling materials (24,35). Otherwise, the etiology of failure in well-obturated teeth may be more likely related to extraradicular infection, cystic lesions, foreign body reaction, and undiagnosed infractions as the conditions that might not respond to retreatment favorably (41).

This study showed different, but insignificant, outcomes for single-rooted and multi-rooted teeth agreeing with several other studies (14,22,42-44); contrary to study carried out in Toronto phase II and IV (21,45).

The lower outcomes in multi-rooted teeth can

be due to the challenge of eliminating root canal infections. However, the difference could be attributed to the use of the tooth as a unit, reflecting the double or triple probability of disease in multi-rooted teeth when assessed according to the worst root (PAI score) (19).

A whole host of studies, with one exception (18), show that gender and age do not significantly affected initial treatment (22-24,33-35,46) and possibly retreatments (36), concurring with our study.

CONCLUSION

Nonsurgical endodontic treatment/retreatments are a favored treatment option regardless of the lesion size, previous status of tooth, and age of the patient. Treating teeth with periapical lesions can be performed in one-visit if canals are dry. Further studies with more samples are recommended. Also, longer follow ups may be required for larger lesions and long-term prognosis of endodontic treatments.

Conflict of Interest: 'none declared'.

REFERENCES

1. Sundqvist G.Taxonomy, ecology, and pathogenicity of the root canal flora. Oral Surg Oral Med Oral Pathol 1994;78:522-30.
2. Soares JA. Microflora of the root canal associated with chronic periapical lesions and its clinical significance. Jornal Brasileiro de Endo/Perio 2002;3:106-17.
3. Calişkan MK, Sen BH. Endodontic treatment of teeth with apical periodontitis using calcium hydroxide: a long-term study. Endod Dent Traumatol 1996;12:215-21.
4. Sundqvist G, Figdor D, Persson S, Sjögren U. Microbiologic analysis of teeth with failed endodontic treatment and the outcome of conservative re-treatment. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1998;85:86-93.
5. Rocha MJC. Estudo microscopic e imunocitoquimico dos cistos periodontais apicais de dentes tratados ou nao endodonticamente. PhD thesis, Universidade de Sao Paulo, Bauru;152 (in Portuguese).
6. Soares JA, Queiroz CES. Periapical pathogenesis-Clinical and radiographic aspects, and treatment for the bone and root resorption of endodontic origin. Jornal Brasileiro de Endo/Perio 2001;21:124-35.
7. Ramachandran Nair PN, Pajarola G, Schroeder HE. Types and incidence of human periapical lesions obtained with extracted teeth. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1996;81:93-102.
8. Roda RS, Gettleman BH. Nonsurgical retreatment. In: Hargreaves KM, Cohen S, Berman LH. Cohen's pathways of the pulp. 10th Edition. St. Louis. CV Mosby, 2011: pp.920-47.
9. Leonardo MR, Silveira FF, Silva LA, Tanomaru Filho M, Utrilla LS. Calcium hydroxide root canal dressing. Histopathological evaluation of periapical repair at different time periods. Braz Dent J 2002;13:17-22.
10. Weiger R, Rosendahl R, Löst C. Influence of calcium hydroxide intracanal dressings on the prognosis of teeth with endodontically induced periapical lesions. Int Endod J 2000;33:219-26.
11. Saatchi M. Healing of large periapical lesion: a non-surgical endodontic treatment approach. Aust Endod J 2007;33:136-40.
12. Regan JD, Guttmann JL. Preparation of the root canal system. In: Pittfprd TR, ed. Harty's endodontics in clinical practice. 5th Edition. Edinburgh: Elsevier Science; 2004: pp. 77-94.
13. Kartal N, Yanikoğlu FC. Root canal morphology of mandibular incisors. J Endod 1992;18:562-4.
14. Engstrom B, Hard Af, Segerstad L, Ramstrom G, Frostell G. correlation of positive cultures with the prognosis for root canal treatment. Odontol Revy 1964;15:257-70.
15. Grahnen H, Hansoon L. The prognosis of pulp and root canal therapy. A clinical and radiographic follow-up examination. Odontol Revy 1961;12:146-65.
16. Storms JL. Factors that influence the success of endodontic treatment. J Can Dent Assoc (Tor) 1969;35:83-97.
17. Brynolf I. A histological and roentgenological study of the priapical region of human incisors. Odontological Revy 1967;18:1-176.
18. Orstavik D. Radiographic evaluation of apical periodontitis and endodontic treatment results: a computer approach. Int Dent J 1991;41:89-98.
19. Friedman s. Prognosis of initial endodontic therapy. Endodontic topics 2002;2:59-88.
20. Peters OA, Barbakow F, Peters CI. An analysis of endodontic treatment with three nickel-titanium rotary root canal preparation techniques. Int Endod J 2004;37:849-59.
21. Farzaneh M, Abitbol S, Lawrence HP, Friedman S; Toronto Study. Treatment outcome in endodontics-the Toronto Study. Phase II: initial treatment. J Endod 2004;30:302-9.
22. Friedman S, Abitbol S, Lawrence HP. Treatment outcome in endodontics: the Toronto Study. Phase

1: initial treatment. J Endod 2003;29:787-93.

23. Peters LB, Wesselink PR. Periapical healing of endodontically treated teeth in one and two visits obturated in the presence or absence of detectable microorganisms. Int Endod J 2002;35:660-7.

24. Sjogren U, Hagglund B, Sundqvist G, Wing K. Factors affecting the long-term results of endodontic treatment. J Endod 1990;16:498-504.

25. Sjögren U, Figdor D, Persson S, Sundqvist G. Influence of infection at the time of root filling on the outcome of endodontic treatment of teeth with apical periodontitis. Int Endod J 1997;30:297-306.

26. Soares JA, Brito-Júnior M, Silveira FF, Nunes E, Santos SM. Favorable response of an extensive periapical lesion to root canal treatment. J Oral Sci 2008;50:107-11.

27. Soares J, Santos S, Silveira F, Nunes E. Nonsurgical treatment of extensive cyst-like periapical lesion of endodontic origin. Int Endod J 2006;39:566-75.

28. Valois CR, Costa-Júnior ED. Periapical cyst repair after nonsurgical endodontic therapy-case report. Braz Dent J 2005;16:254-8.

29. Saatchi M. Healing of large periapical lesion: a non-surgical endodontic treatment approach. Aust Endod J 2007;33:136-40.

30. Orstavik D, Kerekes K, Molven O. Effects of extensive apical reaming and calcium hydroxide dressing on bacterial infection during treatment of apical periodontitis: a pilot study. Int Endod J 1991;24:1-7.

31. Peters LB, van Winkelhoff AJ, Buijs JF, Wesselink PR. Effects of instrumentation, irrigation and dressing with calcium hydroxide on infection in pulpless teeth with periapical bone lesions. Int Endod J 2002;35:13-21.

32. Reit C, Dahlén G. Decision making analysis of endodontic treatment strategies in teeth with apical periodontitis. Int Endod J 1988;21:291-9.

33. Siqueira JF Jr, Favieri A, Gahyva SM, Moraes SR, Lima KC, Lopes HP. Antimicrobial activity and flow rate of newer and established root canal sealers. J Endod 2000;26:274-7.

34. Hoskinson SE, Ng YL, Hoskinson AE, Moles DR, Gulabivala K. A retrospective comparison of outcome of root canal treatment using two different protocols. Oral Surg Oral Med Oral Pathol Oral

Radiol Endod 2002;93:705-15.

35. Marquis VL, Dao T, Farzaneh M, Abitbol S, Friedman S. Treatment outcome in endodontics: the Toronto Study. Phase III: initial treatment. J Endod 2006;32:299-306.

36. Farzaneh M, Abitbol S, Friedman S. Treatment outcome in endodontics: the Toronto study. Phases I and II: Orthograde retreatment. J Endod 2004;30:627-33.

37. Marending M, Peters OA, Zehnder M. Factors affecting the outcome of orthograde root canal therapy in a general dentistry hospital practice. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2005;99:119-24.

38. Allen RK, Newton CW, Brown CE Jr. A statistical analysis of surgical and nonsurgical endodontic retreatment cases. J Endod 1989;15:261-6.

39. Hoen MM, Pink FE. Contemporary endodontic retreatments: an analysis based on clinical treatment findings. J Endod 2002;28:834-6.

40. Kvist T, Reit C. Results of endodontic retreatment: a randomized clinical study comparing surgical and nonsurgical procedures. J Endod 1999;25:814-7.

41. Torabinejad M, Corr R, Handysides R, Shabahang S. Outcomes of nonsurgical retreatment and endodontic surgery: a systematic review. J Endod 2009;35:930-7.

42. Dammaschke T, Steven D, Kaup M, Ott KH. Long-term survival of root-canal-treated teeth: a retrospective study over 10 years. J Endod 2003;29:638-43.

43. Ørstavik D, Qvist V, Stoltze K. A multivariate analysis of the outcome of endodontic treatment. Eur J Oral Sci 2004;112:224-30.

44. Strindberg LZ. The dependence of the results of pulp therapy on certain factors. An analytic study based on radiographic and clinical follow-up examination. Acta Odontol Scand 1956;14:1-175.

45. de Chevigny C, Dao TT, Basrani BR, Marquis V, Farzaneh M, Abitbol S, Friedman S. Treatment outcome in endodontics: the Toronto study-phase 4: initial treatment. J Endod 2008;34:258-63.

46. Orstavik D, Hörsted-Bindslev P. A comparison of endodontic treatment results at two dental schools. Int Endod J 1993;26:348-54.