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Evaluation of Postoperative Pain and Periapical Healing after Single Visit Endodontic Treatment Using Rotary Ni-Ti System

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ABSTRACT

Purpose: This study was designed to evaluate the postoperative pain and periapical healing after single and two visits endodontic treatment using twisted file adaptive "TF Adaptive" Ni-Ti rotary system. **Subjects and Methods:** Twenty patients requiring endodontic treatment for necrotic single rooted teeth with periapical lesion were enrolled in this study. The selected patients were divided into two groups (10 patients each) according to the number of visits; Group I: single visit endodontic treatment and Group II: two visits endodontic treatment. The root canals were prepared using the TF Adaptive system. In group I the obturation was done by modified single-cone technique in a single visit, while in group II the obturation was done in the second visit. Evaluation of postoperative pain at 24, 48 and 72 hours after obturation and periapical healing after 6 and 12 months was done. **Results:** There was no statistical significant difference between the two groups either in postoperative pain or in the periapical healing. **Conclusion:** Single visit and two visits endodontic treatment protocols were comparable regarding the incidence of postoperative pain and periapical healing.

KEYWORDS

Periapical lesion healing,
Postoperative pain,
TF Adaptive Ni-Ti system.

INTRODUCTION

Pain of endodontic origin is widely feared by the public, but only 17% of patients experiencing root canal treatment described it as their most painful dental experience. Root canal treatment clearly reduces pain prevalence and severity although immediate postoperative pain severity may sometimes slightly exceed the pretreatment severity levels. Ongoing inflammatory processes or apical instrumentation especially with preexisting periradicular inflammation may cause postoperative pain [(1)].

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Exacerbation of a pulpal or periradicular pathosis with a subsequent development of pain and swelling after the initiation or continuation of the root canal treatment. Pain usually starts within a few hours or days after root canal procedures and frequently requires unscheduled visits [2].

A previous study has reported varying frequencies of flare-ups, ranging between 1.4% and 16%. Although all instrumentation techniques produce apical extrusion of debris even when the preparation maintained at the apical terminus, the difference lies in the ability of some techniques to extrude less debris than others do [3].

The comparison between single and multiple visits endodontic treatment on postoperative pain and healing showed that single-visit root canal treatment has become preferable than multiple visits root canal treatment since it allows better time saving, cost effectiveness, better patient acceptance, and eliminates the risk of inter- appointment infection. The recent inventions in rotary Ni-Ti systems and irrigation delivery devices have made chemo-mechanical debridement of root canal in single-visit convenient [4].

Previous study reported that cone beam computed tomography (CBCT) offers greater diagnostic sensitivity than periapical radiography [5]. The fact of being able to see the images in three dimensions improves and advances the diagnosis. However, previous study compared the dimensions of the periapical radiolucency using two-dimensional radiography and CBCT, reported no significant differences between the two techniques [6]. Therefore, this study was designed to evaluate postoperative pain and healing rate of periapical lesion after single visit or two visits endodontic treatment using rotary Ni-Ti system (Twisted file adaptive).

MATERIAL AND METHODS

A total of 20 patients were selected from the outpatient clinic, Faculty of Dental Medicine for Girls - Al Azhar University. Inclusion criteria involved, patient's age between 20-35 years with no sex predilection, patients have a non-contributory medical history, patients not receiving any palliatives or analgesics before the treatment by 24 hours and restorable single rooted teeth diagnosed clinically as necrotic pulp and radiographically has periapical radiolucency 1-5 mm in diameter. Patients were fully informed about the study's procedures, benefits and risks. They signed informed consent and research ethics committee approval obtained from Faculty of Dental Medicine for Girls Al Azhar University. The exclusion criteria were: pregnant, lactating female patients, patients with a positive history of pain, or analgesics intake, teeth with open apex and non-restorable teeth.

The selected patients were divided into two groups (10 patients each) according to the number of visits:

Group I: single visit endodontic treatment.

Group II: Two visits endodontic treatment.

Endodontic treatment steps:

Local anesthesia (mepecaine L-carpule) was delivered to the patients, followed by application of rubber dam. Access cavity preparation was performed using round bur # 3 (Dia-bur, Mani, Japan), canals' patency was done with hand K-files (Mani, Japan) #10. Working length was determined using an electronic apex locator (Root ZX J. Morita USA) and confirmed with periapical radiograph to be 0.5-1 mm shorter than radiographic apex.

Root canal instrumentation:

Rotary TFA Ni-Ti system on Elements Motor was used. Pulp chamber was flooded with 2.6% sodium hypochlorite then the TFA green ML1 file (Medium Large) (# 25 taper 8%) was slowly advanced in repeated steps until the working length was achieved. The yellow ML2 (# 35 taper 4%) was used until the file reached the working length. Canals were thoroughly irrigated with 2 ml of 2.6% sodium hypochlorite between every successive files

using a 27-gauge needle at a depth of 2-3 mm from the working length. Finally, 5 ml of 2.6% sodium hypochlorite followed by 5 ml of 17% EDTA solution followed by 10 ml of distilled water were used as a final flush of the canals.

Root canal obturation:

In group I, obturation was done using modified single-cone technique with gutta percha # 35 taper 4%, and AH plus sealer in the same visit. Radiographs were taken to ensure master cone length, then the canals were dried using paper points and AH plus sealer was introduced into the canals by the master cone which was coated with sealer then inserted into the canal to the full working length. Auxiliary cones #25 taper 2% were added and compacted by #25 spreader according to the space remaining next to the master cone. The excess gutta-percha was removed using a heated condenser tip, postoperative radiographs were taken to ensure proper obturation. The coronal final restoration was done by Filtek ™ Z 250 light cured composite.

In group II, calcium hydroxide was used as intracanal medicament for one week after cleaning and shaping. Calcium hydroxide META paste, is a ready-made paste in a plastic syringe, that was injected inside the canal, reached 3mm shorter than the working length then calcium hydroxide application was checked with periapical radiographs. Resin-modified glass ionomer was used as a temporary restoration to ensure proper sealing with no leakage of any oral fluids inside the root canals. At the second visit (after 1 week), rubber dam was applied, resin-modified glass ionomer filling and intracanal medicament were removed, final irrigation was done using 5 ml of 2.6% sodium hypochlorite followed by 5 ml of 17% EDTA followed by 10 ml of distilled water, then the canals were dried with paper points. The canals were obturated by modified single-cone technique as mentioned in group I.

After obturation, the patients were dismissed with placebo capsule (empty capsule filled with milk powder) and a written prescription for analgesic (400 mg Ibuprofen). Patient were instructed to take medication only in the presence of moderate-sever pain, where they were asked to take the placebo tablet first after 1 hour from the treatment, and in case of persistence of moderate-severe pain after 6-8 hours from the first tablet. A prescription of antibiotic (amoxicillin 500 mg two times daily for 7 days) was also given in case of swelling. The patients were asked to contact the operator prior to taking the analgesic or antibiotic. In addition, the participants were asked to fill the pain dairy and record the pain levels at 24, 48 and 72 hours after obturation.

Pain assessment was done postoperatively using the Visual Analogue Scale (VAS) after 24, 48 and 72 hours after obturation. The VAS scale was presented in different ways to facilitate the patient understanding and recording of pain intensity. It expressed pain numerically, verbally and visually. Numerical description represented a 10-point scale, ranging from no pain (score 0) to extreme pain (score 10). Verbal description 'in Arabic' represented as; no pain (0), mild pain (1-3), moderate pain (4-6) and severe pain (7-10). Visual description represented as graphical logo for illiterate patient and easy usage. The dentist called the patient at times points to remind him/her to use the pain dairy. Patient were asked to record the timing, and the number of tablets taken in the postoperative analgesic tablet chart.

The periapical lesion size was evaluated using cone beam computed tomography (CBCT) postoperatively, after 6 and 12 months by tracing the size of periapical lesion after these periods of time, also the periapical healing rate was evaluated after 6 and 12 months.

Statistical analysis:

The Data were tabulated and statistically analyzed using Statistical Package for Social Sciences (SPSS). Data were expressed as mean and standard deviation. Comparisons between the two groups

concerning normally dispersed numeric variables were done using the t-test. Non-normally dispersed numeric variables were compared by Mann-Whitney test. Comparisons over time regarding numeric variables were done by Friedman test and pair wise difference were detected by Wilcoxon rank test. For categorical variables, differences were analyzed with chi square ($\chi 2$) test and Fisher's exact test when appropriate. Adjustments of P-value were done using Bonferroni method for multiple testing. All P-values are two-sided. P-values ≤ 0.05 were considered significant.

RESULTS

1. Postoperative pain incidence:

The postoperative pain incidence at different pain categories (no pain, mild pain, moderate pain and severe pain) for the two groups were presented in Table (1).

I. Comparison of postoperative pain incidence between groups:

After 24 hours: In group I; 40% had no pain, 30% had mild pain, 25% had moderate pain and 5% had severe pain, while in group II; 45% had no pain, 25% had mild pain, 25% had moderate pain and 5% had severe pain. There was no statistically significant difference between the two groups (P=0.891).

After 48 hours: In group I; 55% had no pain, 30% had mild pain, 10% had moderate pain and 5% had severe pain. However, in group II; 60% had no pain, 20% had mild pain, 20% had moderate pain, and 0% had severe pain. There was no statistically significant difference between the two groups (P=0.732).

After 72 hours: In group I; 75% of cases had no pain, 20% had mild pain, 5% had moderate pain, and 0% had severe pain. However, in group II; 85% of cases had no pain, 10% had mild pain, 5% had moderate pain, and 0% had severe pain. There was no statistically significant difference between the two groups (P=0.642).

II. Comparison of postoperative pain incidence within each group:

Group I: The mean scores of pain levels recorded with VAS after 24 hours, 48 hours and 72 hours were 12, 9 and 5 respectively. The results showed that, there was a statistically significant decrease in pain levels by time (P<0.001).

Group II: The mean scores of pain levels recorded with VAS after 24 hours, 48 hours and 72 hours were 11, 8 and 4 respectively. The results showed that, there was a statistically significant decrease in pain levels by time (P<0.001).

Table (1): *Descriptive analysis of postoperative pain incidence between the two tested groups at different pain categories.*

Period	Pain category	Group I (Single visit)	Group II (Two visits)	P-Value
		[n (%)]	[n (%)]	
24 hours	No pain	8(40%)	9(45%)	0.891
	Mild pain	6(30%)	5(25%)	
	Moderate	5(25%)	5(25%)	
	Sever pain	1(5%)	1(5%)	
48 hours	No pain	11(55%)	12(60%)	0.732
	Mild pain	6(30%)	4(20%)	
	Moderate	2(10%)	4(20%)	
	Sever pain	1(5%)	0(0%)	
72 hours	No pain	15(75%)	17(85%)	0.642
	Mild pain	4(20%)	2(10%)	
	Moderate	1(5%)	1(5%)	
	Sever pain	0(0%)	0(0%)	
P-Value		< 0.001*	< 0.001*	

** Significant difference: significant (P≤ 0.05).*

2. Postoperative periapical lesion size:

The mean values and standard deviation of postoperative periapical lesion size by CBCT in mm^3 of the two groups were presented in Table (2) and (Fig. 1)

Table (2): *Descriptive analysis of the size of periapical lesion by in mm3 of the tested* groups.

Period	Group I (Single visit)		Group II (Two visits)		P-Value
	Mean $(mm)^3$	SD	Mean $(mm)^3$	SD	
Postoperative	208	± 51	180	± 40	0.325
After 6 months	98*	± 35	80*	± 33	0.275^{ns}
After 12 months	20*	± 13	15*	± 10	0.153^{ns}
P-Value	< 0.001*		< 0.001*		

** Significant difference: significant (P≤ 0.05) non significant = ns*

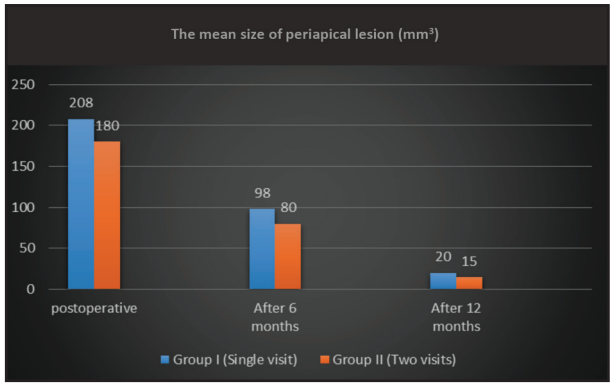

Figure (1): A bar chart comparing the mean values of the size of periapical lesion by between the two groups postoperatively, after 6 and 12 months.

I. Comparison of change in periapical lesion size between groups:

Postoperatively: The mean values and standard deviation of the postoperative periapical lesion size in group I and II were (208±51) and (180±40) respectively. The results showed that, there was no statistically significant difference between the two groups (P=0.325) (Fig. 2).

After 6 months: The mean values and standard deviation of the periapical lesion size in group I and II were (98±35) and (80±33) respectively. The results showed that, there was no statistically significant difference between the two groups (P=0.275) (Fig.3).

After 12 months: The mean values and standard deviation of the periapical lesion size in group I and II were (20±13) and (15±10) respectively. The results showed that, there was no statistically significant difference between the two groups (P=0.153) (Fig. 4).

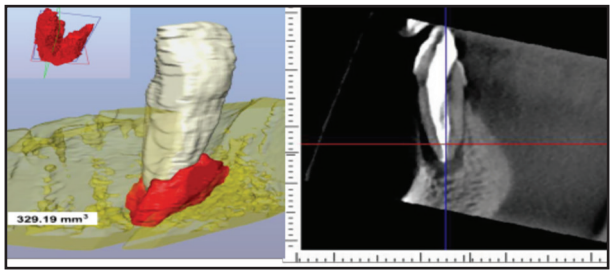

Figure (2): A photograph showing CBCT image of periapical lesion size in mm3 of lower right lateral incisor postoperatively.

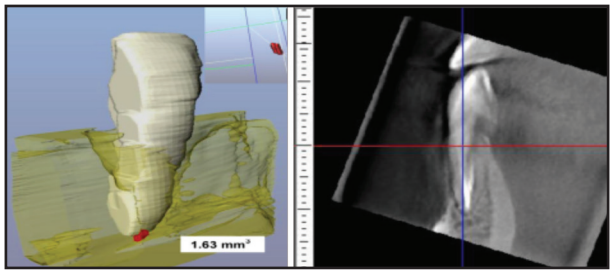

Figure (3): A photograph showing CBCT image of periapical lesion size in mm3 of lower right lateral incisor after 6 months.

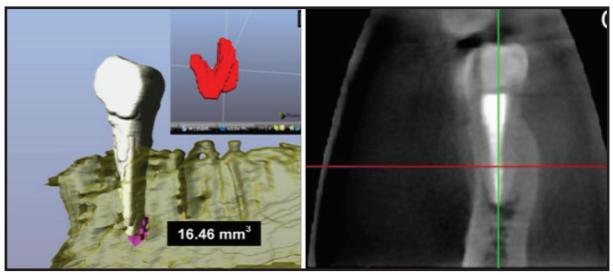

Figure (4): A photograph showing CBCT image of periapical lesion size in mm3 of lower right lateral incisor after 12 months.

II. Comparison of change by time in periapical lesion size within each group:

Group I: The mean values and standard deviation of the periapical lesion size postoperatively, after 6 months and after 12 months were (208±51), (98±35) and (20±13) respectively. The results showed that, there was a statistically significant decrease in periapical lesion size by time (P<0.001).

Group II: The mean values and standard deviation of the periapical lesion size postoperatively, after 6 months and after 12 months were (180±40), (80±33) and (15±10) respectively. The results showed that, there was a statistically significant decrease in periapical lesion size by time (P<0.001).

3. The healing percentage of periapical lesion: (Table 3) and (Fig. 5).

I. Comparison of healing percentage of periapical lesion between groups:

After 6 months: The healing percentage of periapical lesion in group I and II were 52% and 55% respectively. The results showed that, there was no statistically significant difference between the two groups in the healing percentage of periapical lesion (P=0.707).

After 12 months: The healing percentage of periapical lesion in group I and II were 90% and 92% respectively. The results showed that, there was no statistically significant difference between the two groups in the healing percentage of periapical lesion (P=0.698).

II. Comparison of healing percentage of periapical lesion within each group:

Group I: The healing percentage of periapical lesion after 6 months and after 12 months were 52% and 90% respectively. The results showed that, there was a statistically significant increase in the healing percentage of periapical lesion by time (P<0.001).

Group II: The healing percentage of periapical lesion after 6 months and after 12 months were 55% and 92% respectively. The results showed that, there was a statistically significant increase in the healing percentage of periapical lesion by time (P<0.001).

Table (3): *The healing percentage (%) of periapical lesion of the two groups.*

Period	Group I (Single visit)	Group II (Two visits)	P-Value
After 6 months	52%	55%	0.707
After 12 months	90%	92%	0.698
P-Value	< 0.001*	< 0.001*	

** Significant difference significant (P≤ 0.05)*

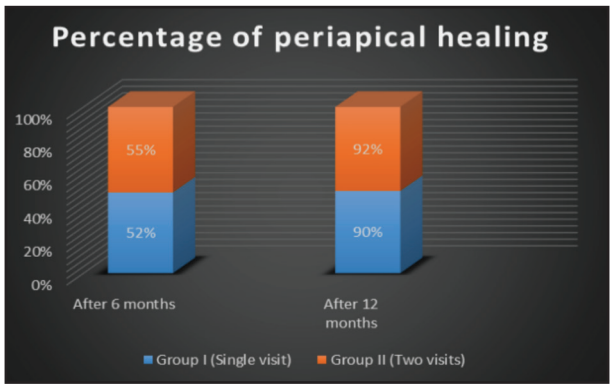

Figure (5): A bar chart comparing the healing percentage of periapical lesion between the two groups after 6 and 12 months.

DISCUSSION

Clinical success of endodontic treatment analyzed based on different points of view, according to values that involve the dentist, the patient or the tooth itself. References for the dentist are the value of symptom (clinical silence – absence of pain), the value of image (root canal space filled with no evidence of periapical inflammation), and the value of clinical condition (a well-restored and functioning tooth) [7].

Although contemporary endodontic treatment can be pain free during the procedure, patients may still experience some pain after the appointment. Pain following root canal instrumentation and/or obturation represents a considerable problem for both patients and endodontists. It is stated that despite the recent advances in root canal treatment and better understanding of the pulpal and periapical inflammation, up to 40% of all endodontic patients report postoperative pain of varying levels [8].

In most cases, dentin chips, pulp tissue fragments, necrotic tissue, microorganisms and intracanal irritants extruded from the apical foramen during the canal instrumentation. This is of concern since material extruded from the apical foramen related to inflammation of periapical tissue, postoperative pain and/or to a flare up [9]. Apical extrusion is common in all preparation techniques, but the amount of extruded material varies. Thus, one of the aims of canal preparation must be to minimize apical extrusion in order to prevent unwanted pain and inflammation, and it would seem logical to use techniques, which minimize this occurrence [10].

The experimental design of the present study aimed to evaluate the postoperative pain (by visual analogue scale after 24 hours, 48 hours and 72 hours), and the healing rate of periapical lesion (using cone beam computed tomography (CBCT) after 6 and 12 months) after single and two visits endodontic treatment using rotary Ni-Ti system; (Twisted file adaptive size Medium Large L1, and L 2)

In the present study, twenty patients requiring endodontic treatment for single rooted teeth with periapical lesion were enrolled in this study with no sex predilection. Their age range was 20 - 35 years old to avoid extremities in pain rates with young or geriatric participants as well as to avoid the possibility of calcification in geriatric participants.

The flora of infected root canals showed the presence of a variety of microorganisms; these microorganisms may be responsible to produce enzymes and endotoxins, which may be responsible for persistence of painful periapical lesion. Therefore, the use of an intracanal medicament has been encouraged for eradicating microorganisms[11,12].

Necrotic pulp is usually not responsive to pulp testing; the pulpal blood supply is absent, and the pulpal nerves are non-functional. Endo-ice (cold test) was used to assess pulp vitality of included teeth because it is convenient, easy to use and reliable [13, 14].

Nickel-titanium rotary instrumentation techniques have become popular in recent years since they can facilitate shaping procedures, decrease the amount of extruded debris, and while minimizing iatrogenic errors, being more flexible than stainless steel instruments [15]. TF Adaptive employs a patented unique motion technology, which automatically adapts to instrumentation stress, when used in the Elements Motor while in TF Adaptive setting. When the TF Adaptive instrument is not (or very lightly) stressed in the canal, the movement can be described as a continuous rotation, allowing better cutting efficiency and removal of debris [16].

Since rotary, hand or hybrid instrumentation, even when performed correctly, are inadequate to clear all organic and inorganic debris from the root canal system. Irrigating solutions play an important role, making up for the shortcomings of instrumentation and complementing endodontic disinfection procedures [17]. In this study, irrigation was performed by 2.6% NaOCl irrigating solution between successive files due to its antimicrobial activity and tissue dissolving effect. In vitro study showed the importance of the removal of smear layer and the presence of patent dentinal tubules in decreasing the time necessary to achieve the disinfecting effect of intracanal medications [18].

Needle penetration was done 2-3mm shorter than the working length using 27-gauge side vent irrigating needle for irrigant delivery since open ended needles produce higher apical pressure increasing the risk for apical extrusion of debris which in turn increases the probability of postoperative pain [19].

In this study, the modified single-cone technique was used for obturation. Previous study revealed less pain immediately after single cone obturation technique in contrast to lateral compaction technique [20]. Additionally, the AH Plus resin-based root canal sealer was selected because of its high physical properties, micro retention to root dentin, proper sealing ability, good radiopacity, great stability in solution, and adequate biological performance [21].

Clinical studies have shown that single-visit endodontic therapy was accompanied with less postoperative pain when compared to multiple-visits endodontic therapy, while other studies revealed no statistically significant difference between single- and multiple-visits endodontic therapy with respect to incidence of postoperative pain [22].

Due to its several advantages, single visit endodontic therapy has become a common practice. Those advantages include less appointments, less cost, unlikelihood of inter-appointment contamination, elimination of the need to re-familiarize the tooth anatomy by the clinician, and reduced chances of immune reactions towards intra-canal medicaments [23].

The patient's subjective assessment and its measurement are considered as the main challenges in investigating pain. The Visual Analogue Scale (VAS) for pain assessment was reported to be an easy method to use, sensitive to treatment effects, applicable in a variety of practice settings and the results are reproducible. This method, is reported to be more sensitive to small changes in pain, reproducible, independent of language, and easily understood [24, 25].

24, 48, 72 hours follow-up periods were selected in conformance with study which showed that postoperative pain is more likely to happen in the first 24 hours, then decreases afterwards as time passes and reduces considerably to minimal levels[26].

In the present study, the healing rate of periapical lesion was observed using cone beam computed tomography (CBCT) after 6 and 12 months. The sensitivity of periapical radiolucencies detected using CBCT was significantly greater than with the two-dimensional imaging techniques. Significant differences between the latter and CBCT were only observed in the case of the vertical measurements. The follow up periods of 6, and 12 months interval were selected for this study. Previous study reported that the complete healing for an established apical lesion detected at 1 year after obturation [27].

The results of postoperative pain showed that there was no statistically significant difference between the two groups at 24, 48, 72 hours intervals. This could be attributed to that the same protocol was followed for the two groups and postoperative pain is generally associated with instrumentation kinematics, over-instrumentation, extruded debris, or filling materials.

The results of the present study were in agreement with previous studies which revealed no statistically significant difference between single and multiple visits endodontic therapies with respect to incidence of postoperative pain [26]. On the other hand, the results were not coincide with clinical studies which concluded that single-visit endodontic therapy was accompanied with less postoperative pain when compared to multiple visits endodontic therapy [24] This discrepancies could be attributed to that endodontic treatment used to take multiple visits to complete, with one of the main reasons for this being that it required a considerable amount of time to complete the treatment, use of contemporary endodontics techniques and equipment.

Regarding changes by time in VAS scales of the two groups after 24 hours, 48 hours and 72 hours, there was a statistically significant decrease in pain levels by time. This could be due to that Ni Ti rotary system could reduce the amount of extrusion of debris, since the flutes of these instruments tend to pull debris back towards the orifice.

These results were in agreement with previous study which showed that postoperative pain is more

likely to happen in the first 24 hours, then decreases afterwards as time passes and reduces considerably to minimal levels [28].

The results of healing percentage of periapical lesion reveled that there was no statistically significant difference between the two groups after 6 or 12 months. This may be evidenced with a treatment protocol with instrumentation to predefined larger apical instrumentation sizes and irrigation Can lead to healing in cases of apical periodontitis, which is a significant finding compared with more dated studies that showed average healing of apical periodontitis cases [29].

The results of present study were in agreement with another study of 12 months follow up after initial nonsurgical root canal therapy on necrotic teeth with apical periodontitis, which reported that, there was no significant difference in radiographic evidence of periapical healing between one visit therapy and two visits therapy with an interim calcium hydroxide/ chlorhexidine paste dressing [30]. Moreover, previous study concludes that both one- and multi -session protocols had similar outcomes without statistical significant difference [31].

Another study showed no statistical significance between one- and multi-appointment protocols, and no correlation between the healing of periapical lesions and the presence or absence of a positive bacteria growth after the cleaning, shaping and irrigation [32].

On other hand, the results of the present study were not coinciding with a recent study that compared the outcome of one-visit and two-visits procedures on dog's teeth with apical pathology determined by periapical radiographs and cone-beam computed tomography scans. Favorable outcomes occurred more frequently on the two-visits procedure compared to one-visit procedure when determined by periapical radiograph or cone-beam technology [33]. This could be attributed to the use of a restrict endodontic protocol such as use of engine-driven rotary adaptive nickel titanium files, rubber dam, magnifying devices, electronic apex locator.

CONCLUSION

Single visit and two visits endodontic treatment protocols were comparable regarding the incidence of postoperative pain and periapical healing.

REFERENCES

1. Wong M, Lytle WR. A comparison of anxiety levels associated with root canal therapy and oral surgery treatment. J Endod. 2010; 17: 461-5.
2. Gorduysus MO, Gorduysus MG. Endodontic patient profile of Hacettepe University, Faculty of Dentistry in Ankara, Turkey. Int Dent J. 2011; 50:274-8.
3. Walton R, Fouad A. Endodontic inter appointment flare-ups: a prospective study of incidence and related factors. J Endod. 2006; 18:172-7.
4. Shahi S, Asghari V, Rahimi S, Lotfi M, Samiei M, Yavari H, Shakouie S, Nezafati S. Postoperative Pain after Endodontic Treatment of Asymptomatic Teeth Using Rotary Instruments: A Randomized Clinical Trial. Iran Endod J. 2016; 11: 38-43.
5. Venkatesh E, Snehal VE. Cone beam computed tomography: basics and applications in dentistry, J Istanb Univ Fac Dent. 2017; 51: 102- 21.
6. Scarfe WC1, Farman AG, Sukovic P.Clinical applications of cone-beam computed tomography in dental practice. J Can Dent Assoc. 2006; 72:75-80.
7. Imura N, Pinheiro ET, Gomes BP, Zaia AA, Ferraz CC, SouzaFilho FJ. The Outcome of Endodontic Treatment: A Retrospective Study of 2000 Cases Performed by a Specialist. J Endod. 2007; 33:278-82.
8. Pasqualini D, Mollo L, Scotti N, Cantatore G, Castellucci A, Migliaretti G, et al. Postoperative pain after manual and mechanical glide path: a randomized clinical trial. J Endod. 2012; 38:32-6.
9. Haapasalo M, Udnæs T, Endal U. Persistent, recurrent, and acquired infection of the root canal system post-treatment. Endodontic Topics 2003, 6, 29-56.
10. Bergenholtz G. Micro-organisms from necrotic pulp of traumatized teeth. Odon. Revy 2011: 25: 347-58.
11. Fouad AF, Zerella J, Barry J, Sapangberg LS. Molecular detection of Enterococcus species in root canals of therapy resistant endodontic infections. Oral Surg Oral Med Oral Path Oral Rad Endo 2005; 99: 112-8.

12. Orstavik D, Qvist V SK. A multivariate analysis of the outcome of endodontic treatment. Eur J Oral Sci 2004; 112:224–30.
13. Marina F and Ataide A. Non-surgical management of periapical lesions. J. of Cons. Dent. 2014; 13: 240- 5.
14. Peters LB, Wesselink PR. Periapical healing of endodontically treated teeth in one or two visits obturated in the presence or absence of detectable microorganisms. Int Endod J, 2002; 35: 660-7.
15. Krithikadatta J, Sekar V, Sudharshan P, Velmurugan N. Influence of three Ni-Ti cleaning and shaping files on post instrumentation endodontic pain – A triple blinded randomized controlled trial. J Conserv Dent. 2016; 19: 311-6.
16. Trishagni C. Comparative Evaluation of Apically Extruded Debris with Protaper Universal, Protaper Gold and Twisted File Adaptive Rotary Instruments- An In-Vitro Study". Acta Scien Dent, 2019; 3: 60-5.
17. Thomas RD, John DR, Gerald NG, Eric SS, Allen LH. Comparative evaluation of endodontic irrigants against Enterococcus faecalis biofilms. J Endod 2006; 32:527–31.
18. Paredes-Vieyra J, Enriquez FJ. Success rate of single- versus two- visit root canal treatment of teeth with apical periodontitis: a randomized controlled trial. J Endod. 2012 Sep; 38:164-9.
19. Wang C, Xu P, Ren L, Dong G, Ye L. Comparison of post-obturation pain experience following one-visit and two-visit root canal treatment on teeth with vital pulps: A randomized controlled trial. Int Endod J. 2010; 43:692-7.
20. Mulhern, S.S. Patterson, C.W. Newton, A.M. Ringel. Incidence of postoperative pain after one-appointment endodontic treatment of asymptomatic pulpal necrosis in single-rooted teeth. J Endod, 1982; 8:370-75.
21. Gopikrishna AV, Kandaswamy D, Jeyaval Rajan K. Comparative evaluation of the antimicrobial efficacy of five endodontic root canal sealers against Enterococcus facials and Candida albicans. J Cons Dent. 2015; 9: 2-11.
22. Penesis VA, Fitzgerald PI, Fayad MI, Wenckus CS, BeGole EA, Johnson BR. Outcome of one-visit and two-visit endodontic treatment of necrotic teeth with apical periodontitis: a randomized controlled trial with one-year evaluation. J Endod. 2008; 34:251-7.
23. Logani A, Shah N. Apically extruded debris with three contemporary Ni-Ti instrumentation systems: an ex vivo comparative study. Indian J Dent Res. 2008; 19: 182-5.
24. Goddard G, Karibe H, McNeill C. Reproducibility of visual analog scale (VAS) pain scores to mechanical pressure. Cranio. 2004; 22: 250-6.
25. Banos JE, Bosch F, Canellas M, Bassols A, Ortega F, Bigorra J. Acceptability of visual analogue scales in the clinical setting: a comparison with verbal rating scales in postoperative pain. Methods Find Exp Clin Pharmacol. 1989; 11: 123-7.
26. Ramis-AA, Tarazona-AB, Cervera-B J, Soto-P D, Peñarrocha-DM, Peñarrocha-OD, et al. Comparison of diagnostic accuracy between periapical and panoramic radiographs and cone beam computed tomography in measuring the periapical area of teeth scheduled for periapical surgery. A cross-sectional study. J Clin Exp Dent. 2019; 11: 732-8.
27. Pak JG, White SN. Pain Prevalence and Severity before, during, and after Root Canal treatment: A Systematic Review. J Endod. 2011; 37:429-38.
28. Patil AA, Joshi SB, Bhagwat SV, Patil SA. Incidence of Postoperative Pain after Single Visit and Two Visit Root Canal Therapy: A Randomized Controlled Trial. J Clin Diagn Res. 2016; 10: 9-12.
29. Figini L, Lodi G, Gorni F, Gagliani M. Single versus multiple visits for endodontic treatment of permanent teeth: a Cochrane systematic review. J Endod 2008; 34:1041–7.
30. Molander A, Warfvinge J, Reit C, Kvist T. Clinical and radiographic evaluation of one and two visit endodontic treatment of asymptomatic necrotic teeth with apical periodontitis: a randomized clinical trial. J Endod, 2007; 32:1145-8.
31. Paula S, Hassan B, Silva L, Leonardo M. Outcome of root canal treatment in dogs determined by periapical radiography and cone-beam computed tomography scans. J Endod 2009; 35:723- 6.
32. Oubaid AH, Mehdi JA. Incidence and severity of pain following the usage of three different root canal instrumentation systems. JODR 2015; 1: 51-8.
33. Orstavik D. Time-course and risk analyses of the development and healing of chronic apical periodontitis in man. Int Endod J 1996; 29:150-5.