

2018

The influence of two instrumentation techniques with two sealers on postoperative pain after endodontic treatment "randomized clinical trial"

Mohamed Sohail Jacoub
mohamedsohail@gmail.com

Abdel-Rahman Kataia

Ahmed Abdel Rahman Hashem

ElSaeed Abdel Hafiz

Follow this and additional works at: <https://digitalcommons.aaru.edu.jo/fdj>



Part of the [Medicine and Health Sciences Commons](#)

Recommended Citation

Jacoub, Mohamed Sohail; Kataia, Abdel-Rahman; Hashem, Ahmed Abdel Rahman; and Abdel Hafiz, ElSaeed (2018) "The influence of two instrumentation techniques with two sealers on postoperative pain after endodontic treatment "randomized clinical trial", *Future Dental Journal*: Vol. 4 : Iss. 2 , PP 175-180. Available at: <https://digitalcommons.aaru.edu.jo/fdj/vol4/iss2/14>

This Article is brought to you for free and open access by Arab Journals Platform. It has been accepted for inclusion in Future Dental Journal by an authorized editor. The journal is hosted on [Digital Commons](#), an Elsevier platform. For more information, please contact rakan@aarj.edu.jo, marah@aarj.edu.jo, u.murad@aarj.edu.jo.



Contents lists available at ScienceDirect

Future Dental Journal

journal homepage: www.elsevier.com/locate/fdj

The influence of two instrumentation techniques with two sealers on post-operative pain after endodontic treatment "randomized clinical trial"

Dr. Mohamed Sohail Jacoub^{a,*}, Professor Medhat Abdel-Rahman Kataia^c,
Professor Ahmed Abdel Rahman Hashem^b, Dr. ElSaeed Abdel Hafiz^c

^a Masters Degree of Endodontics, Future university, Cairo, Egypt

^b Department of Endodontics, Faculty of Dentistry, Ain Shams University, Cairo, Egypt

^c Department of Endodontics, Faculty of Oral and Dental Medicine, Future University, Cairo, Egypt

ABSTRACT

Introduction: Postoperative pain is one of the primary problems in endodontic therapy and an unpleasant situation for both patient and clinician.

Purpose: The aim of this Study was to assess degree of Post-Operative Pain after Endodontic Treatment done using two different instrumentation techniques with combination of two different sealers.

Materials and methods: 84 mandibular first and second molars were selected and randomly divided into four groups, Group 1 was prepared using Protaper Next and obturated using AH plus Sealer. Group 2, the molars were prepared using Protaper Next and obturated using Total Fill Sealer. Group 3, the molars were prepared using WaveOne Gold and obturated using AH Plus Sealer and Group 4, the molars were prepared using WaveOne Gold and obturated using Total Fill Sealer. Assessment of post-operative pain by using The Visual Analogue Scale Pain evaluation was done 3 times for each patient, Post-operatively after 12, 24 and 48 h respectively. Finally the data was tabulated and statistically analyzed using Kolmogorov-Smirnov and Shapiro-Wilk tests.

Results: Neither the type of file nor the type of sealer affected the post-operative pain, however time showed statistically significant difference between (12 h), (24 h) and (48 h) respectively.

Conclusions: Protaper next versus WaveOne Gold was found to have no influence regarding post-operative pain, The pain intensity showed significant decrease by time in all groups especially after 24 h post-operatively.

1. Introduction

Postoperative pain is one of the primary problems in endodontic therapy and an unpleasant situation for both patient and clinician. According to patients, pain is a strong predictor for performance of Root Canal Treatment. When an unexpected pain is experienced, patient's confidence to dentist is undermined. However, etiology of pain is multifactorial and has not been determined precisely yet [1]. It is well known that a small, inadvertent extrusion of debris and irrigants into periapical tissues is a frequent complication during the cleaning and shaping procedures, both with manual stainless steel and nickel-titanium rotary instrumentation techniques. However, recent studies have shown that reciprocating instrumentation techniques seem to significantly increase the amount of debris extruded beyond the apex and, consequently, the risk of postoperative pain [2]. So, it was of prime importance to shed a light on assessment of post-operative pain after using two different instrumentation techniques with two different sealers.

2. Materials and methods

A total of 84 patients were selected from the faculty of oral and dental medicine, Future University. Sixty patients were selected with Asymptomatic non-vital lower first and second molars with three separate canals and without periapical lesion and patients with medically compromised patients were excluded.

2.1. Clinical procedures

2.1.1. Pre-operative procedure

Preoperative instructions were given to the patient about type of the procedure, discomfort as well as benefits of this procedure and their informed consent was obtained prior to the procedure. The patients were randomized by pulling numbered slips out of a hat and divided into four groups according to techniques of instrumentation and type of sealer used:

Peer review under responsibility of Faculty of Oral & Dental Medicine, Future University.

* Corresponding author.

E-mail address: mohamedsohail@gmail.com (M.S. Jacoub).

<https://doi.org/10.1016/j.fdj.2018.10.001>

Received 7 May 2018; Accepted 2 October 2018

Available online 20 November 2018

2314-7180/ © 2018 Faculty of Oral & Dental Medicine, Future University.. Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

- In Group 1: fifteen teeth prepared by ProTaper Next and Obturated By AH Plus Sealer
- In Group 2: fifteen teeth prepared by Wave One Gold and Obturated by AH Plus Sealer
- In Group 3: fifteen Teeth prepared by ProTaper Next and obturated by Total Fill sealer
- In Group 4: fifteen teeth prepared by Wave One Gold and Obturated by Total Fill sealer

2.1.2. Clinical procedure

Tooth diagnosis has taken place through visualization, percussion, palpation, mobility and electric pulp tests. Inferior alveolar nerve block was administrated immediately before access cavity opening and complete de-roofing, anatomically shaped size rubber dam was applied to isolate the tooth. Then the saliva ejector was introduced below the integrated frame and was positioned in the corner of the mouth. All superficial caries was removed to minimize bacterial contamination the access cavity was refined using a tapered diamond stone.¹ [3].. The roof of the pulp chamber was removed by using Endo Z bur.² Crown down technique was used in a gentle brushing motion according to the manufacturers' instruction. Initial filing was done from 15 to 20 size k file³ To make patency. The working length was taken using Root ZX mini⁴ apex locator and was placed 0.5 mm from the apex then confirmed using periapical radiographic x-ray. The patients were divided into two main groups according to techniques of Instrumentation used that was done by X-smart plus endomotor⁵:

- In Group 1: thirty teeth prepared by ProTaper Next according to manufacture instructions till the master apical file and irrigation is done between each file using plastic syringe with side perforated 27-G needle containing 2.5% sodium hypochlorite and another one containing 17% EDTA solution
- In Group 2: thirty teeth prepared by Wave One Gold according to manufacture instructions and irrigation is done using plastic syringe with side perforated 27-G needle containing 2.5% sodium hypochlorite and another one containing 17% EDTA solution.

Each group was subdivided into two subgroups. Each included fifteen teeth according to sealer used for obturation.

Master apical file was done by 35 size k file. After instrumentation each canal was flushed with saline and then dried by paper point.

It was subdivided into two subgroups according to sealer used.

- In Sub-Group 1: Obturation was made by lateral condensation technique where AH plus sealer was introduced using Lentulo spiral and master cone was introduced and the accessory cones were added after it.
- In Sub-Group 2: Obturation was made by lateral condensation technique where Total Fill sealer was added using Lentulo spiral and master cone was introduced and the accessory canals were added after it.

2.1.3. Post-clinical procedures

Patients are asked to evaluate the pain level & although the patients are not prescribed an analgesics, they can take if needed.

¹ Round SKU:F 0001. Chemin du Verger 3 | 1338 Ballaigues – Suisse Tél. 021 843 92 92 | info@dentsplymaillefer.com

² Endo Z Bur FG. . Chemin du Verger 3 | 1338 Ballaigues – Suisse Tél. 021 843 92 92 | info@dentsplymaillefer.com

³ K-FILE SKU: A 012D. Chemin du Verger 3 | 1338 Ballaigues – Suisse Tél. 021 843 92 92 | info@dentsplymaillefer.com

⁴ Root ZX mini 680 Higashihama Minami-cho, Fushimi-ku, Kyoto, 612–8533 Japan, <http://www.jmorita-mfg.com>.

⁵ x-smart plus endomotor. Chemin du Verger 3 | 1338 Ballaigues – Suisse Tél. 021 843 92 92 | info@dentsplymaillefer.com

2.2. Methods of evaluation

Assessment of post-operative pain by using *The Visual Analogue Scale* (VAS) described by Pinkham et al. The VAS consists of a list of adjectives describing different levels of pain intensity with scores assigned to each of the levels of pain intensity (Table 1). The (VDS) was translated in to Colloquial Arabic.

3. Statistical analysis

The data was tabulated and statistically analyzed using Kolmogorov-Smirnov and Shapiro-Wilk tests. Friedman test was used to test the difference between more than two groups in related samples and wilcoxon test was used to compare the difference between two groups in related samples. While Mann-Whitney *U* test was used to compare the difference between two groups in non-related samples.

4. Results

The mean and standard deviation values were calculated for each group. Data were explored for normality using Kolmogorov-Smirnov and Shapiro-Wilk tests and showed non-parametric (not-normal) distribution. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM® SPSS® Statistics Version 20 for Windows.

> Pain score results:

A) Effect of time on pain scores in each sealer with different types of files:(Table 2, Fig. 1)

a) For AH Plus groups:

i) Protaper next:

The highest mean value of pain score was found in (12 h) (5.93 ± 0.88) followed by (24 h) (3.33 ± 0.89) while the least mean value of pain scores was found in (48 h) (1.00 ± 0.92).

ii) Wave One Gold:

The highest mean value of pain score was found in (12 h) (6.53 ± 1.06) followed by (24 h) (3.66 ± 0.89) while the least mean value of pain scores was found in (48 h) (1.00 ± 0.65).

b) For Total Fill groups:

i) Protaper next:

The highest mean value of pain score was found in (12 h) (6.06 ± 0.88) followed by (24 h) (3.46 ± 0.99) while the least mean value of pain scores was found in (48 h) (1.00 ± 0.92).

ii) Wave One Gold:

The highest mean value of pain score was found in (12 h) (6.53 ± 1.06) followed by (24 h) (3.80 ± 0.77) while the least mean value of pain scores was found in (48 h) (1.06 ± 0.70).

B) Effect of File type on pain scores in each sealer with different time factor: (Table 3, Fig. 2)

a) For AH Plus groups:

i) 12 h:

There was no statistically significant difference between (Protaper next) and (Wave One Gold) where ($p = 0.137$). The highest mean value of pain score was found in (Wave One Gold) (6.53 ± 1.06) while the least mean value of pain scores was found in (Protaper next) (5.93 ± 0.88).

ii) 24 h:

There was no statistically significant difference between (Protaper next) and (Wave One Gold) where ($p = 0.325$). The highest mean value of pain score was found in (Wave One Gold) (3.66 ± 0.89) while the least mean value of pain scores was found in (Protaper next) (3.33 ± 0.89).

iii) 48 h:

Table 1
Description of levels of pain intensity.

0	1	2	3	4	5	6	7	8	9	10
No Pain	Slight Pain	Moderate Pain	Strong Pain	Severe Pain	Maximum Pain					
No pain	The involved tooth felt normal and corresponded to digit zero.									
Slight pain	The involved tooth was slightly painful for a time regardless of the duration, but there was no need to take analgesics and corresponded to digit 2.									
Moderate pain	The involved tooth caused pain which was tolerable or was rendered to be tolerable with analgesics and corresponded to digit 4.									
Strong pain	The involved tooth caused pain which disturbed sleep and need narcotic analgesic and corresponded to digit 6.									
Severe pain	The involved tooth caused pain which disturbed normal activity or sleep and analgesics had no effect and corresponded to digit 8.									
Maximum pain	Patient unable to sleep and unable to perform normal activity and corresponded to digit 10.									
Odd Number	Represents intermediate pain levels between the main pain levels.									

There was no statistically significant difference between (Protaper next) and (Wave One Gold) where ($p = 0.870$). The mean value of pain score was (Protaper next)

(1.00 ± 0.92) and (Wave One Gold) (1.00 ± 0.65).

b) For Total Fill groups:

i) 12 h:

There was no statistically significant difference between (Protaper next) and (Wave One Gold) where ($p = 0.250$). The highest mean value of pain score was found in (Wave One Gold) (6.53 ± 1.06) while the least mean value of pain scores was found in (Protaper next) (6.06 ± 0.88).

ii) 24 h:

There was no statistically significant difference between (Protaper next) and (Wave One Gold) where ($p = 0.436$). The highest mean value of pain score was found in (Wave One Gold) (3.80 ± 0.77) while the least mean value of pain scores was found in (Protaper next) (3.46 ± 0.99).

iii) 48 h:

There was no statistically significant difference between (Protaper next) and (Wave One Gold) where ($p = 0.713$). The highest mean value of pain score was found in (Wave One Gold) (1.06 ± 0.70) while the least mean value of pain scores was found in (Protaper next) (1.00 ± 0.92).

C) Effect of Sealer on pain scores in each file with different time factor: (Table 4 , Fig. 3)

a) For Protaper groups:

Table 2

The mean, standard deviation (SD) values of pain scores of time in each sealer with different types of files (Friedman test).

Variables	AH Plus sealer						Total Fill sealer					
	Protaper next			Wave One Gold			Protaper next			Wave One Gold		
	Mean	SD	Median									
12 h	5.93 ^a	0.88	6.00	6.53 ^a	1.06	7.00	6.06 ^a	0.88	6.00	6.53 ^a	1.06	7.00
24 h	3.33 ^b	0.89	3.00	3.66 ^b	0.89	4.00	3.46 ^b	0.99	4.00	3.80 ^b	0.77	4.00
48 h	1.00 ^c	0.92	1.00	1.00 ^c	0.65	1.00	1.00 ^c	0.92	1.00	1.06 ^c	0.70	1.00
P-value	$\leq 0.001^*$											

Mean with different letters in the same column indicate statistically significance difference *; significant ($p < 0.05$) ns; non-significant ($p > 0.05$).

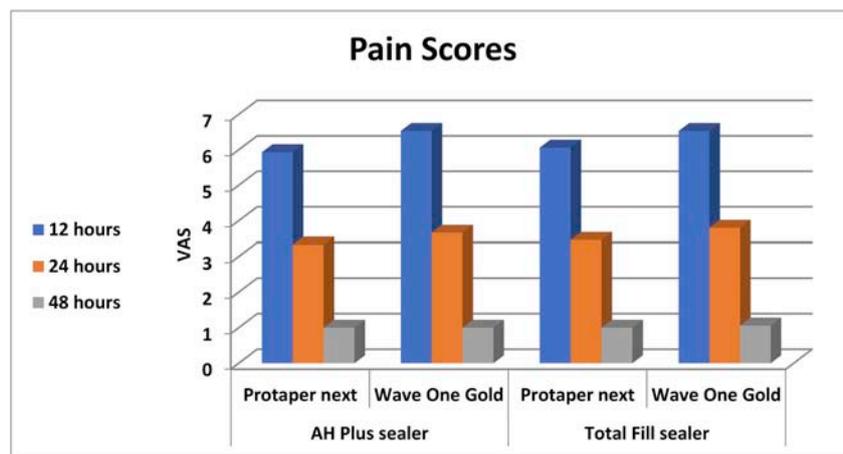


Fig. 1. Bar chart representing effect of time on pain scores in each sealer with different types of files.

Table 3

The mean, standard deviation (SD) values of pain scores of file types in each sealer with different time factor (Mann-Whitney U test).

Variables	AH Plus sealer									Total Fill sealer								
	12 h			24 h			48 h			12 h			24 h			48 h		
	Mean	SD	Median															
Protaper next	5.93 ^a	0.88	6.00	3.33 ^a	0.89	3.00	1.00 ^a	0.92	1.00	6.06 ^a	0.88	6.00	3.46 ^a	0.99	4.00	1.00 ^a	0.92	1.00
Wave One Gold	6.53 ^a	1.06	7.00	3.66 ^a	0.89	4.00	1.00 ^a	0.65	1.00	6.53 ^a	1.06	7.00	3.80 ^a	0.77	4.00	1.06 ^a	0.70	1.00
P-value	0.137ns			0.325ns			0.870ns			0.250ns			0.436ns			0.713ns		

Mean with different letters in the same column indicate statistically significance difference *; significant ($p < 0.05$) ns; non-significant ($p > 0.05$).

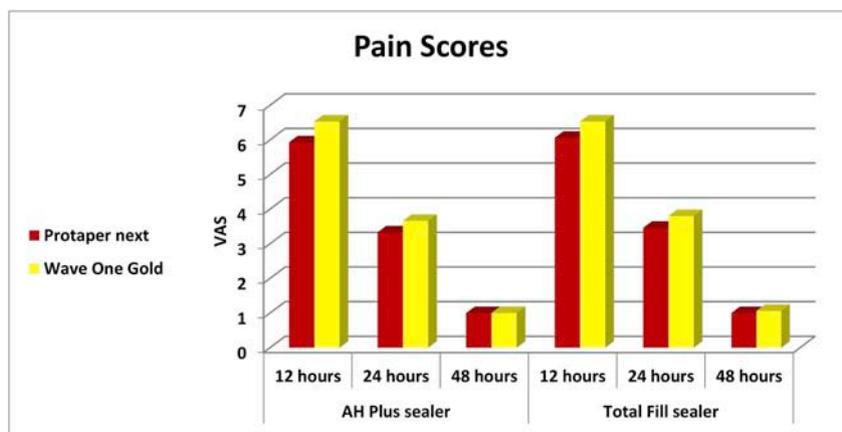


Fig. 2. Bar chart representing effect of file types on pain scores in each sealer with different time factor.

i) 12 h:

There was no statistically significant difference between (AH Plus) and (Total Fill) where ($p = 0.713$). The highest mean value of pain score was found in (Total Fill) (6.06 ± 0.88) while the least mean value of pain scores was found in (AH Plus) (5.93 ± 0.88).

ii) 24 h:

There was no statistically significant difference between (AH Plus) and (Total Fill) where ($p = 0.713$). The highest mean value of pain score was found in (Total Fill) (3.46 ± 0.99) while the least mean value of pain scores was found in (AH Plus) (3.33 ± 0.89).

iii) 48 h:

There was no statistically significant difference between (AH Plus) and (Total Fill) where ($p = 1$). The mean value of pain score for both (AH Plus) and (Total Fill) was (1.00 ± 0.92).

b) For Wave One Gold groups:

i) 12 h:

There was no statistically significant difference between (AH Plus) and (Total Fill) where ($p = 1$). The mean value of pain score for both (AH Plus) and (Total Fill) was (6.53 ± 1.06).

ii) 24 h:

There was no statistically significant difference between (AH Plus) and (Total Fill) where ($p = 0.870$). The highest mean value of pain score was found in (Total Fill) (3.80 ± 0.77) while the least mean value of pain scores was found in (AH Plus) (3.66 ± 0.89).

iii) 48 h:

There was no statistically significant difference between (AH Plus) and (Total Fill) where ($p = 0.806$). The highest mean value of pain score was found in (Total Fill) (1.06 ± 0.70) while the least mean value of pain scores was found in (AH Plus) (1.00 ± 0.65).

5. Discussion

This study design was a randomized clinical trial (RCT) [4–7]. This design is regarded as the most reliable method of evaluating the effects of interventions in health care. A sample of 60 patients, which was nearly equal to the similar clinical trials [8–10], were included and randomly assigned into four equal groups each of 15 patients. Randomization keeps study groups as similar as possible from the outset to minimize bias. In this study, Single visit root canal treatment was done as Single visit root canal treatment fulfill patient's needs because of the inherited advantages. This technique has gained popularity, this can be credited to favourable reports which showed no difference in treatment complications or success rates when compared with teeth treated in multiple visits [11–13]. In the present study, Reciprocation versus linear motion were used to assess the difference in post-operative pain level as One of the important reasons of post-operative pain is the extrusion of debris that obtain virulent bacteria into the periradicular tissues. If the infected debris is extruded into periapical region during root canal instrumentation, it may cause or increase the various of periradicular inflammation [14,15] In the result of the present study, There was no statistically significant difference between Protaper next and Wave One Gold. This came in the agreement of the work of Relvas et al. (2015) [16] and Kherlakian et al. (2016) [17] whom, they found that The Wave One Gold and ProTaper next groups extruded the least amount of debris in comparison to the other groups in their studies. This may be explained with the assessments of metallurgy, design features and kinematics of these systems. It has been shown that heat-treated alloys have less stiffness [18] and a lower ultimate tensile strength than conventional super-elastic wires [19]. Both of Gold systems are produced with using different alloys and a new proprietary thermal process named Gold wire in which the ground NiTi files are heat-treated and slowly cooled to obtain super-elastic NiTi files. It could be attributed to the 2-stage transformation behaviour and the high temperatures from which PTN and WOG is produced; as this material has greater flexibility [12,20] with an elastic modulus lower than that of the austenitic phase [21,22]. Consequently, it could be supposed that the martensitic NiTi wire may ensure a lower amount of apical extrusion at a similar torque

Table 4

The mean, standard deviation (SD) values of pain scores of file types in each sealer with different time factor (Mann–Whitney *U* test).

Variables	Protaper next									Wave One Gold								
	12 h			24 h			48 h			12 h			24 h			48 h		
	Mean	SD	Median															
AH Plus	5.93 ^a	0.88	6.00	3.33 ^a	0.89	3.00	1.00 ^a	0.92	1.00	6.53 ^a	1.06	7.00	3.66 ^a	0.89	4.00	1.00 ^a	0.65	1.00
Total Fill	6.06 ^a	0.88	6.00	3.46 ^a	0.99	4.00	1.00 ^a	0.92	1.00	6.53 ^a	1.06	7.00	3.80 ^a	0.77	4.00	1.06 ^a	0.70	1.00
P-value	0.713ns			0.713ns			1ns			1ns			0.870ns			0.806ns		

Mean with different letters in the same column indicate statistically significance difference *; significant ($p < 0.05$) ns; non-significant ($p > 0.05$).

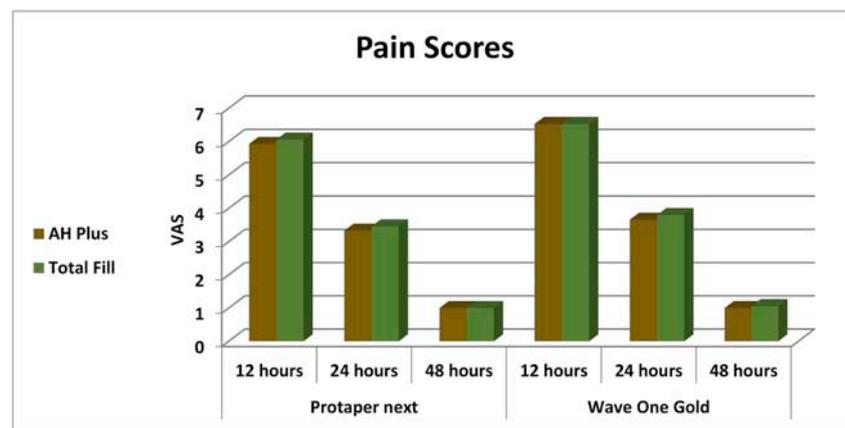


Fig. 3. Bar chart representing effect of sealer types on pain scores in each file with different time factor.

than austenitic NiTi alloy [23]. These metallurgical superior properties that provide less stiffness and reduced restoring force to the instruments [24,25] may explain the least amount of apical extrusion after instrumentation performed by Gold systems.

The design of Gold systems also play a crucial role on apically bacterial extrusion. First of all, the roundly tapered, and semi-active features of Wave One Gold reduce the mass of the center of the tip and contribute to less debris extrusion compared with all other groups [25]. The ProTaper next system has a different geometry; smaller dimensions, an off-centered mass, and a regressive taper. The centering ability of ProTaper Next instruments may ensure that a greater percentage of dentin thickness is retained in the root canal and may facilitate greater bacteria elimination [26]. The convex triangular cross-section and progressive taper enhance the cutting efficacy of ProTaper Next, while decreasing rotational friction between the file blade and dentin. ProTaper Next had a significantly lower torsional resistance. The non-cutting tip design allows each instrument to safely follow the secured portion of the canal, while the small area on the tip enhances its ability to find its way through soft tissue and debris [27]. In the result of the present study, it was found that pain records after root canal treatment with two different sealers is statistically insignificant. This comes in the accordance of the work of Kousalya Vuyyuru et al. [28], Tayfun Alacam et al. [29] and Fox J et al. [30] that stated there is no significant with the pain level with the sealer material used for obturation. In this study, Pain assessment was done by the patients. The time Intervals were recorded at 12, 24 & 48 h and compared as Genet and Wesselink (1986) [31]. Ercan and kaya who showed that most post-operative pain occurred on the first day after initiating endodontic treatment., post-obturation, as postoperative pain episodes are usually caused by the pressure inherent in the insertion of the root canal filling materials or by the chemical irritation from the ingredients of the root canal cements or pastes. Also the occurrence of periapical inflammation results in pain in the periodontal ligaments which usually is a short-lived effect and abate within a 24–48 h period. Seltzer and Naidorf, 2004 [32] and Yoldas et al., 2004 [33]. Furthermore, in the result A statistically significant difference was found between (12 h) on one hand and each of (24 h) and (48 h) on the other hand. This comes in accordance with the work of M. Gotler [34] and Daniel Kherlakian [35] in where they found that there is statistically significant difference in pain level recorded at different intervals.

6. Conclusion

There was no difference in post-operative pain between the ProTaper Next and the WaveOne Gold. The pain intensity showed significant decrease by time in all groups especially after 24 h post-operatively. Total Fill sealers was found to be promising regarding post-operative pain.

References

- [1] Glennon JP, Ng YL, Setchell DJ, Gulabivala K. Prevalence of and factors affecting postpreparation pain in patients undergoing two-visit root canal treatment. *Int Endod J* 2004;37:29–37.
- [2] Bürklein S, Hirschitzka K, Dammaschke T, Schäfer E. Shaping ability and cleaning effectiveness of two single- le systems in severely curved root canals of extracted teeth: reciproc and WaveOne versus Mtwo and Pro- Taper. *Int Endod J* 2012;45(5):449–61.
- [3] Endodontic management of a mandibular first molar with unusual canal morphology. ahmed abdel rahman HASHEM, hany mohamed aly AHMED. *Eur Endod J* 2017;2. <https://doi.org/10.5152/eej.2017.17042>. 5-5.
- [4] Pandis N. The evidence pyramid and introduction to randomized controlled trials. *Am J Orthod Dentofacial Orthop* 2011;140:446–7.
- [5] Uetani K, Nakayama T, Ikai H, Yonemoto N, Moher D. Quality of reports on randomized controlled trials conducted in Japan: evaluation of adherence to the CONSORT statement. *Intern Med* 2009;48:307–13.
- [6] Chung JH, Kang DH, Jo JK, Lee SW. Assessing the quality of randomized controlled trials published in the *Journal of Korean Medical Science* from 1986 to 2011. *J Kor Med Sci* 2012;27:973–80.
- [7] Begg C, Cho M, Eastwood S, Horton R, Moher D, Olkin I. Improving the quality of reporting of randomized controlled trials. The CONSORT statement. *J Am Med Assoc* 1996;276:637–9.
- [8] Rao K, Kandaswamy, Umashetty G, Rathore V, Hoktar C, Patil B. Post-obturation pain following one visit and two visit root canal. *J Int Oral Health* 2014;6(2):28–32.
- [9] Prashanth MB, Tavane PN, Abraham S, Chacko. Comparative evaluation of pain, tenderness and swelling followed by radiographic evaluation of periapical changes at various intervals of time following single and multiple visit endodontic therapy: an-in vitro study. *J Contemp Dent Pract* 2011;12(3):187–91.
- [10] Peters LB, Wesselink PR. Periapical healing of endodontically treated teeth in one and two visits obturated in the presence or absence of detectable micro-organisms. *Int Endod J* 2002;35:660–7.
- [11] Kherlakian Daniel, Sanches Cunha Rodrigo, FRCD(C), Cabral Ehrhardt Iracema, Luis Zuolo Mario, Kishen Anil, da Silveira Bueno Carlos Eduardo. Comparison of the incidence of postoperative pain after using 2 reciprocating systems and a continuous rotary system: a prospective randomized clinical trial. *J Endod* 2015;10:1016.
- [12] Waltimo T, Trope M, Haapasalo M, Qrstavik D. Clinical efficacy of treatment procedures in endodontic infection control and one year follow up of peri-apical healing. *J Endod* 2000;26:751–5.
- [13] Carrotte P. Endodontics : part 7. Preparation of the root canal. *Br Dent J* 2004;197:603–13.
- [14] Seltzer S, Naidorf IJ. Flare-ups in endodontics: I. Etiological factors. *J Endod* 1985;11:472–8.
- [15] Wittgow WC, Sabiston CB. Microorganisms from pulpal chambers of in- tact teeth with necrotic pulps. *J Endod* 1975;1:168–71.
- [16] Relvas JB, Bastos MM, Marques AA, Garrido AD, Sponchiado Jr. EC. Assessment of postoperative pain after reciprocating or rotary NiTi instrumentation of root canals: a randomized, controlled clinical trial. *Clin Oral Invest* 2015;1–7. [Epub ahead of print].
- [17] Kherlakian D, Cunha RS, Ehrhardt IC, Zuolo ML, Kishen A, Silveira Bueno CE. Comparison of the incidence of postoperative pain after using 2 reciprocating systems and a continuous rotary system: a prospective randomized clinical trial. *J Endod* 2016;42:171–6.
- [18] Gambarini G, Plotino G, Grande N, et al. Mechanical properties of nickel– titanium rotary instruments produced with a new manufacturing technique. *Int Endod J* 2011;44:337–41.
- [19] Zhou H-m, Shen Y, Zheng W, et al. Mechanical properties of controlled memory and superelastic nickel-titanium wires used in the manufacture of rotary endodontic instruments. *J Endod* 2012;38:1535–40.
- [20] Hieawy A, Haapasalo M, Zhou H, Wang ZJ, Shen Y. Phase transformation behavior and resistance to bending and cyclic fatigue of ProTaper Gold and ProTaper

- universal instruments. *J Endod* 2015;41:1134–8.
- [21] Hayashi Y, Yoneyama T, Yahata Y, et al. Phase transformation behaviour and bending properties of hybrid nickel-titanium rotary endodontic instruments. *Int Endod J* 2007;40:247–53.
- [22] Park SY, Cheung GS, Yum J, et al. Dynamic torsional resistance of nickel-titanium rotary instruments. *J Endod* 2010;36:1200–4.
- [23] Gao Y, Gutmann JL, Wilkinson K, Maxwell R, Ammon D. Evaluation of the impact of raw materials on the fatigue and mechanical properties of Pro-File Vortex rotary instruments. *J Endod* 2012;38:398–401.
- [24] Ye J, Gao Y. Metallurgical characterization of M-Wire nickel-titanium shape memory alloy used for endodontic rotary instruments during low-cycle fatigue. *J Endod* 2012;38:105–7.
- [25] Gagliardi J, Versiani MA, de Sousa-Neto MD, Plazas-Garzon A, Basrani B. Evaluation of the shaping characteristics of ProTaper Gold, ProTaper NEXT, and ProTaper universal in curved canals. *J Endod* 2015;41:1718–24.
- [26] Berutti E, Negro AR, Lendini M, Pasqualini D. Influence of manual pre-paring and torque on the failure rate of ProTaper rotary instruments. *J Endod* 2004;30:228–30.
- [27] Blum JY, Machtou P, Ruddle C, Micallef JP. Analysis of mechanical preparations in extracted teeth using ProTaper rotary instruments: value of the safety quotient. *J Endod* 2003;29:567–75.
- [28] Kousalya V, Nivedhitha M. Influence of various obturation techniques and materials on postoperative pain- A Systemic review (IOSR-JDMS)e-ISSN: 2279-0853, p-ISSN: 2279-0861. *IOSR J Dent Med Sci* July. 2016;15(7):129–35. Ver. VI.
- [29] Alacam Tayfun. Incidence of postoperative pain following the use of different sealers in immediate root canal filling. *J Endod* 1970;11:135–7.
- [30] Fox J, Atkinson JS, Dinin AP, et al. Incidence of pain following one-visit endodontic treatment. *Oral Surg* 1970;30:123–30.
- [31] Genet, Wesselink. The incidence of preoperative and postoperative pain in endodontic therapy. 1986. <https://doi.org/10.1111/j.1365-2591>.
- [32] Seltzer S, Naidorf LJ. flare-ups in Endodontics: II. Therapeutic measures 2004(6).
- [33] Yoldas O, Topuz A, Isci AS, Oztune H. Post-operative pain after endodontic re-treatment: single versus two visit treatment. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2004;98(4):483–7.
- [34] Gotler M, Bar-Gil B, Ashkenazi M. Postoperative pain after root canal treatment: a prospective cohort study. *International Journal of Dentistry* Volume 2012:5. <https://doi.org/10.1155/2012/310467>. Article ID 310467.
- [35] Kherlakian Daniel, Sanches Cunha Rodrigo, FRCD(C), Cabral Ehrhardt Iracema, Luis Zuolo Mario, Kishen Anil, da Silveira Carlos Eduardo. Bueno comparison of the incidence of postoperative pain after using 2 reciprocating systems and a continuous rotary system: a prospective randomized clinical trial. *J Endod* 2015;10:1016.