



Effect of Different Treatment Regimen and Types of Endodontic Sealers on Pain and Periapical Radiographic Changes

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Abstract

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INTRODUCTION: The study aims as a pilot study to evaluate the effect of different treatment regimen and different types of endodontic sealers on pain and periapical radiographic changes was studied.

MATERIALS AND METHODS: Forty patients in need of an endodontic root canal treatment on anterior teeth were selected and divided into two groups (20 patients each), according to the endodontic treatment protocol (single or multiple visits). Then, each group was subdivided into two subgroups according to sealer used 10 each (AH Plus Jet resin sealer, Total Fill Bioceramic Sealer). To record pain intensity of the patients at different intervals: 1, 2, 3, 7 days, a visual analog scale was used. Furthermore, patients were recalled after 1, 3, 6, 9 months to evaluate periapical radiographic changes.

RESULTS: Showed that as regard pain assessment both tested endodontic sealers, as well as single or multiple visits have no statistically significant difference between pain values of patients during all the observation period from immediately post-operative, after 4, 12, 24, 48, 72 h as well as after 7 days ($p > 0.05$). As regard lamina dura thickness, results showed that with both tested endodontic sealers as well as single or multiple visits, there was no statistically significant difference between lamina dura thickness of patients after 1 month, 3, 6 as well as after 9 months.

CONCLUSIONS: Neither number of visits of endodontic treatment nor type of sealer used for obturation affects post-operative pain and thickness of lamina dura.

Introduction

In previous studies, post-operative pain reports in endodontics range from 3% to 58% [1]. Pain can be provoked by mechanical, chemical, or microbiological injuries to periodontal tissues [2]. The presence of post-operative pain has been shown to be associated with a number of treatment parameter, the number of visits [3], [4], the choice of root canal sealer [5], the choice of instrumentation [6], [7], [8], [9], [10], including working length (WL) estimation [11], [12], [13].

Several researchers pointed out the number of visits as an important factor in post-operative pain. There is a controversy in the dental literature concerning the competition of endodontic therapy in one or multiple appointments [14]. There are several factors concerning the choice of the type of treatment: tooth conditions (vital or nonvital tooth, symptomatic or asymptomatic, presence or absence of swelling), operator ability and clinical experience, medical history and attitude, anatomic and biologic considerations, adequate treatment time, patient's time constraints [15].

Several types of endodontic sealers are available in the market, and they may play a significant role in post-operative endodontic pain [16]. This may

be due to the fact that sealers placed in the root canals interfere with periodontal tissues through the apical foramina, lateral canals, or leaching and can potentially affect the healing process in the periodontium. Hence, local inflammation may occur due to root canal obturation materials which may cause post-operative pain. The intensity of inflammatory reactions depends on a number of different factors including the composition of the sealer [17].

It was reported that bioceramic materials play an important role in improving the outcome of endodontic treatment, because it releases biologically active substances [18], [19], [20], and it promotes the differentiation of odontoblasts [21]. Concerning cytotoxicity, bioceramic materials have been shown to be less cytotoxic than resin-based AH Plus *in vitro* [22]. On the other hand, AH Plus exhibited higher radiopacity [18] and stronger bonding capacity [23] compared with bioceramic sealers. In the dental literature, the clinical behavior of bioceramic sealers data is rare and of great interest.

As regard the null hypothesis, the researchers predict that there is no difference in pain reaction and lamina dura thickness for both number of visits as well as types of tested sealers.

Materials and Methods

Materials

Two types of endodontics sealers were used, representing two categories of endodontic sealers (Table 1):

Table 1: The materials used in this study

Endodontic sealer	Composition	Batch number
AH Plus Jet (Dentsply, Detrey, Konstanz, Germany)	Paste A: Bisphenol-A epoxy resin, Bisphenol-F epoxy resin, calcium tungstate, zirconium oxide, silica and iron pigments. Paste B: Dibenzyl diamine, aminoadamantane, tricyclodecane-diamine, calcium tungstate and zirconium oxide	1512000341
Total Fill (Brasseler, USA, Savannah, GA)	Zirconium oxide, calcium silicates, calcium phosphate, calcium hydroxide, filler, thickening agents	15003SP

Methods

Study design

This study was a randomized clinical comparing two endodontics sealers (AH Plus Jet resin sealer, Total Fill Bioceramic sealer). This research project was approved by the local research Ethics Committee (article number 234) and was performed in compliance with the ethical standards laid down in the 1946 declaration of Helsinki. Sample size calculation was based on a previous study. It considered an error of $\alpha = 0.05$ and a power of 0.994 and indicated a required sample size of 10 patients in each group, thus a total of 40 patients were included in this study.

Participant selection

Patients referred for endodontic treatment at the Faculty of Dentistry, Minia University between January 2019 and October 2019 were invited to participate in this study. They were given complete information on the purpose and methods of the study, and those who agreed to participate signed an informed consent form. Inclusion criteria: Patient age in the range of (18–40) years old referred to undergo endodontic treatment for upper anterior teeth and diagnosed as acute pulpitis without apical rarefaction, with slight pain on percussion and slight periodontal ligament space widening.

Exclusion criteria

Patients using pre-operative drugs that can affect pain perception as anti-inflammatory, analgesics or antibiotics in the past 24 h also, allergic or pregnant patients. Finally, patients diagnosed as having teeth with periapical radiolucency, necrotic pulp, swelling, or sinus tract. Teeth requiring retreatment. Teeth with grade II or III mobility.

Randomization and blinding

Stratified randomization was performed according to different tested groups, using a table of computer-generated random number. Allocation was concealed using envelopes were opened by an assistant not involved in the research, but only when the endodontic sealer was going to be inserted into the root canal. The patients were randomized for the endodontic sealer used. Table 1 states the endodontic sealers used and their compositions. The operator knew which sealer would be used only right before filling the root canal. The patients were blinded to the sealer.

Clinical intervention

Teeth were treated by one experienced endodontist. Local anesthesia and dental dam isolation as a routine steps were performed. Then, access was done following by the determination of the WL using an electronic apex locator (Root ZX II; J Morita, Irvine, CA). A radiograph was taken to confirm the WL, when a reliable electronic apex locator reading could not be achieved.

The canals were prepared using Revo S rotary instrumentation (Revo S rotary files Micro-Mega, France apical file). Between each file irrigation was performed with 2 ml of 2.5% sodium hypochlorite using Endo-Eze irrigation tip (Ultradent Products Inc., Jordan) with (27) gauge needle.

The patients were divided into two groups according to the number of treatment visits. Group I, single visit (20 patients) and Group II, multiple visits (20 patients). Then, the patients were randomly subdivided into two subgroups (10 patients each) according to the type of endodontic sealer used. AH Plus Jet resin sealer (DentSply, Konstanz, Germany) was used for patients in subgroup A and Total Fill Bioceramic sealer (Brasseler, USA, Savannah, GA) was used for patients in subgroup B.

For patients in Group I, after mechanical preparation, root canals were dried using absorbent paper points size 40 (Meta Biomed Co. Ltd, Korea) and root canals were obturated with master cone size 40 ISO standardized gutta percha cone (Meta Biomed Co. LTD). The sealer was used according to manufacturer's instructions. A pre-fitted ISO size 40 gutta percha master cone was inserted to full WL and accessory gutta percha size 25 was used. While for patients in subgroup B, Total Fill bioceramic sealer (Brasseler, USA, Savannah, GA) was used. The sealer was used according to the manufacturer's instructions. A pre-fitted Total Fill master single cone size 40, 0.04 taper was inserted to full WL.

Access cavity was sealed using Cavit temporary filling (3M ESPE, USA) over a dry cotton pellet. All steps were recorded by operator on a work chart and checked radiographically. The patients were referred to a specialist for a final restoration. For

Table 2: Comparison between pain VAS scores after single or multiple visits

Sealer	Time	Single visit (n = 10)		Multiple visits (n = 10)		p-value	Effect size (d)	
		Median	Range	Median	Range			
AH Plus	Pre-operative	6	5-7	5	3-7	0.159	0.639	
	Immediate post-operative	5	0-5	3.5	0-6	0.844	0.085	
	4 h	4.5	0-5	4	0-6	0.536	0.273	
	12 h	4	3-4	3.5	0-5	0.812	0.102	
	24 h	3	2-4	2	0-4	0.337	0.414	
	48 h	3	0-3	0.5	0-3	0.218	0.524	
	72 h	0	0-0	0	0-2	0.067	0.524	
	7 Days	0	0-0	0	0-0	1	0	
	Total Fill	Pre-operative	5	4-6	6	5-7	0.074	0.801
		Immediate post-operative	3	0-4	4	3-6	0.615	0.204
4 h		3	2-4	4	3-4	0.058	0.844	
12 h		4	3-4	3	2-3	0.243	0.506	
24 h		4	2-4	1	0-2	0.071	0.801	
48 h		2	1-3	0	0-1	0.262	0.487	
72 h		0	0-0	0	0-0	1	0	
7 Days		0	0-0	0	0-0	1	0	

*Significant at $P \leq 0.05$, VAS: Visual analog scale.

patients in group II (multiple visits), after mechanical preparation, root canals were dried using paper points and filled with injectable calcium hydroxide intracanal medication (Meta Biomed Co. Ltd, Korea) and access cavities were sealed with Cavit temporary filling. Patients were recalled after 7 days for completion of treatment; a rubber dam was placed and temporary filling was removed. Calcium hydroxide was removed with manual filling and normal saline and the root canals were dried using paper points and then obturated using tested sealers as mentioned previously in Group I.

Post-operative pain evaluation

Pain intensity record was established using a visual analog scale (VAS) at 24, 48, 72 h. The VAS consisted of a 10-mm-long line divided into 10 equal intervals from 0 (no pain) to 10 (very severe pain). Each patient was instructed to mark his or her perceived post-operative pain level on the line. The distance between "no pain" and the mark defined the subject's pain [24].

Post-operative radiographic evaluation

Patients were recalled after 1, 3, 6, 9 months to evaluate periapical radiographic changes to assess lamina dura and osseous changes. The periapical conditions were classified as following:

- Normal denoting normal appearance of the surrounding osseous structure or
- Apical periodontitis denoting apical radiolucency observed [25].

Statistically analysis

Numerical data were explored for normality by checking the distribution of data and using tests of normality (Kolmogorov-Smirnov and Shapiro-Wilk tests). All data showed normal (parametric) distribution except for pain VAS scores which showed non-normal (non-parametric) distribution. Parametric data were presented as mean and standard deviation (SD) values while non-parametric data were presented as median and range values. For parametric data, one-way analysis of variance (ANOVA) test was used to compare between mean age values in the four groups. Repeated measures ANOVA test was used to compare between the two sealers, single and multiple visits as well as to study the changes within each group. Bonferroni's *post-hoc* test was used for pair-wise comparisons when ANOVA test is significant. For non-parametric data, Mann-Whitney U test was used to compare between the two sealers as well as single and multiple visits. Friedman's test was used to study the changes within each group. Dunn's test was used for pair-wise comparisons when Friedman's test is significant. Qualitative data were presented as frequencies and percentages. Fisher's exact test

Table 3: Comparison between pain VAS scores after single or multiple visits

Visit	Time	AH Plus (n = 10)		Total Fill (n = 10)		p-value	Effect size (d)	
		Median	Range	Median	Range			
Single visit	Pre-operative	6	5-7	5	4-6	0.052	0.979	
	Immediate post-operative	5	0-5	3	0-4	0.052	0.979	
	4 h	4.5	0-5	3	2-4	0.226	0.543	
	12 h	4	3-4	4	3-4	0.445	0.308	
	24 h	3	2-4	4	2-4	0.809	0.102	
	48 h	3	0-3	2	1-3	0.308	0.423	
	72 h	0	0-0	0	0-0	1	0	
	7 Days	0	0-0	0	0-0	1	0	
	Multiple visits	Pre-operative	5	3-7	6	5-7	0.211	0.562
		Immediate post-operative	3.5	0-6	4	3-6	0.471	0.308
4 h		4	0-6	4	3-4	0.268	0.487	
12 h		3.5	0-5	3	2-3	0.180	0.6	
24 h		2	0-4	1	0-2	0.622	0.204	
48 h		0.5	0-3	0	0-1	0.625	0.204	
72 h		0	0-2	0	0-0	0.067	0.524	
7 Days		0	0-0	0	0-0	1	0	

*Significant at $P \leq 0.05$, VAS: Visual analog scale.

Table 4: Comparison between pain VAS scores at different times within each group

Time	Single visit–AH Plus (n = 10)		Single visit–Total Fill (n = 10)		Multiple visits–AH Plus (n = 10)		Multiple visits–Total Fill (n = 10)	
	Median	Range	Median	Range	Median	Range	Median	Range
Pre-operative	6 ^A	5–7	5 ^A	4–6	5 ^A	3–7	6 ^A	5–7
Immediate post-operative	5 ^{AB}	0–5	3 ^B	0–4	3.5 ^B	0–6	4 ^B	3–6
4 h	4.5 ^B	0–5	3 ^B	2–4	4 ^{AB}	0–6	4 ^B	3–4
12 h	4 ^{BC}	3–4	4 ^B	3–4	3.5 ^B	0–5	3 ^B	2–3
24 h	3 ^C	2–4	4 ^B	2–4	2 ^C	0–4	1 ^C	0–2
48 h	3 ^C	0–3	2 ^C	1–3	0.5 ^D	0–3	0 ^C	0–1
72 h	0 ^D	0–0	0 ^D	0–0	0 ^D	0–2	0 ^C	0–0
7 Days	0 ^D	0–0	0 ^D	0–0	0 ^D	0–0	0 ^C	0–0
p-value	<0.001*		<0.001*		<0.001*		<0.001*	
Effect size (w)	0.805		0.749		0.796		0.83	

*Significant at $P \leq 0.05$. Different superscripts in the same column indicate statistically significant changes by time, VAS: Visual analog scale.

was used for comparisons between the groups. The significance level was set at $p \leq 0.05$. Statistical analysis was performed with IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.

Results

Pain assessment using VAS (Tables 2-4)

Comparison between single and multiple visits

Whether with AH Plus or Total Fill sealers, there was no statistically significant difference between pain scores of patients who had single or multiple visits pre-operatively, immediately post-operative, after 4, 12, 24, 48, 72 h as well as after 7 days (Table 2).

Comparison between sealer types

Whether after single or multiple visits, there was no statistically significant difference between pain scores of AH Plus and Total Fill sealers pre-operatively, immediately post-operative, after 4, 12, 24, 48, 72 h as well as after 7 days (Table 3).

Changes by time within each group

As regards single visit with AH Plus sealer group, there was a statistically significant change in median pain scores by time ($p < 0.001$, Effect size = 0.805). Pair-wise comparisons between time periods revealed that there was no statistically significant change in median pain scores immediately post-operative as well as from immediate post-operative to 4 h. However, the median

pain score after 4 h showed statistically significant lower median score than pre-operative measurement. From 4 to 12 as well as 12–24 h; there was no statistically significant change in median pain score. However, the median pain score after 24 h showed statistically significantly lower median value than pre-operative, immediate post-operative and 4 h scores. There was also no statistically significant change in median pain scores from 24 to 48 h followed by a statistically significant decrease in median pain score from 48 to 72 h. There was no statistically significant change in median pain scores from 72 h to 7 days.

In single visit with Total Fill sealer group, there was a statistically significant change in median pain scores by time ($p < 0.001$, Effect size = 0.749). Pair-wise comparisons between time periods revealed that there was a statistically significant decrease in median pain scores immediately post-operative followed by non-statistically significant change from immediate post-operative to 4 h, 4–12 as well as 12–24 h. From 24 to 48 as well as 48–72 h, there was a statistically significant decrease in median pain score. There was no statistically significant change in median pain scores from 72 h to 7 days.

As regards multiple visits with AH Plus sealer group; there was a statistically significant change in median pain scores by time ($p < 0.001$, Effect size = 0.796). Pair-wise comparisons between time periods revealed that there was a statistically significant decrease in median pain scores immediately post-operative followed by non-statistically significant change from immediate post-operative to 4 h as well as from 4 to 12 h. From 12 to 24 as well as 24–48 h, there was a statistically significant decrease in median pain score. There was no statistically significant change in median pain scores from 48 to 72 h as well as from 72 h to 7 days.

Table 5: Comparison between lamina dura thickness (mm) after single or multiple visits

Sealer	Time	Single visit (n = 10)		Multiple visits (n = 10)		p-value	Effect size (Partial Eta Squared)
		Mean	SD	Mean	SD		
AH Plus	Pre-operative	0.269	0.061	0.289	0.067	0.425	0.018
	1 month	0.244	0.064	0.253	0.06	0.721	0.004
	3 months	0.223	0.05	0.233	0.052	0.630	0.007
	6 months	0.204	0.034	0.204	0.048	0.995	0.000001
	9 months	0.194	0.025	0.174	0.036	0.133	0.062
Total Fill	Pre-operative	0.28	0.034	0.278	0.051	0.929	0.0002
	1 month	0.269	0.033	0.255	0.052	0.559	0.010
	3 months	0.241	0.035	0.241	0.041	0.988	0.00001
	6 months	0.206	0.023	0.201	0.034	0.770	0.002
	9 months	0.173	0.028	0.176	0.024	0.828	0.001

*Significant at $P \leq 0.05$.

In multiple visits with Total Fill sealer group, there was a statistically significant change in median pain scores by time ($p < 0.001$, Effect size = 0.83). Pair-wise comparisons between time periods revealed that there was a statistically significant decrease in median pain scores immediately post-operative followed by non-statistically significant change from immediate post-operative to 4 h as well as 4–12 h. From 12 to 24 h, there was a statistically significant decrease in median pain score. There was no statistically significant change in median pain scores from 24 to 48, 48–72 as well as from 72 h to 7 days (Table 4).

Lamina dura thickness (mm) (Tables 5-7)

Comparison between single and multiple visits

Whether with AH Plus or Total Fill sealers, there was no statistically significant difference between lamina dura thickness of patients who had single or multiple visits pre-operatively, after 1 month, 3, 6 as well as after 9 months (Table 5).

Comparison between sealer types

Whether after single or multiple visits, there was no statistically significant difference between lamina dura thickness after using AH Plus or Total Fill sealers pre-operatively, after 1 month, 3, 6 as well as after 9 months (Table 6).

Changes by time within each group

As regards single visit with AH Plus sealer group, there was a statistically significant change in mean lamina dura thickness by time ($p < 0.001$, Effect size = 0.495). Pair-wise comparisons between time periods revealed that there was a statistically significant decrease in mean Lamina Dura thickness after 1 month, from 1 to 3 months as well as from 3 to 6 months. From 6–9 months; there was no statistically significant change in mean lamina dura thickness.

In single visit with Total Fill sealer group, there was a statistically significant change in mean Lamina Dura thickness by time ($p < 0.001$, Effect size = 0.708). Pair-wise comparisons between time periods revealed that there was no statistically significant change in mean lamina dura thickness after 1 month followed by

a statistically significant decrease in mean lamina dura thickness from 1 to 3, 3–6 as well as from 6 to 9 months.

As regards multiple visits with AH Plus sealer group, there was a statistically significant change in mean Lamina Dura thickness by time ($p < 0.001$, Effect size = 0.725). Pair-wise comparisons between time periods revealed that there was a statistically significant decrease in mean lamina Dura thickness after 1 month, from 1 to 3, 3–6 as well as from 6 to 9 months (Table 7).

Similarly, in multiple visits with Total Fill sealer group, there was a statistically significant change in mean Lamina Dura thickness by time ($p < 0.001$, Effect size = 0.682). Pair-wise comparisons between time periods revealed that there was a statistically significant decrease in mean lamina dura thickness after 1 month, from 1 to 3, 3–6 as well as from 6 to 9 months.

Discussion

The present pilot clinical study compared the effect of visit protocol (single and multiple) and different endodontic sealers (resin sealer and bioceramic sealer) on pain and radiographic alterations were carried out. A pain scale and parallel technique for peri-apical radiographic view were used. Single visit versus multiple visits has long been an issue of debate in root canal treatment (RCT) research [26].

In this current study, two types of endodontic sealers were used, representing 2 different categories (resin and bioceramic). Over years AH Plus endodontic sealer, which is a resin sealer, has become the gold standard against which newly introduced sealers are assessed, especially if they are based on new concepts. This good reputation of AH Plus was well earned by thousands of long-term successful cases all over the world and hundreds of researches that showed its efficient physical [21], [27], [28].

Epoxy resin-based sealers, such as AH Plus sealer can bond to dentin. Furthermore, it possesses an antimicrobial activity against *Enterococcus faecalis*, biocompatibility, long-term dimensional stability and acceptable flow [21].

Table 6: Comparison between lamina dura thickness after using the two sealers

Visit	Time	AH Plus (n = 10)		Total Fill (n = 10)		p-value	Effect size (Partial Eta Squared)
		Mean	SD	Mean	SD		
Single visit	Pre-operative	0.269	0.061	0.28	0.034	0.636	0.006
	1 month	0.244	0.064	0.269	0.033	0.308	0.029
	3 months	0.223	0.05	0.241	0.035	0.386	0.021
	6 months	0.204	0.034	0.206	0.023	0.916	0.0003
	9 months	0.194	0.025	0.173	0.028	0.115	0.068
Multiple visits	Pre-operative	0.289	0.067	0.278	0.051	0.677	0.005
	1 month	0.253	0.06	0.255	0.052	0.934	0.0002
	3 months	0.233	0.052	0.241	0.041	0.687	0.005
	6 months	0.204	0.048	0.201	0.034	0.857	0.001
	9 months	0.174	0.036	0.176	0.024	0.889	0.001

*Significant at $P \leq 0.05$.

Bioceramics were introduced in endodontics as root repair cements and root canal sealers. Total fill Bioceramic sealer was chosen to be the other arm of comparison in this study, because of its promising results in different researches and its intriguing concept, being insoluble and hydrophilic depending on the dentin inherent moisture for its setting reaction, also it possesses antimicrobial properties, biocompatibility, radiopacity, and chemical and dimension stability [22], [20], [29].

It is well known that pain perception is a highly subjective and variable experience modulated by multiple physical and psychological factors. Pain reporting is influenced by many factors other than experimental procedures. In addition, the measurements of pain are fraught with hazards and opportunities for error. In this study, VAS has been used. Pain has also been visually and verbally quantified to a better understanding by patients. Pain scales are based on the theory that pain intensity is continuous without jumps or intervals. The VAS is suitable for research use and has been extensively utilized within medicine and dentistry. It simplifies pain rating by allowing patients to quantify the extent of their pain by rating it from 0 to 10 [30], [31].

The use of periapical radiographs to assess the success in endodontic treatment is a routine practice. One of the disadvantages of this method is the reproducibility of the assessment results [32]. Reviewers were experienced clinicians, who received training on radiographic assessment on 50 radiographs. They draw the attention that there is no doubt that cone beam computed tomography (CBCT) produces better imaging to improve the validity of the assessment of periapical bone healing after endodontic treatment [33]. CBCT requires larger doses of irradiation, so it should not be the standard assessment method for scientific research [26], [32].

As regard post-operative pain no statistical significant difference was found between single and multiple visits. This is in accordance with Manfredi *et al.* [34] and Ezpeleta *et al.* [35]. This may be due to that it is difficult to determine if a single or multiple factors elicit pain. If a root canal system was not cleaned properly, residual infection may cause exacerbation by imbalances in the host-bacteria relationship, or the presence of decisively pathogenic bacteria before the initiation of treatment [36]. For this reason, only

vital cases were included, while persisting infection cases were excluded as a cause of post-operative pain. A mechanical reason as over instrumentation; chemical factors include the extrusion of medications, filling materials, or irrigants may result in post-operative pain [37]. Furthermore, the results are based on patient's reports and the pain is subjective nature, so the evaluation of patients may show wide variations as there are multiple factors that could influence the individual reaction to pain [38].

Moreover, the instrumentation technique can influence discomfort or pain during endodontic therapy. Crown down technique was utilized which may effectively minimize post-operative pain, this is in agreement with Goreva and Petrikas [33]. Revo S rotary files, used in this study, acts in a sneaky such as motion which results in less debris extrusion, that decreasing post-operative pain. Only single-rooted teeth with a single canal were included to facilitate WL control and to avoid over instrumentation [11].

The results of this current study contradict with that of Albashaireh and Alnegrish [38] who reported that post-operative pain was lower in single visit. This may be due to that the root canal is obturated directly after instrumentation and irrigation aiming to seal remaining bacteria and deprived them from both space and nutrition [15], [39]. At the other side, Jabeen and Khursiduzzaman [40] concluded that post-operative pain was less in multiple visits compared to that of single visit. This may be due to that the application of antibacterial medication as $Ca(OH)_2$ which is injected to disinfect canals between treatment visits [41]. Furthermore, this finding is in accordance with Figini *et al.* [15] and Ghodduzi *et al.* [42] who reported that pain increased after single visit treatment due to longer working time which simulate inflammatory response and that single visit treatment significantly increase the risk of flaring and swelling.

All these contradictions may be due to the fact that these researches were carried out on non-vital teeth, also the difference in the follow-up period. Multiple-visit treatment is recommended when complications is suspected (teeth with periapical lesions) [43].

The results showed that whether with AH Plus or Total Fill sealers, and there was no statistically significant difference between pain scores among tested patients. This is in accordance with the results concluded by Graunaite *et al.* [44] They concluded

Table 7: Comparison between lamina dura thickness (mm) at different times within each group

Time	Single visit-AH Plus (n = 10)		Single visit-Total Fill (n = 10)		Multiple visits-AH Plus (n = 10)		Multiple visits-Total Fill (n = 10)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Pre-operative	0.269 ^A	0.061	0.28 ^A	0.034	0.289 ^A	0.067	0.278 ^A	0.051
1 month	0.244 ^B	0.064	0.269 ^A	0.033	0.253 ^B	0.06	0.255 ^B	0.052
3 months	0.223 ^C	0.05	0.241 ^B	0.035	0.233 ^C	0.052	0.241 ^C	0.041
6 months	0.204 ^D	0.034	0.206 ^C	0.023	0.204 ^D	0.048	0.201 ^D	0.034
9 months	0.194 ^D	0.025	0.173 ^D	0.028	0.174 ^E	0.036	0.176 ^E	0.024
p-value	<0.001*		<0.001*		<0.001*		<0.001*	
Effect size (Partial Eta Squared)	0.495		0.708		0.725		0.682	

*Significant at $P \leq 0.05$, Different superscripts in the same column indicate statistically significant changes by time.

that AH Plus and Total Fill perform the same as regard intensity and occurrence of post-operative pain in teeth. At the same time *in vitro* studies reported that the differences in cytotoxicity between AH Plus and Total Fill, does not seem to reflect clinically. For AH Plus mild pain is probably related to the self-limiting leaching of cytotoxic components as the material sets. This irritation to the host peaks at 3–7 days [17], [22], [45], [46]. As for Total Fill, the persistence of post obturation pain may extend for days, which can be explained by the maintenance of irritating components and therefore inflammatory mediators [47], [48].

The highest VAS score was reported at 24 h after obturation and decreased with time. One could speculate that cytotoxic unpolymerized root canal sealers known to induce reactive oxygen species (ROS) formation before material setting and their leaching components could have played a role during the first 24 h [27], [35].

On the other hand, Paz *et al.* [49] inversely reported that highest post-operative pain using single cone + bioceramic and continuous wave + resin sealer revealed the least levels of pain. Although, it was not the purpose of our study, comparing the obturation techniques. The lamina dura thickness results revealed a non-significant difference between both sealers used as well as duration of treatment. This result is in accordance with of Wong *et al.* [50]. They draw the attention that there was no clinical sign and symptom and no radiographic radiolucency observed by the clinicians in the follow-up examination.

The null hypothesis was accepted as the results showed no significant difference as regard pain and lamina dura thickness for both techniques for RCT (single versus multiple visits), as well as for types of sealers used.

Conclusions

Post-operative pain and lamina dura thickness were not affected by neither with the number of visits nor with type of sealer.

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