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Reem B. Habib
Future University in Egypt, 20184222@fue.edu.eg

Wael H. Kamel
Future University in Egypt, wael.ahmed@fue.edu.eg

Nehal N. Roshdy
Cairo University in Egypt, dr.nehalnabil333@gmail.com

Marwa M. Aboushadi
Future University in Egypt, marwa.moataz@fue.edu.eg

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The Effect of Different Irrigant Activation Methods on Postoperative Pain After Endodontic Retreatment

Reem B. Habib[a,*], **Wael H. Kamel**,[b] **Nehal N. Roshdy**,[c] **Marwa M. Aboushadi**[a]

a. Future University in Egypt
b. Professor of Endodontics , Future University in Egypt
c. Assistant Professor of Endodontics , Cairo University, Egypt
d. Lecturer of Endodontics , Future University in Egypt

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* Corresponding author.
E-mail address:
20184222@fue.edu.eg
(Reem B. Habib).

ABSTRACT

Aim: This study was designed to evaluate the effect of different irrigant activation methods on post operative pain after endodontic retreatment. ***Materials and Methods:*** seventy eight patients need non-surgical retreatment in mandibular first molar were involved in the study. The retreatment was performed in two visits, at first visit cases were randomly divided into three groups according to methods of irrigant activation after root canal retreatment with protaper next rotary ni-ti system. Group A (n=26) Root canals were irrigated using 2.6% sodium hypochlorite (NaOCl) with manual dynamic agitation using master cone Group B (n=26) Root canals were irrigated using 2.6% sodium hypochlorite (NaOCl) using ultrasonic machine (ultra-x) for 60 seconds. Group C (n=26) Root canals were irrigated using 2.6% sodium hypochlorite (NaOCl) with NaviTip (29-gauge 27 mm) with double side tip. At second visit after one week, obturation was performed using modified single cone technique ans access cavity was filled with coronal restoration. After two visits root canal treatment and a specific method of agitation, depending on each group, the patients were given a questionnaire on which the patient would mark the degree of pain in a scale from 0 to 10 at 6, 12, 24, 48 72 hrs and one week post-obturation. Data were statistically analyzed with a significance level of $P \leq 0.05$. ***Results:*** At 6,12,24 hrs., there was significant difference between the groups in pain intensity where control group C (Navitip with side vented needle) showed more pain scores than in the intervention groups (Ultra X and manual dynamic agitation). On the other hand, at 48, 72 hours and 7 days post- operative, there was no statistically significant difference in pain among tested groups. ***Conclusion:*** Agitation of the irrigation is reliable safe to clinican and effective as final step irrigation protocol with successful management of postoperative pain in retreatment cases. The intensity of postoperative pain decreased with time regardless of final irrigation protocol used.

1. INTRODUCTION

Postoperative pain is defined as the sensation of discomfort after endodontic intervention and is reported by 25%–40% of patients irrespective of pulp and periradicular status. The prevalence of pain in the first 24 hours is 40%, falling to 11% after 7 days [(1)].

Root canal re-treatment might cause post- operative pain that is proved to be influenced by several factors among which are the irrigation methods. Studies were made to investigate the best irrigation method yet no enough results were found [(2)].

Irrigation using Sodium hypochlorite is mainly performed by a syringe and a needle, but this simple method is unable to clean remote areas of the root canal system[(3)].

Agitation techniques have been recommended to hasten the penetration of the irrigants into the complexities of root canal morphology with the aim of enhancing the contact of the solution with the canal wall surfaces removing microbes, debris and reducing postoperative pain.

These techniques include: Sonic agitation, Ultrasonic agitation, and the cheapest and simplest of all, Manual Dynamic Agitation (MDA)[(4,5)] Ultrasonic Activator" Cordless endodontic ultrasonic device, reduces the irrigation time utilizes the principle of acoustic micro streaming, agitation and cavitation. Its rapid movement enables penetration into non instrumented areas and enhances shear stress on tissue remnants leading to minimize the postoperative pain[(6)] The NaviTip Fx is a brush-covered irrigation needle it was effective in removing the smear layer in curved root canals [(7)].

2. MATERIALS AND METHODS

The trial design of this study was parallel randomized clinical trial. It was approved by the research ethics committee of faculty of oral and dental medicine,future university in Egypt fuerec(15)/15-6-2020.

Based on a previous study[(9,10)], the sample were divided into 3 groups. A total sample size of 60 (20/group) was sufficient to detect an effect size of 0.2, power of 80%, and a significance level of 5%. This number is to be increased to a total sample of 66 to adjust for using non parametric test. Further

increased again to total sample size of 78 (26 in each group) to compensate for losses during follow up. The sample size was calculated by PS (power and sample size) G*Power program.

Seventy eight patients from the outpatient clinic of endodontics at the faculty of oral and dental medicine, Future University were diagnosis that need non surgical retreatment for mandibular first molar. The exclusion criteria comprised medically compromised patients, pregnant or lactating females, psychologically disturbed patients, patients allergic to any medication used in this study, patient with swelling or acute periapical abscess, patients who administered anti-inflammatory analgesics or antibiotics 12 hours preoperatively, comprised teeth with wide or open apex, vital pulp tissues, association with swelling or fistula tract, no possible restorability, abnormal anatomy or calcified canals, previous root canal treatment, or periodontally affected with grade 2 or 3 mobility.

Treatment procedure

The retreatment of all cases were completed in two visits, each patient was given an a pain scale chart (VAS) at first visit to record his/her pain level before any retreatment. The tooth was isolated using rubber dam (Sanctuary Powder Free Latex Dental Dam, Malaysia) all caries and /or defective restorations were completely removed and the access was done using a round bur size 4.

The root canal filling material was gradually removed using light apical pressure with protaper retreatment files D1 (9%), D2 (8%) and D3 (7%). The retreatment procedure was completed when the working length was obtained and no root canal filling covring the instrument.

Working length will be determined using an electronic apex locator and will be confirmed by a radiographic image that will be obtained using dental x-ray unit operating at 70 kVp,8mA with exposure set 0.25 sec, phosphorous plate size 2 Kodac intraoral periapical plate, Kodac, USA. and by the aid of parallel technique using Rinn film holder to be empty from any gutta percha.

Shaping of the canals will be performed in a crown-down technique using ProTaper Next Rotary instruments (X-Smart, DENTSPLY, Tulsa Dental, DENTSPLY Maillefer, TN, USA) in an endodontic motor according to the manufacturer's instructions the speed of the endodontic motor will be adjusted at 300rpm while the torque adjusted according to the used file.

Preparation of all canals was completed with X3 in which 30 k file snugly fit the apical 1/3 of the canal at the working length.

The canals were thoroughly irrigated with 2ml of freshly prepared 2.6% sodium hypochlorite(NaOCl) solution using plastic disposable syringe with side-vented needle (NaviTip; Ultradent, South Jordan, UT, USA) gauge 29 between every subsequent instrument. It was used passively into the canal, without forceful dispensing of the irrigant, placed 2mm short from the working length, which was verified by rubber stoppers.

To achieve standardization, the volume of irrigating solution was fixed (2ml) after each file.

A lubricant of 17% EDTA gel (EDTA, META, BIOMED, CO, LTD, Korea) was used with each file. Pain was assessed by giving the patient visual analogue scale (VAS) to assess his/her pain at 6,12,24,48,72 and 1 week postoperatively.

VAS is a straight horizontal line of fixed length 100 mm, the patients marks on the line point that they feel represents their prescription of their current state using a ruler,the score is determined by measuring the distance (mm) on the 10 cm line.

A higher score indicate greater pain intensity, in which the postoperative pain intensity as follow none (0-4mm), mild (5-44mm), moderate (45-74mm) and severe (75-100mm). In case of moderate or severe pain patients were allowed to take Ibuprofen (400mg). Number and frequency of analgesic tablets taken by the patient after root canal treatment were recorded.

Final irrigation protocol

Group (A) Manual dynamic agitation group

2 ml of 2.6 % NaOCl solution was delivered into the canal using double side-port irrigation needle (Navitip Side port 29G / 27mm) which was used passively without forceful dispensing of the irrigant. Intermittent manual agitation for 60 seconds in corono-apical movements using master cone that inserted 1 mm shorter than working length.. After which, master cone was inserted 1 mm shorter than working length with agitation.

Group (B) Ultra X group

2 ml of 2.6 % NaOCl solution was delivered into the canal using double side-port irrigation needle (Navitip Side port 29G / 27mm) which was used passively without forceful dispensing of the irrigant. Then irrigant was ultrasonically activated for 60 seconds with an ultrasonic device (Ultra X) at power 3 (40 kHz) using X-blue (bendable) metal ultrasonic tip (Length: 18mm, Size: 20/2%) in an up-and-down motion where the tip was 1 mm short of the canal's working length.

Group (C) SVN group (control group)

Root canals were irrigated using 2 ml of 2.6% NaOCl solution with NaviTip double Side port 29 G / 27 mm 1 mm shorter than the working length but without agitation. For all root canals in tested groups, 2 ml of 17% EDTA solution was then introduced into each canal for 1 minute to remove smear layer, followed by 10 ml of distilled water were used as a final flush of the canals to prevent erosion of the dentinal tubules.

After completion of the biomechanical instrumentation of the root canals, the coronal access cavity was then temporarily restored to proper sealing and no oral fluid leaking inside the canal.

At second visit (after one week)

Rubber dam was applied for isolation of root canal system, temporary filling was removed from the pulp chamber, each root canals were completely dried using ProTaper Next absorbent paper points corresponding to the same size of the master file (X3).

The root canals were obturated using the modified single cone technique by proper selection of gutta percha master cone corresponding to the same size as the master apical file (X3) and ADSEAL (ADSEAL, META BIOMED CO., LTD, Chungbuk) resin root canal sealer were used for obturation.

The access cavity was sealed using Resin-modified glass ionomer. All canals were shaped, cleaned, and obturated in a double visit.

Statistical analysis

The mean and standard deviation values were calculated for each group in each test. Data were explored for normality using Kolmogorov-Smirnov and Shapiro-Wilk tests and showed parametric (normal) distribution. Friedman test was used to test the difference between more than two groups in related samples while Wilcoxon test was used to test the difference between two groups in related samples. Mann–Whitney U test was used to compare the difference between two groups in non-related samples for Pain evaluation. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM® SPSS® Statistics Version 20 for Windows.

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3. RESULTS

Manual dynamic agitiation group (Group A) and Ultra X group (Group B) showed significantly lower intensity of pain than the control group at 6,12 and 24 follow-up periods. Table 1, figure 1 show the intensity of preoperative and post-operative pain of the tested groups at different time intervals The frequency of analgesics taken by patients decreased by the time in each tested group.Table 2, Figure 2 show The highest mean value was recorded at 6 hours for all groups,while no pain after 48 hours in PUI group and 72 hours in the side vented needle and manual dynmaic agitation group.

Table (1)

Intensity of pre & post-instrumentation pain of the tested groups after 6 hrs, 12 hrs, 24 hrs, 48 hrs,72 hrs and 7 days.

Period	Pain intensity						P-value
	Control		Manual dynamic		Ultra X		
	Mean	SD	Mean	SD	Mean	SD	
Preoperative	5.19	2.38	4.58	2.42	4.85	2.59	**0.555ns**
After 6hrs	5.08	1.92	3.35	1.32	3.15	1.54	**<0.001***
After 12hrs	4.12	2.55	2.27	0.87	2.08	1.09	**0.001***
After 24hrs	2.46	1.86	1.31	0.68	1.27	0.78	**0.020***
After 48hrs	1.19	1.27	1.00	0.80	1.04	0.72	**0.937ns**
After 72hrs	0.15	0.37	0.12	0.43	0.08	0.27	**0.601ns**
After 7 days	0.00	0.00	0.00	0.00	0.00	0.00	**1ns**
p-value	**<0.001***		**<0.001***		**<0.001***		

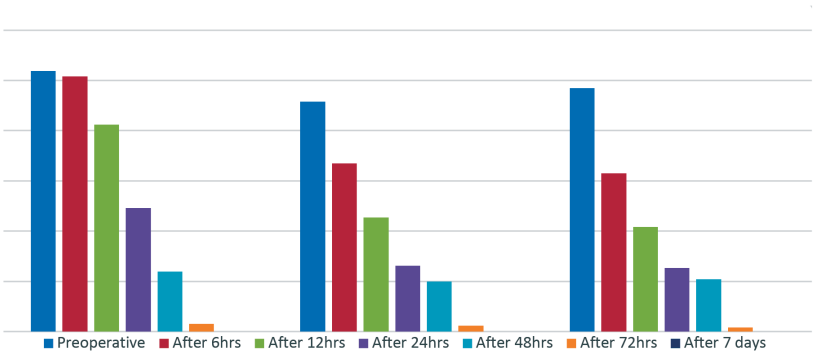

Figure (1) — Bar chart representing the intensity of Pre and post-instrumentation pain at different time intervals for each group

Table (2):

Incidence of intake of analgesic of all groups

Variables		Analges-ics						
		Control		Manual dynamic		Ultra X		
		N	%	n	%	N	%	p- value
Incidence of analgesic intake	**Yes**	8	30.8%	5	19.2%	4	15.4%	**0.381ns**
	No	18	69.2%	21	80.8%	22	84.6%	

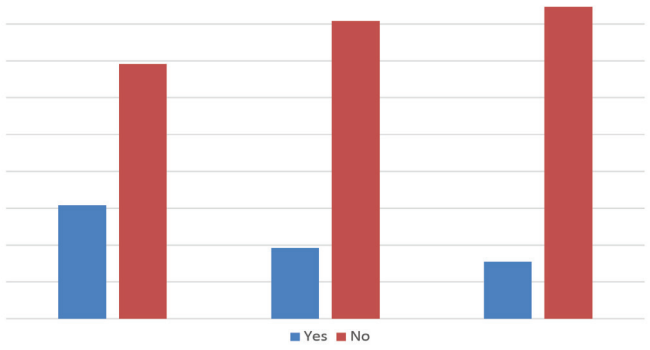

Figure (2) — Incidence of intake of analgesic of all groups

4. DISCUSSION

The aim of non surgical endodontic retreatment is to correct errors in previously failed treated teeth. Retreatment is achieved by first eliminating pre-existing filling materials, then gaining access to the apical third to adequately clean and shape the root canal system and finally seal the root canal[11].

Post operative pain is multifactorial and modulated both by factors related to the patients themselves and by condition of teeth or irrigation method[12].

Although the success rate of non surgical endodontic retreatment is lower than initial endodontic treatment is still high,around 80% of endodontically treated teeth heal and 89-95% remain asymptomatic[13,14].

The aim of This study was designated to evaluate the degree of post-operative pain and analgesic intake in non-surgical retreated mandibular first molar, through visual analogue scale (VAS) at 6, 12, 24, 48,72 hours and one week respectively after using 2.6% Sodium- hypochlorite using a NaviTip 29-gauge 27mm with side vented tip, 2.6% Sodium hypochlorite activated by Manual dynamic agitation using Mastercone and 2.6% Sodium hypochlorite activated by Ultrasonic machine (Ultra X)

Patients aged between 25 to 55 years old were only eligible to participate in the study. This age range was chosen as **Sood *et al.*[15], Visconti *et al.*[16], Allegretti *et al*[17]. Kreimer *et al* [18].** who reported that the younger patients showed higher pain levels during endodontic treatment than older range age and according to **Watkins *et al* [19].** reported that the experienced outcome pain levels significantly decreased with increasing age, due to less pain tolerance,less blood flow and delayed healing in older patients and delayed healing in older patients.

Mandibular first molars selected in the study because they significantly induce higher intraoperative pain as well as postoperative pain. [20,21]

Mepivacaine was chosen in this study as the local anesthetic agent for the standard inferior alveolar nerve block. It is a methyl derivative of N-alkyl pipecoloxylidine. It has rapid onset (2–3 min) and intermediate duration of action it has low vasodilatation effect [22]. Mepivacaine provides greater safety because of its low absorption, which reduces the risk of high blood concentrations and toxicity. [23]

Root canal treatment was completed in two visits.Multiple-visit endodontic (MVE) treatment allows the clinician to determine the effect of the therapy on the inflamed tissues and shorter initial visit for the emergency patient.[24] A systematic review concluded that patients undergoing single-visit root canal treatment might experience a higher risk of flare-up with increased risk of swelling when compared to multiple visits root canal treatment.[25]

In this study the pain intensity was recorded preoperatively to set a reference point for postoperative pain after chemo-mechanical preparation. Then pain was recorded postoperatively (after 6, 12, 24, 48, 72 hours 7 days after chemo-mechanical preparation) The 6-hour postoperative interval was chosen to provide sufficient time for the anesthetic effect to disappear. However, 12 and 24 hours were chosen as studies showed that most of the postoperative pain occurred on the first day after chemo-mechanical preparation[26] **Damyanov et al [27],.** found that most of the postoperative pain occurs after chemo-mechanical preparation between (24 and 48 hours)interval. On the other hand **Singh and, Garg et al[28],**found that some patients may experience pain till 7 days after chemomechanical preparation, therefore pain was recorded 7 days after chemo-mechanical preparation.()

The VAS scale with values between 0 and 10 was used for assessing the postoperative pain [29]. This scale can be easily understood by the patient and, if used appropriately, it provides simple, reliable and valid results by allowing a broader range of responses compared to other scales [30].

The mean scores of post-operative pain intensity were higher in the control group (Navitip with side vented needle) than in the intervention groups (Ultra X and manual dynamic agitation) at 6,12 and 24 follow-up periods. On the other hand, at 48, 72 hours and 7 days post-operative,there was no statistically significant difference in pain among tested groups.

The postoperative pain scores after chemo-mechanical preparation were significantly higher among patients in the side vented needle group than those in the passive ultrasonic group at 6 and 24 hour time intervals. This might be because of the positive pressure exerted by the needle that leads to greater hydraulic pressure which may result in postoperative pain. This in accordance to systematic review published by **Romualdo *et al.,*** [31] they reported that the irrigation method using apical negative pressure prevents the apical extrusion of the irrigant compared with methods using positive pressure manual dynamic agitation and needle. **Shetty *et al.,*** [32] stated that positive pressure of conventional irrigation extrude greater weight of debris apically. Further the inability to completely reach the full working length can leave behind vital pulp remnants and microbes that could contribute to the reported postoperative pain.

The intensity of post-instrumentation pain significantly decreased at different time intervals within each group compared to preoperative. The mean pain scores decreased significantly to reach the lower value at 7 days. This might be due to induction or exacerbation of the inflammatory response in the periapical tissues triggered by endodontic therapy. Exudative process begins within 6 hours, where polymorphonuclear leukocytes (PMNs) begin to enter the injured site and increases steadily, peaking at about 24 to 48 hours after the injury increasing the release of inflammatory mediators and neuropeptides. Then, the proliferative process begins after 48 to 96 hours, which is characterized by declining the PMN population, and beginning of macrophages to enter the wound site [33,34]

The secondary outcome was to assess the number of patients taking the analgesic. The frequency of analgesics taken by patients decreased by the time in each tested group. The highest mean value was recorded at 6 hours for all groups, while no pain after 24 hours in Navi tip group, 48 hour in MDA and 12 hour in Ultra-x group. There was no statistically significant difference between the three tested groups regarding the incidence of analgesic intake (P= 0.381).

This is in accordance with the results of **Middha *et al.*** [35] where there was no significant difference in analgesic consumption between US and SVN groups.

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5. CONCLUSION

Machine-assisted irrigation agitation devices are considered a reliable safe to clinicians and effective method as a final step irrigation protocol with successful management of post-operative pain of root canal treatment in retreatment mandibular first molar and analgesic intake was not prerequisites when Machine-assisted agitation irrigation was used as a final step irrigation protocol for endodontic in retreatment of mandibular first molar.

6. REFERENCES

1. **Kherlakian D, Cunha RS, Ehrhardt IC, Zuolo ML, Kishen A, Da 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(2):171-176.
2. **Salehrabi R and Rotstein I.** Endodontic treatment outcomes in a large patient population in the USA: an epidemiological study. *JEndod*. 2004;30(12):846-850.
3. **Caˇputa˘PE, Retsas A, Kuijk L, Chávez de Paz LE, Boutsioukis C.** Ultrasonic Irrigant Activation during Root Canal Treatment: A Sysematic Review. *J Endod*.2019; 45(1):31-44.
4. **Decurcio DA, Rossi-Fedele G, Estrela C, Pulikkotil SJ, Nagendrababu V.** Machine-assisted Agitation Reduces Postoperative Pain during Root Canal Treatment: A Systematic Review and Meta-analysis from Randomized Clinical Trials. *J Endod*. 2019;45(4):387-393.
5. **6. Siqueira JF Jr and Rôças IN.** Clinical implications and microbiology of bacterial persistence after treatment procedures. *JEndod*. 2008; 34(11):1291-1301.
6. **Galler KM, Grubmüller V and Schlichting R.** Penetration depth of irrigants into root dentine after sonic, ultrasonic and photoacoustic activation. *Int Endod J*. 2019;52(8):1210-1217.
7. **Zmener O, Pameijer CH, Serrano SA, Palo RM and Iglesias EF.**
8. Efficacy of the NaviTip FX irrigation needle in removing post instrumentation canal smear layer and debris in curved root canals. *J Endod*. 2009;35(9):1270-1273.
9. **Ramamoorthi S, Nivedhitha MS, Divyanand MJ:** Comparative evaluation of postoperative pain after using endodontic needle and EndoActivator during root canal irrigation: A randomised controlled trial J Endod.2015;41(2):78-87.
10. **Middha M, Sangwan P, Tewari S, Duhan J:** Effect of continuous ultrasonic irrigation on postoperative pain in mandibular molars with nonvital pulps: a randomized clinical trial. *Int Endod J 2017*.;50(6):522-30.
11. **Salehrabi R and Rotstein I.** Endodontic treatment outcomes in a large patient population in the USA: an epidemiological study. *JEndod*. 2004;30(12):846-850.
12. **12. Louis Berman and Kenneth Hargreaves.** Cohen's pathways of the pulp 11th edition.
13. **Ali, S. G., Mulay, S., Palekar, A., Sejpal, D., Joshi, A., & Gufran, H:** Prevalence of and factors affecting post-obturation pain following single visit root canal treatment in Indian population: A prospective, randomized clinical trial., *Contemp Clin Dent* 2017; *3*:459-63.
14. **Segura-Egea, J.J., Cisneros-Cabello, R., Llamas-Carreras, J.M., & Velasco-Ortega, E:** Pain associated with root canal treatment., *Int Endod J*. 2011; 42: 614–620.
15. **Sood R, Hans MK, Shetty S.** Comparison of anesthetic efficacy of 4% articaine with 1:100,000 epinephrine and 2% lidocaine with 1:80,000 epinephrine for inferior alveolar nerve block in patients with irreversible pulpitis. *J Clin Exp Dent 2014*.;6(5):520-3.
16. **Visconti, R. P., Tortamano, I. P., & Buscariolo, I. A.** Comparison of the Anesthetic Efficacy ofMepivacaine and Lidocaine in Patients with Irreversible Pulpitis: A Double-blind Randomized Clinical Trial. *J Endod.2016*:42(9), 1314–49.
17. **Santos-Junior AO, De Castro Pinto L, Mateo-Castillo JF, Pinheiro CR.** Success, or failure of endodontic treatments: A retrospective study. *J Conserv Dent*. 2019;22(2):129-132.
18. **Del Fabbro M, Corbella S, Sequeira-Byron P, et al.** Endodontic procedures for retreatment of periapical lesions. *Cochrane Database Syst.*10(10):CD005511.2016.
19. **Watkins CA, Logan HL, Lester Kirchner H.** Anticipated and experienced pain associated with endodontic therapy. J Am Dent. Assoc.2002; 133:45–54.
20. **Ali, S. G., Mulay, S., Palekar, A., Sejpal, D., Joshi, A., & Gufran, H:** Prevalence of and factors affecting post-obturation pain following single visit root canal treatment in Indian population: A prospective, randomized clinical trial., *Contemp Clin Dent.2012*; *3*:459-63.
21. **Segura-Egea, J.J., Cisneros-Cabello, R., Llamas-Carreras, J.M., & Velasco-Ortega, E:** Pain associated with root canal treatment., *IntEndod J*.2011; 42: 614–20.
22. **Saha S, Jain S, Dubey S, Kala S, Misuriya A, Kataria D:** Effect of oral premedication on the efficacy of inferior alveolar nerve block in patients with symptomatic irreversible pulpitis: A prospective, double-blind, randomized controlled clinical trial. J Clin Diagn Res.2016; 10:25-29.
23. **Aggarwal V, Singla M, Kabi D:** Comparative Evaluation of Effect of preoperative oral medication of ibuprofen and ketorolac on anesthetic efficacy of inferior alveolar nerve block with lidocaine in patients with irreversible pulpitis: A prospective, double-blind, randomized clinical trial. J Endod.2010; 36:375-78.
24. Tarale K. Post-operative pain analysis between single vis- it and two visit root canal treatments using visual analogue scale: an in vivo study. Journal of Dental & AlliedSciences.2013;2(1):8–15.
25. **Prashanth MB, Tavane PN, Abraham S, Chacko L**. Comparative evaluation of pain, tenderness and swelling followed by radio- graphic evaluation of periapical changes at various intervals of time following single and multiple visit endodontic therapy: an in vivo study. J Contemp Dent Pract.2013;12(3):187–91.
26. **Ince B, Ercan E, Dalli M, Dulgergil CT, Zorba YO, Colak H:** Incidence of postoperative pain after single- and multi-visit endodontic treatment in teeth with vital and non-vital pulp. *Eur J Dent.2010*; 3(4):273-9.
27. **Damyanov ND, Witter DJ, Bronkhorst EM, Creugers NHJ:** Dental status and associated factors in a dentate adult population in Bulgaria: A cross-sectional survey. *Int J Dent*.2012;74(8):17-31.
28. **Singh S, Garg A:** Incidence of post-operative pain after single visit and multiple visit root canal treatment: A randomized controlled trial. *J Conserv Dent*.2012; 15(4):323-.
29. **Camargo EJ, Duarte MAH, Marques VAS, Só MVR, Duque JA, Alcalde MP, Vivan RR.** The ability of three nickel-titanium mechanized systems to negotiate and shape MB2 canals in extracted maxillary first molars: a micro- computed tomographic study. *Int Endod J.2019*; 52(6):847-56.
30. **Nagendrababu V, Duncan HF, Bjørndal L, Kvist T, Priya E, Jayaraman J, Pulikkotil SJ, Dummer PMH.** PRIRATE 2020 guidelines for reporting randomized trials in Endodontics: explanation and elaboration. *Int Endod J.2020*;53(6):774-803.
31. **Topçuoğlu, H. S., Topçuoğlu, G. & Arslan, H:** The Effect of Different Irrigation Agitation Techniques on Postoperative Pain in Mandibular Molar Teeth with Symptomatic Irreversible Pulpitis: A Randomized Clinical Trial. *J. Endod*.2018; 44, 1451-6.

32. **Romualdo PC, de Oliveira KMH, Nemezio MA, Küchler EC, Silva RAB, Nelson-Filho P, Silva LAB:** Does apical negative pressure prevent the apical extrusion of debris and irrigant compared with conventional irrigation? A systematic review and meta-analysis. *Aust Endod J.2017*; 43(3):129-137.

33. **Mythri H.** Oil pulling: A traditional method on the edge of evidence. *Dent. Hypotheses*.2017;8(3):57-60.

34. **Leoni GB, Versiani MA, Silva-Sousa YT, Bruniera JF, Pecora JD, Sousa-Neto MD.** Ex vivo evaluation of four final irrigation protocols on the removal of hard-tissue debris from the mesial root canal system of mandibular first molars. *Int. Endod J, 2017.*; 50(4):398-406.

35. **Middha M, Sangwan P, Tewari S, Duhan J:** Effect of continuous ultrasonic irrigation on postoperative pain in mandibular molars with nonvital pulps: a randomized clinical trial. *Int Endod J.*2017'50(6):522-30.

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