

Incidence of Post Endodontic Pain in Mandibular Molars after Using 3 Different Rotary Instruments in Single Visit Root Canal Treatment: A Randomized Clinical Trial

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ABSTRACT

Background: The aim of the present study was to compare the effect of three different rotary instruments on postoperative pain in teeth with asymptomatic irreversible pulpitis.

Methods and Materials: A total of 300 mandibular first and second molars were divided into three groups (n=100), and their root canal preparation was carried out with ProTaper Universal, Protaper Next, Hyflex CM rotary instruments. All the subjects underwent one-visit root canal treatment, and the severity of postoperative pain was evaluated using a visual analog scale (VAS) at 4-, 12-, 24-, 48- and 72-h and 1-week intervals. Data were analyzed with the repeated-measures

Results: Comparison of mean pain severity between the groups at various postoperative intervals reveal any significant differences (P=0.10).

Conclusion: Highest Intensity of pain was observed six h after the treatment, after which the Intensity of pain decreased in the groups. Postoperative pain was significantly higher in patients undergoing root canal instrumentation with the PTU rotary instruments than PTN and HyflexCM file systems at the end of 24 and 48.

Keywords: Irreversible Pulpitis; Flare-Up; Postoperative Pain; ProTaper; ProTaper Next; Hyflex-CM; Root Canal Treatment.

INTRODUCTION

In today's world, everyone is in a hurry, so not only patient endodontist also wants to complete root canal treatment in a single visit. But it is frustrating to the endodontist when an asymptomatic, endodontically treated tooth becomes symptomatic shortly after the single-visit treatment. Amongst the various complications reported for single visit

endodontics, the incidence of post endodontic pain (PEP) is the most common. (1)

However, in many studies, it is established that the incidence of post endodontic pain may vary due to variation of study design, type of instrument used, and experience of the operator. (2) Meanwhile, post

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endodontic pain is reported by 25%-40% of patients irrespective of pulp and periradicular status [3]. However, the prevalence of postoperative pain in the first 24 hours is 40%, falling down to 11% in 7 days. (4)

Multiple risk factors, including pain due to over or under instrumentation, apical extrusion of infected dentin debris, irrigant, hyper occlusion, missed canal, and persistent periapical pathosis with preoperative pain have been studied to elucidate which factors could be correlated with the occurrence of postoperative pain (5)

Several factors affect the extrusion of debris, including the irrigation protocol, the final apical size, the time spent on root canal instrumentation and the technique employed for it and the instrument design (6). It is possible that certain factors can be controlled by the operators, such as selection of endodontic file systems and technique of root canal preparation, but the virulence of the microorganisms extruded beyond the apex is almost impossible to control. (7)

This extrusion is an undesired consequence of the mechanical instrumentation of the root canal, and none of the available instrumentation systems can avoid apical debris extrusion. Thus, methods to minimize this phenomenon are continuously investigated (8).

A convex triangular cross-sectional design with three cutting edges, a negative cutting angle, and a fluted design that combines progressive tapers within the shaft is observed in ProTaper instruments (Dentsply Maillefer, Ballaigues, Switzerland). (9)

ProTaper Next (Dentsply Maillefer, Ballaigues, Switzerland) is an innovative NiTi file system. An off-centred rectangular design and progressive and regressive percentage taper on a single file are seen in ProTaper Next. Having various percentage tapers decreases the effect of the screwing in and dangerous taper lock by minimizing the contact between the file and the dentin. (10)

The HyFlex CM multiple-file system (ColteneWhaledent, Cuyahoga Falls, OH, USA) was developed for use in continuous rotation and is composed of a modified NiTi alloy (52 Ni wt% versus 54.5–57 Ni wt% in conventional NiTi alloys).

This alloy undergoes Controlled Memory (CM) thermomechanical surface treatment, which increases the fatigue resistance by 150% and 390% compared with M-Wire and non-surface-treated conventional NiTi alloy, respectively (11).

AIMS AND OBJECTIVE

Since there are very few clinical trials available to compare postoperative pain after the endodontic treatment using ProTaper universal, Pro taper Next, and HyflexCM rotary instruments, the present study was undertaken to compare the severity of postoperative pain after endodontic treatment of the first and second mandibular molars with asymptomatic irreversible pulpitis using these common systems.

MATERIAL AND METHOD

Data was collected from 300 patients who had received endodontic treatment in mandibular molars over a 24- month period in the Department of Conservative and Endodontics in Haldia Institute of Dental Science and Research, West Bengal, by the same different operator. Informed consent was taken from all the participants, and approval from the institutional ethical committee was taken. Information was obtained for each patient treated, including pulp and peri-radicular diagnosis for the tooth, presence of pre-operative pain, type of medication being used, type of instrumentation technique used and a number of appointments needed to complete the root canal treatment.

Inclusion criteria included patients aged between 18 to 60 years, the average age of 32 years, a mandibular molar with

- fully formed roots,
- Canal curvature less than 30 degrees,
- non-calcified canals,
- normal pulp for intentional endodontic treatment,
- irreversible pulpitis,
- apical periodontitis with and without any periapical lesion.

Exclusion criteria included

- retreatment cases
- acute pain with swelling,
- teeth with mobility,

- pregnant patients.
- Apical root resorption
- Sub alveolar caries extension.

Table 1: Showing the difference in the number of patients experiencing pain between the groups.

Name of Group		Treatment Carried Out		Number of patients	
Group 1		Protaper universal		100	
Group 2		Protaper next		100	
Group 3		High flex cm		100	
Table 1					
INCIDENCE OF PAIN		Group 1		Group 2	
Yes		40		27	
No		60		73	
				P<0.5	
Duration & Stage of pain-Table 1A					
Duration		Group 1		Group 2	
Less than 3 hrs		5		4	
3-24 hrs		15		12	
24-48 hrs		20		16	
48hrs-7 days		8		5	
Intensity of Pain-					
Mild (Table A)		Less than 3 hrs		3-24 hrs	
Group 1		3		6	
Group 2		3		5	
Group 3		2		4	
Moderate(Table B)		Less than 3 hrs		3-24 hrs	
Group 1		5		8	
Group 2		6		4	
Group 3		4		6	
Severe(Table C)		Less than 3 hrs		3-24 hrs	
Group 1		0		1	
Group 2		0		0	
Group 3		0		1	
Nature of Pain – Continuous / Intermittent					
Continuous: Table D		Less than 3 hrs		3-24 hrs	
Group 1		6		17	
Group 2		7		10	
Group 3		7		9	
Intermittent: Table E		Less than 3 hrs		3-24 hrs	
Group 1		2		21	
Group 2		0		7	
Group 3		0		8	
Nature of Pain – Dull/Boring or Sharp/Shooting					
Dull/Boring-Table-F		Less than 3 hrs		3-24 hrs	
Group 1		0		6	
Group 2		0		3	
Group 3		0		2	
Sharp/Shooting;Table:G		Less than 3 hrs		3-24 hrs	

Group 1	1	0	0	1
Group 2	0	0	1	0
Group 3	0	1	0	0
Nature of Pain- Localized / Diffuse				
Localized :Table -H	Less than 3 hrs	3-24 hrs	24-48 hrs	48hrs-7 days
Group 1	0	21	13	10
Group 2	0	15	10	19
Group 3	0	10	6	13
Diffuse :Table-I	Less than 3 hrs	3-24 hrs	24-48 hrs	48hrs-7 days
Group 1	0	1	2	1
Group 2	0	1	1	0
Group 3	0	0	1	0
Nature of Pain – Spontaneous / Precipitated				
Spontaneous: Table-J	Less than 3 hrs	3-24 hrs	24-48 hrs	48hrs-7 days
Group 1	0	2	3	6
Group 2	0	1	2	3
Group 3	0	1	1	2
Precipitated : Table-K	Less than 3 hrs	3-24 hrs	24-48 hrs	48hrs-7 days
Group 1	0	7	10	4
Group 2	0	4	8	2
Group 3	0	2	4	1

Table 2: Statistical significance of observed pain using single tailed t-test.

Criteria	Group1 > Group2 (p-value)	Group2 > Group3 (p-value)	Group1 > Group3 (p-value)
Duration & Stage of pain	0.01	0.01	0.01
Intensity of Pain(mild)	0.03	0.01	0.01
Intensity of Pain (moderate)	0.08	0.50	0.02
Intensity of Pain(severe)	0.50	0.50	NA
Nature of Pain – Continuous	0.14	0.20	0.14
Nature of pain -Intermittent	0.17	0.32	0.13
Nature of Pain – Dull/Boring	0.05	0.04	0.04
Nature of Pain-Sharp/Shooting	0.32	0.50	0.32
Nature of Pain- Localized	0.50	0.03	0.16
Nature of Pain- Diffused	0.09	0.02	0.03
Nature of Pain -Spontaneous	0.07	0.09	0.07
Nature of Pain – Precipitated	0.03	0.07	0.04

According to study criteria, 300 patients with asymptomatic apical periodontitis in mandibular molar teeth or were selected. For each instrument group, 100 patients were randomly selected regarding age, sex equally across three groups (n=100).

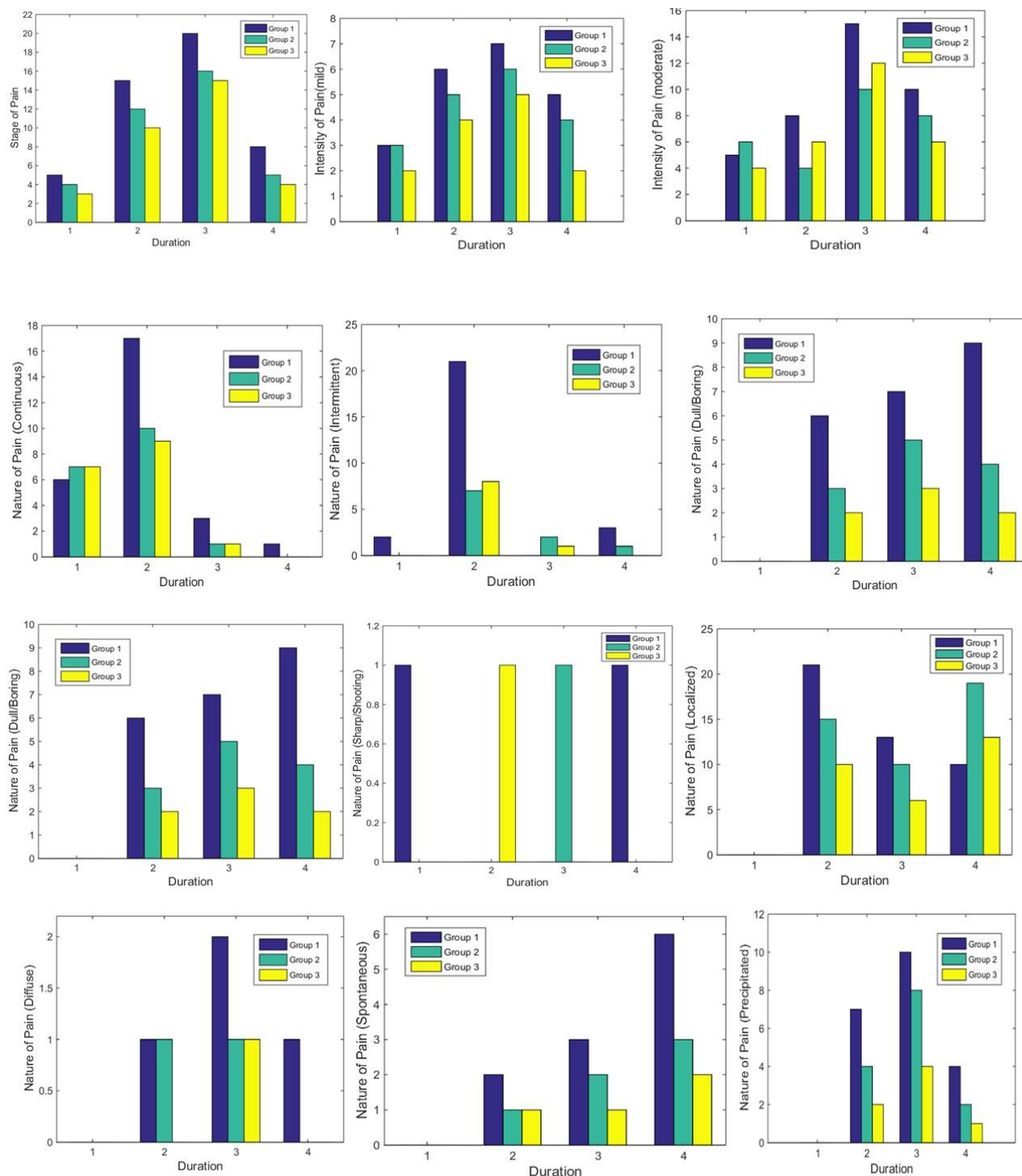
Under rubber dam isolation, after profound anaesthesia, conventional straight-line access

preparations were made, and working length was established using #10 stainless file and apex locator (Canal-Pro, Coltene Whaledent, Cuyahoga Falls, OH, USA), confirmed by radiograph.

Endodontic working lengths were determined by deducting 1 mm from these lengths. Before instrumentation, the glide path was created in all the of every group. In the cases treated with rotary

files, Protaper [Dentsply Maillefer, Ballaigues, Switzerland] rotary files were used in crown-down instrumentation technique till F3 in distal canals

and till F2 in mesiobuccal (MB) and mesio-lingual (ML) canals lower molars and till F4 for distal canals in some cases.



For proper next X2(25/06) for MB and ML, for distal canals X3 (30/07)-X4 (40/60) some cases.

For Hyflex CM (25/04) for MB and ML, for distal canals (30/04)-(40/04) some cases.

Irrigation was performed with 2.5% NaOCl, 17% ethylenediaminetetraacetic acid, and 0.9% normal saline according to the protocol suggested by Schafer et al. (23). Obturation was done with single cone gutta parcha(GP) for each group of an instrument using AH plus sealer. Accessory GP was

given (if required) using cold lateral compaction. No apical extrusion of G P or sealer was observed in any of the cases. (confirmed by post obturation radiograph)

The same irrigation protocol was followed for all the groups to minimize the confounding factors. For all patients, post endodontic restoration was carried out with composite in the same appointment. Three hours after the anaesthesia wore off, each patient was given a feedback form to fill. Patients were recalled to the clinic, examined and given a feedback form to fill at the expiry of 24 hours, 48 hours and seven days. If any patient had moderate pain, Ibuprofen 600 mg at 12 hours was advised. If the pain was severe in nature, the patient was asked to take medicine eight hourly. In the questionnaire, questions pertaining to the presence or absence of pain, time duration, Intensity and nature of pain were enquired. One of the faculties explained and helped the patients in filling up the questionnaire. PEP was evaluated at the following stages – within 3 hrs, between 3- 24 hrs, 24- 48 hrs, and 48 hrs- 7 days of wearing off of the local anaesthesia. Modified Visual Analogue Scale (VAS) was used for categorization of pain by the patient and filling up of the questionnaire. The VAS consisted of a line of 10 cm length anchored by two extremes with 0 cm signifying no pain and 10 cm representing the worst pain imaginable. Intensity and level of pain were defined as following – No pain - 0 Mild pain - that could be ignored. (1-3) Moderate pain – interferes with tasks and concentration. (4-7) Severe pain – interferes with basic needs and concentration. (8-10) Nature of pain was classified as – Continuous or Intermittent, Dull & Boring or Sharp & Shooting, Localized or Diffuse, Spontaneous or Precipitated by trigger factors.

Results of the incidence, duration, Intensity and nature of pain were compared between the experimental groups and were analysed with a Single tail t-test using Matlab software and a level of significance ($p < 0.05$) was found.

RESULTS

In our experiment, we used 100 patients/samples corresponding to each of the three devices to evaluate their efficacy. For the patients treated with Protaper universal device (Group 1), we observed 40 patients (see Table 2) experienced pain at

various phases of the recovery period after the treatment. As the total number of patients for a particular group is 100, so it can be said that the probability of pain and no-pain with the Group 1 is 0.40 (40/100) and 0.60 (60/100), respectively. Similarly, for the other two groups (i.e., Group 2 & Group 3), the corresponding probabilities of pain and no pain are 0.27 & 0.73, and 0.30 & 0.70, respectively. To measure/quantify the success of a treatment method in terms of less suffering (i.e., pain), we can compute entropy using Eq. 1.

$$H = - \sum_{i=1}^n p_i \log(p_i)$$

In this equation, $n=2$ as we have to incidences (i.e., pain and no-pain). The variable p_1 ($p_i|i=1$) refers to the probability of occurrence of pain, and p_2 ($p_i|i=2$) indicates the probability of the opposite condition. We obtained Entropy values corresponding to Group 1, Group 2 and Group 3 are 0.97, 0.84 and 0.88. Hence, it can be said that the most painless treatment is availed by the patients of the second group (i.e., with Protaper next device), where the achieved painlessness with the third group of patients (i.e., treated by High flex cm) is almost the same with that of the previous one. This slight fluctuation mainly occurs due to the variable pain sensitivities of different individuals. However, we observed that the patients treated using Protaper universal device (Group 1) provides a high entropy value (0.97) which is almost 1. It indicates the occurrence of after-treatment pain with this device is almost random.

In Table 2, Group1 > Group2 indicates that the patients belonging to Group 1 experience more pain than the other group. Here the null hypothesis is both these two groups experience the same pain. Using the single-tailed t-test, we rejected the null hypothesis with a p value of 0.01, which gives us 99.99% confidence to say that the patients in Group 2 will experience less pain than Group 1. Similar explanations are also applicable for the other tests. Note that in the case of moderate pain (row 3, Table 2), the p-value to reject the null hypothesis (i.e., assuming Group2 and Group3 patients experience the same Intensity of pain) is 0.50. This reflects that we can claim with 50% confidence (i.e., random) that the Group2 patients experience more pain than that of Group 3. We cannot reject the null

hypothesis, and hence, there is no significant difference of the patients in these two cases

The duration of pain was longest in the PTU Group, with more patients experiencing pain, whereas the duration of pain was least in the Hyflex-CM group. The difference in the number of patients experiencing pain between the groups was statistically significant between 48 hrs- 7 days. [Table -A, B, C] Across the groups, maximum patients experienced mild pain. ($p < 0.1$) Between 3- 24 hrs, more subjects in the PTU group ($n=100$) experienced pain, whereas, between 48 hrs- 7 days, more subjects in the PTN group (group2) ($n=100$) experienced mild pain, which was found to be statistically significant. [Table 1A] Most of the subjects experienced Continuous type of pain, which was found to occur more in PTU group-1 between 3- 24 hrs, whereas its occurrence was more between 48 hrs – 7 days in PTN group 2 and these were found to be statistically significant. Intermittent type of pain was found to be significantly higher in PTU group between 48 hrs – 7 days. [Table-E] Dull & boring type of pain was not found to occur significantly different than Sharp & shooting pain. [Table-F, Table-G] No statistically significant difference was found between Localized and Diffuse pain over different time periods. [Table -H, Table-I] Spontaneous pain was found to occur to a statistically significant level between the groups at 3- 24hrs time period and was highest in the PTU group

DISCUSSION

Pain after endodontic treatment is an unexpected phenomenon. Studies had reported that the incidence of postoperative pain ranges from 1.4% to 16% (12). During instrumentation or irrigation, the periapical tissue may get irritated, which releases multiple pain-producing mediators like neuropeptides, arachidonic acid metabolites, cytokines, lysosomal enzymes, platelet-activating factors, fibrinolytic peptides, vasoactive amines, anaphylatoxins and kinins (13). So the amount of apical debris extrusion should be kept minimum to avoid postoperative pain.

Most of the NiTi instruments used in the crown down technique enlarges the coronal third of the root canal to provide a passageway for debris to escape (due to Archimedes' screw effect), which

reduces the apical extrusion of debris (14). So in the present study, NiTi instruments and CrownDown technique was used. In addition, the type of irrigation, volume of irrigation and technique in three groups were kept the same to reduce the confounding variables during the chemo-mechanical preparation except for the instrument design.

From the clinical point of view, factors influencing postoperative pain include – occlusal contacts, presence of preoperative pain, presence of radiolucency, type of teeth, previous emergency treatment. (14.) Numerous studies concluded that the Intensity of pain depends upon the – position of tooth and age of the patient, while duration depends on – age, gender and periapical radiolucency. (14)

In our study, there were numerous variables that could not be controlled in differentiating the patients into different groups. So patients were divided randomly assigned to three groups without any differentiation on the basis of age or gender. Four factors were kept constant – (i) absence of symptoms pre-operatively, (ii) treatment was carried out by a single operator, using the same method but different techniques. (iii) Mandibular posterior teeth were selected as post endodontic pain is significantly higher in these teeth.

(iv) 400-mg ibuprofen is given in case of pain perception since ibuprofen has dose-dependent activity and its analgesic effect completely disappears after eighth (15)

Thus all variables related to technique and operator were controlled. The relationship between obturation level and postoperative pain incidence was found to be 14%, 53% and 60% in patients with under-filling, flush filling and overfilling, respectively. (16) Cold lateral condensation technique was used in our study as it produces minimum postoperative pain other than thermal obturation methods.

The design of the questionnaire for pain assessment must be fully understood by the patients, statisticians and researchers. (17) In the current study, Modified VAS was considered as a valid and reliable scale for the evaluation of pain perception. According to the Cochrane database of systematic reviews for post endodontic pain, it is suggested

that the level of discomfort/pain must be rated in categories arranged in advanced order and exactly described with the use of analgesics. Thus, making it an accurate criteria for quantifying pain. (18)

The duration of pain was longest, in more patients treated Protaper universal (PTU) intermediate with Protaper Next (PTN) least in patients treated with Hiflex CM instrument. However, the difference was statistically nonsignificant, at different time intervals, except between 48 hours- 7 days.

In multiple in vitro studies have found that PTU extruded more debris apically as compared to PTN. (19) The design of the PTN file system boasts of an off-centred rectangular cross-section resulting in only two-point contact to the root canal wall at a time. The axis of rotation in the PTN system differs from the centre of mass. The offset design of the PTN system, along with its swaggering motion in the canal, could have enhanced the augering of debris out of the canal coronally rather in the apical direction. (20) Thus, causing lesser postoperative pain.

HCM file facilitates penetration into the canal and presents a root canal shape corresponding with the original anatomy. The cross-section is almost triangular at the top, trapezoidal at the middle, quadratic at the tip. It works with the continuation motion, which improves coronal transportation of dentin debris by acting like a screw conveyor (21), which is inconsistent with our and with the other studies too.

Instrumentation with the HyFlex CM system, the spirals unwound in 95% of the instruments (114/120 uses). Capar et al. (2014) (22) found that 80% of instruments were distorted. The lower extrusion rate in the HCM group could be related to this design modification, which could reduce the cutting efficiency and the amount of collected debris.

Mild and continuous pain was experienced by a maximum number of patients. With PTU and PTN instrumentation, it was present in more patients during the 3 to 24 hours period, whereas with Hiflex instruments, it was more during 48 hours to 7 days period. Findings in our study could be probably due to higher debris load with PTU instrumentation with faster resolution of

inflammation, whereas with PTN and Hyflex instrumentation, a lower load of debris might have caused delayed inflammatory response. Intermittent pain was experienced more with PTU instrumentation during the 48 hours to 7 days period, probably because of persistent debris. Incidence of dull and boring pain was not different statistically than the sharp and shooting pain, signifying that the biologic response of the periradicular tissues to different instrumentation techniques is not widely different. The difference in incidence between localized and diffuse pain was also not significant, indicating that periradicular inflammation could lead to either type of pain. Amongst spontaneous and precipitated pain, the former occurred to a significantly higher level across the treatment protocols in between 3 to 24 hour periods. This indicated that periapical inflammation due to debris dispersal after endodontic treatment is highest within the first 24 hours.

CONCLUSION

Within the limitations of this study, the following conclusions were drawn: Highest Intensity of pain was observed at six h after the treatment, after which the Intensity of pain decreased in the groups, Postoperative pain was significantly higher in patients undergoing root canal instrumentation with the PTU rotary instruments than PTN and HyflexCM file system at the end of 24 and 48.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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