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Original Research Article

Incidence of post endodontic pain after single visit root canal treatment with manual, rotary and rotary instruments with ultrasonic cleaning: a comparative study

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Abstract: Amongst the various complications reported for single visit endodontics, incidence of post endodontic pain (PEP) is the most common. To evaluate and compare the incidence, duration, intensity and nature of post endodontic pain (PEP) in single visit endodontic treatment, following biomechanical preparation (BMP), using K files with Step Back Technique, Protaper Next with Crown down Technique and Passive Ultrasonic Instrumentation (PUI) along with Protaper Next. 75 patients, with asymptomatic irreversible pulpitis in Maxillary anterior teeth were selected and treated with single sitting root canal treatment, by a single operator. Patients were randomly divided into 3 groups, Control (K files using step back technique), Experimental 1 (Protaper Next using crown down technique) and Experimental 2 (Protaper Next along with PUI). Patients were recalled, examined and asked to fill up questionnaire after 3hrs, 24 hrs, 48 hrs and 7 days of wearing-off of anaesthesia. On the basis of response given in the feedback forms, PEP was evaluated for incidence, duration, intensity and nature. Statistical analysis of the data was carried out using Chi square test and level of significance ($p < 0.05$) was evaluated. Incidence of PEP was identical in the two experimental groups, which was lower than the control group. Statistically, difference in the incidence of pain, amongst the three groups was found to be non-significant. The duration of pain was longest in Control group, with more patients, experiencing pain, whereas it was least in Experimental group 2. Across the groups, maximum patients experienced mild, continuous pain. Majority of patients experience PEP that is mild, continuous, localised and precipitated by trigger factors. It lasts longer, with hand instruments.

Keywords: Post Endodontic Pain (PEP), Passive Ultrasonic Instrumentation (PUI), Protaper Next, Step Back Technique, Crown Down Technique, K files.

INTRODUCTION

As a natural mode of progression, endodontic treatment is of late gradually shifting from multiple visits to a single visit procedure. This suits the time constraint, patients experience in the current economic and working environment. Amongst the various complications reported for single visit endodontics, incidence of post endodontic pain (PEP) is the most common [1]. It has been reported [2, 3] and reviewed [4, 5] in a number of studies. The prevalence of pain in various reports is also variable, which is reflective of the variations in the study method, treatment procedure, case selection and experience of the operator [1, 6]. In the contemporary endodontic practise, rotary instrumentation with Crown down technique is preferred over manual instrumentation with Step back technique. The advocated advantages being time efficient [7] more flexible [8] less possibility of instrument fracture, [8] more removal of pulp tissue and debris [8], less extrusion of debris [9], ability to instrument curved canals, [8] increased cutting efficiency [9], create centred preparation [9] and decreased canal transportation [9].

During the endodontic treatment, debris comprising of necrotic tissue and/or bacteria and their products are commonly pushed into the periapical area. This leads to inflammation or exacerbation of previously present inflammation, resulting in PEP. [10] To prevent the latter different biomechanical preparation techniques and endodontic file systems have been advocated to display superiority over the others. [11] Earlier multiple sittings were advised to rid the periapical region of inflammation and resultant pain.

With the realization that single visit treatment could achieve similar results, crown down technique and numerous rotary endodontic file systems have been introduced.

The usage of rotary files in crown down technique is gradually gaining increasing popularity over the manual K files in step back technique. The former offers advantages in the form of saving time and leading to less apical extrusion of debris. [9] Protaper Next is one of the more recent additions to the plethora of rotary instruments, which amongst other professed advantages, reduces the apical extrusion of debris. Based on M-wire alloy, it claims up to 400% reduced cyclic fatigue than the original NiTi instruments [12].

Of late the general opinion is moving towards use of Passive Ultrasonic Instrumentation (PUI) after completion of biomechanical preparation, which leads to reduced debris load in the root canal, [13, 14] thereby reducing the possibility of PEP. Some PEP studies have not use NiTi instruments. [15, 16] The available studies for assessment of incidence of post endodontic pain using NiTi instruments and PUI are very few. A few studies have assessed incidence of pain after root canal preparation with different irrigation systems. [17, 18] Literature on studies which delineate the incidence, duration, intensity and nature of PEP arising due to biomechanical preparation with rotary files with or without PUI is limited. To assess these parameters, this study was conducted.

MATERIAL AND METHODS

This clinical study was carried out in the Department of Conservative Dentistry & Endodontics in collaboration with Department of Pedodontics, at Rungta College of Dental Sciences & Research, Bhilai, India. The approval of the study was taken from the institutional ethical committee.A total of 75 patients were selected and treated in this study, which was carried out over a period of nearly one year. Maxillary anterior teeth were treated with single sitting root canal treatment, by a single operator. All patients were informed of the aims and design of the study and written consent was obtained.Inclusion criteria for the selected patients were – (i) Maxillary permanent anterior teeth with asymptomatic irreversible pulpitis (ii) Teeth with well formed root apex (iii) Patient without history of pain or medication in the last 5 days (iv) Between 18 to 65 years of age. Exclusion criteria were – (i) Internal or External resorption (ii) Calcified canals (iii) Extreme root curvature (iv) Presence of pain or tenderness in the last 5 days (v) Patients on medication for pain or infection (vi) Pregnancy (vii) Uncontrolled diabetes (viii) Recent history of Myocardial Infarction (within last 6 months) (ix) Root fracture (x) Wide open apex (xi) Multiple root or canals (xii) Root canal retreatment (xiii) Failure to obtain authorization from patient.

The patients chosen for this study were diagnosed with asymptomatic irreversible pulpitis and normal periapical tissue. So that any pain or discomfort arising out of the procedure could be clearly attributed and delineated from the pre-operative condition. Teeth with apical periodontitis, necrotic teeth or retreatment cases were not taken up and a meticulous aseptic protocol was maintained, to reduce the risk of exacerbation by residential microorganisms or introduction of bacterial by-products. For diagnosis of pulpal status clinical history, clinical examination, electric pulp test and IOPA radiographs were evaluated. Patients with past history of pain or trauma in relation to the concerned tooth, deep carious lesion involving the pulp, absence of tenderness, electric pulp test eliciting delayed response and radiographically intact lamina dura, normal or slightly widened periodontal space and absence of periapical radiolucency were the selection criteria.

Patients were randomly divided into 3 groups of 25 patients each, without any discrimination of age, gender or teeth. (Table 1) Prior to start of the procedure, all patients were administered 1.8 ml of local anaesthesia [Lignocaine hydrochloride & adrenaline 1:80000; Xicaine, ICPA, India] through buccal infiltration, if any patient experienced pain during instrumentation, intra pulpal anaesthesia was administered. After 5 minutes, when the area was anesthetized, tooth to be treated was isolated with a rubber dam [Hygenic, U.S.A.] Access cavity was prepared with Endo Access bur [Dentsply International, York, PA, USA] and refined with Endo Z bur [Dentsply International, York, PA, USA] using a air-rotor handpiece [Kavo Dental, Germany] with air water spray.

Patency of the canal was checked with a no. 15 K-file [Dentsply Mallifer, Ballaigues, Switzerland]. Working length was also evaluated using the same file with a Root ZX Mini apex locator [J Morita Europe, Frankfurt, Germany] and was kept short of the apex by 1 mm. In teeth where the no. 15 K- file was loose, a no. 20 K-file was used instead. The working length obtained with the apex locator was confirmed by taking a digital radiograph. In case of a discrepancy between the radiographic and electronic measurements, the latter was selected.

In Group 1 or Control group biomechanical preparation (BMP) of the canal was carried out manually, using K files by Step Back Technique. Apical preparation was carried out till no. 50 and coronal preparation till no. 80. During the preparation, irrigation was carried out with 2.5% NaOCl solution [Novo Dental Products, Mumbai, India] using 27 gauge side vented needle [Omega Inc.] and as a final rinse after a penultimate rinse with 17% EDTA [Amdent, India]. Following the preparation, Obturation of the canal was carried out using no. 50 Gutta Percha (GP) cones as

Master Cone and AH plus sealer [Dentsply Maillefer] with lateral condensation technique. Lateral compaction of no. 15 G P cones [Dentsply Maillefer] with no. 20 finger spreaders [Dentsply Mallifer] was performed. No apical extrusion of G P or sealer was observed in any of the cases.

In Group 2 or Experimental group 1, canals were prepared with Protaper Next by Crown Down technique. During the biomechanical preparation canals were filled with Glyde. [Dentsply Mallifer] Preparation was started with X1, followed by X2, X3, X4 and X5 were sequentially used. If X1 was loose in the canal, preparation was started with X2. Apical preparation was carried out till X5 at 300 rpm and torque of 2.8 N/s, with X-Smart Endo-motor [Dentsply, USA]. Same irrigation protocol was followed as in Group 1. Obturation of the canal was carried out with X5 GP cones and AH plus sealer.

In Group 3 or Experimental Group 2, canals were prepared and obturated in the same manner as Experimental Group 1. The only difference was that after completing the biomechanical preparation, cleaning of the canal was carried out with NiTi Endo U-file no. 30 [Woodpecker, Guilin, China] in Endodontic attachment E1 with Ultrasonic Scaler [Woodpecker Model No. UDS-P, Guilin Woodpecker Medical Instrument Co. Ltd, Guilin, China]. The canal was kept filled with 2.5% NaOCl; ultrasonic file was kept short by 2 mm from the working length and free of the canal walls. The PUI was carried out for 1 minute [13, 18].

In order to keep the root canal preparation size similar, across the groups, BMP in control group was carried out till no. 50 in the apical portion and no. 80 in the coronal. In both the experimental groups, BMP was carried out till Protaper Next X 5 file, since this file has tip diameter of 50mm and 6% taper. The preparation with Protaper Next files was started with either X 1 or 2 and was ended with X 5. 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 7 days. If any patient had moderate pain, Ibuprofen 600 mg at 12 hours was advised. If the pain was severe in nature, patient was asked to take the medicine 8 hourly. In the questionnaire, questions, pertaining to 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 was 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.

1 out of the 25 patients, in the Experimental group 1, did not turn up after 24 hours. For evaluation and statistical analysis that patient was not considered, leaving behind only 24 patients in Experimental group 1. (Table 2)

Results of the incidence, duration, intensity and nature of pain were compared between the control and experimental groups and were analysed with Chi-square test using SSP 16.0 software and level of significance ($p < 0.05$) was found.

RESULTS

Across different groups, incidence of PEP was identical in the two experimental groups, which was lower than the control group. Statistically, difference in the incidence of pain, amongst the three groups was found to be non-significant. [Table 2]The duration of pain was longest in Control group, with more patients, experiencing pain, whereas duration of pain was least in Experimental group 2. The difference in number of patients experiencing pain between the groups was statistically significant between 48 hrs- 7 days. [Table 3]Across the groups, maximum patients experienced mild pain. Between 3- 24 hrs, more subjects in Control group (n=8) experienced pain, whereas between 48 hrs-7 days more subjects in Experimental group 1 (n=8) experienced mild pain, which was found to be statistically significant. [Table 4] Most of the subjects experienced Continuous type of pain, which was found to occur more in Control group between 3- 24 hrs, whereas its occurrence was more between 48 hrs – 7 days in Experimental group 1 and these were found to be statistically significant. Intermittent type of pain was found to be significantly higher in Control group between 48 hrs – 7 days. [Table 5(a)] Dull & boring type of pain was not found to occur significantly different than Sharp & shooting pain. [Table 5(b)] No statistically significant difference was found between Localized and Diffuse pain over different time periods. [Table 5(c)] Spontaneous pain was found to occur to a statistically significant level between the groups at 3- 24

hrs time period and was highest in Experimental group 1. [Table 5(d)]

Table-1: Group Distribution

Group No.	Name of Group	Treatment Carried Out	Biomechanical Technique Used
1	Control Group	Manual Instrumentation using K-files	Step Back Technique
2	Experiment Group 1	Rotary Instrumentation using Protaper Next	Crown Down Technique
3	Experimental Group 2	Rotary Instrumentation using Protaper Next and Passive Ultrasonic Cleaning	Crown Down Technique with Passive Ultrasonic Cleaning

Table-2: Incidence of Pain

INCIDENCE OF PAIN	**CONTROL GROUP**	**EXPERIMENTAL GROUP 1***	**EXPERIMENTAL GROUP 2**	**Chi square value**	**P value**
YES	13	11	11		
NO	12	13	14	0.35	P>0.05

*1 patient with No pain, from Experimental group 1 did not come after 24 hours

Table-3: Duration & Stage of pain

Duration	**Control group**	**Experimental group 1**	**Experimental group 2**	**Chi sq value P value**
Less than 3 hrs	-	2	5	CHI SQUARE=5.97 P=0.0502
3-24 hrs	10	7	5	CHI SQUARE=2.44 P=0.29
24-48 hrs	8	6	4	CHI SQUARE=1.75 P=0.41
48hrs-7 days	7	5	4	CHI SQUARE=6.21 P= 0.046 **SIGNIFICANT**

Table-4: Intensity of Pain

Mild	Less than 3 hrs	3-24 hrs	24-48 hrs	48hrs-7 days
CONTROL GROUP	0	8	7	6
EXPERIMENTAL GROUP 1	2	2	8	8
EXPERIMENTAL GROUP 2	0	2	7	1
Chi square value	4.10	7.14	0.13	6.5
P value	0.122	0.028 **significant**	0.94	0.038 **significant**
Moderate				
CONTROL GROUP	0	1	0	1
EXPERIMENTAL GROUP 1	0	2	0	0
EXPERIMENTAL GROUP 2	0	0	2	3
Chi square value		2.08	4.11	3.69
P value		0.35	0.128	0.158
Severe				
CONTROL GROUP	0	1	1	0
EXPERIMENTAL GROUP 1	0	0	0	0
EXPERIMENTAL GROUP 2	0	1	1	0
Chi square value		1.02	1.02	
P value		0.60	0.60	

Table-5(A): Nature of Pain – Continuous / Intermittent

CONTINUOUS	<3 hrs	3-24 hrs	24-48 hrs	48hrs-7 days
CONTROL GROUP	0	6	7	0
EXPERIMENTAL GROUP 1	2	0	4	10
EXPERIMENTAL GROUP 2	2	3	4	2
Chi square value	2.11	6.82	1.5	16.67
P value	0.348	0.033 **significant**	0.47	0.001 **significant**
INTERMITTANT				
CONTROL GROUP	0	3	2	6
EXPERIMENTAL GROUP 1	0	0	0	0
EXPERIMENTAL GROUP 2	0	1	2	1
Chi square value		3.70	2.11	9.77
P value		0.16	0.348	0.007 **significant**

Table 5(B): Nature of Pain – Dull/Boring or Sharp/Shooting

DULL/BORING	Less than 3 hrs	3-24 hrs	24-48 hrs	48hrs-7 days
CONTROL GROUP	0	2	1	3
EXPERIMENTAL GROUP 1	0	2	0	4
EXPERIMENTAL GROUP 2	0	1	1	1
Chi square value		0.43	1.03	1.96
P value		0.80	0.59	0.37
SHARP/SHOOTING				
CONTROL GROUP	0	1	1	1
EXPERIMENTAL GROUP 1	0	0	0	0
EXPERIMENTAL GROUP 2	0	1	0	0
Chi square value		1.03	2.02	2.02
P value		0.59	0.35	0.35

Table-5(C): Nature of Pain- Localized / Diffuse

LOCALIZED	Less than 3 hrs	3-24 hrs	24-48 hrs	48hrs-7 days
CONTROL GROUP	0	3	5	5
EXPERIMENTAL GROUP 1	2	5	8	9
EXPERIMENTAL GROUP 2	0	2	3	3
Chi square value	4.11	1.61	3.02	4.26
P value	0.128	0.447	0.22	0.12
DIFFUSE				
CONTROL GROUP	0	2	3	2
EXPERIMENTAL GROUP 1	0	0	0	0
EXPERIMENTAL GROUP 2	0	0	0	0
Chi square value		4.11	4.11	4.11
P value		0.128	0.128	0.128

Table-5(D): Nature of Pain – Spontaneous / Precipitated

SPONTANEOUS	Less than 3 hrs	3-24 hrs	24-48 hrs	48hrs-7 days
CONTROL GROUP	0	0	0	0
EXPERIMENTAL GROUP 1	0	4	2	4
EXPERIMENTAL GROUP 2	0	0	2	1
Chi square value		8.45	2.11	5.57
P value		0.014 **Significant**	0.348	0.06
PRECIPPITATED BY TRIGGER FACTOR				
CONTROL GROUP	0	2	5	4
EXPERIMENTAL GROUP 1	0	2	4	4
EXPERIMENTAL GROUP 2	0	1	1	1
Chi square value		0.43	3.00	2.27
P value		0.9	0.21	0.32

DISCUSSION

The predictive factors for developing PEP include – occlusal contacts, presence of pre-operative pain, presence of radiolucency, type of teeth, previous emergency treatment. [2, 3, 19, 20] Intensity of pain depends upon – position of tooth and age of patient, while duration depends on – age, gender and periapical radiolucency. [2, 3, 19, 20] In this clinical study, there were numerous variables which could not be controlled in differentiating the patients in different groups. Without any differentiation or discrimination on the basis of age or gender, patients were sequentially assigned to the three groups. Two factors were kept constant – (i) absence of symptoms pre-operatively, since pre-operative pain is one of the most predictable indicator for PEP [3, 19, 20] (ii) treatment was carried out by a single operator, using same method but different techniques. Thus all variables related to technique and operator, were controlled. Although statistically non-significant, the incidence of pain was found to be higher with hand instruments than rotary instrumentation. Former was probably due to limited number of patients. The latter could be attributed to the design of Protaper Next. The design features include multiple progressive taper, which decreases the possibility of taper lock and bilateral symmetrical rectangular cross section an offset from central axis of rotation [21] which leads to precession or swagger, that helps in removal of debris in a coronal direction because the off- centre cross section allows for more space around the flutes. The swaggering motion of the instrument initiates activation of the irrigating solution during canal preparation, improving the debris removal. Thus as a consequence of less debris being pushed in the apical area, the possibility of PEP decreases. The results of this study were the same as reported by Aqrabawi *et al*. [22] Pasqualini *et al*. also reported less pain with rotary instruments after single visit root canal treatment. [23] But they are different from the findings of Wei *et al*. [24] Al-Ababreen [25] and Arias *et al*. [26] who reported statistically significant higher incidence of pain with stainless steel hand instruments than rotary instruments. The difference might be attributed to the different rotary files used and treated teeth being multirooted. Incidence of pain was identical in teeth treated with and without PUI. Patients treated with PUI, reported mild pain with the same incidence as non-PUI patients treated with Protaper Next. These findings were similar to those found in the study by Pafford *et al*. [18] who reported mild pain, with similar incidence, with and without ultrasonic instrumentation after hand and rotary instrumentation. Burleson *et al*. [13] and Sluis *et al*. [14] in separate studies have found PUI following biomechanical preparation to be effective in removing debris load along with bacterial contamination whereas Rodriques *et al*. [27] did not find PUI to be more effective. In separate studies PUI has been found to serve as an important supplement for cleaning of root canal. Acoustic microstreaming is the basic process involved in the latter. Further these studies have found PUI to result in removal of greater amount of organic tissue, planktonic bacteria and dentine debris in comparison to irrigation with syringe [13, 14].

The duration of pain was longest, in more patients treated with manual instrumentation and least in patients treated with rotary instrumentation along with PUI. Although the difference was statistically non-significant, at different time intervals, except between 48 hours- 7 days. This finding is justified by the results reported by Madhusudhana *et al*, [28] Zarrabi *et al*. [29] and Ferraz *et al*. [30] They reported higher apical extrusion of debris and irrigants with hand instrumentation than rotary instrumentation but the difference was found to be statistically non-significant. Pasqualini *et al*. reported faster resolution of PEP when a glide path is achieved with rotary NiTi instruments than a manual glide path. [31] On the contrary Arias *et al*. [26] reported a significantly longer duration of pain with rotary instruments than manual. The reason for longer duration of pain with manual instrumentation

could be because of higher debris load in the periapical area as a result of piston like effect generated with manual instrumentation.

Mild and continuous pain was experienced by maximum number of patients. With manual instrumentation it was present in more patients during 3 to 24 hours period, whereas with rotary instruments it was more during 48 hours to 7 days period. On the contrary El- Mubarak et al found higher percentage of severe PEP than mild and moderate pain after 24 hours. [16] Findings in our study could be probably due to higher debris load with manual instrumentation with faster resolution of inflammation, whereas with rotary instrumentation lower load of debris might have caused delayed inflammatory response. Intermittent pain was experienced more with manual 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. 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, former occurred to a significantly higher level across the treatment protocols in between 3 to 24 hour period. Thus indicating that periapical inflammation due to debris dispersal after endodontic treatment is highest within the first 24 hours.

CONCLUSION

Post endodontic pain is a major unwanted outcome of single visit root canal treatment. Majority of patients tend to experience pain that is mild, continuous, localised and precipitated by trigger factors. It tends to last for a longer duration, when biomechanical preparation is carried out with hand instruments. The use of Protaper Next rotary instruments, results in lesser incidence of PEP than hand instruments, although not statistically significant. The use of passive ultrasonic instrumentation after biomechanical preparation with Protaper Next does not lead to any substantial decrease in incidence of PEP, though it decreases the duration. In order to draw more conclusive results, a wider study needs to be undertaken.

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