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# Comparison of the Incidence of Flare-Up and Time Efficiency in Single Visit Root Canal Treatment Employing Either Rotary or Manual Step-back Canal Preparatory Technique

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## Abstract

**Aim:** This study aims to compare the incidence of flare-up and operating time in root canal treatments where rotary or manual step-back canal preparatory technique was employed. **Materials and Methods:** A randomised study was conducted in a Nigerian Teaching Hospital. One hundred and twenty teeth belonging to 95 patients were randomised into two (Rotary and Manual) groups. Root canal treatment was performed using either rotary or manual step-back canal preparatory technique. Canal preparation time and total operating time were measured. Patients were monitored for severe pain and/or swelling over 1-week. Data were analysed using SPSS version 20.0, at alpha-level of  $P \leq 0.05$ . Chi-square and independent Student's *t*-test were employed for comparison where categorical and numeric variables were involved, respectively. **Results:** There was neither associated pain/swelling before treatment in 28 (46.7%) of the teeth in rotary group nor in 27 (45.0%) of the teeth in manual group. Pain incidence was 11.7% and 16.7% in rotary and manual groups, respectively, at 1-week review. Severe pain was experienced by 3.3% patients in both groups at 1-week review. Only 1.7% and 6.7% in rotary and manual groups, respectively, presented with swelling over 1-week. Flare-up incidence at 1-week review was 3.3% in rotary and 8.3% in manual groups, the difference was not significant ( $P = 0.243$ ). Canal preparation and total operating times were significantly shorter ( $P < 0.05$ ) in the rotary group in all tooth categories. **Conclusion:** No significant difference was noted in flare-up incidence between rotary and manual groups. Canal preparation time and total operating time were significantly shorter for rotary technique. Time efficiency is clinically invaluable, especially for multi-rooted teeth.

**Keywords:** Endodontics, flare-up, rotary system, single-visit, step-back

## INTRODUCTION

Flare-up is a specific term used to describe the characteristic symptoms of severe pain and/or swelling which occurs a few hours to 7 days following endodontic treatment which requires an unscheduled visit for active treatment.<sup>[1,2]</sup> Flare-up also known as endodontic interappointment emergency<sup>[3]</sup> is a complication that is alarming to the patient and challenging to the dental surgeon.<sup>[1]</sup> Prevention of this occurrence is thereby greatly desired. Literature has reported the flare-up incidence following treatment to be as low as 0.39%<sup>[4]</sup> to as high as 20%.<sup>[5]</sup>

Host factors, microbial factors and operator factors are considered to be the causative factors of flare-ups. The host factors consist of patient's demographics, psychological factors and local tissue changes (such as changes in periapical tissue pressure), while the microbial factors depend on the

contents of infected pulp tissue/debris; and the operator factors involves the operator skill and mode of treatment (type of canal preparation – conventional and rotary, adequate canal debridement, overinstrumentation, amount of apical extrusion of the canal contents, number of visits, quality of obturation and placements on medication).<sup>[1,3,6,7]</sup> Pre-operative pain, anxiety, intracanal medicament used, tooth vitality and size of periapical lesion are also considered as causative factors affecting flare-up rates.<sup>[6-10]</sup> Out of the numerous causative factors of flare-ups, apical extrusion of microorganisms

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from the canal into periradicular tissues had been reported to be the most significant factor.<sup>[6]</sup> All the various root canal preparation techniques have been linked with apical extrusion of canal debris and irrigants at varying degrees.<sup>[11,12]</sup> Therefore, a technique that would minimise the debris extrusion would ultimately reduce the flare-up incidence.

It would be beneficial to compare the flare-up incidence following the use of a modern approach (rotary technique) and the conventional step-back technique for canal preparation. The manual step-back canal preparation technique is performed by preparation of the apical stop following the establishment of the first file that binds to the apical constriction. This is done by preparing the canal walls using three successive larger files. The last file used to prepare the canal at the apical constriction is the final master apical file (MAF). Each successively larger file is then inserted 1 mm less into the canal to maintain the funnel shape. In-between placing each larger instrument, the MAF is reinserted to the working length for recapitulation.<sup>[13,14]</sup> The rotary technique, on the other hand, is performed using crown-down technique according to the manufacturer's instructions of each rotary system. When using ProTaper rotary system, a gliding path has to be established first using size ISO 10 K-file. The coronal two-third portion of the canal is first pre-enlarged with the shaping file using a brushing movement, followed by preparation of the apical portion of the canals using the shaping and finishing files up to the working length.<sup>[13]</sup>

There is a paucity of research work that compared flare-up incidence where root canals were prepared using either of the two techniques in a single-visit root canal treatment. Thus, a randomised controlled study was carried out to compare flare-up incidence and operating time following single-visit root canal treatments where either rotary or step-back canal preparatory technique was employed.

## MATERIALS AND METHODS

A randomised clinical study was conducted at the Conservation Unit of Restorative Dentistry Clinics of our University Teaching Hospital over a 12-month period between June, 2014 and June, 2015. This study was part of a larger study, for which ethical approval was obtained before commencement of the study from the Health Research and Ethics Committee of Lagos University Teaching Hospital with the protocol number-ADM/DCST/HREC/1684 on the 3 February, 2014. Adult patients requiring root canal treatments who satisfied the inclusion criteria and who agreed to participate in the study were recruited. The inclusion criteria were: teeth of patients with no pain to moderate pain, irreversible pulpitis, apical periodontitis of not more than 2 mm × 2 mm periapical radiolucency, necrotic teeth with/without apical lesion associated with a non-discharging sinus, Ellis Class III fracture, while the exclusion criteria included unrestorable tooth, severely curved roots, weeping canals and acute abscess. These criteria were strictly adhered to during subject selection.

The minimum sample size of 28 patients per group was determined using a formula for comparison of equal proportions<sup>[15]</sup> and this was calculated based on a previous study by Wei *et al.*<sup>[16]</sup> To compensate for attrition and to increase validity, the required sample size per group was increased to 60 teeth. One hundred and twenty teeth belonging to 95 patients were randomly divided into two groups. Patients who had multiple teeth due for treatment had the teeth randomly assigned to a treatment technique. All tooth types were treated and all canals of each tooth were treated by a particular technique. The rotary group had teeth whose root canals were prepared using ProTaper NiTi rotary instrument (Dentsply Maillefer Ballaigues, Switzerland) in a crown-down preparation technique, while the manual group had teeth whose root canals were prepared with stainless steel K-files (Mani, Inc. Tochigi, Japan) using manual step-back preparation technique.<sup>[13]</sup> All the single-visit root canal treatments were performed by a single operator to eliminate inter-operator bias.

A written informed consent was obtained from all the human adult participants/subjects before commencing treatment. The procedure followed was in accordance with the ethical standards of the committee on human experimentation (institutional and national) and with the last update of Helsinki Declaration, as revised in 2000.<sup>[17]</sup> Standard laid down treatment protocol was employed during root canal treatment. Proper history was taken, a conclusive diagnosis was established and oral prophylaxis was done prior to commencing endodontic treatment. Local anaesthesia was administered, rubber dam was placed for isolation, caries excavation and access cavity preparation was done. The pulp chamber and canals were copiously irrigated with 2.5% sodium hypochlorite and lubricated with RC Prep (Stone Pharmaceuticals, Philadelphia, Pa). The working length terminated at the apical constriction as determined by radiographs (long cone paralleling technique). This was followed by biomechanical preparation and obturation of the root canals. A core build-up (with/without a post) was done following the endodontic procedure, and thereafter, an extracoronary restoration was fitted.

The canal preparation time and total operating time were measured in minutes using a stopwatch. The total operating time was the time taken from start to the end of the procedure while the canal preparation time was the time taken for the canal preparation and obturation only. Patients were not given prophylactic analgesics post-operatively but were advised to use analgesics in the event of unbearable pain. Patients were also given a number to call if they needed advise. All patients were reviewed for pain and/or swelling at 1-day and 1-week following treatment. Pain assessment was done using the universal pain assessment tool-Faces scale<sup>[18]</sup> and the use of analgesics following the procedure was investigated. This assessment was carried out by two independent examiners (endodontists). A diagnosis of flare-up was made when a patient presented with characteristic symptoms of severe pain and/or swelling which occurred a few hours to

7 days following endodontic treatment and which required an unscheduled visit for active treatment.<sup>[1,2]</sup>

All the data collected were analysed using Statistical Package for the Social Sciences version 20.0 (SPSS 20 IBM, Chicago, IL). Kolmogorov–Smirnov test for normality was used to analyse data distribution. Test for association between the two groups where categorical variables were involved was carried out using Pearson's Chi-square test and where numerical variables were involved, independent Student's *t*-test was performed. The level of statistical significance was set at  $P \leq 0.05$ .

## RESULTS

A total of 95 subjects enrolled in the study, 55.8% were female and 44.2% were male. Majority of the patients fell within the age group 21–30 years (46.7%), the mean age being  $31.56 \pm 11.35$  years. The two treatment groups were similar with respect to age ( $P = 0.550$ ), gender ( $P = 0.084$ ), the tooth type treated ( $P = 0.537$ ) and diagnosis ( $P = 0.881$ ).

There was neither associated pain/swelling before treatment in 28 teeth (46.7%) in the rotary group nor in 27 (45.0%) teeth in the manual group. Following treatment, the incidence of pain at 1 week was higher in the manual group (16.7%) compared to the rotary group (11.7%). Ten per cent and 15% of these patients in the rotary and manual groups, respectively, used

analgesics for the pain. However, there was no significant difference between the two groups in relation to post-operative pain ( $P = 0.432$ ) and use of analgesics,  $P = 0.408$  [Table 1]. Among the patients who had post-operative pain at the 1-week review, 3.3% in each group presented with severe pain. Table 1 also showed that the difference in the pain intensity between the two groups was not significant,  $P = 0.701$ .

At the 1-day review, there was swelling associated with 1 (1.7%) tooth in the rotary group and 4 (6.7%) teeth in the manual group. At the final review, the swelling among the patients in the manual group had resolved, but there was only a decrease in size of the only case of swelling in the rotary group [Table 1].

The incidence of flare-up, that is, new cases of severe pain and/or swelling over the 1-week review period was 3.3% and 8.3% in the rotary and manual groups, respectively. The difference in incidence of flare-up between both groups was not significant,  $P = 0.243$  [Table 1].

The total operating time and canal preparation time of the anterior and posterior teeth in the rotary group was approximately half the time taken for the corresponding anterior and posterior teeth in the manual group. The differences in total operating and canal preparation times between the two treatment groups were significant in all the different tooth categories [Table 2].

**Table 1: Incidence of pain, swelling and flare-up at different post-operative review periods**

Variable	Review period	Treatment groups				$\chi^2$	<i>P</i>
		<i>n</i>	Rotary, <i>n</i> (%)	<i>n</i>	Manual, <i>n</i> (%)		
Post-operative pain	1 day	60	4 (6.7)	60	8 (13.3)	0.224	0.432
	1 week	60	7 (11.7)	60	10 (16.7)		
Use of analgesics	1 day	60	4 (6.7)	60	7 (11.7)	0.343	0.408
	1 week	60	6 (10.0)	60	9 (15.0)		
Pain intensity	1 day	60				3.481	0.323
	None		56 (93.3)	60	52 (86.7)		
	Mild		0		1 (1.7)		
	Moderate		2 (3.3)		6 (10.0)		
	Severe		2 (3.3)		1 (1.7)		
	1 week	60				1.421	0.701
	None		53 (88.3)	60	50 (83.3)		
	Mild		0		1 (1.7)		
	Moderate		5 (8.3)		7 (11.7)		
Swelling	Severe	60	2 (3.3)		2 (3.3)	1.878	0.171
	1 day						
	Absent		59 (98.3)	60	56 (93.3)		
	Present		1 (1.7)		4 (6.7)		
	1 week	60				1.008	0.315
	Absent		59 (98.3)	60	60 (100.0)		
	Same size		0		0		
	Decreasing		1 (1.7)		0		
Flare-up	Increasing	60	0		0	0.402	0.243
	1 day		2 (3.3)	60	4 (6.7)		
	1 week		2 (3.3)	60	5 (8.3)		

*n*=Total number of treated teeth per group at the different review periods

**Table 2: Time taken during treatment in the two treatment groups**

Tooth category	Time taken (min)	Treatment groups		P
		Rotary	Manual	
All the teeth	t <sub>1</sub>	42.9±23.30	69.7±41.66	0.015*
	t <sub>2</sub>	29.6±18.15	56.7±31.78	0.003*
Anterior teeth	t <sub>1</sub>	27.0±5.90	43.8±13.88	0.006*
	t <sub>2</sub>	18.8±6.23	35.1±13.28	0.001*
Posterior teeth	t <sub>1</sub>	58.8±23.35	95.7±44.10	0.007*
	t <sub>2</sub>	40.4±19.74	78.3±30.20	0.002*

\*Significant. t<sub>1</sub>: Total operating time, t<sub>2</sub>: Canal preparation time

## DISCUSSION

Extrusion of bacteria from the canal contents is considered the most important factor that leads to a flare-up.<sup>[6]</sup> It has been reported that the crown-down technique used by NiTi rotary instruments has contributed significantly in the reduction of debris extrusion into the periapical tissues as compared to step-back technique.<sup>[11,12]</sup> This has been attributed to the fact that the motion of rotary files directs the debris toward the coronal orifice, thereby preventing compaction of debris apically.<sup>[19]</sup>

The flare-up incidence in this study at 1-week review was lower in the rotary group (3.3%) compared to the manual group (8.3%), although the difference between the two groups was not significant ( $P = 0.243$ ). Tanalp *et al.* in 2013 reported a similar flare-up incidence of 3.4% following rotary instrumentation.<sup>[20]</sup> However, their study did not compare flare-up rates recorded using different techniques. In 2014, Edionwe *et al.* also reported a 0% flare-up rate following a single-visit root canal treatment, in which canal preparation was performed employing step-back technique and handheld K-files.<sup>[21]</sup> However, their study also did not compare the flare-up rate with that of teeth prepared using rotary technique. A study conducted by Oginni and Udoeye in 2004 reported a higher flare-up incidence of 18.3% compared to results of this present study after preparing canals using step-back technique in a single visit.<sup>[22]</sup> They compared the flare-up incidences following single- and multiple-visit root canal treatment. In 2011, Udoeye *et al.* reported an endodontic flare-up rate of 10% and compared the flare-up rates in relation to different factors such as number of visits, presence of intra-operative pain, age and gender.<sup>[2]</sup> However, preparation technique was not considered in their study. A study conducted by Menakaya *et al.* in 2015 also reported a slightly higher flare-up rate of 5.7% using step-back technique endodontic treatment protocol, but this was performed in multiple visits.<sup>[23]</sup> Despite the differences in the study protocols,<sup>[22,23]</sup> and this present study, the varied flare-up rates reported following canal preparation using the step-back technique were higher than the rates obtained after rotary technique from this present study. This further supports the reports that rotary technique of root canal preparation causes less extrusion and consequently fewer flare-ups after treatment.<sup>[11,12]</sup>

In 2014, Pamboo *et al.* revealed a significant difference ( $P = 0.035$ ) in flare-up incidence between ProTaper rotary and

manual groups.<sup>[24]</sup> This is contrary to the findings of this study and this could be attributed to the slight difference between our study protocols. Although both studies had very similar inclusion/exclusion criteria and made use of the same ProTaper rotary system, three operators were involved in treating their subjects unlike this study which had a single operator. Besides, some patients were placed on antibiotics and/or analgesics following treatment in their study which could have affected the flare-up incidence unlike this study where no patient was placed on either of the medications prophylactically following treatment. Another possible reason for the difference is that treatment was performed in either single/multiple visits in their study unlike this present study where all treatment was performed in a single visit. The varying reports of flare-up incidence by these different studies are possibly due to the differences that may have arisen from the different treatment protocols such as number of operators, dexterity of operators and number of endodontic visits.

The results of this present study supports the notion that rotary technique is expected to enable root canal preparation to be done at a shorter operating and preparation times. This effect was shown to be statistically significant for all the different tooth type categories in the rotary group compared with the manual technique group. These findings are consistent with those of previous studies.<sup>[25-27]</sup> These studies proved, in particular, that time efficiency exists when rotary instruments are used for canal preparation in molar endodontics. This would help overcome time-related challenges while performing root canal treatment, especially in a single visit in the molar teeth (which have complex root morphology, multiple roots and poorer access).<sup>[28]</sup> The time efficiency of the rotary instruments saves both the clinician's and patient's time, this would ultimately lead to better co-operation, increased productivity and more efficient clinic management.

## CONCLUSION

In this study, lower flare-up incidence rate was recorded following root canal preparation using rotary technique in a single visit though the difference was not significant when compared to manual step-back technique. The preparation and operating times were significantly shorter in the rotary group. This time efficiency is clinically invaluable, especially for multi-rooted teeth where there is poor access and higher technical demand.

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## Conflicts of interest

There are no conflicts of interest.

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