Original Article

Root Canal Technique

A Comparative Assessment of Root Canal Preparation, Employing Manual and Rotary Instrumentation Technique - An in Vitro Study

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ABSTRACT

Objectives: To determine changes in root canal curvature after preparation with manual or rotary instrumentation technique and to determine maintenance of working length by either manual or rotary instrumentation technique.

Study Design: Experimental study

Place and Duration of Study: This study was carried out at Aga Khan University Hospital over a period of six months.

Materials and Methods: Mandibular molars, extracted due to caries or periodontal reasons and mesiobuccal canals, with curvature between 20- 40^0 were included. In Group A preparation was carried out with ProTaper instruments and in group B with manual NiTi files. An ISO #15 NiTi file was placed in the canal and radiograph taken to determine working length, radiograph was scanned, print made and canal curvature determined. Upon completion of preparation, radiograph with #30 NiTi file was taken and working length assessed. Same radiograph was scanned, and changes in curvature were assessed by comparing preoperative and postoperative prints. Data analysis was done with SPSS version 14.0 and Paired and Independent sample t tests.

Results: Difference in Pre and Post operative root canal curvature was lower in ProTaper group, but not satisfactorily significant. Working length was better maintained in ProTaper group as compared to group prepared with Manual Ni-Ti instruments.

Conclusion: ProTaper instrumentation technique maintained working length better than manual instrumentation technique. No difference in operative curvature was observed, although difference was smaller in ProTaper group.

Key Words: Pulpectomy, Rotary NiTi, Working length determination, Canal curvature, Apical Preparation.

INTRODUCTION

Root canal preparation of curved root canals is associated with many procedural difficulties such as maintaining the shape of the curved canals. Instrumentation of curved canals is very difficult because conventional instruments are stiff and result in straightening of the canal which is associated with ledges, perforations, zips and elbows.[1,2] In order to eliminate some of the short comings of these traditional endodontic instruments, nickel titanium instruments have been developed.

Purpose of root canal filing is the achievement of a conical configuration, allowing a more effective filling and establishment of accurate length of the tooth during root canal treatment. [3-6]

Traditional stainless steel instruments, when used in severely curved canals, often fail to achieve the tapered root canal shape.[1,7,8] Enlargement of curved root canals with stainless steel (SS) files may result in instrumentation accidents.[9]

Nickel Titanium (NiTi) endodontic instruments have been shown to be more flexible than stainless steel instruments. NiTi-alloy has several advantages over stainless steel such as greater flexibility, shape memory effect and a better resistance to torsional fracture, the elastic limit for NiTi files has been shown to be two to three times that of stainless steel.[10]

During the last decade, several new nickel–titanium (Ni–Ti) instruments for rotary endodontic treatment have extended the endodontic armamentarium. Several investigations have shown the ability of some new rotary Ni–Ti systems to maintain the original root canal curvature well.[11-13]

The purpose of this study was to determine which instrumentation technique was better in maintaining root canal curvature and working length. Although many reports on root canal preparation can be found in the literature, definitive scientific evidence on the quality and clinical appropriateness of different instruments and techniques remains elusive. To a large extent this is because of methodological problems, making comparisons among different investigations difficult if not impossible.[14] Not many studies have compared manual and rotary instrumentation techniques and the results are still very contradicting regarding choice of the instrumentation technique. In addition, very few studies have been done in developing countries so far, there fore it was important to carry out a study which could help us in determining an instrumentation technique which was more beneficial in achieving the objectives of root canal treatment.

MATERIALS AND METHODS

This In Vitro Quasi experimental study was carried over a period of six months at The Aga Khan University Hospital, Karachi. Total sample size was sixty extracted molar teeth. The inclusion criteria for the study were human mandibular molars, extracted due to caries or periodontal reasons and mesiobuccal canal of mandibular molars, with curvature between 20-40 degrees as measured by Schneider's method.[15,16]

Teeth with calcified canals, internal or external resorption and with less than 20^0curvature or severely curved canals with more than 40^0curvature as measured by Schneider's method were excluded from the study. Teeth were randomly distributed into two boxes thirty teeth in each box, labeled 'A' and 'B'. Each group was assigned an instrumentation technique. This was done by a draw performed by a colleague, who was not related to the study. Group A: Prepared with rotary (ProTaper/ Dentsply) instruments. Group B: Prepared with manual instruments (Ni-Ti Files/ Dentsply).

Ethical Clearance: Ethical clearance from University Research Council of The Aga Khan University Hospital was obtained along with grant for conducting this study URC Project ID: 052024SUR.

Access cavities were prepared and occlusal surfaces reduced to solid flat reference points in both the groups. An ISO #15 Ni-Ti file was placed in the canal and radiograph was taken to determine working length 1.0 mm short of the radiographic apex and recorded for each canal. Radiographs were taken with the help of standardized XCP (Henry Schein) in mesiodistal direction using paralleling technique. For preoperative canal curvature assessment the same radiograph with #15 Ni-Ti file in the canal, was scanned and image transferred to computer, the image was magnified ten times (Adobe Photoshop 6.0), a print made and canal curvature measured and determined by Schneider's method. In group A instrumentation with rotary instruments was carried out according to manufacturer's instructions. In group B instrumentation with manual technique was carried out with NiTi files using step back technique. Upon completion of root canal preparation in both the groups, post interventional radiograph with #30 NiTi master apical file was taken in order to assess changes in working length. The post interventional radiograph was scanned and transferred to computer, the image magnified ten times (Adobe Photoshop 6.0), a print made and canal curvature measured and determined by Schneider's method.

Deviation in canal curvature (degrees) was determined by comparing postoperative curvature measurements with preoperative values and changes in working length (mm) were determined by subtracting the final working length from original working length.

Data was analyzed using Statistical Package for Social Sciences (SPSS) version 14.0. The difference in the pre and post operative readings of canal curvature and working length was compared using Paired samples t-test (with in the group comparison) for the two procedures. Independent samples t-test (between the groups comparison) was used to compare the canal curvature and working length in the two groups. A p-value less than 0.05 were taken as statistically significant. Error graphs (Mean with 95% confidence intervals for mean) were also made for type of procedures, pre operative and post operative root canal curvature and working length.

RESULTS

Root Canal Curvature in group A prepared with Rotary instruments was better maintained as compared to group B prepared with Manual instruments (Table 1). No significant difference was also observed between the two groups before procedure for root canal curvature. The average difference of the curvature in pre and post operation was found to be lower among Rotary technique when compared with manual technique (p-value=0.119) (Table 2).

Table No.1: Mean Distribution of Manual and Rotary (ProTaper) Instrumentation Techniques with 95 percent Confidence Interval for the Difference

Manual or Rotary(Protaper)	Pre-operation	Post-operation	95% Confidence Interval for the difference	p-value
	Mean (SD)	Mean (SD)		
Manual Working Length	17.2 (2.07)	16.3 (1.97)	0.9 (0.47, 1.33)	<0.001
Rotary Working Length	16.9 (2.49)	16.6 (2.65)	0.3 (0.02, 0.45)	0.032
Manual Curvature	25.9 (5.35)	21.6 (5.31)	4.3 (3.2, 5.34)	<0.001
Rotary Curvature	26.0 (5.19)	22.9 (4.53)	3.1 (2.04, 4.16)	<0.001

Table No.2: Mean Difference (Pre – Post) Distribution of Manual and Rotary (Protaper) Instrumentation Techniques with 95 percent Confidence Interval for the Difference

Working Length or Curvature	Difference in pre-post Manual	Difference in pre-post Rotary (Protaper)	95% Confidence Interval for the difference	p-value
	Mean (SD)	Mean (SD)		
Working Length	-0.90 (1.15)	-0.23 (0.57)	-0.67 (-1.14, -0.19)	0.007
Curvature	-4.27 (2.86)	-3.10 (2.84)	-1.17 (-2.64, 0.31)	0.119

Working length in group A prepared with Rotary instruments was better maintained as compared to the group B prepared with Manual instrument (Table I). No significant difference was observed between the two groups before procedure for working length. The average difference of the working length in pre and post operation was found to be significantly lower among Rotary technique when compared with manual technique (p-value=0.007) (Table 2).

DISCUSSION

During instrumentation of root canal, development of a continuously tapered form and the maintenance of the original shape and position of the apical foramen are important objectives. Ledge formation, blockages, perforations and apical transportation are undesirable accidents observed following the preparation of curved root canals. Flexible nickel-titanium instruments have been effective in minimizing complications in narrow and curved canals. [17-19] To deal with the complex problem of preparing curved root canals, several instrumentation techniques have been introduced.[20]

Working length and canal curvature maintenance are two very important objectives to be obtained in root canal therapy by any instrumentation technique; therefore in order to achieve these objectives the author used Nickel Titanium files in both the groups. Several studies [21-26] have been carried out and have shown that that preparation with nickel-titanium files was more effective and produced more appropriate canal shapes than stainless steel files. They found that rotary instruments were able to maintain working length better. They concluded that ProTaper rotary instruments prepared curved root canals effectively and safely were able to maintain working length better than manual instruments ($P < 0.05$),

In developing countries this area of endodontics needs to be evaluated, this system is used widely, there fore we felt a need to conduct a study in order to assess the capabilities of this system in maintaining working length and canal curvature and our results statistically prove that this system maintains working length and canal curvature better than manual Nickel Titanium instruments.

Following are the limitations of our study.

1. Can not generalize the results as they were performed by one operator.
2. Inter examiner reliability cannot be measured, since it was performed by one operator.
3. Bias: Due to single person examination, personal bias might be introduced, although precautions were made.

CONCLUSION

Within the limits of this study, following conclusions were drawn:

- Rotary (ProTaper) instrumentation technique maintained working length better than manual instrumentation technique. On the other hand, no difference in the operative curvature was observed, although the difference was smaller in ProTaper group.
- ProTaper instruments prepared canals in extracted human mandibular molars without obvious procedural errors to a smooth tapered shape of appropriate sizes

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