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In vitro evaluation of sealing ability of matched-taper single cone obturation with an electrochemical method.

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Abstract

widespread use of rotary Nickel-Titanium systems has caused manufacturers to produce gutta-percha cones that match the taper of the canals prepared with these systems. The aim of this study was to use electrochemical method to compare the apical sealing ability of taper single-cone, Thermafil obturation in canals prepared with ProTaper and ProFile instruments. Forty extracted human mandibular premolar were divided into 2 groups. All canals in group (A) prepared with ProFile, while all canals in group (B) prepared with ProTaper. Each group subdivided into two subgroup according to the method of obturation, (Thermafil and matched taper- single cone).The apical leakage in these groups was evaluated using an electrochemical method. T-test showed a non significant difference between Thermafil and matched taper-single cone obturation technique in the same group. A significant difference was found between ProTaper and ProFile group in both obturation techniques.

Keywords: Matched taper-Single cone, ProTaper, Thermafil.

Introduction

Successful endodontic therapy involves instrumentation of the root canal, to produce a surface free from debris and organic matter, and obturation, to achieve hermetically sealed canal. Determinants in successful therapy include the anatomy and physiology of the root canal and the restorative technique and armamentarium[1]. Previous studies have suggested it is difficult to accomplish an effective apical seal and that the majority of endodontic filling leak, even with good instrumentation and satisfactory condensation of root canal restoration [2].

In recent years, rotary nickel-titanium (NiTi) instruments have become popular because of their superiority over stainless steel hand files, elasticity and resistance to torsional fracture[3]. Moreover, rotary NiTi instruments improve working safety, shorten working time and prepare well-shaped root canals with fewer canal transportations[4,5]. Currently they are available in several configuration including .02, .04, and .06 mm/mm like ProFile NiTi instrument. Other NiTi instruments have multiple taper within the shaft, ProTaper NiTi instrument has a progressive taper ranging from 2% to19% for shaping file, where as for the finishing file taper ranging from 5% to 9% [1].

Obturation of canals prepared with NiTi instruments may be achieved using a variety of thermoplasticized or lateral condensation[6], cold lateral condensation is still one of the most frequently used techniques[7,8]. Because of the widespread use of the rotary NiTi systems, manufacturers have produced gutta-percha cones that match the taper of canals prepared with these systems. Preparation of a root canal with rotary NiTi instruments and the use of a sealer with these cones may provide 3-dimensional obturation of the root canal in less time [9].

Numerous studies have evaluated the apical sealing ability of root canal fillings using methods such as dye leakage[10], electrochemical techniques[11,12], radioisotope techniques[13] and fluid filtration techniques[14]. Electrochemical techniques offer advantages in terms of speed, accuracy and efficiency, as well as their ability to perform longitudinal studies[15]. However, recent study has demonstrated excellent correlation between electrochemical and dye leakage assessment methods[16]. The aim of this study was to compare the apical sealing ability of Matched taper-single cone, Thermafil techniques in teeth prepared with either ProTaper or ProFile instruments by using an electrochemical technique .

Material and method

Forty human lower premolar teeth that were extracted for periodontal and prosthetic reasons were used. The teeth had mature apices and a single-canal configuration. The crowns were removed at the cementoenamel junction with a diamond disc under water coolant. The roots were accessed and #15 K-file (Dentsply Maillefer) was inserted into the root canal. To determine the working length, #15 K-file was inserted into the root canals until it was visible at the apical foramen. The working length of each canal was calculated to be 1 mm short of that position. Two milliliters of 5.25% NaOCl solution was used for irrigation between each file size. The teeth were randomly divided into two main groups consisting of 20 samples in each group and prepared as follows:

Group (A): All teeth were prepared with ProFile NiTi rotary instruments. Each canal was prepared mechanically to the working length with rotary endodontic instruments profile taper .04, taper .06 (Dentsply, Maillefer, Switzerland) using a slow speed handpiece (300 rpm) with crown-down technique in the following manner:

A profile #25 taper .06 is used to about 1/2 of the canal followed by #25 taper .04 to about 2/3 of the canal in crown down manner, this is to prepare the coronal portion of the canal, for the apical portion, profile #15 taper .04 used to the working length followed by profile #20 taper .04, #20 taper .06, #25 taper .04, #25 taper .06, #30 taper.04, #30 taper .06 sequentially used to the working length.

Group (B): All teeth were prepared with ProTaper NiTi rotary instruments. Each canal was prepared mechanically with the ProTaper system (Maillefer, Ballaigues, Switzerland) a system made up of six instruments. According to the manufacturer's recommendations, using a low speed hand piece (300rpm) with crown- down technique, For coronal portion of the canal start with shaping file S1 to achieve straight line access with brushing movement once resistance felt remove the file and force against the canal walls on its removal, this action performed just to remove

any cervical interference. After that shaping file SX is used with the same manner. When the canal is patent and working length is confirmed shaping file S1 is reused to the working length with brushing motion, followed by shaping file S2 used with the same manner till it reached the working length, followed by irrigation and recapitulation. The apical portion is prepared with finishing files, first start with F1 file to working length followed by F2 file to the working length. Finally use F3 file is used to working length its tip size equal to #30 file, with that instrument the preparation of the apical portion is completed. After the preparation procedure was completed, the teeth in each group were divided into subgroup each consisting of 10 samples according to the type of obturation:

Group (A) divided into:

(A1): obturated with taper single-cone (gutta-percha for ProFile, size 30 ISO .06).

(A2): obturated withThermafil technique (Dentsply Maillefer)

Group (B) divided into

(B1): obturated with taper single-cone (gutta-percha for ProTaper, size F3).

(B2): obturated with Thermafil technique (Dentsply Maillefer)

Taper Single-Cone Obturation

Size 30 ISO (.06) gutta-percha cone (Dentsply Maillefer) for group (A1) and size F3 gutta-percha (Dentsply Maillefer) for group (B1) was prefitted into the root canal at the working length. Then the canal was dried with paper points and AH Plus was applied to the root canal walls with a size 30 K-file. Then the cone was lightly coated with the sealer and placed into the canal to the working length. The excess gutta-percha was removed with a heated instrument and the canal orifice was sealed with Cavit-G (3M ESPE, Germany).

Thermafil Obturation

Verifier size #30 was prefitted into the canal at the working length. The same size Thermafil obturator was heated in the Therma Prep Plus Oven (Dentsply Maillefer, Holland). The canal was dried, and AH Plus sealer was applied to the canal. Then the obturator was slowly placed at the working length in a single motion. After the gutta-percha was cooled, the obturator was severed at the canal orifice and the canal was sealed with Cavit-G. After obturation, all teeth were stored at 37^0C, 100% humidity.

Electrochemical leakage method:

The test methodology required placing PVC-coverd copper wire with an exposed end (that is stripped of the pvc insulation)coronally, to contact the obturation system in each tooth root. The wire was sealed in place with sticky wax and covered by three layers of nail varnish. All external surfaces of the teeth were coated with three layers of nail varnish to provide electrical insulation and prevent fluid penetration through the cementum and/ or any accessory canals[(11)]. The apex of the treated tooth root was left patent, and care was taken on ensure that no nail varnish was deposited on the apex[(11)]. The teeth were immersed in 0.9 percent NaCl solution with a stainless steel counter electrode. A 20-volt DC current from stable supply was connected between the stainless steel and each tooth and current flow was determined by voltage drop across standard resistor placed within electrical circuit Fig(1). The measurements were taken at baseline, 1 day, 1 week, 2 weeks, 3 weeks, 4 weeks, the conductivity was recorded in microsiemens. Siemens = 1 / Resistance (Ohm).

Results

The mean electrochemical leakage values and their standard deviations in all time periods are summarized in table(1).While the lowest leakage values at all time period were observed in group A1, the highest values were observed in group B1, table(2). t-test show no differences (P>0.05) between group A1 and group A2 or between group B1 and group B2. Significant differences (P<0.05) were found between group A1 and group B1, and between group A2 and group B2, table (3). For all groups apical leakage values increased over time Fig.(2).

Discussion

With the widespeared of rotary NiTi instruments, taper gutta-percha cones were develop and the single cone technique has become popular again. In this study canals prepared either with ProTaper or ProFile and filled with single cone and Thermafil technique. No significant differences were shown between A1&A2 groups (canals prepared with ProFile and obturated either with taper single-cone or Thermafil technique), and between B1&B2 groups (canals prepared with ProTaper and obturated either with taper single-cone or Thermafil technique). Zmmener and colleagues[17] prepared the root canals using a rotary system and obturated with single-cone and other techniques. They reported that with the use of a methacrylate-based sealer, the difference was not significant. This result come in agreement with Inan et al. [18] study that found that the apical sealing ability of matched-taper single-cone obturation was comparable with that of lateral condensation and Thermafil techniques, and the difference between groups was not statistically significant (P> 0.05).

A single cone obturation technique was compared between group A1 (canals prepared with ProFile) and group B1 (canals prepared with ProTaper). A significant difference (P<0.05) was found between them. Koch and Drave[19] sated that the precision matching of the primary cone to the preparation (endodontic synchronicity) is very important with any single cone technique because the accuracy of the cone fit to the preparation minimizes the amount of sealer and any dimensional change. Further more, a constant taper preparation routinely employs a series of files with a constant taper such as .04 or .06 and varying apical sizes, because of the constant taper, the result of using a series of constant taper file is a more conservative, reproducible shape[19]. A key factor in the use of constant taper is that the consistency of shape facilitates the primary cone fit, which expedites the overall obturation process[20]. A variable taper is not recommended because of its lack of shaping predictability (and its corresponding lack of reproducibility) will lead to a less than ideal cone fit[20]. Also a significant difference was found in Thermafil obturation technique between group A2 (canals prepared with ProFile) and group B2 (canals prepared with ProTaper). It could also be hypothesized that firstly a significant shrinkage occur in gutta-percha in ProTaper group, and this may be due to the amount of gutta-percha on the F3 core, and secondly the greater tapering of ProTaper preparation in comparing with ProFile group.

Conclusion

Under the conditions of this study matched taper-single cone gutta-percha created a better apical seal in canal prepared with a constant tapering than

Thermafil. Themafill technique showed less leakage than matched taper-single cone in canals prepared with variable tapering. In this study teeth with single straight canals had been used, but posterior have narrow and curved canals, which might present greater challenges. Further study is needed to evaluate the sealing ability of obturations of matched taper gutta-percha cones.

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Table (1): Descriptive statistics of groups

		1 day	1 week	2weeks	3weeks	4 weeks
Group A1	**Mean**	1.075	1.983	2.333	2.443	3.075
	SD	0.4893	0.3525	0.4004	0.4063	0.4893
Group A2	**Mean**	2.206	2.625	2.736	3.236	3.836
	SD	0.3614	0.4825	0.5501	0.5501	1.471
Group B1	**Mean**	3.261	3.651	4.419	4.832	5.168
	SD	0.5353	0.4276	0.3214	0.3977	0.2303
Group B2	**Mean**	2.906	3.953	4.132	4.383	4.681
	SD	0.486	0.2151	0.1882	0.2615	0.4352

Table(2): Mean leakage values of all groups

	Group A1	Group A2	Group B1	Group B2
Mean	2.1818	2.9278	4.2662	4.011
SD	0.7337	0.6264	0.7977	0.6757

Table(3): t-test between groups

Groups	t-test	P-value	Sig
A1&A2	1.73	0.13	*NS
B1&B2	0.55	0.60	NS
A1&B1	4.30	0.0037	**S
A2&B2	2.63	0.034	S

*P>0.05 Non significant
**P<0.05 Significant

Fig.(1): Electrochemical leakage test circuit.

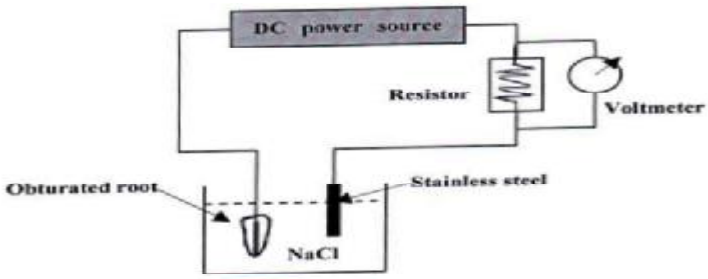

Fig.(2):Mean leakage vs. time behavior for groups