A comparison of apical sealing and extrusion between Thermafil and Lateral condensation techniques

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Abstract

One hundred Thirty two canals from 66 mesial roots of extracted human mandibular molars were instrumented with Protaper and K-file crown-down technique and divided into two groups. The group I was obturated with Thermafil technique and group II was obturated with lateral condensation technique. Topseal sealer was used in both groups. Apical extrusion, apical microleakage, time for instrumentation and time for obturation were recorded in each sub group. Six molars were used as control teeth. All specimens were stored in 100% humidity for 1 week, coated with nail polish, except for the apical 2mm, and were suspended in methylene blue dye for 72h. Linear dye leakage was statistically different (ANOVA) test, while apical extrusion between techniques was not statistically different (Chi-square test).

Key words: Thermafil technique, apical seal, apical extrusion, Protaper system.

Introduction

Complete obturation of the root canal with an inert filling material and creation of a hermetic apical seal are the goals of successful endodontic treatment [(1)]. Further more, the integrity of the root canal filling in the apical few millimeters is one of the criteria believed to be important for achieving successful endodontic treatment [(2)].

Lateral condensation of gutta-percha is one of the most accepted root canal obturation methods. However, its ability to conform to the internal surface of the root canal has been questioned. Brayton *et al* [(3)] reported voids, spreader tracts, and incomplete fusion of the gutta-percha cones and lack of surface adaptation from the lateral condensation technique. Eguchi *et al* [(4)] reported that this technique results in excessive amount of sealer and apical voids. Peter [(5)] demonstrated that some sealer used in lateral condensation techniques may resorb with time. This might decrease the effectiveness of the root canal obturation.

Nearly 60% of all endodontic failures have been attributed to incomplete obturation of the root canal system [(6)]. Most of the new obturation techniques use thermally softened gutta-percha to better fill all canal spaces and isthmuses [(7)]. One of the methods of obturation using warmed gutta-percha is the Thermafil endodontic obturator device (Dentsply, Maillefer, Ballaigues, Switzerland).

Thermafil obturator is made of plastic cores coated with so-called alpha-phase gutta-percha [(8)]. This stereo form of gutta-percha is considered to have better flow characteristics when molten than beta-phase gutta-percha, from which conventional gutta-percha cones are made [(8)]. After heating in a special oven, the gutta-percha surrounding the Thermafil carrier becomes plasticized, and the obturator is inserted into the prepared canal. The carrier remains in the root canal as apart of the root canal

filling. This technique has been shown to be comparable to cold lateral compaction of gutta-percha with respect to apical sealing [9,10] Gutman *et al* [11], Clark and ElDeeb [12] showed that the Thermafil technique produced a significantly greater incidence of apical extrusion of gutta-percha compared with the lateral condensation technique. However, Dummer *et al* [9] found that there were no significant differences on curved canals.

Apical microleakage results from failure to obdurate the canal space fully. Therefore, adapting the filler to the canal walls, including canal fins and cul-de-sacs, is a parameter for success. This filling quality has been evaluated clinically and radiographically [13].

Since the end of the $1980_{s,}$ files made from NiTi become available [14], which have more elastic flexibility and superior resistance to fracture, relatively maintaining original canal curvature and less aberration in comparison with similar size stainless steel file [15]. The recent introduction of rotary instruments made from NiTi with different design and taper found to be effective to over come problems associated with hand instruments like zipping, elbow, perforation and loss of working length [16]. Many types of rotary instruments is know available in the market like: Profile taper 04 and taper 06, Profile GT, Quantec and Protaper. In response to the problems associated with step back technique, the rotary instrument recommended to be used with crown-down technique, which involves preparation of the canal from the cervical aspect to the apex rather than classical aspect from the apex to the crown [17].

The aim of this study was the comparison of the Thermafil and lateral condensation techniques with regard to apical sealing and extrusion.

Materials and methods

Sixty-six extracted human mandibular first molars were selected and stored in a 10% formalin solution. In addition, all mesial roots had two separated canals and separated apical foramen with similar shape and curvature. The distal roots were removed and crowns were not sectioned to simulate clinical situation. All teeth were numbered and stored for 48h in a 5% sodium hypochlorite solution to remove attached soft tissue before access preparation. Canals were divided into two groups. For group I, 60 canals were obturated using Thermafil obturation technique. For the group II, 60 canals were obturated using the lateral condensation technique. Twelve additional canals of six molars were used as control teeth.

Canal length was determined visually by passing a size 10 K-File into the canal until was flush with the root surface at the apical foramen. Working length was established by subtracting 1mm from this length. Periapical radiographs were taken with file in each canal to verify the working length. All the mesiobuccal canals were prepared mechanically with the Protaper system (Maillefer, Ballaigues, Switzerland) according to the manufacturers recommendations, using a low speed hand piece (300rpm) with crown- down technique. For coronal portion of the canal start with shaping file S1 (Purple colour) 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

(white colour ring) 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 (yellow ring) to working length its tip size equal to #20 file followed by F2 file (red ring) to the working length. Finally, use F3 file (blue ring) is used to working length its tip size equal to #30 file, with that instrument the preparation of the apical portion is completed. A 5% sodium hypochlorite solution was used to irrigate the canals between usages of each instrument.

The mesiolingual canals were instrumented by Step-back instrumentation protocol in the apical third. The coronal two-third was enlarged with Gates-Glidden drills to accomplish flaring of the coronal root canal (crown down technique). A wet environment with 5% sodium hypochlorite was maintained in all canals during instrumentation. The same person performed all the instrumentation. Prepared specimens were dried with paper points.

The total time of canal preparation was recorded in minutes for the both instrumentation procedure. This included the active instrumentation, irrigation and time used to exchange the instruments. After instrumentation, the canals were divided into two groups (30 teeth for each), group I was obturated with the Thermafil plus technique and a group II was obturated with lateral condensation technique. Topseal sealer (Maillefer, Ballaigues, Switzerland) was used in both groups and was mixed according to the manufacturers instructions.

The canals of the Thermafil group (group I) were obturated as specified by the manufacturer. We selected a Thermafil obturator the same size as the size of the verifier which is size 30. A rubber stop was adjusted to coincide with the working distance taken from the root. The obturator was heated in the Therma Prep oven (Dentsply, Maillefer). Sterile paper points were used to coat the walls of the canal of the working length with Topseal sealer. The Thermafil obturator was inserted in the canal to the established working length. The shaft level was severed with the orifice using a tungsten carbide inverted cone bur in a high-speed hand piece. The carrier was stabilized with the index finger. The total time was measured from the checking of obturator until shaft removal.

In group II, A master cone was selected according to the last file used (06, gutta-percha). Snipping the tip until tug back was achieved and placing it at the working length customized it. The inner walls of the canals were also coated with sealer and then seated into place. A size 20 finger spreader (Dentsply, Maillefer) was used for lateral condensation. The spreader was remained in the canal until a fine accessory gutta-percha cone was ready to be put in place. Accessory cones were added until the spreader reached the coronal third of the canal. This was followed by vertical condensation using a plugger. The total time was measured from master cone selection until vertical condensation with a plugger.

After obturation of all specimens, access preparation was sealed with Coltosol (Coltene, Alsatten, Switzerland) and teeth were then stored in 100% humidity for 1 week to ensure the setting of the sealer. The same person performed both obturation techniques. Radiographs were taken from the buccal and mesial aspect of each root to visually evaluate the obturation. For positive control, the canals of 3 teeth were enlarged as described above, but the root canals were not filled. In the 3 teeth serving

as negative controls, the root canals were prepared and filled as described and then were completely covered with nail varnish and subjected to leakage testing.

The apex was observed with a magnifying glass and the observation recorded using the following parameters:-

0 rating-no sealer or gutta- percha at the foramen.
1 rating- sealer and/ or gutta-percha only at the foramen.
2 rating-sealer and/ or gutta-percha beyond the foramen (Table I).

The obturated roots were dried and coated on their external surfaces with nail varnish; except for the apical 2mm. After the varnish had dried the specimens were immersed in methylene blue 1% at 37^0C for 72h. They were then thoroughly washed with water, the varnish was carefully removed with a Lacron, and the teeth were dried. Using a diamond disk, two grooves were made longitudinally on the roots were then splitted in half by placing the edge of Lacron carver in the grooves and applying a gentle pressure. Linear apical dye penetration was measured for each specimen using Stereomicroscope at X10 magnification. The resulting measurements of time, dye leakage and apical extrusion were subjected to statistical analysis.

Results

The minimum and maximum values of mean and standard deviation values for each technique are presented in table II. ANOVA test (table III) showed a highly significant difference among the groups at $P<0.001$.

A T-test showed that a highly significant difference in time of preparation between Protaper and K-file, crown-down technique at $P<0.001$. And also the T-test showed a highly significant difference between the time for obturation of the Thermafil technique and lateral condensation technique (table IV).

LSD test were used to see the differences in apical microleakage between the sub groups (Protaper and K-file, crown-down technique) in a Thermafil group, and in lateral condensation group. The test showed no significant difference between the two techniques (Fig. I).

The percentage of canals with extruded sealer and /or gutta-percha in each technique is given in table I. The extrusion was evaluated using a χ^2 (Chi-square) and showed no significant difference between the methods at $P> 0.05$.

Discussion

Besides proper cleaning and shaping of the root canal, the complete and hermetic obturation of the root canal system is a major objective in root canal treatment. Several techniques have been developed to improve the seal of the prepared root canal. Currently, the most accepted and common technique is the cold lateral compaction of gutta-percha in combination with an insoluble root canal sealer [8]. In many studies, this method served as a known standard to compare new obturation techniques against [18].

The mean leakage and standard deviation values for each technique are presented in table (II). ANOVA test (table III) showed a highly significant difference among the sub groups ($P<0.001$). The Thermafil sub groups showed less microleakage than lateral condensation technique. This come in agreement with Leuny and Gulabivals [19] study found that the Thermafil sealer is a significantly better method than the lateral condensation

technique. This in agreement with Beatty *et al*, [20] and Gencoglu *et al* [12] which found that the Thermafil technique resulted in less leakage than did the lateral condensation technique. Gutman *et al* [11] study showed no significant difference between the two techniques at each time interval. Kytridou *et al* [22] found that both obturation techniques filled irregular canal well. They found no significant difference in leakage between the two techniques.

Our result came in disagreement with Lares and ElDeeb study [23]. They found mean leakage value was less in molars obturated with the lateral condensation technique than the Thermafil technique.

One of the concerns with respect to the Thermafil technique is shrinkage associated with gutta-percha phase transformations. Techniques that use thermo plasticity but that do not include vertical compaction or techniques that subject apical gutta-percha to temperatures above 45°C, are predisposed to shrinkage, irrespective of the type of gutta-percha used [24]. Apparently, if shrinkage of the thermo plasticized, gutta-percha in the Thermafil group was a significant factor; it would contribute toward a greater apical dye penetration. It is possible that the presence of the sealer could help off set any contraction of the Thermafil mass [25]. It could also be hypothesized that the solid plastic core that accounts a major portion of the Thermafil obturator device could prevent a significant shrinkage of the outer mass of gutta-percha.

Assessment of linear dye penetration is a common method to explore apical leakage of root filings after splitting the roots or after cleaning them [26]. The microleakage technique that was used in this study was a passive dye penetration. There appears to be no significant differences between the amounts of leakage obtained by passive or by negative-pressure penetration methods. Even if entrapped air exists in the root canal filling, it does not inevitably exert an influence of the dye penetration [27]. After root canal filling, all teeth were radiographed to standardize obturation consistency between the specimens and to assure the radiographic quality of obturation.

A T-test was done for measuring the time used for the preparation procedure of the sub groups between the Protaper and hand instrument using k-file, crown-down technique and showed highly significant difference at $P<0.001$ (table IV). Preparation of the canals with most rotary instruments using contra-angle hand piece at low speed (300 rpm) with crown-down technique as recommended from the manufacturer. The result showed that the time use to prepare the canal with Protaper rotary instrument required less time and effort to prepare the canals than hand instrument with k-file, crown-down technique which exhibited higher time of canal preparation because it needs more effort and pressure exerted during preparation [16] and this agree with Ruddle [28], Hyung and Kim [29].

A T-test was done to measure the time need for obturation the canals between the Thermafil procedure and lateral condensation technique .We found that a highly significant difference between Thermafil and lateral condensation technique at $P < 0.001$, and this came in agreement with Coyne [30].

Many factors influencing acceptance of Thermafil, which are clinical handling, ease of use and time for obturation. Clinical evaluations of products provide important information. Schoenrock [31] reported the finding of the Mid West Dental Evaluation Group (MDEG), which

evaluated Thermafil with other obturation techniques. MDEG recommendations were that Thermafil is the most complete system among other groups and its easy to use, easily removed with peeso reamers at any time for post preparation, save time and dose not cause root fracture. Clinical Research Associates Newsletter has reported that Thermafil is fast, predictable, easy to use, and useful in small or curved canals [32].

Chi-square test showed no significant difference in apical extrusion between Thermafil and lateral condensation technique. This came in agreement with Pathomvanich *et al* [33]. Gutman *et al* [11], Clark and ElDeeb [12] found that the Thermafil obturation resulted in significantly more material extrusion beyond the apical preparation than the lateral condensation technique.

Our investigation was made, unlike Gutman *et al*, using a mechanical technique, and the root canals were prepared and obturated with a master cone, this resulted in amore homogeneous instrumentation technique and an obturation confined to the canal. Our study agrees with Dummer *et al* [9].

The canal curvature may restrict the flow of thermo-plasticized gutta-percha over the carrier tip, thereby reducing the incidence of apical extrusion. We also suggest the use of small quantities of sealer to reduce the extrusion even more.

Conclusion

Our study showed that apical sealing and extrusion using Thermafil are adequate and not very different from conventional techniques, such as lateral condensation. Therefore, we found that the Thermafil system is a satisfactory alternative to lateral condensation of gutta-percha for any canals.

Table(I): Incidence (%) of apical extrusion

Rating	Thermafil	Lat. Cond.	Chi-squre	P-value	Sign.
0 Rating	35	45	0.2760	0.5993	N.S.
1 Rating	10	10			
2 Rating	15	5			

Table(II): Mean leakage values of test groups

Groups	No.	Minimum	Maximum	Mean	SD
Thermafil ProTaper	30	0.80	1.20	0.970	0.1337
Thermafil K-file	30	0.80	1.30	1.090	0.1663
Lat. Cond. ProTaper	30	0.90	1.50	1.270	0.1767
Lat. Cond. K-file	30	1.10	1.60	1.390	0.2025

Table(III): ANOVA test

Source of Variation	Sum of Sq.	DF	Mean Sq.	F	Prop.	Sign.
Between	1.0440	3	0.3480	15.1304	0.000	H.S.
Residual	0.6210	27	0.0230			
Total	1.6650	30				

Table(IV): T-test (Time in Second)

Groups	Minimum	Maximum	Mean	SD	t	P-value	Sign.
ProTaper Vs K-file	335 720	360 755	347 737.5	7.888 10.865	87.993	0.000	H.S.
Thermafil Vs Lat.Cond.	52 240	68 266	59.6 252.5	5.641 8.462	-62.443	0.000	H.S.

Figure(I): LSD test

Protaper Obt. With Thermafil	K-file Obt. With Thermafil	Protaper Obt. With Lateral Condensation	K-file Obt. With Lateral Condensation
		P=0.089 NS	P=0.104 NS

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