The effect of smear layer removal on apical seal of teeth obturated with two different obturation techniques

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Abstract

Background and objectives: .The purpose of this study was to evaluate the effect of smear layer removal on apical seal and the quantity of microleakage associated with lateral cold condensation and thermafil obturation.

Methods: Forty extracted single–rooted human teeth were randomly divided into two experimental groups; in group A, 20 roots with smear layer free, 5.25 % sodium hypochlorite (NaOCl) and 17% Ethylenediamine tetraacetic acid (EDTA) were used as irrigants to remove the smear layer, while in group B, 20 roots with smear layer, normal saline was used as irrigant. All root canals were instrumented with the Pro-taper rotary system using a crown-down technique. Each group of instrumented roots were subdivided randomly into two obturation groups; in group 1, 10 roots were obturated by thermafil with plastic carrier, while in group 2, 10 roots were obturated by cold lateral compaction technique. Zinc oxide euginol was used as the sealer. The root surfaces were then coated with nail polish except for the apex, then dye penetration study conducted and samples were examined under the stereomicroscope. Data had been collected from two independent examiners and statistically analyzed using student t-test.

Results: There was non significant difference between all the groups radiographically while stereomicroscopic analysis showed significant difference of smear layer free group when obturated by thermafil with other groups.

Conclusion: Smear layer free group gave the best results when used with lateral condensation technique (LCT) and smear layer group gave the best results when used with thermafil.

Key words: Smear layer, Thermafil, obturation.

Introduction

An important consideration in endodontics is the ultimate seal of root canals to prevent microleakage that may cause root filling to fail. Microleakage in root canals is complicated as many variables may contribute, such as anatomy and instrumented size of the root canal, irrigating solutions, root filling techniques, physical and chemical properties of the sealer, and the infectious state of the canal [1] All endodontic instruments create a smear layer as a consequence of their action on root canal walls [2]. Whether the smear layer needs to be removed or retained before canal obturation still remains a controversial topic. From biologic point of view; the presence of smear layer contributes to leakage and it is also a source of nutrients for microorganisms [3]. Smear layer may be compacted along the entire surface of canal walls, increasing the risk for bacterial contamination and prevent medicaments and obturating materials from gaining intimate adaptation to the canal wall and penetration into dentinal tubules [4,5]. Furthermore, this debris may be compacted apically and create an apical plug that prevents the complete filling of this important region [2].On the other hand, smear layer may prevent unwanted bacterial activities by sealing the

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bacteria into the dentinal tubules; it also blocks the entry of bacteria in contaminated canals into the dentinal tubules, thus acting as a barrier against the free movement of bacteria into or out of open dentinal tubules and reinfection of dentinal tubules if the sealing fails [6,7].Many different obturation techniques have been introduced ranging from solid core filling of gutta percha to its softening techniques with either solvents or heat to increase the quality of the apical seal**.** Lateral cold condensation has been proven to be a very popular and clinically effective filling technique. It has the advantage of simple execution, conservative canal preparation and controlled filling [8-10]**.** While many thermoplasticized procedures and devices have been evaluated to improve the three-dimensional sealing of the root canal space and produce a more homogeneous canal seal. A method for carrying thermoplasticized gutta-percha in which heated gutta-percha is on a metal or plastic carrier to the canal space described by Johnson in 1978. Johnson claimed that the technique was effective in filling canal space [4, 9, 11]**.**The goals of this study were to assess the effect of smear layer removal on apical seal of endodontically treated teeth and the quantity of microleakage associated with lateral cold condensation and thermafil obturation

Methods

1. Sample selection

The samples were obtained from freshly extracted teeth collected from dental polyclinic with the following characteristics: the roots did not have fractures, caries, open or resorbed apices and the roots were straight or had slight curvature (not more than 10°).Then the external tissue debris, calculus, soft tissue and the clotted blood were removed with scalar and tooth brush under running tab water and were collected in a special container containing distilled water.

2. Sample preparation

The collected teeth had been subjected to de-coronation process. After that, each root with a single canal would be chosen and checked by a stainless steel k-file (size # 15) (Densply, Maillefer, Switzerland) to verify the canal patency. The stainless steel k-file (size # 15) must reach the apical terminus and appear from the root apex slightly and tightly (just seen). Any root that was not fulfills this criterion had been discarded. After that the working length was calculated using stainless steel k-file (size # 15) with rubber stop and the working length determined by keeping it 1 mm short of the apex.

3. Sample grouping

The selected forty roots were divided by simple random method into 2 groups; Group A: 20 roots smear layer free, Group B: 20 roots with smear layer. Then each group was subdivided randomly into 2 subgroups; 1. 10 roots obturated by thermafil, 2. 10 roots obturated by cold lateral compaction technique

4. Instrumentation techniques

The pro-taper rotary Ni-Ti (Densply, Switzerland) step-down technique was used for instrumentation of all groups, the shaping file no. 1 (S1) was inserted to the coronal one-third of the canal length and rotated until the file was found to be sung at this length. Shaping file no. 2 (S2) was inserted to the coronal two-third of the canal. Then finishing files F2 and F3 were inserted just to the full working length and rotated for 1 sec [12]. In group A; after using each file, the canal was irrigated with 10 ml of 5.25% prepared NaOCl (Fas, Iraq) and in completion of instrumentation each canal was irrigated with 10 ml of 17% Ethylenediamine tetraacetic acid (EDTA)(META, Korea) for 1 minute and 10 ml of 5.25% NaOCl to eliminate the smear layer. While in group B, after using each file and in completion each canal was irrigated with 10 ml of normal saline (Adwic, Egypt). After completion of the instrumentation phase, the canals in groups A and B were dried with paper points. the full working length with complete freedom and was used to adapt the master gutta-percha cone laterally to the proximal walls of the canals and to provide

a space for the accessory gutta-percha cones. Standardized gutta-percha cones (size # 15) were used as accessory cones .The technique was considered completed when the spreader had no more space to penetrate the canal orifice. Finally, excess gutta-percha was removed using a heated Ash no. 49 aided with spirit lamp and was compacted later on vertically using heated endodontic finger plugger. All the obturated samples were stored at a temperature (37 °C) in a special container.

6. Radiographic evaluation

The obturated samples were left dry aside for 7 days after obturation at a temperature (37 °C) with complete humidity to allow complete setting of the sealer [13]. After that, the samples were radio- graphed in buccolingual aspect to evaluate the homogeneity, compaction, adaptation and extension of the obturation. The radiographs were then read by two experienced specialists (blinded to the groups) with two readings for each of them with interval of three days, (Figure1), so for each sample four reading and each group becomes forty. The criteria for the radiographic measurements were as following[14]: Score 1: Optimum obturation without spaces between canal wall and filling material and without voids in between the obturating mass to the full working length. Score 2: Optimum obturation without spaces between canal wall and filling material and without voids in between the obturating mass short from the full working length. Score 3: Incomplete obturation with spaces between canal wall and filling material and / or with voids in between the obturating mass to the full working length.

Score 4: Incomplete obturation with spaces between canal wall and filling material and / or with voids in between the obturating mass short from the full working length.

7. Dye penetration study

With the exception of apical 2mm, the rest of the root surface was covered with three layers of nail polish and stored in 2% Methylene blue dye solution at 37°C on complete humidity for 72 hours to allow the dye to enter into unfilled space of the canal. After this period, the roots were removed from dye and washed under tap water thoroughly and allowed to dry for 48 hours, at room temperature. Then nail varnish was removed with scalpel and each root was marked at the middle of mesial and distal sides with a longitudinal line by a permanent marker, then the roots were cut into two halves buccal and lingual using a diamond cutting disc (Komet, Germany) via slow-speed conventional hand-piece with water coolant [15]. Each half was fixed to microscopic slide by sticky wax (Vevy, Switzerland) to allow its examination under stereomicroscope.

8. Stereomicroscope measurement

The slides with the samples were examined under the stereomicroscope (2x) (better vision) to measure linear dye penetration along the canal filling interface, from the most apical extent of gutta-percha to the most coronal point of dye penetration by two experienced specialists (blinded to the groups), (Figure 2), so for each sample two reading and each group becomes twenty. The criteria for the stereomicroscopic evaluation were as following [16]:

- Score 0: No dye penetration.
- Score 1: 0-0.9 mm dye penetration
- Score 2: 1-1.9 mm dye penetration.
- Score 3: 2-2.9 mm dye penetration.
- Score 4: ≥ 3 mm dye penetration

Results

1.Radiographic evaluation

By using paired t- test, there was non-significant difference between all the groups' scores at p> 0.05, (table 1, 2 and Figure 3).Generally groups of smear layer free gave better results than groups with smear layer, specially when smear layer free group obturated by thermafil.

2.Stereomicroscopic evaluation

By using paired t- test, generally, there was non-significant difference between the group scores at p> 0.05, except there was significant difference between smear layer groups compared smear layer free when obturated by theramafil. Also there was significant difference when lateral compaction technique compared with the thermafil technique in smear layer free group scores at p< 0.05, (table 3, 4 and Figure 4).The best results obtained from smear layer group when obturated by thermafil and smear layer free group when obturated by lateral compaction technique.

Figure 1: Radiographic evaluation (Smear layer free, thermafil)

Figure 2: Stereomicroscopic evaluation (Smear layer, thermafil)

Table 1: The descriptive statistic of radiograph reading

Obturation technique	Instrumentation techniques	No. of samples	Mean of scores	SD	Std. Error Mean
Thermafil	**Smear layer free**	40	2.00	± 1.176	0.186
LCT	**Smear layer free**	40	2.30	± 1.202	0.190
Thermafil	**With smear layer**	40	2.35	± 1.122	0.177
LCT	**With smear layer**	40	2.47	± 0.905	0.143

Table 2: t-test for difference between the groups (radiograph)

Technique	Techniques differences	df	t-statistic	P-value	Sign.
Thermafil	**Smear layer free** - With smear layer	78	-1.361	0.177	NS
LCT	**Smear layer free** - With smear layer	78	-0.735	0.464	NS
Smear layer free	**Thermafil** - LCT	78	-1.128	0.263	NS
With smear layer	**Thermafil** - LCT	78	-0.548	0.585	NS

Table 3: The descriptive statistic of stereomicroscope reading

Obturation technique	Instrumentation techniques	No. of samples	Mean of scores	SD	Std. Error Mean
Thermafil	**Smear layer free**	20	1.35	± 0.875	0.195
LCT	**Smear layer free**	20	0.75	± 0.638	0.142
Thermafil	**With smear layer**	20	0.75	± 0.638	0.142
LCT	**With smear layer**	20	0.95	± 0.510	0.114

Table 4: t-test for difference between the groups (stereomicroscope)

Technique	Techniques differences	df	t-statistic	P-value	Sign.
Thermafil	**With smear layer** - Smear layer free	38	-2.477	0.018	S
LCT	**Smear layer free** - With smear layer	38	-1.094	0.281	NS
Smear layer free	**LCT -** Thermafil	38	-2.477	0.018	S
With smear layer	**Thermafil** - LCT	38	-1.094	0.281	NS

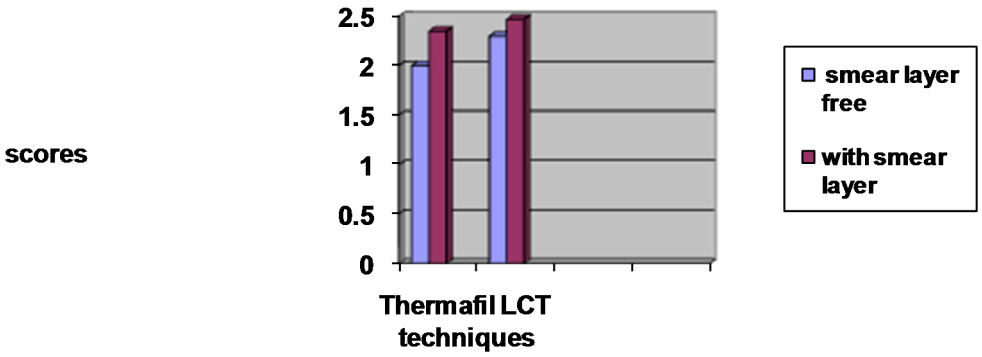

Figure 3: Bar chart showing the techniques of obturation (radiograph scores)

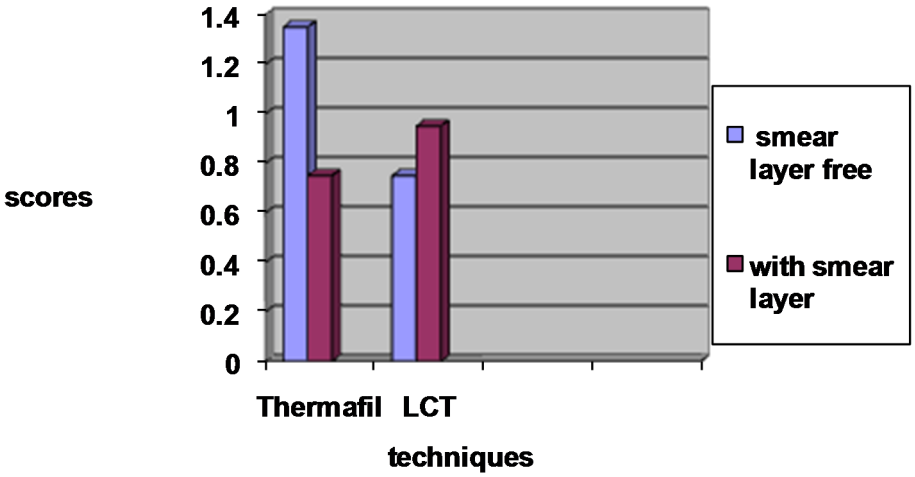

Fig. 4: Bar chart showing the techniques of obturation (stereomicroscope scores)

Discussion

The three dimensional obturation of the root canal system and the creation of a fluid-tight is widely accepted as a key factor for successful endodontic therapy [17]. Root canal micro leakage is a complex subject because many variables may influence infiltration, such as root filling technique, physical and chemical properties of sealers and presence or absence of smear layer [18]. Smear layer is one of the factors that may affect the apical microleakage and thus compromise the long term success of the treatment. This layer is a thin film composed of organic and inorganic portions, and is produced during canal instrumentation [6].One purpose of the irrigation is to remove the smear layer from instrumented canal walls. Irrigation with EDTA alone can only remove the inorganic portion of smear layer. Therefore to eliminate smear layer completely, it should be combined with an organic solvent such as NaOCl [6]. On the other hand, using sodium hypochlorite alone for irrigation produces clean canal walls having the smear layer still present [19]. Yang & Bae, 2002 [20], showed that in removing the smear layer, there was no significant difference between saline irrigation and NaOCl irrigation. For removing the smear layer efficiently NaOCl ,which has an organic tissue dissolving activity, should be coupled with a chelating agent such as EDTA (EDTA alone can only remove the inorganic portion of smear layer) to complete removed of the smear layer [21]. Considering studies by the Rajeswari et al, 2005 [17] and Fróes et al, 2000 [22], for efficient and complete removal of smear layer, alternate irrigation with 5.25% NaOCl and 17% EDTA was used in this study. In lateral compaction technique, smear layer free group showed less apical leakage in comparison to smear layer groups, although the result was non significant. This result some what in agreement with some authors studies [22-24] as they showed that smear layer had no significant effect on apical microleakage and better obturation adaptation and bonding were achieved when the lateral condensation technique was used in the absence of a smear layer. Root canal filling material was compressed with the use of spreader in lateral condensation technique and the standardized cones are easily adapted to canal walls because they allow the insertion of additional accessory cones up to the root apex, thus improving the obturation quality.

in the apical third and increasing the contact surface between dentin and filling material when the smear layer is removed from dentinal walls [9,22]. While this result disagreed with Farhad & Elahi, 2004 [6], who concluded that the removal of smear layer might improve the long term apical seal and success of endodontically treated teeth. The factors that may be considered in obtaining these conflicting results are: technique of instrumentation, type of sealer used, sealer thickness, type of filling technique, type and concentration of chelating agents used, and the technique used to remove the smear layer. About obturation techniques, this result some what in agreement with some authors studies [25-27] as they showed that the apical sealing of thermafil was adequate and not very different from lateral compaction technique. Apical seal of smear layer free group obturated with theramafil technique in comparison with other groups was significant; this result is in agreement with Ravanshad & Khayat [9].Probably the smear layer may have acted as a barrier obstructing the filling material/ root canal wall interface and making the penetration of methylene blue dye difficult. This explains the lower leakage found in the presence of the smear layer[22]. an increase in permeability in the initial stages when shrinkage occurs as the gutta-percha cools, as a result of easer dye penetration between the obturation and the dentinal walls in groups of smear layer free obturated by thermafil in comparison with other groups where voids have created by smear layer removal and the cooling of gutta-percha when plasticized at high temperatures underwent shrinkage[22,28]. In the present study methylene blue dye used for leakage assessment as many studies used it [14,29], because it is inexpensive, easy to manipulate, has a high degree of staining and molecular weight even lower than that of bacterial toxins [30]

Conclusion

Removing of smear layer was produced better apical seal when canals obturated by lateral compaction technique. While the remain of smear layer was produced better apical seal when canals obturated by thermafil obturation technique.

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