Obturation of internally prepared cavities (simulating internal resorption) with three different techniques

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Abstract

Background and objectives: There is controversy as to which instrumentation and/or obturation techniques to choose for the treatment of the internal resorption defects. This in vitro study compared the instrumentation and obturation quality of simulated internal resorption cavities (IRC) with 3 different techniques.

Methods: Ninety extracted human roots were used and sectioned transversely 5 mm from the apex and hemi-circular cavities were prepared in both sections. The sections were glued back together using superglue and embedded in plaster mold, thus obtaining root canals with cavities simulating internal resorption. The samples were randomly divided into 3 groups of 30 roots and instrumented by pro-taper rotary files, hybrid technique, or step-back technique, then each group subdivided into three subgroups of 10 roots and obturated with cold lateral condensation, warm vertical compaction, or injectable thermo-plasticized technique. After obturation, the samples were radio-graphed in Bucco-lingual and Mesio-distal view. After that, the plaster molds were removed, and the samples were then sectioned at the previous level and the quality of the obturation of the IRC were viewed under stereomicroscope.

Results: There was highly significant difference between pro-taper rotary files compared with hybrid and step-back techniques. The results of obturation techniques radiographically and by stereomicroscope showed that there was highly significant difference in between injectable thermo-plasticized compared with other two techniques.

Conclusion: The pro-taper rotary files and injectable thermo-plasticized technique gave the best results for treatment of simulated internal resorption cavities (IRC).

Key words: Dental caries, salivary flow rate, pH, saliva, microorganisms, oral hygiene.

Introduction

The treatment of internal resorption involves conservative endodontics with particular attention given to cleansing and filling of the resorbed area in combination with the chemical preparation of the defects[1]. Often management of unusual cases will require some deviation from standard treatment techniques, so various obturation techniques have been advocated by different authors to obturate the internal resorption defects [2]. Some authors suggested the use of lateral and vertical condensation and in the combination with a method of heated vertical condensation in the treatment of internal resorption [3], while others stated that injectable gutta-percha (Obtura II) gave the best results[4]. This study aimed to evaluate the efficacy of three most common instrumentation techniques; step-back, hybrid, and step-down (pro-taper) techniques and to evaluate the efficiency of three recommended obturating techniques; cold lateral condensation, vertical compaction of warm gutta-percha and injectable thermo-

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plasticized technique for canals with simulated internal root resorption .

Methods

1. Sample preparation

The collected ninety extracted human 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) 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.

2. Simulated internal resorption cavities creation

The simulated internal resorption cavities (IRC) were created in the roots using the following procedure; a guide mark line was placed vertically in such away parallel to the long axis of the buccal surface of each root apico-coronally using a soft pen. This mark line would act as a guide helping in the correct reassembly of the two sections of the root after the IRC creation. Another guide mark line was placed horizontally at 5 mm away from the apex at the coronal direction calibrated by the digital caliper. The roots were sectioned horizontally at this line using diamond cutting disc, in such away perpendicular to the long axis of the root in a mesio-distal plane. Then hemi-circular cavities were prepared using round burs (#2) by high-speed turbine hand-piece with water coolant for the both openings of the root canal sections. Both sections were then glued back together using universal glue by pairing back the guide mark. Care had been taken to maintain the patency of the canal by using minimal amount of glue and by using stainless steel K-file (# 15). After that the working length was calculated using stainless steel k-file (size # 15). Later on each root was varnished with Vaseline as a separating medium and embedded in cylindrical plaster mold.

3. Sample grouping

The ninety selected roots were divided randomly into 3 groups; Group A: thirty roots instrumented with rotary step-down pro-taper, Group B: thirty roots instrumented with hybrid technique. Group C: thirty roots instrumented with hand step-back technique. Then each group was subdivided randomly into 3 subgroups; 1. Ten roots obturated by cold lateral compaction technique, 2. Ten roots obturated by vertical compaction of warm gutta-percha technique. 3. Ten roots obturated by injectable thermo-plasticized gutta-percha technique.

4. Instrumentation techniques

For pro-taper rotary Ni-Ti step-down technique, the instrumentation was used for group A begun with lubricating the canal with 0.2 ml of 17% EDTA solution using a disposable syringe for one minute, then 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. The 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. The hybrid instrumentation was used for group B started with Gates-Glidden drill no. 1, to prepare the coronal two-third of the canals. Then followed by no.2 and no.3, which were used to the coronal half of the canal and then no. 4, 5 and 6 were used only at the orifice level. After that, apical third instrumentation was started with hand Ni-Ti K-file. The Ni-Ti K-file # 30 was considered the master apical file since it was the third file used to full working length after the initial file. After each file, the canal was irrigated with 0.2 mm of %17 EDTA for 1 minute combined with 1ml of 5.25% prepared NaOCl to remove the organic and inorganic remnants. The Step-back instrumentation was used for group C started with hand Ni-Ti k-file (#15) which was introduced to the full working length and used in watch-winding action and was repeated for #25, and #30 and the Ni-Ti K-file #30 was considered the

master apical file. Flaring of the canal to (#45) and recapitulation was executed with (# 30). The canal instrumentation was finished with F3 (= size # 30 ISO specification) to standardize the preparation for all the techniques.

5. Obturation techniques

The cold lateral compaction technique was used in the usual way and the technique was considered completed when the spreader had no more space to penetrate the canal orifice. For warm vertical compaction technique, heated finger plugger (size # 30) was introduced inside the canals in such away it reached apical third with complete freedom and was used to compact the master gutta-percha cone vertically in an apical direction with sustained pressure until apical resistance to the compaction pressure was felt. A second piece and third piece of gutta-percha were cut off at the canal orifice with heated finger plugger (size # 35 and #40) and then (size # 35) was introduced inside the canals in such away it reached the coronal 2/3 with complete freedom and was used to compact the gutta-percha vertically in an apical direction. The technique was considered completed when the canal orifice completely filled. For injectable thermo-plasticized technique, the canals were obturated by injecting thermo-plasticized gutta -percha mass using the bee-fill device via a bee-fill cartridge whice was inserted into the canals in three steps. As gutta-percha was injected, the tip felt raised, at this point, the hand was removed from the sensor pad to stop gutta-percha ejection, the tip was removed from the canal and as soon as possible, cold finger pluggers (sizes # 30, # 35, and # 40) were introduced inside the canals in such away they reached (to the coronal two thirds of the canal, to the coronal one third, and coronal up to 2-3 mm from the canal orifice respectively). All the obturated samples were stored at a temperature (37 °C) in a special container.

6. Radiographic evaluation

The obturated samples were left aside for 7 days after obturation at a temperature (37 °C) to allow complete setting of the sealer. After that, the samples were radiographed in both bucco-lingual and mesio-distal aspects. The radiographs were then viewed by two experienced specialists (blinded to the groups) with two readings for each of them with an interval of three days, (Figure 1).

7. Stereomicroscope evaluation

After taking the roots out from the plaster molds, the roots were re-sectioned at the same previous level of the horizontal gluing using a sharp surgical blade to separate the two sections. The two sections of the roots were fixed on microscopic slides in which the IRC surfaces of both pieces were upward not toward the microscopic slides. Then these were examined under the stereomicroscope (2x and 4x) by two experienced specialists (blinded to the groups) with two readings for each of them with interval of three days, (Figure 2).

Results

1. Radiographic evaluation

Using specific evaluation scores interpreted by two specialized inter-examiners, the instrumentation & obturation techniques had been assessed. The hybrid technique (HT) had the higher mean value of the criteria scores which was (6.6), than the other techniques, while the rotary Ni-Ti (RNT) technique had the least mean value of the criteria scores which was 1.7, i.e., the rotary Ni-Ti technique gave the best results than other techniques to shape the canals in receiving optimum obturation quality for IRC. By using paired t- test, there was highly significant difference between pro-taper rotary files compared with hybrid and step-back (ST) techniques at $p< 0.01$. The vertical compaction technique (VCT) had the higher mean value of the criteria scores which was (6.6), than the other techniques, while the injectable thermo-plasticized technique (ITT) had the

least mean value of the criteria scores which was 1.7, i.e., the injectable thermo-plasticized technique gave the best results than other techniques to obturate the IRC in optimum quality. By using paired t- test, there was highly significant difference between the obturation techniques at $p< 0.01$.

2. Stereomicroscopic evaluation

The rotary Ni-Ti technique had the higher mean value of the criteria scores which was (9.9), than the other techniques, while the hybrid technique had the least mean value of the criteria scores which was 3.9, i.e., the rotary Ni-Ti technique gave the best results than other techniques to shape the canals in receiving optimum obturation quality for IRC. By using paired t- test, generally, there was highly significant difference between pro-taper rotary files compared with hybrid and step-back techniques at $p< 0.01$, (Table 1, 2 and Figure 3). The injectable thermo-plasticized technique had the higher mean value of the criteria scores which was (9.9), than the other techniques, while the vertical compaction technique had the least mean value of the criteria scores which was 3.9, i.e., the injectable thermo-plasticized technique gave the best results than other techniques to obturate the IRC in optimum quality. By using paired t- test, there was highly significant difference between the obturation techniques at $p< 0.01$, (Table 3, 4 and Figure 4).

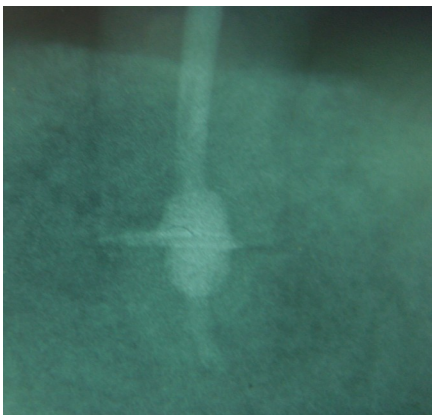

Figure 1: Radiographic evaluation of obturated samples

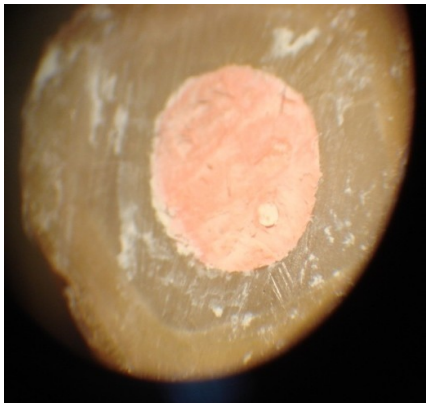

Figure 2: Stereomicroscopic evaluation of obturated samples

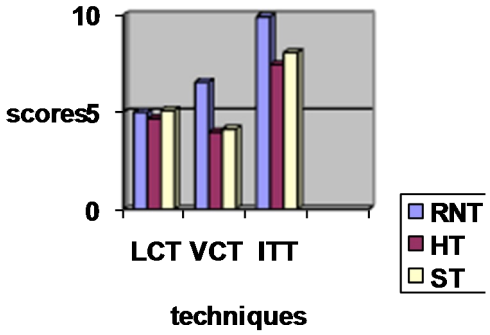

Figure 3: Bar chart showing the instrumentation scores

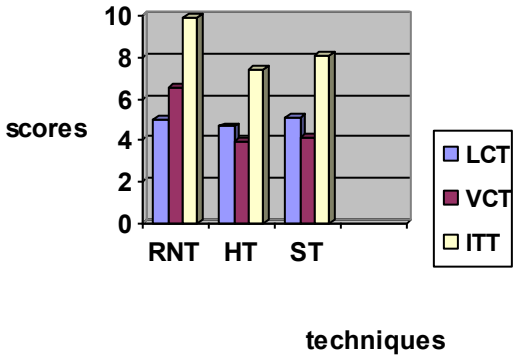

Figure 4: Bar chart showing the obturation scores

Table 1: The descriptive statistic of the instrumentation techniques

Obturation technique	Instrumentation techniques	No. of samples	Mean of criteria scores	SD
LCT (lateral condensation tech.)	**Hybrid (HT)**	80	4.65	± 1.999
LCT	**Step-back (ST)**	80	5.08	± 2.696
LCT	**Rotary Ni-Ti (RNT)**	76	4.9	± 2.675
VCT (vertical compaction tech.)	**Hybrid**	80	3.9	± 3.003
VCT	**Step-back**	80	4.1	± 2.803
VCT	**Rotary Ni-Ti**	80	6.5	± 3.585
ITT (injectable thermo-plasticized tech.)	**Hybrid**	80	7.4	± 4.260
ITT	**Step-back**	80	8.05	± 3.916
ITT	**Rotary Ni-Ti**	80	9.9	± 2.641

Table 2: t-test for difference between the instrumentation techniques

Obturation technique	Instrumentation techniques differences	df	t-statistic	P-value	Sign.
LCT	**Rotary Ni-Ti** - Hybrid	139	0.85	0.39	NS
LCT	**Step-back**- Rotary Ni-Ti	154	0.23	0.81	NS
LCT	**Step-back** - Hybrid	146	1.13	0.25	NS
VCT	**Rotary Ni-Ti** - Hybrid	153	4.92	2.18E-06	HS
VCT	**Rotary Ni-Ti** – Step-back	149	4.74	4.93E-06	HS
VCT	**Step-back**- Hybrid	157	0.3537	0.72	NS
ITT	**Rotary Ni-Ti** - Hybrid	132	4.3940	2.26E-05	HS
ITT	**Rotary Ni-Ti** – Step-back	139	3.5027	0.00062	HS
ITT	**Step-back** - Hybrid	157	0.9467	0.34	NS

Table 3: The descriptive statistic of the obturation techniques

Instrumen. tech-niques	Obturation technique	No. of samples	Mean of criteria scores	SD
RNT	**LCT**	76	4.98	± 2.675
RNT	**VCT**	80	6.5	± 3.585
RNT	**ITT**	80	9.9	± 2.641
HT	**LCT**	80	4.6	± 1.99
HT	**VCT**	80	3.9	± 3.00
HT	**ITT**	80	7.4	± 4.26
ST	**LCT**	80	5.08	± 2.696
ST	**VCT**	80	4.1	± 2.803
ST	**ITT**	80	8.05	± 3.916

Table 4: t-test for difference between the obturation techniques

Instrum. Techn.	Obturation technique differences	df	t-statistic	P-value	Sign.
RNT	**Vertical** - Lateral	146	3.07	0.002	HS
RNT	**Thermo-plasticized** - Lateral	153	11.5	1.52E-22	HS
RNT	**Thermo-plasticized** - Vertical	145	6.75	3.26E-10	HS
HT	**Lateral** - Vertical	138	1.73	0.08	NS
HT	**Thermo-plasticized** - Lateral	112	5.2	6.5E-07	HS
HT	**Thermo-plasticized** - Vertical	142	5.9	1.88E-08	HS
ST	**Lateral** - Vertical	158	2.2	0.02	S
ST	**Thermo-plasticized** - Lateral	140	5.5	1.25E-07	HS
ST	**Thermo-plasticized** - Vertical	143	7.2	1.95E-11	HS

Discussion

The chronic inflammatory granulation tissue is a common in the inflamed pulp but it may cause internal resorption defect only if the odontoblastic layer and pre-dentin are lost or altered. Reasons for loss of predentin layer are not obvious but trauma has been suggested as the etiological factor in most cases. The root canal treatment for such cases needs special management for the defect cavity during instrumentation & obturation to get perfect optimum treatment, however, few researches considering the root canal management for such challenge[4]. The correct extent of the resorptive defect cannot be estimated by radiograph as they are essentially a two dimensional image of a three dimensional object as it fails to accurately reflect the bucco-lingual appearance of root canal treatments. Further, in a clinical setup, radiographs are only possible in bucco-lingual view where as irregularities may be more visible in mesio-distal view[5]. In this study all teeth were radio graphed in both bucco-lingual and mesio-distal view, the bucco-lingual view showed total obturation of simulated internal resorption cavities, where as mesio-distal view showed partial obturation of simulated internal resorption cavities. In this study stereomicroscope was used as another way (more reliable than radiographs due to the real magnified cross-sectioned 3-D image) to determine the obturation of internal resorption cavity whether the cavities were obturated or not in addition to determine the obturation quality & the predominant material in internal resorption cavity whether the predominant material was, gutta-percha, sealer or equal amount of them[4].

For an efficient obturation of internal resorption with gutta-percha as stressed by various authors, the obturated IRC should contain more gutta-percha than the sealer as the latter is more prone to shrinkage and dissolution[4].

The Pro-Taper rotary files produce better results in instrumentation of canals with simulated internal resorption cavity.

This result some what in agreement with a study that concluded better canal preparations achieved with rotary instruments than manual files for internal resorption[6]. In addition, others demonstrated that engine-driven, nickel-titanium instruments produce rounder and more centered preparations than do hand instruments[6]. The concept of a greater taper, more centered and circular canal produced by Ni-Ti rotary instruments lead to more efficient preparation of the root canal space[7]. This will end with gradual smooth nice flared preparation matching the natural canal anatomy and this would be compatible homogenous with the concept of the continuous wave of obturation presented by the injectable thermo-plasticized and warm vertical compaction techniques. The proper shaping (a continuously tapering funnel, from the apical matrix to the canal orifice) is essential for the flow of the softened material and to the steadily work of the pre-fitted heated sized pluggers in the proper way[8].

Statistical analysis of the radiographic data as well as stereomicroscopic data indicated that there was highly significant difference between injectable thermo-plasticized gutta-percha with other two techniques. This result is consistent with the previous studies[4,9]. As they concluded that injectable thermo-plasticized gutta-percha (Obtura II) gave the best results and in most of the specimens obturated with this technique, the IRC were filled mainly with gutta-percha. The concept of injectable thermo-plasticized gutta-percha arose following the demonstration that gutta-percha in a heated state, when mechanically forced under pressure, would in three dimensional filled the root canal system more effectively and quicker than lateral or vertical condensation[10]. Injected thermo-plasticized gutta-percha can adapt more effectively to irregularities in the canal, thus replicating the root canal system[11, 12]. This might explain the results of the present study.

Conclusion

Pro-taper rotary Ni-Ti instrumentation gave the best results and shape of canals with simulated internal resorption cavities than step-back and hybrid techniques. The obturation technique that gave the best quality of obturation and filled the simulated internal resorption cavities was the injectable thermo-plasticized gutta-percha technique.

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