Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/q9c0kt81

A SPIRAL COMPUTER TOMOGRAPHIC ANALYSIS OF VARIOUS OBTURATION TECHNIQUES IN SIMULATED INTERNAL RESORPTIVE CAVITIES – AN IN VITRO STUDY

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Abstract

Aim: To assess and evaluate efficacy of three different obturation techniques in natural teeth with simulated internal resorption cavities using Spiral CT scan.

Methodology: 30 single rooted teeth (adjusted to length 16 mm) are selected. Chemo mechanical preparation is done using 2.5% NaOCl and 17% EDTA alternatively to the master apical file size 40.Teeth are sectioned horizontally with a fine diamond disc 6mm from apex.Semi circular cavities with no.6 round diamond bur are made around the periphery of each section simulating internal resorption cavities. Sections are cemented with cyanoacrylate adhesive and teeth are embedded in wax. Teeth are then divided into three groups of 10 each. The teeth are then obturated as follows - Group 1 : Lateral compaction technique, Group 2 : Thermo plasticized GP technique – non carrier based (Calamus),Group 3 : Chemically plasticized GP technique (Guttaflow). Teeth are stored for 7 days at room temperature. The obturated teeth are then evaluated using spiral CT scan.

Results: Among the three groups, Calamus has obturated with greatest volume with statistical difference. Gutta flow was the next best but was statistically not significant compared to lateral compaction group. Lateral compaction group had the least percentage of volume filled.

Conclusion: The study indicates that in case of internal resorptive defects it is better to adapt a warm vertical compaction technique for obturation than Guttaflow or lateral compaction obturation techniques.

Keywords: Calamus, Guttaflow, Lateral compaction, Obturation, Simulated internal resorptive cavities, Spiral CT scan.

INTRODUCTION

One of the important goals of root canal therapy is to successfully achieve three dimensional obturation [1]. Several pathological processes alter the internal structure of the root canal, like internal root resorption. It is an irreversible pathological event that can results in permanent loss of the tooth structure and if left untreated it will result in permanent loss of the tooth. In resorptive lacunae it is difficult to remove all the bacteria and their products from the dentinal tubules. However, densely compacted gutta-percha can block dentinal tubules thus may lead to complete

entombment of the microorganism [2]. To achieve this dense compacted filling of root canal space, various obturation techniques can be used. The present study aims to assess the volumetric efficacy of three such obturation techniques commonly employed. Lateral compaction procedure results in a cold welded, non-uniform mass of guttapercha cones in the canal with various sealers and exhibited leakage after storage in saliva [3]. The warm vertical compaction technique has shown greater ability to flow into the canal irregularities with increase the guttapercha mass density and homogenecity on previous cold lateral compacted obturations. However, negotiating curved root canal segments with pluggers and/or guttapercha injection needles can be questionable [4]. Thus, thermoplasticized guttapercha was developed to enhance the flow while maintaining the ease and predictability of use of lateral compaction. In the current study, Calamus dual 3D obturation system was used as the warm condensation technique and Guttaflow was used as flowable non heated gutta-percha in comparison with conventional lateral compaction technique.

In previous studies, the teeth were sectioned longitudinally and photos were analyzed with digital image processing to measure the surface area covered with obturation material. In the current study, spiral Computed Tomographic where three dimensional volumetric measurements are possible non-invasively and are considered more accurate than surface area measurements.

MATERIALS AND METHODS:

Thirty single rooted, freshly extracted, mandibular premolar teeth with fairly good amount of intact crown structure were collected, disinfected using 2.5% NaOCl and stored in saline. The working length of each teeth was adjusted to 16mm and were prepared chemo mechanically with ISO standard files (Mani) using 2.5% NaOCl and 17% EDTA alternatively to the master apical file size 40.Teeth were then sectioned horizontally with a fine diamond disc, 6mm above anatomic apex and semicircular cavities with no. 6 round diamond bur were made within the canal of each section. Sections were cemented with cyanoacrylate adhesive. Teeth were then divided into three groups of 10 each and mounted in wax. Group I was obturated using lateral compaction technique with ISO standard no.40 master cone (Dentsply) and zincoxide eugenol sealer. Group II was obturated using Calamus dual (Dentsply) 3D backfilling technique. Group III was obturated with Guttaflow2 (Coltene) The teeth samples were subjected to spiral computer tomographic exposure and the volume of each internal resorptive cavity was measured using Sienet Sky software (Table 1). Volume of the resorptive cavity and volume of the obturation were recorded and the percentage of filled volume was calculated. (Figure 1 (a-h)).

Statistical analysis:

All the analysis was done using Statistical Product and Service Solutions (SPSS) version 14. A p-value of <0.05 was considered statistically significant. Comparison of mean percentage of volume filled among the three groups was done using ANOVA with Post-hoc Tukey's test.

There was significant difference in the mean percentage of volume filled among the three groups ($p<0.001$)(Table 2).It has revealed that groupII had significantly higher mean percentage of volume filled than group I and III. No significant difference was seen between group I and III (Table 3).

DISCUSSION

The success and failure of root canal therapy depends upon total and complete obliteration of root canal space. Obturating materials are expected to prevent passage of micro-organisms and their toxins into peri-apical space. [5]. The cold lateral compaction is one of common techniques employed for obturation. However its ability to obturate internal resorptive cavities is still questionable because of its lack of surface adaptation, voids, spreader tracts, incomplete fusion of the guttapercha cones.

The thermoplasticized injectable gutta-percha obturation techniques were introduced to improve the surface adaptation and homogenicity of gutta-percha. The Calamus Dual 3D Obturation System with the combination of both Calamus "Pack" and Calamus"Flow" handpieces helps to dispense

warm guttapercha into the preparation during the backpacking phase of obturation as well as to remove and condense guttapercha during the downpacking phase of obturation by softening .
In 2004, Coltene/WhaledentInc (Cuyahoga Falls, OH) introduced an obturation material for root canals that combines Guttapercha and polydimethylsiloxane based sealer into one injectable system available as capsules which is cold, flowable and self-curing and thus eliminating any form of manual lateral or vertical compaction for placement. Volume analysis gives more accurate result than surface area measurement. With spiral CT, three dimensional volume analysis is possible without sectioning the specimens and thus avoiding the loss of material integrity during sectioning [6].Nandini et al used volumetric analysis by spiral CT to determine the removal efficiency of calcium hydroxide intracanal medicament with two calcium chelators [7].Kandaswamy et al used spiral CT for the volumetric analysis to assess the efficiency of laterally condensed, vertically compacted thermoplasticized and cold free flow guttapercha obturation [8]. Results of the study indicate that volume obturated using thermo-plasticized technique is better than cold free flow gutta-percha technique and cold lateral compaction technique. Among the three techniques used (Table 2, Chart I) group II had more percentage of volume filled compared to group III and group I. Group III had more percentage than group I but lesser than group II. There is no statistical difference between group II and group I (Table 3). The Calamus obturation system is designed to deliver filling material with an adjustable flow rate. The Downpack phase creates an effective apical plug and backfill phase effectively seals lateral canals and furcal canals [9]. This explains the result of the current study which is in conjunction with study done by Reader CM et al to evaluate the effective method for filling lateral canals and found out that warm obturation has more gutta-percha in lateral canals, the reason for which he explained is the continuous wave of condensation results in adaptation of gutta-percha to the grooves and depressions of the canal walls and lateral canals [10]. The polydimethylsiloxane-based Gutta-Flow sealer is claimed to expand slightly during setting, enhancing its adaptation to root dentin walls [11]. This phenomenon may be beneficial in the apical third of a root canal where the master cone has a better fit to the shaped canal. But in case of the internal resorptive cavity it showed lower filling percentage than Calamus. The use of a single-cone filling technique is often considered inferior to the more sophisticated 3D compaction techniques, because the volume of sealer is high relative to the volume of the cone, which promotes void formation and reduces the quality of the seal [12, 13] which is in contrast to the study conducted by Kandaswamy et al where E and Q plus (warm vertical compaction) with Guttaflow and lateral compaction were compared and was found that Guttaflow obturation was superior to warm vertical compaction [8]. Lateral condensation group showed the least volume of obturation attributed to the non-homogenous mass of gutta-percha that poorly replicates the root-canal space which is prepared and does not adequately obturate the internal resorptive cavity simulated [14].Additionally, lateral compaction technique leaves voids between cones that often are not filled with sealer and may provide a niche for bacteria to thrive [15, 8]. Therefore, within the limitations of the current study it is shown that for internal resorptive defects it is better to adapt a warm vertical compaction technique for obturation than lateral compaction or Guttaflow obturation techniques.

Conclusion:

The study indicates that in case of internal resorptive defects it is better to adapt a warm vertical compaction technique for obturation than Guttaflow or lateral compaction obturation techniques.

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Tables

Table 1: Percentage of volume is calculated using Sienet sky software

Groups	Group I	Group II	Group III
Percentage of volume filled			
Sample 1	62.00	73.77	68
Sample 2	54.76	87.50	69
Sample 3	60.82	64.91	55.55
Sample 4	53.84	70.31	61.19
Sample 5	56.75	63.63	61.10
Sample 6	41.66	73.20	46.80
Sample 7	45.20	68.25	64.80
Sample 8	44.87	63.07	50
Sample 9	52.70	73.60	60.70
Sample 10	60.30	71.42	68.33

Table 2: one way ANOVA analysis of data

	Group						p-value
	I		II		III		
	Mean	SD	Mean	SD	Mean	SD	
percentage of volume filled	53.29	7.21	70.97	7.10	60.55	7.69	<0.001

Table 3: represents Post-hoc Tukey's test, comparison and significance between each of the two groups is done.

Group	Mean Difference	p-value
I vs II	-17.68	<0.001; Sig
I vs III	-7.26	0.087
II vs III	10.42	0.010; Sig