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COMPARATIVE STUDY OF ENDODONTIC FILLING PENETRATION INTO LATERAL CANALS USING TWO DIFFERENT OBTURATION TECHNIQUES

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ABSTRACT

Aim of the study: this study was designed to compare penetration ability of two different obturation techniques into simulated lateral canals.

Materials and methods: sixty-eight non carious freshly extracted teeth were decoronated, instrumented up to size 30/.04, Irrigated with 17% EDTA and 5% NaOCl. Simulated lateral canals were Created in each third, at 3, 6, 11 mm short of working length, while diaphonization of the specimens, with size 10 ISO k-files. Samples were divided into two equal groups (n=34) In accordance with obturation methods, Guttacore and Continuous wave of condensation and examined under stereomicroscope after obturation. Mann Whitney and Kruskal Wallis tests were used to statistically analyze the data.

Results: For Guttacore group, showed significantly higher median score for filling penetration ability than continuous wave group at apical third ($p>.043$), while continuous wave penetration ability was significantly higher at the apical third ($p>.048$). There was no significant difference in filling penetration among the three thirds for continuous wave ($p>.679$). for Guttacore technique apical third showed significantly higher filling penetration ability than both coronal and middle thirds ($p>.001$).

Conclusion: both Guttacore carriers and continuous wave techniques exhibited proper penetration into simulated lateral canals. While Guttacore carriers provided better filling ability in the apical area, The Continuous wave vertical condensation had superior filling ability in the middle third of the root canal.

KEYWORDS: Guttacore, Continuous wave vertical condensation, Simulated lateral canals, Penetration ability.

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INTRODUCTION

The anatomy of the root canal system is extremely complicated and includes fins, accessory and lateral canals, deltas, and curvatures. They often lie perpendicular to the major canal, with a small slope towards the apex, and emerge in the direction of the periodontal ligament from the main canal. However, Weine 1984[1] showed that lateral lesions associated with lateral canals have been linked to chronic draining sinus tracts. He has also seen situations where apical healing or normalcy occurs, but later failure results from an untreated lateral canal.

Several methods of obturation were presented to improve three-dimensional obturation. Gutta percha homogeneity and mass density on earlier cold lateral condensation obturation can be increased by warm vertical compaction.[2,3] The ability of the heated vertical condensation approach to flow into imperfections in canals has demonstrated increased capability.[4,5] On previously cold lateral condensation obturation, increases in gutta percha mass density and homogeneity can be achieved through warm vertical compaction.[6,3]

The method of continuous wave of condensation that Buchanan invented,[7] functions as a cross between warm vertical condensation and cold lateral condensation. The method reduces gutta-percha apical extrusion by utilizing a well-fitting master apical cone of lateral compaction, and it also incorporates the benefits of warm vertical compaction to fully seal off the root canal system. One master cone is positioned as part of the continuous wave of condensation process and applying the system B heat source at 200°C. [8,9] to a depth that is 3 mm less than the working length.[10] Warm gutta-percha is injected back into the canal in increments of up to 10 mm.[11] It takes less time for the continuous wave of condensation., reduces the coronal leaking of microbes.[12] Additionally, it accommodates to canal walls' grooves and depressions more effectively than lateral compaction does.[4,13]

The GuttaCore is the first obturator with a crosslinked gutta-percha core; it is a thermoplastic gutta-percha core. GuttaCORE is a new core-carrier system. Gutta-percha is strengthened by a well-established scientific process called crosslinking, which joins the polymer chains and preserves the greatest qualities of the material. In the event that retreatment is necessary, a prior study demonstrated how these carriers enable the material to be removed from the root canal more quickly and easily.[14]

When assessing root canal filling materials for clinical application, the ability to fill lateral canals is crucial. Simulated lateral canals can be produced in artificial,[15,16] or natural teeth.[4,17] The evaluation of root canal fillings may involve radiographic testing.[4] tooth decalcification and clearing techniques,[18] or by an association of techniques.[17]

To the best of our knowledge, no study compared continuous wave vertical condensation and Guttacore, so the purpose of this study was to examine the penetration ability of the two techniques into simulated lateral canals in natural teeth.

MATERIALS AND METHODS

Preparation of Extracted Teeth

One hundred sixty-eight non-carious human extracted teeth were equally and arbitrarily split into two groups (n=34) with 204 simulated lateral canals each. Canals were instrumented by one operator up to size 30/.04, Irrigated with 17% EDTA (EUFAR, Bogotá, Colombia) and 5% NaOCl. Dental wax was used to fix a cotton pellet on the foramina and to fix specimens. In heavy body silicone impression material. To simulate in vivo conditions.

Preparation of Simulated Lateral Canals

Preparing, instrumenting, and demineralizing the specimens until they reached rubber-like viscosity. In order to create standardized simulated lateral canals, #10 K-files (Dentsply Maillefer) cut and cautiously put into the softened root such that

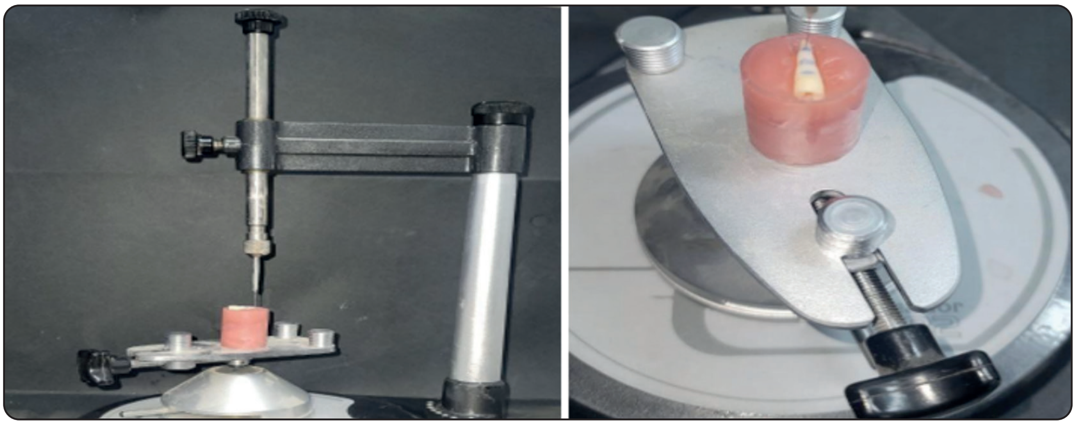

Fig. (1) Simulated lateral canal creation

it was perpendicular to the demineralized surface sample, the 5 to 8 mm apical part of the #10 K-Files shaft (Dentsply Maillefer). Mounted on a dental surveyor through the labial to the lingual. At 3, 6, and 11 mm short of working length. This created 204 simulated lateral canals in total. Following the rinse procedure, the specimens were dehydrated with gradually ascending concentrations of ethanol, submerged in methyl salicylate to restore their original consistency.[18] As illustrated in (figure 1) Using a #06 K-File, the lateral canals' patency was examined. (Dentsply Maillefer).

Filling techniques

Specimens were divided at random into two groups according to the obturation techniques used. **Continuous wave Group:** a size 30.04 gutta-percha cone (Dentsply Sirona) was selected as a master cone, a size 40.04 taper heat carrier (gutta-smart by Dentsply Sirona) was introduced up to 5 mm from the working length in a constant wave of condensation. Buchanan hand pluggers (Sybron Endo Corp.) were used to compact the gutta-percha in the apical third. Before using a warm gutta-percha injection method to backfill the canal. Gutta-percha was extruded following the insertion of a 23-gauge needle (gutta-smart by Dentsply Sirona) into the root canal. **Guttacore Group:** a size verifier (Dentsply Sirona) was chosen to fit the canal's terminal diameter. The carrier-based obturator is suspended by its handle straight in the oven (Thermaprep2, Dentsply Sirona) in less than 20 seconds the obturator reaches the appropriate temperature. Then inserted into full working length in line with the guidelines provided by the manufacturer. The samples were examined under stereomicroscope (Nikon SMZ-1000, Nikon Corp, Tokyo, Japan). with 10x to 40were examined. They evaluated the filling quality according to Venturi et al.[18] utilizing a five-scores scale (0 through 4) depending on whether gutta-percha or endodontic cement is present. The (Mann-Whitney and Kruskal-Wallis tests) were employed in the data's statistical analysis.

RESULTS

Analysis of the data of filling ability scores among different root thirds for each group is presented in table (1). Fig.; 2. Data revealed that, For Guttacore group, showed significantly higher median score for filling penetration ability than continuous wave group at apical third ($p \leq .043$), while continuous wave penetration ability was significantly higher at the apical third ($p \leq .048$). There was no significant difference in filling penetration among the three wave ($p \geq .679$). for Guttacore technique apical third showed significantly higher filling penetration ability than both coronal and middle thirds($p > .001$). Fig. 3, shows a stereo microscope picture of one specimen from Guttacore group, and one specimen from Continuous wave vertical condensation group.

TABLE (1) Comparison of filling ability scores between techniques at different sites

	Guttacore			Continuous wave			Mann-Whitney test
	M	**Min**	**Max**	**M**	**Min**	**Max**	
Coronal	2.00 A,a	.00	4.00	2.00 A,a	1.00	4.00	.341
Middle	1.00 A,a	.00	4.00	2.50 B,a	.00	4.00	.048*
Apical	3.00 A,b	2.00	4.00	2.00 B,a	.00	4.00	.043*
Kruskal Wallis test		<.001*			.679		

***p is significant at the 5% level; M, median, Min, minimum, and Max, maximum.**

Different capital letters in each row denote a significant difference between groups (Kruskal Wallis test, p < .05).

Different small letters in each column denote significant differences between groups (Mann Whitney test, p < .05).

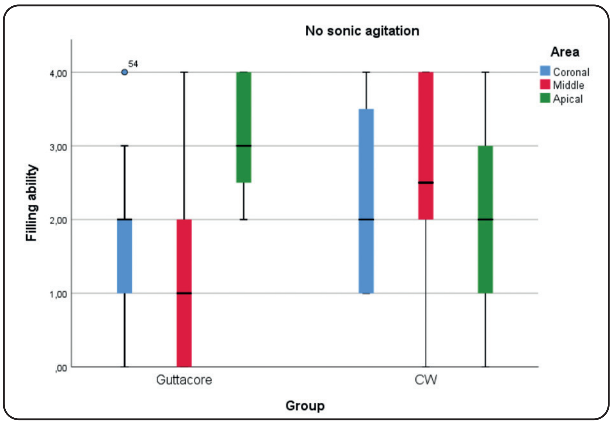

Fig. (2) Comparison of filling ability scores between techniques at different sites (thirds) no sonic agitation

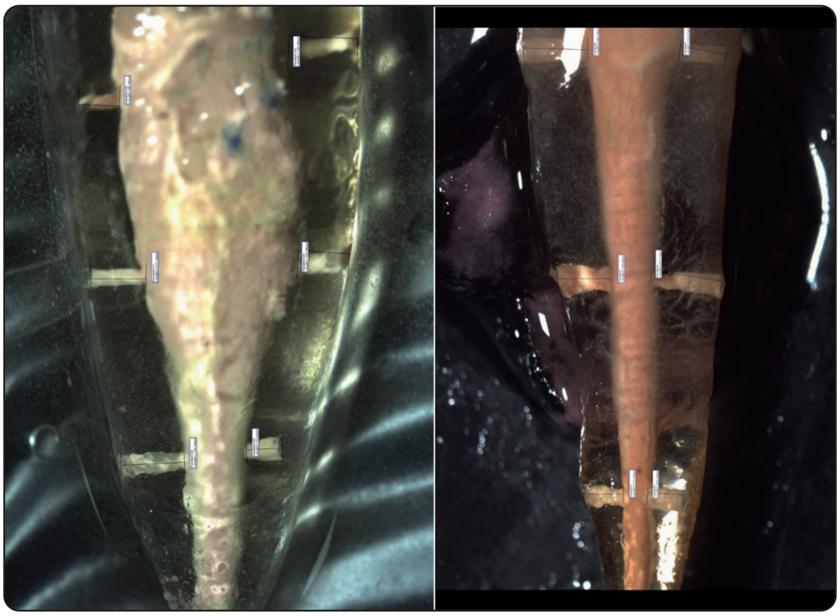

Fig. (3): On the left a stereo-microscope picture of one specimen from Guttacore group, on the right showing a stereo-microscope picture of one specimen from Continuous wave vertical condensation group

DISCUSSION

For any obturation technique, to prevent potential bacterial growth and reinfection of the root canal system, filling the lateral canal is clinically significant.[19,20] Several studies have documented endodontic success after lateral canal filling; various obturation methods were proposed to achieve better obturation of these canals.[21]

Cold lateral condensation, which is in a more crystalline phase, is employed in lateral condensation. Applied or frictional heat has been used in other methods to plasticize gutta-percha., enabling more homogeneity and improved adaption to canal walls.[22,23,24] These methods, however, employ warm gutta-percha in distinct ways. It has been mentioned that 5–7 mm can be the distance at which heating, and compaction are carried out from the end point while applying the warm vertical condensation technique, of the gutta-percha,[25,26] that an elevation in temperature to 40–42°C often takes place in the apical gutta-percha. and that in order to prevent phase-change-dependent volume fluctuations, the temperature shouldn't go above 45°C.[27] In contrast, when using Thermafil obturators, thermomechanical compaction[23] and the Obtura II System, as is the case with all semicrystalline thermo polymers, gutta-percha increases in proportion when heated to higher temperatures.[28]

The newest generation of carrier-based root canal filling material, known as GuttaCore, contains thermoplasticized gutta-percha as its core component. The core of Guttacore systems consists of a "thermostable semi-rigid cross-linked gutta-percha", which is resistant to the heat produced by the oven meant for these kinds of materials.[29] In addition, both systems may be retreated more quickly and easily.[30]

Previous research evaluating the efficacy of filling procedures has produced results that are inconsistent.[31,32,33,34] Some authors revealed that none of the methods examined produced a better seal, but subsequent investigations revealed that warm gutta-percha treatments produced better results and improved lateral canal filling. [35,36,4,37] In this regard the purpose of this study was to evaluate the penetration ability of two different obturation methods penetrated simulated lateral canals.

Several prior research assessed the efficacy of various obturation methods and materials in filling the lateral canals. In these experiments, lateral canals were simulated on natural teeth.[4,13,19] or resin blocks that feature synthetic lateral canals in an effort to standardize the groups. involved in the experiments .[38,39,17] Resin blocks remove the variable effects of instruments and offer a suitable standardized sample size.[39] Resin blocks can have certain drawbacks, too, namely the absence of a smear layer. Also, the gutta-percha or sealer's flow characteristics may be affected favorably or unfavorably by the resin's surface texture and state.

In this study, human teeth were used, which were made transparent using the decalcification and clearing protocol described. by Venturi et., al.[40] allowed three-dimensional internal visualization of the root canal filling within the simulated lateral canals, There aren't many researchs that look into the location, size, and shape of lateral canals. Since research has only revealed a small number of lateral canals (between 27 and 45%). To achieve standardization and a sufficient number of samples for the current study, artificial lateral canals were constructed. Using size 10 k-file, the lateral canal's diameter was produced, and this size matched the lateral canals' (0.1 mm) dimensions as reported in an earlier work.[41] It is feasible that applying this technique will result in the same lateral canal diameter and angle with respect to the axis of the main canal.

According to the results of the current investigation, filling penetration was noticeably higher at the medium level. ability into simulated lateral canals using continuous wave technique than

Guttacore technique. The higher penetration ability of filling into lateral canals with continuous wave was in accordance with Fernández R, et al.[42.] When he evaluated the ability of two gutta-percha filling methods and endodontic sealers based on calcium silicate and epoxy resin to fill artificial lateral canals and found that, the apical third was associated with the lowest number of simulated lateral canals with acceptable filling. This was followed, in ascending order, by the coronal and the middle thirds. These variations, however, only became noticeable when the apical third was contrasted with the other root thirds. Our explanation to this deep filling penetration may be related to the depth of penetration of the plugger of gutta-percha compaction which did not exceed 5 mm that permitted compaction of gutta-percha against canals walls at middle third more than apical third.

According to earlier research, the optimal apical sealing is achieved by heating and compacting gutta-percha at 5 to 7 mm from the apex.[25] When the temperature is 40 to 42°C.[27] Allison et al.[43] stated that in order to create an apical seal, compaction should extend 1 to 2 mm to the apex. and a 3 to 5°C apical under clinical conditions, it is impossible to manage an increase in body temperature. In the current study we prefer to compact gutta-percha at 5 mm from the apex to mimic clinical situations when the clinician tries to avoid apical extrusion of gutta-percha. The apical control of high-temperature thermoplasticized gutta-percha obturation was an interesting discovery. Gutta-percha never extended past the apical foramen.

Concerning guttacore obturation, it showed a greater filling penetration ability in simulated lateral canals at the apical level more than continuous wave technique, this is in accordance with the findings of many studies.[44,45,46,47] They attributed this proper apical filling penetration to the influence of the materials' physical properties on their behavior within the canal. The gutta-percha of the heated obturator reaches a temperature of approximately 200°C as it nears the canal orifice.[48] Thermoplasticized gutta-percha exhibits thixotropic behavior, enabling it to flow with reduced viscosity at higher insertion rates (i.e., greater force).[44] In the Guttacore group, Guttacore's viscosity was sufficiently low to allow the filling material to flow to the working length. One benefit of carrier-based systems is the capability to use thermoplasticized gutta-percha to fill the apical region of the canal.[49,50]

Comparing the penetration ability among different thirds of root canal (coronal, middle, apical) the present study's findings indicated a comparable penetration among the three thirds using continuous wave technique. While Guttacore obturation exhibited a deeper penetration of the filling at the apical level compared to middle and coronal levels. Similar finding using penetration of sealers into the simulated lateral canals was recorded by Chan et al.[51] They attributed the deeper penetration at the apical level to the apical root canal diameter being less than the coronal root canal diameter. This should result in a greater hydraulic pressure, which pushes the sealer farther into the lateral canal during obturation.

The issues discussed above indicated the superiority of Guttacore filling to penetrate the simulated lateral canals over continuous wave obturation at the apical level. also, it gave the deepest penetration at the apical third when contrasted to the coronal and middle third. This observation has theoretical implications for clinical practice because the majority of ramifications are found in the apical part of the root.[52] It is preferable to have more sealer penetration at this point because it may improve the root canal's apical barrier against tissue fluid infiltration.

CONCLUSION

Both Continuous wave and Guttacore techniques showed the ability to fill simulated lateral canals. Guttacore obturation may be considered a better technique for obturation according to its proper behavior apically.

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