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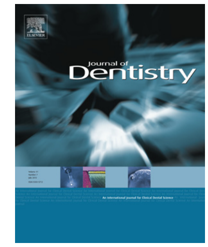

Quality of obturation achieved by an endodontic core-carrier system with crosslinked gutta-percha carrier in single-rooted canals

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ABSTRACT

Objectives: The present study examined the quality of obturation in root canals obturated by GuttaCore, a gutta-percha-based core-carrier system with a cross-linked thermoset gutta-percha carrier, by comparing the incidence of gaps and voids identified from similar canals obturated by cold lateral compaction or warm vertical compaction.

Methods: Thirty single-rooted premolars with oval-shaped canals were shaped and cleaned, and obturated with one of the three obturation techniques ($N = 10$): GuttaCore, warm vertical compaction or cold lateral compaction. Filled canals were scanned with micro-computed tomography (micro-CT); reconstructed images were analysed for the volumetric percentage of gaps and voids at three canal levels (0–4 mm, 4–8 mm and 8–12 mm from working length). The roots were subsequently sectioned at the 4-mm, 8-mm and 12-mm levels for analyses of the percentage of interfacial gaps, and area percentage of interfacial and intracanal voids, using scanning electron microscopy (SEM) to examine negative replicas of root sections. Data were analysed with parametric or non-parametric statistical methods at $\alpha = 0.05$.

Results: Both micro-CT and SEM data indicated that canals obturated with GuttaCore core-carriers had the lowest incidence of interfacial gaps and voids, although the results were not significantly different from canals obturated by warm vertical compaction. Both the GuttaCore and the warm vertical compaction groups, in turn, had significantly lower incidences of gaps and voids than the cold lateral compaction group.

Conclusions: Because of the similarity in obturation quality between GuttaCore and warm vertical compaction, practitioners may find the GuttaCore core-carrier technique a valuable alternative for obturation of oval-shaped canals.

Clinical Significance: The quality of obturation achieved by GuttaCore in single-rooted canals is not significantly different from that achieved by warm vertical compaction.

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1. Introduction

Success in root canal treatment was founded upon the triad of thorough canal débridement, effective disinfection and obturation of the canal space.[1] Although contemporary research indicates that shaping and cleaning are strategically more significant than obturation of the canal space for eliminating root canal infections,[2] a significant share of this triad has historically been allocated to obturation of the canal space.[3] Three-dimensional obturation of the canal space to the working length[4] has been depicted as the most critical component of root canal treatment for sealing and isolating the canal space from irritants that remain after shaping and cleaning, and for eliminating leakage from the periradicular tissues or oral cavity into the filled canal space.[5,6] Results from these early studies are supported by recent outcome studies that highlight the contribution of root filling quality to the success of primary and secondary root canal treatment.[7–10] It is undeniable that a high quality coronal seal is important for endodontic success[11]; apical periodontitis has been shown to heal in teeth with unfilled canals following meticulous shaping and cleaning, and placement of a coronal seal.[12] However, insisting that healing reliably occurs in the presence of a defective root filling is to have created a very short-sighted view on the important roles played by root canal obturation in preserving the environment created by shaping and cleaning and preventing microbial reinfection of the canal space,[13,14] both of which are essential for maintenance of long-term periradicular health.[15]

Interfacial gaps and voids present in filled root canals are clinically relevant because as low as 1% shrinkage of root canal sealers can result in gaps that are large enough for penetration of bacteria and their noxious products.[16,17] Different methods have been utilised for examination of interfacial gaps and sealer penetration within filled root canals, including destructive and non-destructive methods. Destructive methods involve sectioning of the filled root canals and examination by light microscopy, confocal laser scanning electron microscopy or scanning electron microscopy (SEM). Although light microscopy and laser confocal scanning microscopy are useful for examining the extent of sealer penetration into dentinal tubules and the percentage of gutta-percha-filled areas, sealer-filled areas and large voids,[18–20] these morphological evaluation techniques lacked the resolution to quantify thin interfacial gaps between the root filling and intraradicular dentine. Scanning electron microscopy of sectioned slabs of root-filled canals has also been used to evaluate the penetration of root canal sealers into dentinal tubules. These SEM techniques offer a number of advantages. Images produced using SEM permit observation of the interfacial quality at higher resolution. The main disadvantage of SEM is the potential for producing artefacts during specimen preparation; dehydration of the specimens during laboratory processing and examination in a high vacuum environment create artefactual interfacial gaps. This renders evaluation of the interfacial quality of the root canal fillings futile using conventional scanning electron microscopes. However, this limitation may be overcome by examining polyvinylsiloxane impressions (i.e. negative replicas) of the root fillings directly,[21] or positive epoxy resin replicas prepared indirectly from those impressions.[22] Micro-computed tomography (micro-CT) is a non-destructive three-dimensional (3-D) imaging technique that has been adopted in endodontics for analysing the interfacial quality of root fillings.[23–29] Because micro-CT imaging is non-invasive, specimens remain intact during examination and may be subsequently sectioned and examined by SEM for confirmation of the image reconstruction results. An enormous amount of information may be generated from scans; planar slices may be recreated in any plane and data may be represented as two-dimensional (2-D) or 3-D images and evaluated qualitatively or quantitatively.

The most common techniques employed for root canal obturation include cold lateral compaction, warm vertical compaction and core-carrier techniques.[30] Coating metal carriers such as gold wire, silver points and endodontic files with heat-softened gutta-percha for three-dimensional obturation of the canal space[31–34] has long existed before the commercialisation of different prefabricated alpha-phase gutta-percha-based or polycaprolactone-based core-carrier systems. These core-carrier systems are claimed to enhance adaptation of the gutta-percha to the canal wall, and flow of the filling material into lateral canals. Due to the difficulties encountered in retreatment and in the preparation of post spaces, the original metal carriers were subsequently replaced by plastic obturators.[35,36] Recently, a new core-carrier system was introduced (GuttaCore, Dentsply Tulsa Dental Specialties, Tulsa, OK, USA) in which the Vectra (a liquid crystal polymer) or polysulphone plastic carriers in Thermafil Plus (Dentsply Tulsa Dental Specialties) were replaced by cross-linked thermoset gutta-percha, which enables the carrier (obturator) to be removed more easily during retreatment. The cross-linked thermoset gutta-percha does not melt by heat used in an obturator oven, and is insoluble in common organic solvents employed for root canal retreatment.[37] Removal of this modified obturator during retreatment may be achieved by mechanical trephining through the carrier.[38]

Although the core-carrier obturation technique has been regarded by some as the only genuine warm gutta-percha technique for adaptation to the apical third of the canal space,[39,40] the quality of root canal obturation achieved by the new core-carrier system that incorporates cross-linked thermoset gutta-percha carriers has not been reported. Thus, the objective of the present in vitro study was to examine the quality of obturation in single-rooted canals obturated by the GuttaCore core-carrier system by comparing the results with similar canals obturated by the cold lateral compaction technique or the warm vertical compaction technique, using non-destructive (micro-CT) and destructive (SEM) methods of investigation. The null hypothesis tested was that there are no differences in the percentage of interfacial gaps and voids in single-rooted canals obturated by the GuttaCore core-carrier technique, gutta-percha cold lateral compaction technique and gutta-percha warm vertical compaction technique using the same root canal sealer.