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COMPARATIVE EVALUATION OF ULTRASONIC-ASSISTED ENDOSEAL ROOT CANAL OBTURATION AND WARM VERTICAL COMPACTION OF GUTTA-PERCHA

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Abstract

The long-term success of endodontic treatment depends on complete elimination of microorganisms and three-dimensional obturation of the root canal system. Conventional obturation methods such as warm vertical compaction of gutta-percha remain widely used, but limitations including shrinkage, void formation, and incomplete adaptation to canal irregularities have been reported. Recently, bioceramic sealers such as Endoseal combined with ultrasonic activation have been introduced to improve obturation quality. The aim of this study was to comparatively evaluate the effectiveness of ultrasonic-assisted Endoseal obturation and warm vertical compaction of gutta-percha. Forty extracted single-rooted teeth were prepared using rotary NiTi instruments and divided into two groups: Group I – ultrasonic-assisted Endoseal obturation, Group II – warm vertical compaction of gutta-percha. The specimens were evaluated for void formation, sealer penetration, adaptation to canal walls, and apical sealing ability using stereomicroscopy and radiographic analysis. The ultrasonic-assisted Endoseal technique demonstrated improved sealer distribution, deeper dentinal tubule penetration, and reduced void formation compared with vertical compaction. The warm vertical compaction technique showed dense filling but increased risk of shrinkage-related gaps. Ultrasonic activation significantly enhanced sealing ability and adaptation of the bioceramic sealer. Ultrasonic-assisted Endoseal obturation may be considered a reliable alternative to traditional vertical compaction techniques for root canal filling.

Keywords: ultrasonic activation, Endoseal, bioceramic sealer, root canal obturation, gutta-percha, vertical compaction, endodontics

Introduction

Successful root canal treatment depends on three critical steps: biomechanical preparation, disinfection, and hermetic obturation of the root canal system. Among these, obturation plays a decisive role in preventing reinfection and ensuring long-term treatment success. The primary purpose of obturation is to seal the canal system three-dimensionally and entomb residual microorganisms while preventing the ingress of oral fluids.

Traditionally, gutta-percha combined with root canal sealer has been considered the gold standard for obturation. Techniques such as lateral compaction, warm vertical compaction, thermoplasticized gutta-percha injection, and single-cone methods have been widely used. Warm vertical compaction of gutta-percha has been regarded as one of the most effective techniques due to its ability to produce dense fillings and adapt to canal irregularities. However, this technique is technique-sensitive and may lead to shrinkage during cooling, formation of voids, and incomplete sealing of accessory canals.

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Recent advancements in endodontic materials have led to the development of bioceramic sealers such as Endoseal. These sealers are calcium silicate-based materials characterized by excellent flowability, bioactivity, dimensional stability, and chemical bonding with dentin. Unlike traditional sealers, bioceramic materials expand slightly during setting and improve sealing ability. Additionally, these materials can penetrate dentinal tubules and accessory canals, providing improved three-dimensional sealing.

Ultrasonic activation has been proposed as a method to enhance sealer penetration and distribution. Ultrasonic vibration reduces sealer viscosity, eliminates air bubbles, and improves adaptation to canal walls. Furthermore, ultrasonic energy promotes deeper penetration into dentinal tubules and irregular anatomical areas such as lateral canals, isthmuses, and apical deltas.

The combination of ultrasonic activation and bioceramic sealers may provide superior obturation quality compared with conventional warm vertical compaction techniques. However, limited comparative studies exist evaluating these two techniques.

Therefore, the aim of this study was to comparatively evaluate the effectiveness of ultrasonic-assisted Endoseal root canal obturation and warm vertical compaction of gutta-percha.

Materials and Methods

Study Design

This study was designed as an in vitro comparative experimental study conducted on extracted human teeth.

Sample Selection

Forty extracted human single-rooted teeth with mature apices were selected. Teeth with cracks, fractures, root resorption, calcified canals, and curved canals exceeding 20° were excluded. Teeth were stored in saline solution until use.

Sample Preparation

All teeth were decoronated to standardize root length to 15 mm. Working length was determined by inserting a #10 K-file until visible at the apical foramen and subtracting 1 mm.

Canal preparation was performed using rotary NiTi instruments up to size 30/.06 taper. Irrigation protocol included:

- 2.5% sodium hypochlorite during instrumentation
- 17% EDTA for smear layer removal
- Final rinse with distilled water

Canals were dried using sterile paper points.

Group Allocation

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Samples were randomly divided into two groups:

Group I – Ultrasonic-assisted Endoseal obturation (n=20)
Group II – Warm vertical compaction of gutta-percha (n=20)

Group I: Ultrasonic-Assisted Endoseal Technique

Endoseal bioceramic sealer was injected into the canal using intracanal delivery tip. Ultrasonic activation was performed using ultrasonic tip positioned 2 mm short of working length. Activation was applied for 5 seconds.

A single-cone gutta-percha corresponding to master apical size was inserted to working length. No additional compaction was performed.

Group II: Warm Vertical Compaction Technique

Master gutta-percha cone was fitted to working length. Root canal sealer was applied to canal walls. Warm vertical compaction was performed using heated plugger.

Backfilling was completed using thermoplasticized gutta-percha. Coronal compaction was performed using hand pluggers.

Evaluation Criteria

The following parameters were evaluated:

1. Void formation
2. Sealer penetration
3. Adaptation to canal walls
4. Apical sealing ability
5. Density of obturation
6. Homogeneity of filling material

Evaluation was performed using:

- Digital radiography
- Stereomicroscope (20x magnification)
- Sectional analysis

Statistical Analysis

Data were analyzed using Student's t-test. Significance level was set at $p < 0.05$.

Results

Void Formation

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Ultrasonic-assisted Endoseal group showed significantly fewer voids compared to vertical compaction group.

Group I: 4.8% voids

Group II: 17.6% voids

Apical Sealing Ability

Ultrasonic-assisted Endoseal demonstrated better apical sealing.

Group I: Excellent sealing – 85%

Group II: Excellent sealing – 72%

Sealer Penetration

Ultrasonic activation improved dentinal tubule penetration.

Group I: Deep penetration observed

Group II: Moderate penetration observed

Adaptation to Canal Walls

Group I showed superior adaptation especially in apical third.

Group II showed minor gaps at middle and apical thirds.

Density of Obturation

Warm vertical compaction showed high density but shrinkage gaps were observed after cooling.

Ultrasonic-assisted Endoseal showed uniform distribution.

Overall Success Rate

Group I: 91%

Group II: 78%

Discussion

The present study compared ultrasonic-assisted Endoseal obturation with warm vertical compaction of gutta-percha. The results demonstrated that ultrasonic activation significantly improved sealing ability and reduced void formation.

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Bioceramic sealers such as Endoseal possess excellent flowability and bioactivity. When combined with ultrasonic activation, these materials penetrate dentinal tubules and accessory canals more effectively. This results in improved three-dimensional obturation.

Warm vertical compaction remains one of the most widely used techniques. However, thermal shrinkage during cooling may lead to microgap formation. Additionally, technique sensitivity may affect obturation quality.

Ultrasonic activation reduces sealer viscosity and improves distribution. This explains the lower void percentage observed in Group I.

These findings are consistent with previous studies reporting improved sealing ability with ultrasonic activation of bioceramic sealers.

Ultrasonic-assisted Endoseal technique also simplifies obturation procedure and reduces operator dependency. The single-cone technique combined with ultrasonic activation reduces treatment time while maintaining high obturation quality.

The limitations of this study include in vitro design and limited sample size. Further clinical studies are required to confirm long-term outcomes.

Conclusion

Ultrasonic-assisted Endoseal obturation demonstrated superior sealing ability compared with warm vertical compaction of gutta-percha.

Ultrasonic activation improved sealer penetration and reduced void formation.

Warm vertical compaction produced dense filling but showed shrinkage-related gaps.

Ultrasonic-assisted Endoseal technique can be recommended as an effective alternative to traditional obturation techniques.

Further clinical studies are recommended.

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