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In Vitro SEM Comparison of Marginal Adaptation in Retrograde Fillings: Neoputty Vs. ProRoot MTA

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Aim: In terms of marginal adaptation, the research set out to compare and contrast Neoputty MTA with Proroot MTA, two retrograde filling materials.

Materials and methods: We retrieved forty anterior single-rooted teeth from the maxilla that had just been removed and cleaned them with sodium hypochlorite. After amputating the specimens at the CEJ, a size #10 K-file was used to confirm that the canals were patent. shaping, cleaning and obturation of the canals were followed. Using a diamond stone with water cooling, the teeth were resected 3mm from the apex, perpendicular to the long axis of the root. Using a Satalec ultrasonic tip AS3D, root-end cavities were produced to a class I design, with a depth of 3mm and an apical diameter of 1mm. A periodontal probe was used to standardise the preparation depth of 3mm. Twenty teeth were randomly assigned to each of the two groups.Two groups were given retrograde materials: one was given Neoputty MTA and the other Proroot MTA. Using SEM, we checked the materials in both groups for marginal adaptation. The two groups were compared using a paired sample t-test.

Results: The following was the mean gap at the material-dentin contact, as shown by quantitative SEM observations: When compared with ProRoot MTA, Neoputty MTA exhibited a smaller gap distance.When comparing Proroot MTA with Neoputty MTA for marginal adaptation, there was no statistically significant difference.

Conclusion: Neoputty MTA could be used instead of Proroot MTA as a retrograde filling material.

Keywords: ProRoot MTA, Neoputty MTA, SEM, Retrograde filling, Marginal Adaptation

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Introduction

Endodontic surgery is a dental treatment with a lengthy history. Concepts of apical surgery were presented by a number of doctors in the late 19th and early 20th century. Debris removal from the infected periapical tissue and necrotic portions of the apex were the primary goals.[1]

While these methods were effective, they failed to account for intraradicular infection.Publications by Faulhaber and Neumann in the early 90s brought root end resection to a broader audience.[2]

Root resection is done by removing 3 mm of the apex aiming to remove anatomical variations as ramifications, lateral canals and apical deltas. In addition to remove any procedural errors that encountered during RCT.

Root end cavity preparation is performed using an ultrasonic tip ensuring adequate cleaning and shaping for the last 3 mm of the canal system including isthmus. The parallel walls that are created achieves an adequate retention for subsequent addition of a root-end filling materials.[3]

To stop germs and their toxins from getting out of the canal and into the peri radicular tissues, root-end filling material is designed to form an apical seal with the canal. It needs to be safe for the surrounding cells, not irritate them, and promote bone and periodontium renewal. Accordingly, it should be dimensionally stable, insoluble and have adequate bond strength to the radicular dentin. Traditionally there was some materials that used as root end filling material cannot fulfil these requirements.[4]

MTA (mineral trioxide aggregate) is the material of choice for endodontic surgeries. Nevertheless, there are several disadvantages, including handling difficulties, longer setting times, discoloration, and its powder/liquid form, which contribute significantly to material waste. Bioceramic materials are developed to address these challenges.[5]

"Ceramic products or components employed in medical and dental applications, mainly as implants and replacements that have osteoinductive properties" is how bioceramics are described by kosh and courageous.[6] Given their resemblance to biological hydroxyapatite, they demonstrate remarkable biocompatibility. Inducing a regenerative response in humans is possible with bioceramics. They have an osteoconductive action when they come into touch with bone, which means they encourage the growth of new bone at the interface. In the fifth generation of bioceramics, premixed materials have been introduced to the market. They are easier to work with, have a more consistent consistency, and reduce waste.[7]

Neoputty MTA® is a bioactive premixed bioceramic material known for its excellent handling properties. Tangalite, dicalcium silicate, tricalcium aluminate, calcium sulphate, stabilisers, unique organic liquid, and calcium aluminate are all components. The product boasts many qualities, including being bioactive, biocompatible, initially high in pH (alkaline/basic), non-cytotoxic, non-genotoxic, and antimicrobial, according to the maker.[8]

Additionally, it encourages the development of hydroxyapatite, which aids in healing, and has the greatest radiopacity of its kind. Resin-free for dimensional stability without shrinkage and is non-staining to prevent tooth discoloration.

In this context, this research aimed to assess the marginal adaption of two materials used for retrograde root end filling—ProRoot MTA and Neoputty MTA—using a scanning electron microscope.

Our null hypothesis is that Neoputty MTA and ProRoot MTA exhibit no difference in marginal adaptation when used as root-end filling materials.

Materials and methods

Sample selection

Forty single-rooted teeth from the upper jaw that had recently been removed were gathered from the oral surgery departments of two Egyptian universities: Ain Shams University's Faculty of Dentistry and Future University's Faculty of Oral and Dental Medicine.

Inclusion criteria:

- Teeth that have developed apices and a wide, unbroken root
- According to Ver Tucci's categorization, teeth having a single root and a single root canal are classified as Type I.
- Root canals that have typical anatomy devoid of (type I) calcifications, significant curvature, dilacerations, or any other abnormalities.
- Teeth with adequate root length.

Exclusion criteria

- Using a preoperative periapical radiograph taken mesiodistally and buccolingually, teeth showed signs of root fracture abnormalities and cracks.
- Teeth that exhibit anomalies, such as calcification in the root canals or internal or external resorption.
- Teeth with open apex.
- Teeth with previous root canal treatment.

Sample size calculation

According to a prior research, the average and standard deviation of the gaps when using MTA as a material for filling the ends of root canals were determined to be 6.72±3.74. Assuming a t-test with a power of 0.8 and a type I error of 0.05 will show that the Neoputty MTA will bring the mean percentages of gaps down to 3.72.[9] the sample size necessary to detect a statistically significant difference between the two groups will be 36 (18 teeth per group). To make up for any losses that may occur during scanning electron microscopy examination, the number is raised to 40 teeth in total (20 teeth each group).

Sample preparation

After removing calculus, stains, and organic debris from all teeth using an ultrasonic scaler, they were placed in a jar with a saline solution and left at room temperature. A size #10 K-file was used to confirm canal patency after the crowns were severed at the CEJ.

The canals were shaped using ProTaper Universal rotary instruments, following a crown-down technique.

Shaping files were used in a specific sequence, and canal preparation was completed when a hand K-file snugly fit the apical third. The root canals were obturated using a warm vertical compaction technique.

Using a diamond stone on a high-speed handpiece with plenty of water cooling, the teeth were resected 3mm from the apex, perpendicular to the long axis of the root, after obturation.

Using a low-power ultrasonic unit and a Satalec ultrasonic tip AS3D, root-end cavities were produced to a class I design, measuring 3mm deep and 1mm at the apical end.

The water spray was used to encase the tip as it was moved back and forth throughout the cutting process.

A periodontal probe was used to standardise the preparation depth, ensuring that all cavities were 3mm deep. The cavities were thereafter wiped dry with paper swabs and washed with distilled water. It was determined via post-operative radiography that the cavities were contained inside the root canal. This made guaranteed that all specimens were consistent and accurate.

Using ProRoot MTA from DENTSPLY in Maillefer, Switzerland, half of the samples were filled. After getting everything ready as per the manufacturer's instructions, the material was placed into the cavity and sealed with pluggers from Eighteeth in Changzhou. Neoputty MTA, made by NuSmile Ltd and distributed by Avalon Biomed in the United States, filled the other.

Pluggers (Eighteeth, Changzhou) were used to seal the Neoputty MTA after it was extracted from the preloaded syringe given by the manufacturer and placed into the prepared cavity.

For 24 hours, the teeth were kept in jars inside an incubator (Hmg, India) that was set at 37°C. Following this time, the teeth were extracted and carefully rinsed with distilled water to make sure the material had fully set. A periodontal probe was used to gently push down on the filling's surface to check for completion of setting.

Sample evaluation:

The SEM tubes have the specimens attached to them. A 20kV excitation voltage, an in-lens detector, and a 10.1mm working distance were all part of the scanning electron microscope setup. We assessed the gap thickness between the root end filling material and the retro cavity dentine walls at seven places along the material-dentine interface in transverse section while examining the samples at X1000 magnification.

The program Image Tool 3.0 was used to quantify the extent of the gap in micrometres (µm) from the data. In order to get the mean and standard deviation (SD) of the sample gaps, we averaged the gaps from the seven spots that were chosen.

Statistical Analysis:

Kolmogorov-Smirnov and Shapiro-Wilk tests were used to examine the data for normality. For every test, the data demonstrated a parametric distribution as seen by the mean and standard deviation values for each group. The researchers compared the two groups in a similar study using a paired sample t-test.For Windows, IBM® SPSS® Statistics Version 20.

Results

Figure 1 shows with a minimum of 7.4 µm and a high of 8.9 µm, the mean gap thickness between the dentino-material interfaces for Neoputty MTA was observed as (8.330 ±0.433 µm).

With a minimum of 7.9 µm and a high of 9.3 µm, the measured mean gap thickness between the dentino-material interfaces for Proroot MTA was (8.775±0.4153 µm).

In terms of adaptation, the Neoputty group had smaller gaps, although this did not constitute a statistically significant difference.

Table 1: Neoputty MTA vs Proroot MTA

	Neoputty	**Proroot MTA**
	8.330 ±0.433	9.090 ±0.893
P-value	0.801ns	

ns; non-significant (p>0.05)

Discussion

Calcium silicate-based root-end filling materials have become highly popular over the last ten years and are now commonly used in endodontics for a range of applications, such as root-end fillings in surgical procedures.[10]

The success and healing process of endodontic surgery depend on several factors, including the right choice of retrograde filling material. During its setting, any retrograde filling material can be contaminated by tissue fluids. Therefore, it's essential to choose a material that is least likely to be affected by its environment.[8]

In addition to being radiopaque, biocompatible, bioactive, and bacteriostatic, the perfect material should form an effective seal. Additionally, it should not be poisonous, cariogenic, difficult to apply, or leave behind any visible stains. This is why bioceramics were introduced into endodontics. Their physical, chemical, and biological properties make them excellent candidates for primary use in this field.[11]

Due to its superior physical, chemical, and biological qualities, mineral trioxide aggregate (MTA) became the favoured material after the advent of bioceramic materials in clinical endodontics. But there are a few downsides to using MTA: it's not easy to remove from the root canal once it sets, it has poor handling qualities, and mixing it is necessary, which may lead to substantial material loss. Furthermore, dentin may be stained by both white and grey MTA. Though it has its limits, MTA is still the gold standard for assessing newly released content.[12]

The recently developed bioceramic materials include a repair putty based on premixed tricalcium silicate. The remarkable properties of this substance include its solubility in water, its ease of handling, and its remarkable malleability.[13]

An innovative new material, NeoPutty MTA, has been developed to improve the efficiency of both handling and placing. An ultra-fine tricalcium/dicrylcium silicate powder contained in an organic medium makes up this bioactive paste. It is a great material for retrograde fillings because of its bioactivity, firmness, and low-tack consistency.[14]

The purpose of this research was to compare Neoputty MTA and Proroot MTA with respect to marginal adaptation when employed as retrograde filling material in order to assess the qualities of these novel materials in comparison to the ideal attributes that are needed.

By precisely mimicking clinical settings, the use of recently removed human teeth increased the investigation's dependability. To guarantee uniformity and remove factors linked to several canals and intricately curved canal morphology, single-rooted teeth with wide, straight roots and a single root canal were chosen.[15]

To keep germs and their toxins out of the endodontic system, the retrograde cavity needs a hermetic apical closure. Retrograde filling materials are designed to be well-adapted to the dentinal walls and function as a barrier from the periapical tissue.[16]

A transverse slice of the tooth was used to measure the gap between the root end filling material and the retro cavity dentine walls, which allowed for an assessment of the materials' marginal adaptation. Accuracy was ensured by measuring the mean gap distance over the whole length of the gap at seven chosen places at the material-dentine contact in the transverse section.[17] Materials may vary in their degree of adaptability depending on factors such as their composition, particle size, and the surrounding environment.[18]

Neoputty MTA had a reduced distribution of gap present in marginal adaptation findings compared to Proroot MTA, but there was no statistically significant difference between the two materials (P-value: $p = 0.801$).

Due to compositional variations, NeoPutty MTA has superior adaption capabilities compared to regular cement. The greater surface area and smaller particle size of NeoPutty MTA's powder may hasten the process, resulting in more hydroxyapatite crystal formation and improved marginal adaption.[19]Being premixed, it has improved handling properties and consistency, making it easier to place and adapt within the root canal.

Additionally, NeoPutty MTA exhibits better washout resistance, contributing to its superior adaptability in clinical settings. The bioactive nature of NeoPutty MTA promotes better interaction with the surrounding tissues, enhancing its adaptability and integration. These factors collectively contribute to the improved adaptability of NeoPutty MTA over ProRoot MTA.[20]

our results were in accordance with Yassien MM etal.[21] who compared marginal adaptation for both neoputty MTA and MTA angelus and found that neoputty MTA had better marginal adaptation with no significant difference between the tested groups.

In addition, Mahmoud Ahmed Abdelmotelb etal .[12] evaluated marginal adabtability of both MTA and bioceramic putty and he found that bioceramic putty showed better adaptability than MTA with no significance difference.

Conclusion

When tested in vitro as a retrograde grade filling material, Neoputty MTA outperformed Prorupt MTA in terms of adaptability.

Further research is needed for the Neoputyy MTA.

Ethical approval

This study protocol received ethical approval from the Faculty of Dentistry Ain Shams University Research Ethics Committee (FDASU-RECID032224).

Competing interest

The authors declare that they have no conflicts of interest in relation to this study. Additionally, they have not received any financial support or other benefits from commercial entities that could be perceived as influencing the research outcomes.

Data availability

Data available upon reasonable request from the corresponding author.

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