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A review of the scientific literature concerning the effectiveness of mineral trioxide aggregate in conservative dentistry

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ABSTRACT

This literature study sought to evaluate the clinical performance of MTA in order to determine the amount of evidence for its efficacy in essential pulp therapy, perforation repair, and retrograde root canal filling. An exhaustive literature search was conducted using the Internet databases PubMed/MEDLINE. This study analysed a total of 58 papers, of which 2 were systematic reviews/meta-analyses, 9 were randomised controlled trials (RCTs), and the remainder fell into other categories. As a direct capping material, mineral trioxide aggregate (MTA) provided superior pulp protection than calcium hydroxide. As a perforation repair material, MTA displayed outstanding in vitro sealing properties. In clinical trials, MTA resulted in normal healing of periodontal tissues surrounding a hole. Therefore, it may be stated that MTA has a strong potential for perforation correction. MTA is the most promising material for retrograde root canal fillings, exhibiting normal healing in both short- and long-term clinical outcomes.

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Keywords: Mineral trioxide aggregate (MTA), Pulp capping, Perforation repair, Retrograde filling

INTRODUCTION

Early in the 1990s, Torabinejad1) created mineral trioxide aggregate (MTA). It is an inorganic substance with exceptional physical and biological properties. CaO, SiO2, Al2O3, and Fe3O4 are its primary constituents, together with SiO2, Al2O3, and SiO2. It was approved by the Food and Drug Administration (FDA) of the United States in 1998 and marketed under the brand name ProRoot MTA (Dentsply Tulsa Dental, Johnson City, Tennessee, USA). Rapidly, it spread over the globe for a wide range of applications, including direct pulp capping, perforation repair, retrograde and other root canal fillings, vital pulpotomy, and apexification. As MTA became commercialised, several research were conducted, and its good biocompatibility, activity in promoting hard tissue formation, and marginal sealing capacity were established, along with its antimicrobial activities and other features. Numerous studies have also revealed outstanding clinical outcomes comparable to or superior to those of calcium hydroxide, which is often used for the same goals. However, there were still concerns that required addressing, such as setting time, property handling, and tooth yellowing. In recent years, researchers and manufacturers have made strides in resolving these issues, and new and improved solutions are emerging. We conducted a literature review of clinical and basic studies of direct pulp capping, perforation repair, and retrograde root canal filling after apicoectomy in order to establish the level of evidence for the efficacy of MTA in these applications, so as to encourage its use in a greater number of cases and bring its outstanding benefits to more patients. This will provide a comprehensive overview of the current status of MTA and reaffirm the material's efficacy, laying the groundwork for its expanded application.

Direct pulp capping material

1.Context methods of pulp capping as

An essential pulp therapy can include: be separated into direct and indirect strategies for capping.In the clinical recommendations or reviews for treating caries 19), scientific evidence for

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the efficacy of indirect pulp capping, in which some of the infected tooth substance is left in place, is documented, and this approach is already frequently utilised in clinical practise. However, the success rate for direct pulp capping, in which the pulp of the carious tooth is exposed, has varied greatly among studies, with reported rates ranging from 30% to 80%8,15,16,20,21), and satisfactory long-term results are not always attained. This variance may be the result of patient selection and pulp capping techniques. In this section, we examined the scientific evidence for the efficacy of MTA as a material for direct pulp capping of either pulp at the stage of reversible pulpitis from pulp hyperemia or clinically healthy pulp that has been exposed after the removal of infected dentin, tooth fracture, or cavity preparation.

2. Histopathological assessments

Calcium hydroxide (CH) has frequently been employed as the direct pulp capping material. In this part, we compared the effectiveness of MTA and CH. We examined both basic research and clinical papers pertaining to MTA in order to determine the evidence supporting its expanded clinical application.

Prior to clinical research of direct pulp capping, numerous fundamental studies of CH or MTA were conducted on the mechanically exposed pulp of monkey or canine teeth. Ford et al. (17) exposed the pulp of upper canine teeth in monkeys with a #1 round burr and employed CH or MTA as a pulp-capping material in 6 teeth each. There was no inflammation in 5/6 teeth capped with MTA at the 5-month follow-up, and complete hard tissue deposition (a dentin bridge) had formed in 6/6. Six of six teeth capped with CH exhibited an inflammatory response, whereas only two of six teeth exhibited hard tissue deposition. Faraco and Holland40) generated regions of exposed pulp with a diameter of 0.5 mm on the labial side of 30 canine teeth and capped 15 with CH and MTA, respectively. After 2 months of follow-up, all MTA-capped teeth exhibited tubular dentin bridge development, with no inflammatory signs. In 5/15 of the CH-capped teeth, a dentin bridge had formed, whereas inflammation was detected in 12/15. The authors came to the conclusion that MTA was a more efficient pulp capping material than CH.

Sealing ability for perforations

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Numerous in vitro experiments have examined the sealing capacity of MTA, and the general consensus is that it is superior to that of other materials 14).The developers released the first investigation of simulated perforation repair using holes produced in the roots of excised human teeth as the first paper describing MTA 1). Dye leakage tests indicated that MTA's sealing capability was much superior to that of amalgam and reinforced zinc oxide-eugenol cement. Studies of perforations in the pulp chamber floor using extracted human teeth found that MTA provides superior sealing performance compared to amalgam 14, resin-modified glass ionomer cement 56, and intermediate reinforced material (IRM) cement (Dentsply Sirona, York, PA, USA), a zinc oxide-eugenol cement 18. Fluid filtration tests of the sealing ability of MTA for perforations of the floor of the pulp chamber of extracted human teeth, including analysis over time, revealed that after 24 h its performance was slightly inferior to those of Super EBA (Harry Bosworth, Skokie, IL, USA)55, a reinforced zinc oxide-eugenol cement, and One-up Bond (Tokuyama Dental, Tokyo, Japan) 17, a one-step bonding agent, although it was subsequently equivalent. These data demonstrate that the MTA setting reaction is slow and time-consuming. All of the aforementioned research can be construed as providing evidence that MTA has good sealing ability when used for perforation repair, but its sealing ability may not reach the appropriate level immediately after mixing.

Clinical assessment

Siew et al.13) conducted a systematic review and meta-analysis of the outcomes of perforation repair utilising various materials. They discovered that the combination .Using data from 12 studies, the success rate was 72.5% for all teeth [confidence interval (CI) 61.9–81.0%] and 80.9% (CI 67.1–89.0%) for MTA-repaired teeth. The use of MTA tended to increase the success rate, however this difference was not statistically significant. A nonrandomized clinical trial of the outcomes of secondary root canal treatment performed at the University of Toronto (4–6 years follow-up)21) discovered that 14 patients exhibited a perforation associated with preoperative radiolucency, and that all four teeth repaired with MTA were deemed to have healed, whereas only three of ten teeth healed after repair with resin-modified glass ionomer cement. In a non-randomized clinical trial of the outcomes of non-surgical endodontic treatment

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(including both primary and secondary treatment) conducted at the University of London (2–4 years follow-up)24, 81 perforations were repaired using various different materials (MTA, glass ionomer cement, EBA cement, IRM cement, gutta-percha, or amalgam), but there were no differences in the healing rates between any of these materials. Pontius et al.16) conducted a multicenter retrospective cohort study (mean, 37-month follow-up) and discovered that 92% (32/37) of perforation repairs with MTA were successful, but that a high success rate of 85% (11/13) was also obtained when other materials were used, and there was no statistically significant difference. In case series investigations (prospective studies) of perforation repair with MTA, Gorni et al. (20) investigated a series of 110 patients over 8 years. According to this study, within 2 years of the treatment, the outcomes were deemed favourable in 92 percent of 101 patients, with probabilities of progression at 5 and 8 years of 18 percent (95% CI 9–27 percent) and 33 percent (95% CI 16–47 percent), respectively.

In a retrospective case series study, Main et al.17) reported the treatment outcomes of 16 patients who underwent perforation repair with MTA. After 12–45 months (mean, 25 months), no patient exhibited radiolucency or periodontal pockets of 3 mm or more in depth, regardless of the presence or absence of preoperative radiolucency. Pace et al. (33) conducted a retrospective investigation on 10 patients with perforation of the pulp chamber floor and observed satisfactory outcomes in 9 cases 5 years following MTA repair. Mente et al. (23) conducted a retrospective case series investigation on 26 patients and discovered that the success rate was 81% 12–65 months (mean, 33 months) after perforation repair using MTA. Subsequently, they added additional instances to this series and conducted a retrospective case series investigation of a total of 64 patients28), in which the success rate was 86% after 12–107 months (mean: 27.5 months) of follow-up. The outcome was greatly influenced by the operator's experience and postoperative post placement.

Krupp et al. (17) conducted a retrospective case series study of 90 cases of perforation repair with MTA and found that the success rate after 1–10 years (mean, 3.4 years) was 73% and that the presence of preoperative radiolucency near the perforation site and communication between the perforation and the oral cavity both affected the outcome[18-20]. The case series studies

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presented previously indicated that the use of MTA for perforation repair had very predictable outcomes. Thus, the clinical usage of MTA is believed to increase the success rate compared to other materials, despite the lack of sufficient research with a high degree of proof.

In 9 percent of cases following retrograde root canal filling during a four-year period, recurrent apical lesions developed percent patients judged to have healed after one year4), and precise evaluation of the pace of healing requires long-term follow-up of results.[21-23] In addition to reporting the healing rates after one year when retrograde root canal filling was performed with MTA, resin, or Super EBA, von Arx et al. also reported the healing rates after five years9). They discovered that after 5 years, identical to after 1 year, MTA had the highest healing rate (86.4%), followed by resin (75.3%) and Super EBA (67.3%), with a substantial difference between MTA and Super EBA. In another study of the 1-year and 5-year healing rates of 271 teeth after retrograde root canal filling with MTA or resin29), the rates of healing after 1 year were 96.7% for MTA and 90.7% for resin, a difference that was not statistically significant.[24-26] However, after 5 years, there was a statistically significant difference, with the rates being 92.5% for MTA and 76.6% for resin.

When MTA is utilised as a retrograde root canal filling material, it has a stronger tissue-healing impact than other materials, and its continual release of MTA promotes tissue regenerati

CONCLUSIONS

In the field of endodontics, a highly regarded substance and/or drug that offers a positive prognosis for direct pulp capping, perforation repair, and retrograde root canal filling.Filling has been long overdue. Conventional restorative materials and/or resin-based adhesives are still in use today despite the lack of a standardised material and/or medication supported by substantial scientific data. Since its introduction two decades ago, MTA has become one of the most versatile materials with numerous clinical applications, and it is presently virtually universally acknowledged as such. The exceptional qualities of MTA could benefit numerous individuals whose teeth could not otherwise be saved or who would be forced to undergo pulp extirpation. However, compared to conventional materials and medications, MTA has a number of

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drawbacks to overcome, including the potential for discolouration, challenging handling features, an extended setting time, and a protracted maturation period.

As MTA is currently undergoing development, alterations to its composition are anticipated to improve its physical and biological qualities. To increase the quality of life of patients through better dental health, additional clinical research with a well-controlled study design must be undertaken on MTA.

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