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REVIEW STUDY

Antimicrobial Efficacy of Different Root Canal Sealers

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ABSTRACT

Microorganisms are considered as the primary etiological agent in the spread of infection and destruction of carious teeth. Root filling of poor quality results in breakdown of periodontal tissue. There is a retarded or impaired periodontal tissue healing subsequent to periodontal therapy of endodontically treated teeth with periapical pathology. Antimicrobial agents are added to root canal sealers to improve their antibacterial effect. Several root canal sealers based on epoxy resin, calcium hydroxide, and zinc oxide eugenol are available; however, few sealers are effective against endodontic pathogens, especially strict anaerobes. The present review study compares the antimicrobial efficacy of different root canal sealers.

Keywords: Calcium hydroxide, Epoxy resin, Microorganism, Sealer, Zinc oxide eugenol.

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INTRODUCTION

Microorganisms and their by-products are considered as the primary etiological agents in the spread of infection and destruction of carious teeth, and endodontic therapy is an invaluable measure to preserve teeth. One of the main aims of endodontic therapy is complete obturation of the root canal system resulting in sterility of the root canal, thereby preventing recolonization of bacteria and recontamination of root canal space. According to Grossman, one of the ideal requirements of root canal sealer is that it should be bacteriostatic.[1] Root filling of poor quality results in breakdown of periodontal tissue. There is a retarded or impaired periodontal tissue healing subsequent to periodontal therapy of endodontically treated teeth with periapical pathology. Antimicrobial agents are added to root canal sealers to improve their antibacterial effect. Several root canal sealers based on epoxy resin, calcium hydroxide, and zinc oxide eugenol are available; however, few sealers are effective against endodontic pathogens, especially strict anaerobes. The present review study compares the antibacterial efficacy of different root canal sealers.[2]

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CALCIUM HYDROXIDE-BASED SEALERS

The antibacterial efficacy of calcium hydroxide sealer is because of its ability to release hydroxyl ions and raise pH. Elimination of bacteria depends on ionization that releases hydroxyl ions, causing an increase in pH. A pH greater than nine may reversibly or irreversibly inactivate cellular membrane enzymes of the microorganisms, resulting in a loss of biological activity. Antimicrobial action is influenced by its speed of dissociation into calcium and hydroxyl ions. This dissociation into hydroxyl ions creates a high pH environment, which inhibits enzymatic activities that are essential for microbial metabolism, growth, and cellular division.[3,4]

ZINC OXIDE EUGENOL-BASED SEALERS

Eugenol is a potent antibacterial agent. It is a phenolic compound acting on microbes by protein denaturation. The antimicrobial effect of zinc oxide eugenol cement was mainly attributed to the action of eugenol. Eugenol, a phenolic compound, acts on microorganisms by protein denaturation whereby the protein becomes nonfunctional.[5-7]

EPOXY RESIN SEALER

Formaldehyde in epoxy resin sealer has an antibacterial action. Even small quantities of formaldehyde may act as an irritant impeding or retarding bacterial regeneration.[8]

COMPARATIVE STUDY OF DIFFERENT SEALERS

According to Kaplan et al[8], the most effective antimicrobial sealer contains eugenol and formaldehyde. Results of *in vivo* study revealed that periapical tissues diminish the inhibitory effect of cement on bacterial growth. Canalda et al[9] compared inhibition of growth of bacterial strains (*Staphylococcus aureus*, *Escherichia coli*, *Candida albicans*) produced by two root canal sealers with a calcium hydroxide base CRCS and sealapex, with those obtained with two zinc oxide eugenol sealers, Endomethasone and Tubliseal, and one epoxy resin, AH-26 sealer. The results of their study showed that antimicrobial efficacy attained with cements with a calcium hydroxide base is similar to that obtained with other cements. The paraformaldehyde component of zinc oxide eugenol cement increases the inhibition significantly. The greater inhibition obtained with endomethasone sealer is essentially due to its paraformaldehyde component, which spreads easily in the culture medium.

Mickel and Wright[10] compared the growth inhibition of *Streptococcus anginosus* by calcium hydroxide sealers (CRCS, Sealapex, Apexit) with a zinc oxide eugenol-based sealer (Roth sealer) in a agar culture medium, and they concluded that Roth sealer had statistically significant larger mean zone of inhibition than calcium hydroxide sealer. All the sealers exhibited clinically relevant antimicrobial activity. It is likely that eugenol in the Roth sealer is responsible for its greater antimicrobial activity. There was no significant difference between calcium hydroxide sealers tested. These findings are in contrast to Canalda et al,[9] who found bacterial inhibition produced by Sealapex and CRCS was similar to that obtained by zinc oxide eugenol-based sealers. Al-Khatib et al[11] found zinc oxide eugenol sealers to have more antimicrobial activity than either CRCS or Sealapex. They found out that eugenol in zinc oxide eugenol sealer and calcium in $Ca(OH)^2$ sealers are responsible for the antimicrobial action; nevertheless, eugenol in zinc oxide eugenol sealer is cytotoxic. Eugenol is an antibacterial agent. Mickel and Wright[10] found zinc oxide eugenol-based sealant Roth 811 and showed larger zone of inhibition against *Enterococcus faecalis* when compared to $Ca(OH)_2$-based sealer Sealapex and epoxy resin-based sealer AH Plus. Cox et al[12] have shown that zinc oxide eugenol is also an effective bactericidal agent against bacterial species like *S. aureus* and *Streptococcus viridans*.

In a study by Fisher[13], it was found that in carious dentin zinc oxide eugenol was found to be a more effective antibacterial agent than $Ca(OH)_2$. Eugenol being a phenolic compound is also effective against mycotic cells and vegetative forms of bacteria. In order to improve antibacterial efficiency of zinc oxide eugenol sealers, known bactericidal agents, such as iodoform, have been incorporated, resulting in modified zinc oxide eugenol-based sealers, such as Endoflas FS and medicated canal sealers (MCS). Iodoform acts by liberation of iodine, which is an oxidizing agent. Oxidizing agents like iodine can irreversibly oxidize and thus inactivate essential metabolic compounds like protein, which has been accounted for the antimicrobial action.[14,15]

Al Khatib et al[11] tested the antibacterial activity of various sealers like Grossman's sealer, Tubliseal, Calciobiotic, Sealapex, Hypocal, Eucapercha, Nogenol, and AH-26. They also tested dry calcium hydroxide powder, $Ca(OH)_2$, with saline and a Teflon formulation. The microbes used were *Streptococcus mutans* (Gram-positive microerophile), *S. aureus* (Gram-positive facultative anaerobes), and *Bacteroides endodontalis* (Gram-negative obligate anaerobe). Grossman's sealer was the most effective antimicrobial agent against all three microorganisms used. However, AH-26 was most effective against *B. endodontalis* and also among calcium hydroxide powder, hypocal, and $Ca(OH)_2$ saline mixture. Fuss et al[16] also found Roth 811, a zinc oxide eugenol-based sealer, to have a more potent antimicrobial activity than calcium hydroxide sealer, Sealapex after a 24-hour period.

Enterococcus faecalis has been shown to be highly persistent once established in the root canal system and may play an important role in the endodontic failure; therefore Mickel and Wright[10] evaluated the antimicrobial activity of four root canal sealers on *E. faecalis*. Sealers tested were Sealpex, Roth 811, Kerr EWT, and AH Plus on blood agar using Lawn technique. Roth 811 showed largest zone of inhibition, followed by Sealapex and Kerr EWT, whereas AH Plus had no antimicrobial activity. There was no difference in zones of inhibition between 24 and 48 hours time periods.

Orstavik[17] investigated the antimicrobial activity of MCS (iodoform-containing sealer), AH Plus, Grossman's sealer, Sealapex, Apexit on *E. faecalis* by direct contact test They concluded that MCS, AH Plus, and Grossman's sealer were effective in reducing the number of cultivable cells of *E. faecalis*. $Ca(OH)_2$-based sealers – Sealapex and Apexit – were ineffective in this short-term experiment.

Gopikrishna et al[18] evaluated the antimicrobial efficiency of a traditional ZOE-based sealer (Tubliseal) with iodoform incorporated ZOE-based sealer (Endoflas FS), a $Ca(OH)_2$-based sealer (Apexit), and epoxy resin-based sealer (AH Plus and RC seal) against *E. faecalis* and *E. albicans* by agar diffusion test. Endoflas FS performed far better than other sealers against *E. faecalis* and *E. albicans*. Endoflas FS was followed by Tubliseal, Apexit which showed mild antimicrobial efficacy. AH Plus and RC seal showed no antimicrobial properties whatsoever.

Saleh et al[19] observed colony forming units (CFUs) from infected, root canal-treated teeth and comparative results of antibacterial activity on *E. faecalis* was found as follows:

AH Plus and Grossman's sealer had equal antibacterial activity (mean CFU = 0). Glass-ionomer cement-based sealer Ketac endo (1.94) had highest antibacterial activity, this was followed by Apexit (1.40), followed by Roekoseal Automix (1.36) and $Ca(OH)_2$ (0.53).

Kayaoglu et al[20] by direct contact test found the following results for antimicrobial efficacy: MCS > AH Plus > Grossman's sealer > Sealapex > Apexit; while indirect test showed that: MCS > AH Plus > Grossman's sealer > Apexit > Sealapex.

Sipert et al[21] observed Sealapex and filled canal with antibacterial activity on *E. faecalis* while EndoREZ had no such antimicrobial activity.

Antimicrobial efficiency of endo-fill root canal sealant and filling material was microbiologically evaluated. No zone of inhibition was seen around endo-fill against microorganisms like *Staphylococcus pyogenes*, *E. coli*, *C. albicans*, and *Pseudomonas aeruginosa*. Thus endo-fill was evaluated as inefficient microbiologically. Lee[22] reported that endo-fill does not in itself cause lesion resolution.

CONCLUSION

The antibacterial component of endodontic sealers may be an essential factor to prevent the continuous growth of bacteria in the canal. The bactericidal or bacteriostatic activity of root canal sealers eradicates the remaining microorganisms and overcomes persistent residual infection. The present review study reveals that the dissociation of calcium hydroxide into calcium and hydroxyl ions creates a high pH environment, which inhibits enzymatic activities that are essential for microbial metabolism, growth, and cellular division. Eugenol in ZOE sealer is a potent antibacterial agent which acts on microbes by protein denaturation. Paraformaldehyde component and iodoform in modified ZOE sealer act as an oxidizing agent causing bacterial inhibition, and the antibacterial action of formaldehyde in epoxy resin sealer can be attributed to antimicrobial efficacy of the sealer.

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