ANTIBACTERIAL MECHANISM OF NOVEL ENDODONTIC SEALER

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Objective: With growing concern over bacterial resistance to antimicrobial agents, the identification of new antimicrobial means is necessary. In particular, endodontic treatment failure is caused mainly due to bacterial infection. As previously described, quaternary ammonium nanoparticles incorporated into endodontic sealers have the ability to kill a wide array of bacteria. Thus, it is likely that they can overcome bacterial resistance. Here, we tested the ability and the mechanism by which a novel endodontic sealer, incorporating the nanoparticles, can limit Enterococcus faecalis growth.

Method: A polyetleneimine scaffold was used to synthesize nano-sized quaternary amine particles, optimized for incorporation into an epoxy-based endodontic sealer (RCS, B.J.M Laboratories Ltd, Or-Yehuda, Israel). The novel endodontic sealer was first evaluated for its antimicrobial efficacy using: (i) Direct contact test and (ii) electron microcopy (SEM). Results were analyzed using ANOVA followed by Tukey's test ($p<0.05$). Further evaluation of the antibacterial mechanism was conducted using (i) electron microscopy (SEM, TEM) (ii) flow cytometry and (iii) viable counts.

Result: The nanoparticles interact within minutes with bacteria, triggering cell death within 1h across wide pH values. The antibacterial potency was evident when 1.5% wt/wt of the nanoparticles were incorporated in the sealer. Electron microscope images revealed that most of the observed bacteria underwent changes in bacterial morphology and dispersion, with no visible signs of cell division. Syncytium-like cells and bacterial lysis were observed after contact between the bacteria and a surface containing the nanoparticles. Furthermore, the nanoparticles were observed penetrating the bacterial membrane. Flow cytometry analysis showed a decrease in the ratio of the red to green fluorescence in the test group, indicating a higher membrane potential.

Conclusion: The novel endodontic sealer showed potent antibacterial properties. The antibacterial mechanism is through an electrostatic interaction between the nanoparticles and the bacteria, affecting bacterial integrity and permeability, leading to cell death.