P10-5

The study on magnetic nanoparticles modified antibacterial root canal sealer

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OBJECTIVE

Persistent apical periodontitis is a critical challenge for endodontists. Complex root canal system anatomy and continuous infection of microorganisms and biofilms are the main reasons for its occurrence. Therefore, development of root canal filling materials with continuous antibacterial effect and tightly sealed root canals is an important strategy to avoid failure of root canal therapy and prevent persistent apical periodontitis. Adding Dimethylaminododecyl methacrylate (DMADDM) with a mass fraction of 2.5% and MNP with different mass fractions to the EndoREZ root canal sealer respectively or in a mixture. The objectives of this study were to: (1) investigate its effects on the material properties and biological safety; and (2) investigate the antibacterial effect on the multi-species biofilms in the root canal.

MATERIALS & METHODS

2.5% DMADDM and different mass fractions of MNP (0%, 1%, 2%) were added to EndoREZ root canal sealer individually or together. This study compared the effects of DMADDM and different mass fractions of MNP added to EndoREZ sealer on their biological safety, solubility, apical sealing ability, and percentage of penetration under the influence of magnetic fields. This study tested the antibacterial properties and composition of multi-species biofilms composed of *Enterococcus faecalis*, *Lactobacillus acidophilus*, *Streptococcus gordonii*, *Actinomyces naeslundii*.

RESULTS

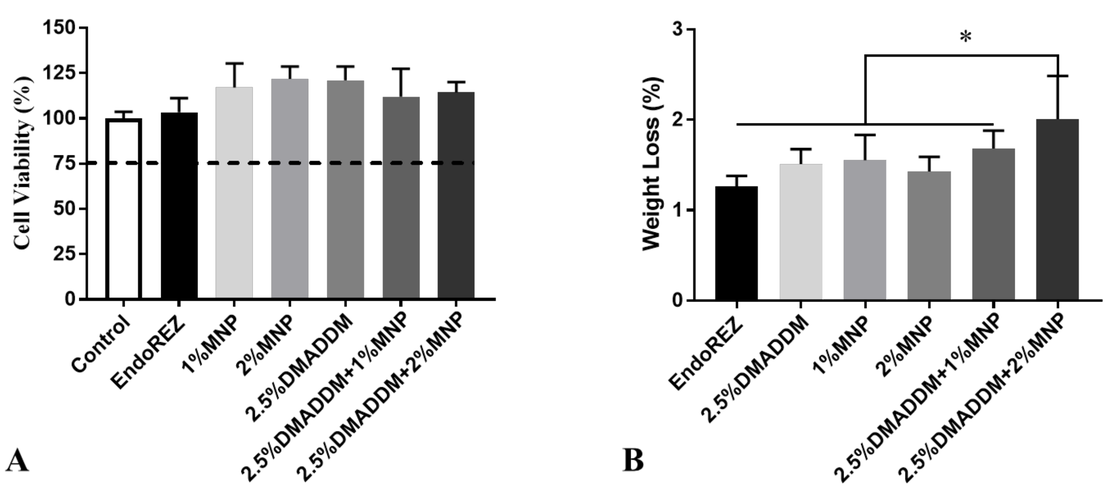

Figure 1. Correlation property tests of sealers. (A) Cytotoxicity assay of sealer eluents with mouse fibroblast. (B) Solubility test of sealers in different groups. *$p < 0.05$. Values are presented as mean ± SD.

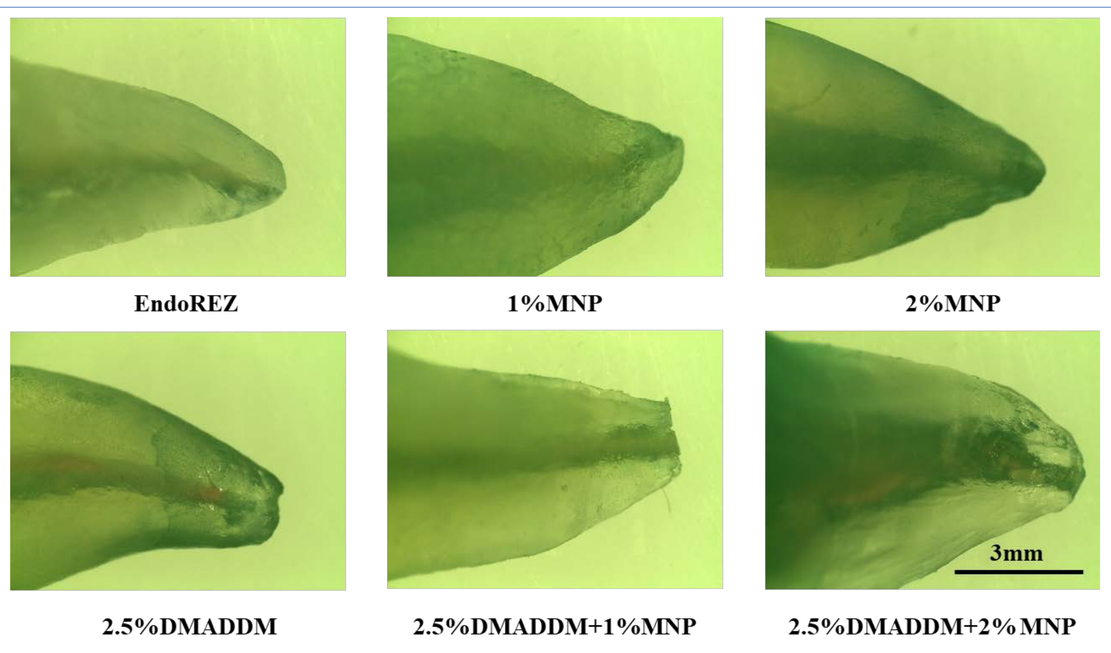

Figure 2. Images of apical sealing ability recorded using a stereomicroscope.

Table 1. Apical sealing ability test of the sealers.

group	The length of penertration（mm）
EndoREZ	1.507±0.123
1%MNP	1.995±0.055
2%MNP	2.935±0.395 *
2.5%DMADDM	1.26±0.17
2.5%DMADDM+1%MNP	1.415±0.045
2.5%DMADDM+2%MNP	2.345±0.275 *

*$p < 0.05$. Values are presented as mean ± SD.

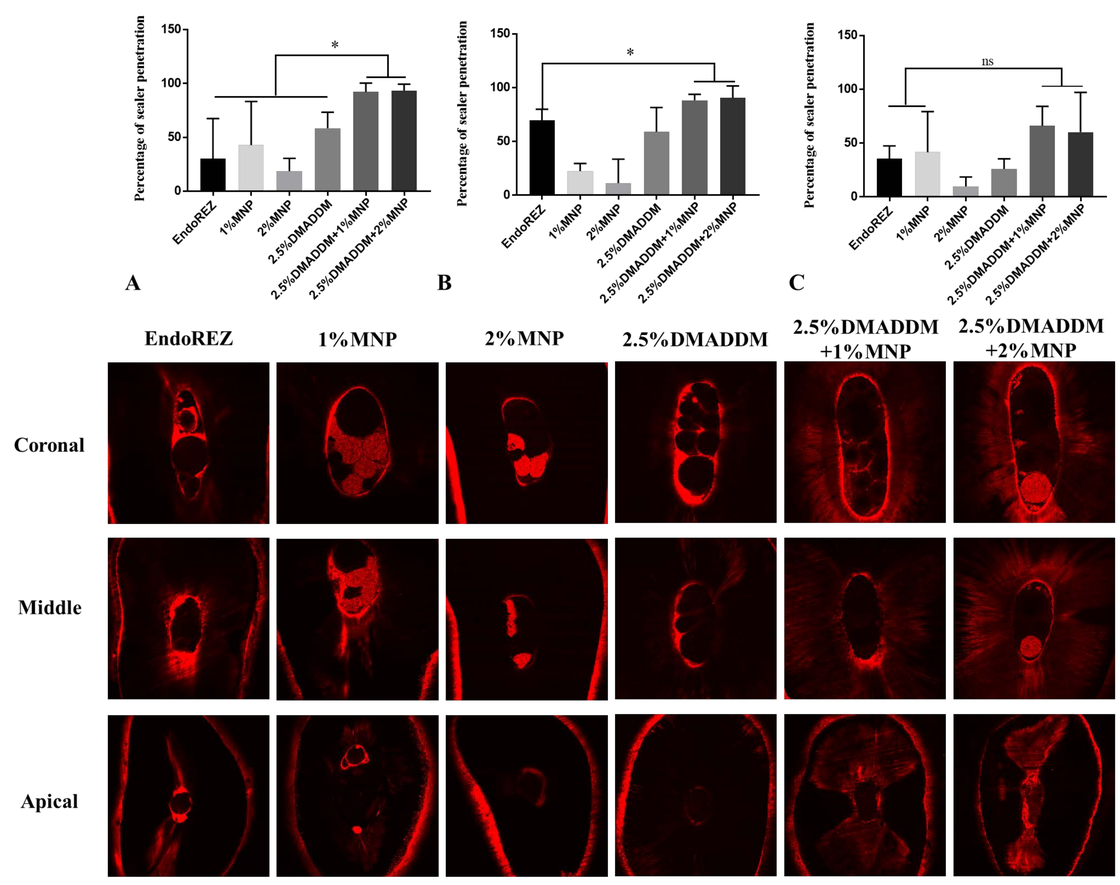

Figure 3. The results of percentage of penetration. Percentage of sealer penetration at coronal root (A), middle root (B) and apical root (C). (D) Representative confocal laser scanning microscopy images from each experimental group at coronal, middle, and apical regions. *$p < 0.05$. NS, not significant; Values are presented as mean ± SD.

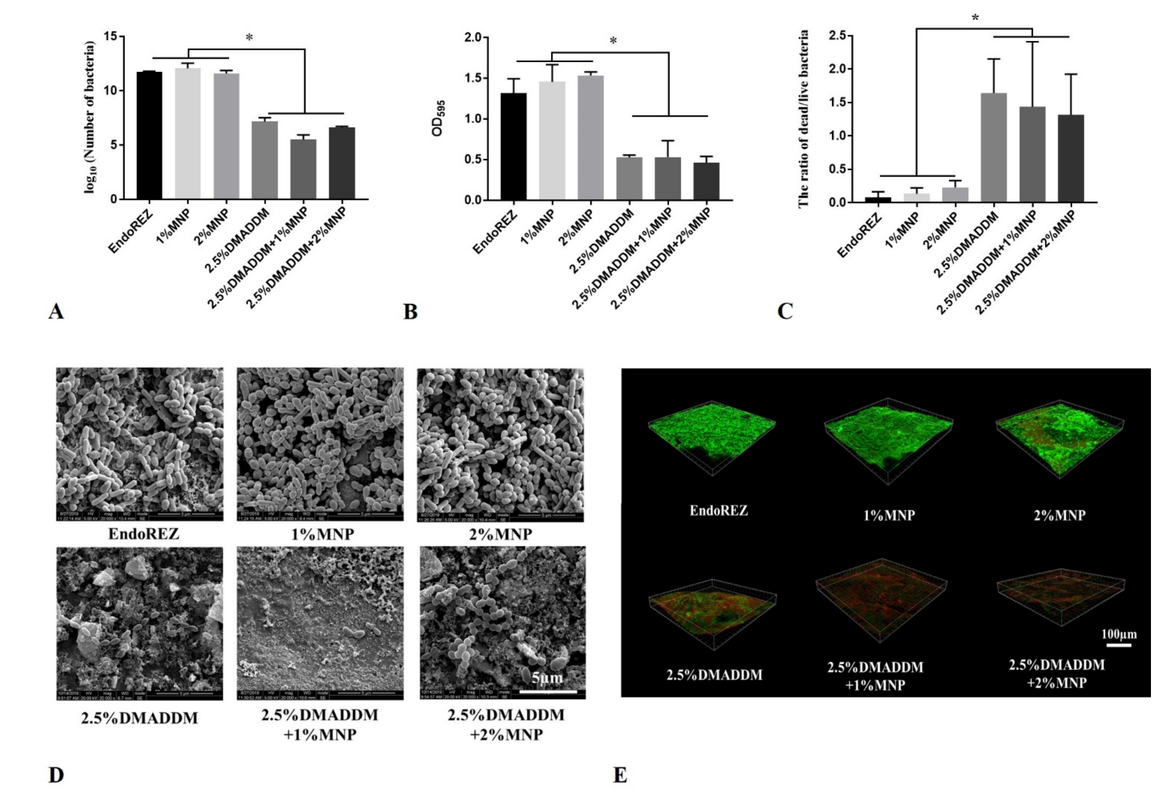

Figure 4. Antibacterial effect of the sealers to multispecies biofilms. (A) Colony-forming unit counts of biofilms. (B) Biofilms biomass on different groups after 48 h, tested via crystal violet assay. (C) The ratio of live/dead bacteria computed in line with 3 random sights of biofilms. (D) SEM images of multispecies biofilms. (E) Live/Dead bacteria staining assay. *$p < 0.05$. Values are presented as mean ± SD.

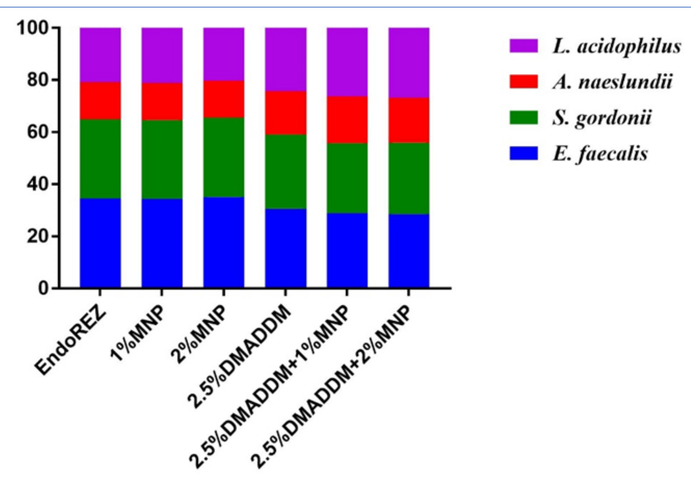

Figure 5. Ratios of four bacteria species in multispecies biofilms formed on the sealers.

CONCLUSIONS

DMADDM and MNP modified root canal sealers had material properties and could increase root canal sealer percentage of penetration under the action of magnetic fields. They had significant inhibitory effects on and multi-species biofilms and prospects for clinical applications.