Cement for prevention of peri-implantitis: Antibacterial and cytotoxic effects of developed dental cements containing phytic acid

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Introduction

Recently, cement or screw retained systems have been commonly used in dental implant. The cement has high satisfaction based on patient aesthetics; however, the remnant cement may cause peri-implantitis. Here, I studied the ability of cement with phytic acid to inhibit peri-implantitis. Phytic acid may inhibit plaque formation, and cement containing phytic acid was developed for dental implants by Tateyama et al. This cement has fluoroaluminosilicate glass that may release fluoride, and it has at least the same physical properties as glass ionomer cements (GIC). The goal of this study was to compare antibacterial and cytotoxic effects of developed dental cement containing phytic acid (i.e., developed cement) with those of GIC.

Material and Methods

Powdered developed cement was subjected to a powder of GIC with 50% phytic acid (liquid) via heat treatment. The powder:liquid ratio was 11:1, which has been reported to yield the best physical properties. GIC (Fuji I) was used as control. *Porphyromonas gingivalis* (*P. g.*) and *Fusobacterium nucleatum* (*F. n.*) were used due to their involvement in periodontal disease and peri-implantitis. Primary human gingival epithelial cells (HGEP) and human periodontal ligament cells (HPDL) were used as human periodontal tissue cells. To examine the antibacterial properties of hardened cement paste, developed cement or Fuji I was immersed in a bacterial solution. The solution was incubated anaerobically for 48 hours, and then the quantity of viable cells was measured. The same tests were conducted using the eluate of hardened cement paste. To examine the cytotoxicity of hardened cement pastes, developed cement or Fuji I was seeded for 1, 6, 12, 24, and 48 hours in dedicated medium. Absorbance, measured using WST-1, was used to calculate cell viability. Elution was determined after 48 hours to elucidate the antimicrobial mechanism of the cement. I examined the antibacterial effects of fluoride (F^-), aluminum (Al^{3+}), and eluted phytic acid components on *P. g.* or *F. n.*. In addition, the antibacterial effects of combined F^- + phytic acid on the elution concentration of *P. g* or *F. n.* were quantified.

Results

The hardened developed cement paste showed antibacterial effects (greater than those of Fuji I) against *P. g.* and *F. n.* The developed cement showed higher cytotoxicity than

Fuji I against HGEP and HPDL from human periodontal tissue after about 6 hours. There were no significant differences between the two groups at 48 hours. Developed cement eluent was detected at 6.5 ppm, 1.3 ppm, and 6.2 ppm for F^-, Al^{3+}, and phytic acid, respectively. There were no antibacterial effects against *P. g.* or *F. n.* at these concentrations; however, the combination of F^- and phytic acid did show antibiotic effects.

Discussion

The developed cement showed high antibacterial effects than Fuji I against *P. g.* and *F. n.*. The powder in the developed cement is the same heat-treated fluoroaluminosilicate glass as in Fuji I ; the difference is the liquid component. The liquid in the developed cement is 50% phytic acid solution, while the liquid in Fuji I is an aqueous solution of polycarboxylic and tartaric acids. The difference in liquid component is believed to cause the differences in antibacterial effects between the two cement groups. Some of the antimicrobial properties of the prototype cement are believed to be based on strong chelating action of phytic acid.

The high cytotoxic effect of the developed cement is likely due to F^- and phytic acid. However, since there was no significant difference between the two cement groups after 48 hours, it is likely not a significant issue for clinical utility. The F^- and Na^+ eluted from the developed cement were less than those from group Fuji I . This is likely because the solubility of the glass powder is reduced following crystallization by heat treatment.

Elution ions and phytic acid did not show antibacterial effects, but the hardened developed cement did show antibacterial effect. This is likely the combined effect of the F^- and phytic acid. Therefore, the antibacterial effects of the developed cement are likely due to the combined effects of the F^- and phytic acid rather than phytic acid alone.

Conclusions

The developed cement was found to exhibit higher antibacterial effects against *P. g.* and *F. n.* than Fuji I ; there were also no cytotoxic effects after 1 hour against HGEP and HPDL.

The antibacterial effects of the developed cement are likely due to the combined effects of phytic acid (from the liquid) and F^- (from the powder). This result suggests that the developed cement containing phytic acid has good operability, excellent physical properties, and high chemical stability, and its clinical applications are promising.