Synthesis of antibacterial 3D printing resin with long-term fluoride-releasing properties

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A study aiming to synthesize a three-dimensional (3D) printing resin with good mechanical properties, low cytotoxicity, antibacterial activities, and long-term fluoride-releasing properties was presented at the 102nd General Session of the IADR, which was held in conjunction with the 53rd Annual Meeting of the American Association for Dental, Oral, and Craniofacial Research and the 48th Annual Meeting of the Canadian Association for Dental Research, on March 13-16, 2024, in New Orleans, LA, U.S..

The abstract, "Synthesis of Antibacterial 3D Printing Resin with Long-Term Fluoride-Releasing Properties," was presented during the "Innovations in Digital Dental Research" Oral Session on Wednesday, March 13, 2024, at 1:30 p.m. Central Standard Time (UTC-6).

The study, by Gan Jin of the Yonsei University Oral Science Research Center, Seoul, Korea, synthesized (4,4-Bis-4-[2-hydroxy-3-(2-methacryl oyloxy)propoxy]-phenyl-pentanol-amine)-N,N-diacetic acid zirconium (IV) fluoride complex from 4,4-bis-(4-hydroxyphenyl)-pentanoic acid and monitored using proton nuclear magnetic resonance spectroscopy.

The synthesized monomer was incorporated into a urethane-acrylate-based (UA) resin at 5 wt% and 10 wt% (5F-UA and 10F-UA groups, respectively). The UA resin without the synthesized monomer was considered the control group.

All groups were three-dimensionally printed using an Asiga printer, followed by 10 minutes of washing and 20 minutes of curing. Surface characteristics were observed using scanning electron microscopy. Flexural strength was evaluated using a tabletop universal testing instrument. Vickers hardness was tested using a Vickers hardness tester.

The antibacterial property was investigated with direct and indirect contact tests and a WST-8 metabolic activity assay. The suspension was fully mixed and diluted for counting the number of colony-forming units. A cell viability test was performed using a cell proliferation assay. The amount of fluoride released was measured daily for 28 days using ion chromatography. One-way analysis of variance was performed for statistical analyses using SPSS software.

The amount of fluoride released increased with the amount of monomer in the resin. Fluoride ions were constantly released at a low concentration from the 3D-printed specimens.

The antibacterial efficacy was acceptable in both the 10F-UA and 5F-UA groups and higher in the former. No cytotoxicity of the resin was detected. The addition of the fluoride-releasing monomer significantly influenced the mechanical properties. The findings of the study demonstrated that the UA 3D printing resin, formulated with a fluoride-releasing monomer, proved non-cytotoxic, effectively inhibited S. mutans growth, and continuously released fluoride over a 28-day period.

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