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Preliminary Assessment of Polymer Mixtures Designed for Self-Limited Dental Burs Manufacture

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Objectives The objective of this study was to identify an effective polymer mixture for manufacturing polymeric dental burs, with the specific goal of addressing primary dental caries. The process involved various combinations of polymers meeting the requirements for such instruments, while ensuring greater compatibility with tooth structure.

Methods Four different mixtures were tested: two containing polymer mixtures of Bis-GMA/TEGDMA/UDMA (R1, R2), and the other two containing Bis-GMA/PMMA/MMA (R3, R4). Incorporating nanoparticles into the polymer matrix has become crucial to enhance polymer biocompatibility and promoting teeth surface remineralization. Therefore, each mixture was then supplemented with a powder filler consisting of 5% glass with BaF_2 and 0.5% graphene with silver particles (synthesized in research laboratory of Babes Bolyai University, Raluca Ripan Institute for Research in Chemistry, Cluj-Napoca, Romania). Considering that the distinctive cutting property of the polymer relies on the contrast in hardness among various tooth tissues, the Vickers hardness and ultramicroscopic structure using Scanning Electron Microscope (SEM) analysis of the four new polymer mixture recipes were assessed, aiming to identify key features essential for the development of experimental self-limited dental burs. All datasets underwent statistical analysis using the One-Way ANOVA test.

Results In laboratory conditions, the average Vickers microhardness values obtained for the four tested materials did not exhibit statistically significant differences ($p>0.05$). Regarding the SEM analysis, the samples based on Bis-GMA, exhibited an uniform and compact polymeric matrix without pores. Upon the addition of fillers, an intriguing microstructure emerges with larger BaF_2 particles evenly dispersed within the compact matrix. Additionally, nanostructural components such as graphene with Ag, were observed to be well-dispersed within the polymer matrix, appearing indistinguishable from other microstructures.

Conclusions Overall, while there wasn't a robust correlation observed between the filler amount and Vickers microhardness, filler materials tended to demonstrate higher microhardness values.