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Research Article

Effect of Nanohydroxyapatite and Silver Nanoparticle Incorporation on the Flexural Strength of Resin Composites

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This in vitro study investigated the impact of silver nanoparticles (AgNPs) and nanohydroxyapatite (nanoHAP) on the flexural strength of dental composite resin. Fifty composite samples were prepared in five groups ($n = 10$): (1) nonspatulated composite resin (negative control); (2) hand-spatulated composite resin (positive control); (3) composite resin and 2 wt% nanoHAP; (4) composite resin and 1 wt% AgNPs; and (5) composite resin, 2 wt% nanoHAP, and 1 wt% AgNPs. Flexural strength was measured using a universal testing machine. Scanning electron microscopy (SEM) was used to evaluate the dispersion of nanoparticles in the composite resin. The data were analyzed using the Kruskal–Wallis and Mann–Whitney tests ($p < 0.05$ was considered significant). The highest mean flexural strength was observed in the negative control, while the lowest flexural strength was seen in Group 4 (composite resin and AgNPs). The nanoHAP group demonstrated significantly higher flexural strength than the AgNP group ($p = 0.043$). However, no significant difference was observed between the nanoHAP-only group and the group containing both nanoHAP and AgNPs ($p = 0.075$). These findings suggest that nanoHAP-loaded composite resin possesses higher flexural strength than AgNP-incorporated composite resin. Additionally, comparisons with the positive control group indicated that the addition of nanoparticles did not necessarily result in significant improvement in flexural strength. These findings can pave the way for future studies on optimizing the composition of advanced dental materials with enhanced longevity and improved mechanical properties.

Keywords: composite resin; flexural strength; nanohydroxyapatite; silver nanoparticles

1. Introduction

Composite resins are extensively used in modern dentistry for cosmetic and restorative applications. They play a crucial role in restoring both tooth function and aesthetics. To improve clinical outcomes, manufacturers aim to enhance the mechanical strength and antimicrobial properties of these materials, thereby improving their resistance to masticatory forces and minimizing the risk of secondary caries [1–4]. Despite significant advancements in the field, challenges persist in achieving optimal toughness, strength, and longevity of composite restorations in the high-stress oral environment [5, 6].

Nanotechnology has emerged as a promising avenue in dental material research, offering novel solutions to improve composite resin performance [7]. Nanoparticles—ultrafine particles with dimensions less than 100 nm—have become integral to a range of dental applications [8].

One such nanoparticle is nanohydroxyapatite (nanoHAP), an inorganic compound naturally found in hard tooth tissue, bones, and pathologically calcified tissues [9–11]. Synthetic HAP offers distinct advantages due to its chemical similarity to natural hydroxyapatite. This synthetic material is biocompatible, bioactive, and nontoxic, showing no inflammatory or carcinogenic effects [12–15]. The addition of HAP

Conflicts of Interest

The authors declare no conflicts of interest.

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