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STEM-CELL–DERIVED BIOENGINEERED DENTAL PULP CONSTRUCTS FOR VITAL PULP THERAPY: A RANDOMIZED LABORATORY TRIAL

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Abstract

Introduction: *Conventional vital pulp therapy relies primarily on calcium silicate-based cements that induce reparative dentin formation without restoring the native neurovascular architecture of the pulp tissue. Advances in tissue engineering using stem cells and biodegradable scaffolds offer the potential for true pulp regeneration rather than mere preservation.*

Material and Methods: *Human dental pulp stem cells were isolated from healthy third molars and encapsulated within gelatin methacryloyl hydrogel constructs. In this randomized laboratory trial, 60 standardized human tooth slices were allocated into three groups: negative control (empty), positive control (Biodentine™), and test group (human dental pulp stem cells-gelatin methacryloyl construct). Cell viability, proliferation, odontogenic differentiation, and angiogenic potential were assessed using Live/Dead staining, Cell counting Kit-8 colorimetric assay, and quantitative reverse transcription polymerase chain reaction analysis of dentin sialophosphoprotein, dentin matrix acidic phosphoprotein 1, and vascular endothelial growth factor expression.*

Results: *The quantitative reverse transcription polymerase chain reaction constructs demonstrated high cytocompatibility, with cell viability exceeding 94% at day 7. Proliferation was significantly greater in the test group compared with Biodentine at day 7 ($p < 0.01$). Odontogenic marker expression was comparable between the test and Biodentine groups, while vascular endothelial growth factor expression was markedly higher in the test group group, indicating superior angiogenic potential.*

Conclusion: *Stem cell–laden gelatin methacryloyl constructs exhibit enhanced regenerative properties compared with conventional bioceramic materials in an ex vivo tooth slice model. These findings support the translational potential of hydrogel-based regenerative strategies as next-generation approaches for vital pulp therapy.*

Keywords: *vital pulp therapy, dental pulp stem cells, gelatin methacryloyl , GelMA, regenerative endodontics, tissue engineering, hydrogels*

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