PCE 02

Combining Nanotechnology With Bone Tissue Engineering For Faster Bone Regeneration

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ABSTRACT: Bone tissue engineering aims to induce new functional bone regeneration via the synergistic combination triad of biomaterials, cells and regulatory signals. A novel bone replacement is fabricated to enhance bone Regeneration by combining bioceramics with nanotechnology. In this study, hydrogel containing Hyaluronic acid (HyA)-Chitosan (Ch) nanoparticles are loaded onto biphasic calcium phosphate (BCP) scaffold to achieve high bioresorption rate. Resulted scaffold showed high interconnected porosity with high compressive strength of 2.5 ± 0.5 MPa. In vitro bioactivity was seen very well by immersing the scaffolds in simulated body fluid. In vitro cytocompatibility studies were conducted using Bone marrow mesenchymal stem cells. BCP scaffolds loaded with HyA-Ch nanoparticles hydrogel resulted in a significant increase in cell proliferation on day 4 ($p < 0.05$) and day 7 ($p < 0.001$) and high alkaline phosphatase activities at 14 and 21 days. A bone matrix formation was confirmed by positive immunostaining results for osteopontin, osteocalcin and F-Actin. In vitro expression of extracellular matrix proteins demonstrated that this novel bone substitute holds great promise for use in stimulating new bone regeneration.

Keywords: *Bone Tissue Engineering, Scaffold, Biomaterials, Biphasic calcium phosphate, Chitosan, Nanoparticles*

BACKGROUND:

OBJECTIVES: The aim of present study is to develop a novel Biphasic calcium phosphate scaffold decorated with hyaluronic acid-chitosan Nanoparticles- hydrogel for improved bone regeneration.

SCOPE: To achieve Tissue Engineering goal i.e. to generate diseased/damaged tissue and to attach body cells to ECM, there should be a balance between the rate at which the scaffold resorbs and the rate at which the cells are depositing the new native extracellular matrix. Use of nanoparticles will help to achieve this goal by controlling the release rate of hyaluronic acid.

METHODOLOGY:

Biphasic calcium phosphate (BCP) Scaffolds were prepared by Sponge Replica Method

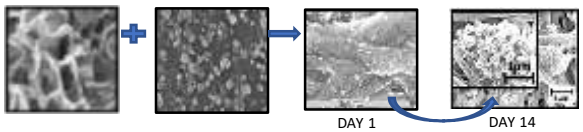
Hyaluronic acid-Chitosan Nanoparticles (HA-CH-NP) were prepared using ionic gelation technique

BCP Scaffold was then immersed in the HA-CS-NP hydrogel and frozen at –80^{0}C for 8 h, and freeze-dried for 48 h at -80^{0}C

CHARACTERIZATION:

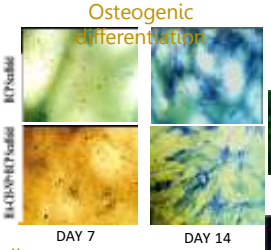
- Element composition
- Morphology
- Porosity and pore size distribution
- In vitro bioactivity
- Cell cytotoxicity using MTT assay
- Scaffold swelling and degradation rates
- Osteogenic differentiation

Surface Morphology

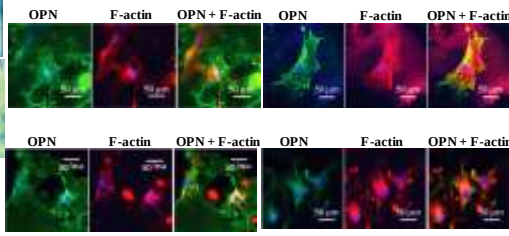


In Vitro Cytocompatibility

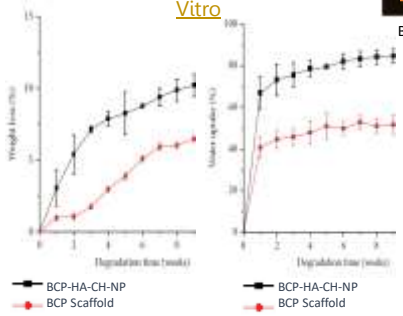
Osteogenic differentiation



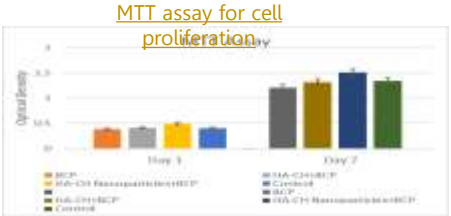
Cell Proliferation and Viability assay



Degradation properties In Vitro



MTT assay for cell proliferation



Abdelaziz, A. G., Nageh, H., Abdo, S. M., Abdalla, M. S., Amer, A. A., Abdal-hay, A., & Barhoum, A. (2023). A Review of 3D Polymeric Scaffolds for Bone Tissue Engineering: Principles, Fabrication Techniques, Immunomodulatory Roles, and Challenges. *Bioengineering*, *10*(2), 204. https://doi.org/10.3390/bioengineering10020204

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