Native mechanobiological regulation of human mesenchymal stem cells on 3D-printed PLA trabecular scaffolds via dual mechanical stimulation

Shahd Alahmad, Farah Daou, Stefano Gabetti, Beatrice Masante, Eleonora Zenob , Carlotta Achille, Elisa Scatena, Simone Israel, Cristina Bignardi, Diana Massai, Andrea Cochis, Lia Rimondini

UNIVERSITÀ DEL PIEMONTE ORIENTALE
CENTER FOR TRANSLATIONAL RESEARCH ON AUTOIMMUNE AND ALLERGIC DISEASE
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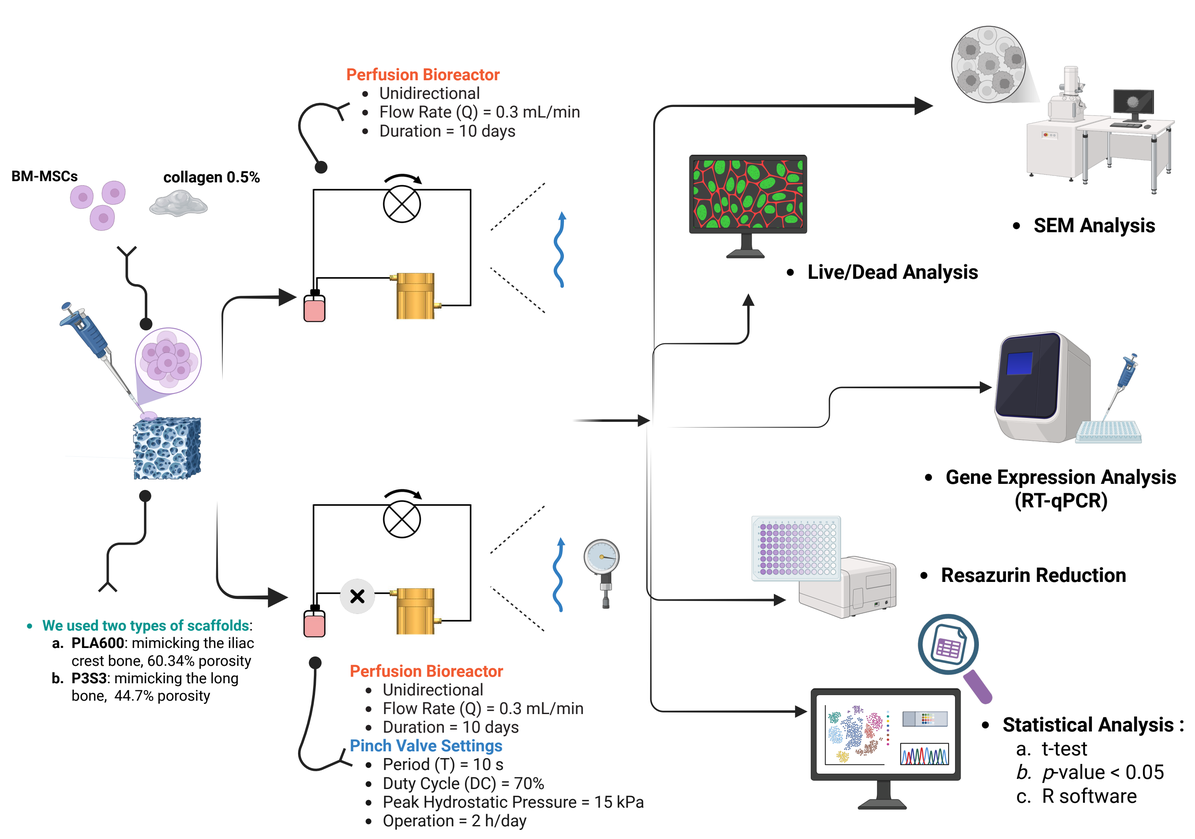
INTRODUCTION

- Bone regeneration is significantly influenced by the specific architecture of various anatomical sites.
- Different bones possess unique internal architectures and mechanical stress profiles.

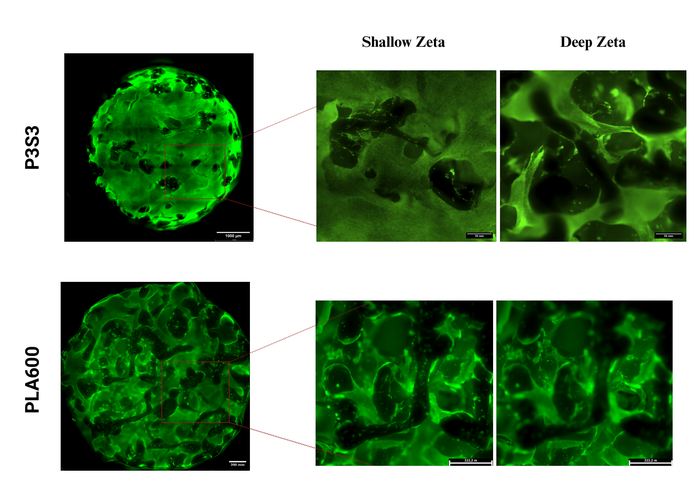
This study investigates how site-specific geometries affect the osteogenic differentiation of hBM-MSCs to optimize local bone healing processes via:

- PLA600 scaffolds replicating the porous structures of the iliac crest.
- P3S3 scaffolds mimicking the dense structure of the tibia, ulna, and femur.
- Automated, perfusion bioreactor providing physiological stimulation (shear stress 0.3mL/min and hydrostatic pressure 15 kPa).

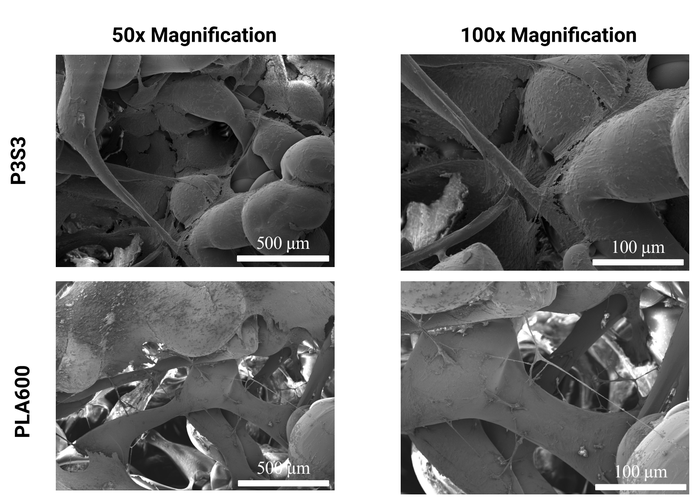
METHODS



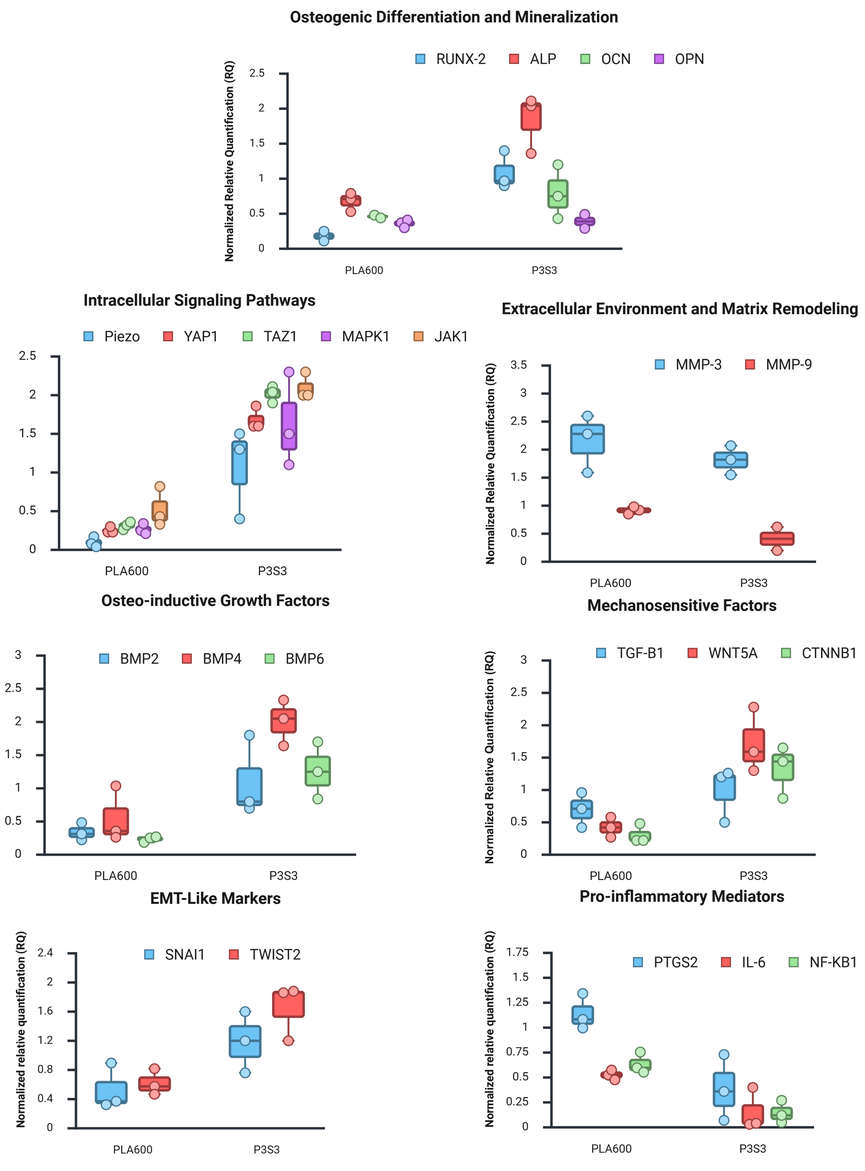
RESULTS



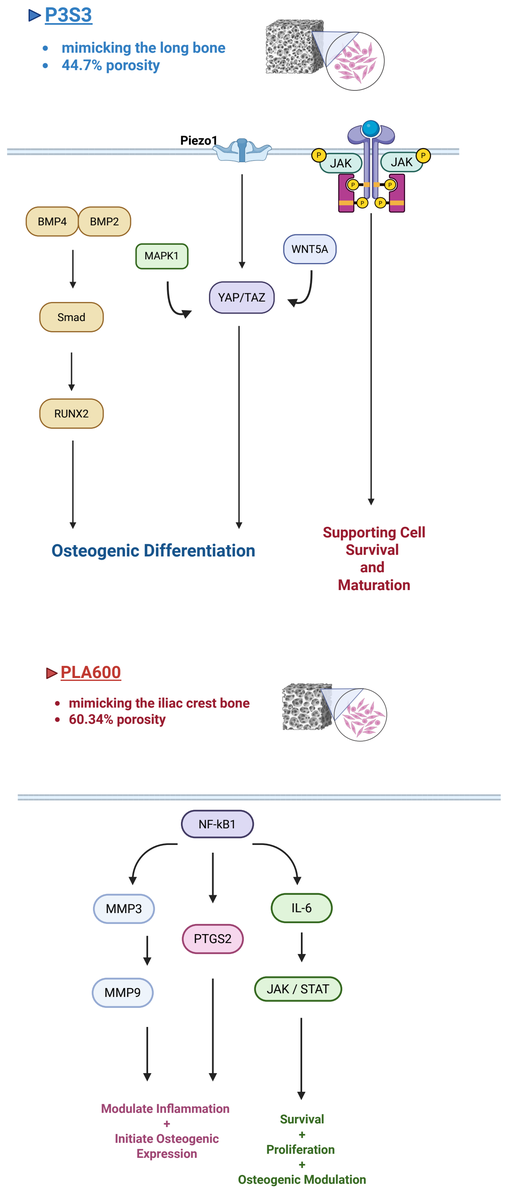
Live / Dead Assay



SEM Assay



Gene Expression Analyses (fold change in comparison to perfusion)



Mechanotransduction Signaling Pathways

CONCLUSION

By recreating a physiologically relevant bone-like environment *in vitro,* we demonstrate how mechanical loading shapes regenerative outcomes.The P3S3 scaffold shows superior performance over PLA600 enhancing RUNX2 and ALP expression, activating YAP1/TAZ signaling, and reducing IL-6 ultimately creating a more favorable microenvironment for bone repair.

INNOVATION tissue engineering and biomaterials evaluation



BIGMECH

"Study carried out within the BIGMECH project – funded by European Union – Next Generation EU within the PRIN 2022 program (D.D. 104 - 02/02/2022 Ministero dell'Università e della Ricerca)"

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