3D BIOPRINTED SCAFFOLD WITH CONTROLLED RELEASE OF MESENCHYMAL STEM SECRETOME FOR BONE REGENERATION

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Background

Bone tissue engineering aims to repair bone defects through *in vivo* grafting of scaffolds manufactured by 3D printing, enabling a finer control of the scaffold porosity when compared to traditional methods [1-3]. Although this technique is promising, the results are not always satisfactory due to the poor ability of cells to deeply colonise the scaffold, both *in vitro* and *in vivo*, compromising the proper tissue regeneration [4, 5].

Recent Advances

Given such considerations, we have recently proposed a 3D-coprinted hybrid scaffold made by polycaprolactone (PCL) and alginate-based hydrogel containing lyosecretome [6], which is a freeze-dried formulation of mesenchymal stem cells secretome (pool of molecules composed by growth factors, cytokines, proteins, lipids, and oligonucleotides) that can promote cellular proliferation and differentiation aided to an effective scaffold colonisation. Thanks to the simultaneous presence of PCL, which provides mechanical resistance, and the hydrogel that releases the lyosecretome, the scaffold is designed to perform a double function: to stimulate its *in vitro* and *in vivo* bio-integration, thanks to lyosecretome action, and to bear loads.

In this context, we demonstrated that the inclusion of the lyosecretome strongly improves the osteoinductive potency of the scaffold [7] and that its release kinetics can be controlled up to 10 days by tuning the parameters of scaffold manufacturing [6]. Moreover, the mechanical performance of the scaffold and its implications for the design of the device have been investigated by implementing a validated computational framework (structural Finite Element Analysis – FEA) to support the design of the hybrid scaffold. Results show an increase in mechanical properties by changing the scaffold infill pattern (145.38±28.90 vs 278.96±50.19, linear vs honeycomb, respectively), while alginate inclusion does not always impact the mechanical performance of the hybrid scaffold (stiffness: 145.38±28.90 vs 195.42±38.68 N/mm, with vs without hydrogel inclusion, respectively).

Future directions

A case study for repairing bone defect is proposed as future development. Starting from the patient-specific's bone defect, the defect model is extracted from the instrumental images. Then, the model is modified in order to create the hybrid scaffold by adding the lyosecretome/alginate inclusion(s) and defining the structural parameters of PCL structure. Mechanical properties of hybrid scaffold is predicted for identifying the best configuration that satisfies the targets.

Michele Conti has been working in Biomechanics since studying for his master thesis about stent simulation (2007), continuing his research in computational biomechanics during the joint PhD in Biomedical Engineering (Pavia University, IT and Ghent University, BE).
Afterwards he has contributed to promote the biomechanical activity of CompMech Group of Pavia University, where is actually Associate Professor in Industrial Bioengineering, fostering close collaboration with clinical partners. He has published over 70 papers in peer-reviewed international journals and organised several events about biomechanics and bioprinting, actively contributing to Italian chapter of ESB. He is currently member of the ESB council.

Figures

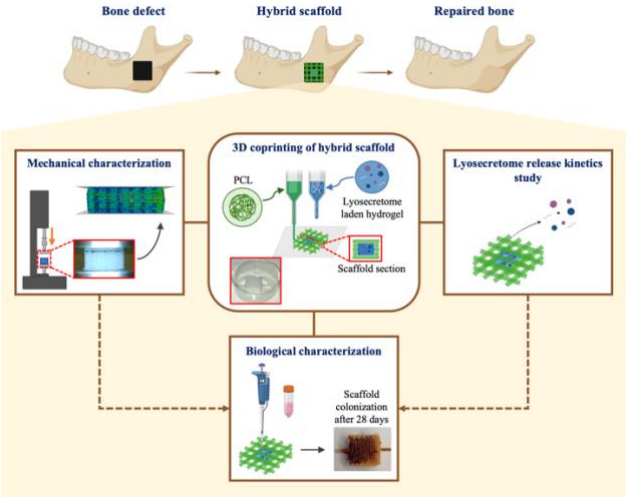

Figure 1: 3D coprinting and characterization of hybrid scaffold.

References

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