Development of a cardiac dECM-based hydrogel for cell-compatible bioprinting applications

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Aims: The primary objective of this study is to conduct the initial tests necessary for the development of a hydrogel suitable for bioprinting cell-compatible devices. These devices will be designed to address various cardiac pathologies.

Materials and Methods: A series of hydrogels, composed of gelatin, 6% sodium alginate, and 5% decellularized extracellular matrix (dECM) derived from ovine cardiac tissue, were developed. Gelatin concentrations were adjusted to 10%, 15%, 20%, and 25%. The printability of these formulations was systematically evaluated by extrusion-based bioprinting to identify the optimal pressure and temperature conditions that ensure structural integrity and preserve cell viability. All hydrogels were printed in a mesh-like structure with dimensions of 30 × 30 × 1 mm for standardization.
Finally, the mechanical properties of the target tissue and the biomaterials were determined by dynamic mechanical analysis to determine which of them better aligns with the target tissue.

Results: To ensure optimal cell viability, the printing temperature was set at 37 °C.
The 10 % hydrogel exhibited insufficient consistency to achieve the required precision for printing the structure.
In contrast, the 15 % hydrogel demonstrated the necessary accuracy to print the structure at a pressure of 10 kilopascals (Fig. 1).
The 20 % hydrogel showed the necessary precision when printing the structure with a pressure of 20 kilopascals.
Regrettably, the 25 % hydrogel presented issues during processing, making it impossible for the material to be free of lumps that would impede extrusion.

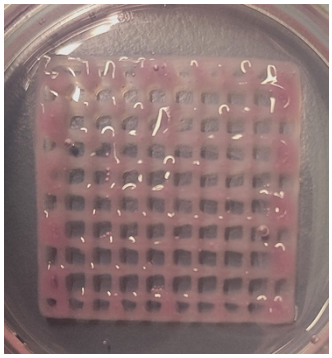

Fig. 1 Bioprinted mesh-like constructs fabricated using a hydrogel composed of 15% gelatin, 6% sodium alginate, and 5% cardiac dECM. The formulation showed consistent printability and maintained its shape post-crosslinking.

Conclusions: Based on the preliminary results obtained from this study, we can conclude that hydrogels composed of 15 % gelatin, 6 % sodium alginate and 5 % dECM provide optimal bioprinting parameters to ensure the survival of the embedded cells.
Although, once crosslinked, the structure is strong enough to be easily manipulated for surgical implantation, its mechanical properties are still far from those of cardiac tissue.
In the future, if it is desired to bioprint structures intended to replace those of native tissue, it will be necessary to modify the composition of the tissue or to resort to the development of a multilayer structure using different techniques in addition to bioprinting.

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