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Combining Magnetically-Assisted and Matrix-Assisted 3D Bioprinting for Anisotropic Tissue Engineering

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A major obstacle in biofabrication is replicating the organization of the extracellular matrix and cellular patterns found in anisotropic tissues within bioengineered constructs. While magnetically-assisted 3D bioprinting techniques have the potential to create scaffolds that mimic natural biological structures, they currently lack the ability to accurately control the dispersion of magnetic substances within the bioinks without compromising the fidelity of the intended composite. To overcome this dichotomy, the concepts of magnetically- and matrix-assisted 3D bioprinting are combined here. This method preserves the resolution of printed structures by keeping low viscosity bioinks uncrosslinked during printing, which allows for the arrangement of magnetically-responsive microfibers without compromising the structural integrity of the design. Solidification is induced after the microfibers are arranged in the desired pattern. Furthermore, the precise design of these magnetic microfillers permits the utilization of low levels of inorganic materials and weak magnetic field strengths, which reduces the potential risks that may be associated with their use. The effectiveness of this approach is evaluated in the context of tendon tissue engineering, and the results demonstrate that combining the tendons like anisotropic fibrous microstructure with remote magneto-mechanical stimulation during in vitro maturation provides both biochemical and biophysical cues that effectively guide human adipose-derived stem cells towards a tenogenic phenotype In summary, the developed strategy allows the fabrication of anisotropic high-resolution magnetic composites with remote stimulation functionalities, opening new horizons for tissue engineering applications.

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