Magnetic Biomaterials Systems for Tendon Regeneration

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Despite our still limited understanding of the specific mechanisms involved in tendon homeostasis and disease, it is evident and consensual that mechanical loading plays a central role in regulating various mechanotransduction pathways behind tendon pathologies and healing processes. This has triggered our interest on the development of 3D magnetically responsive systems that recapitulate key features of the native tissue and that can be remotely actuated both during in vitro culture and/or upon in vivo implantation, through the application of external magnetic stimuli. We are exploring conventional and innovative tools such as magnetic cells sheets constructions and multimaterial 3D bioprinting to design magnetic responsive systems mimicking specific aspects of tendon tissue architecture, composition and biomechanical properties, which, combined with adequate stem cells, shall render appropriate behavioural instructions to stimulate the regeneration of tendon tissue. We have demonstrated that the magnetic stimulus of different intensities/frequencies can trigger tenonegic differentiation of hASCs and/or modulate inflammatory response of various cell types involved in tendon healing response. Simultaneously, the 3D cell-laden magnetic system are also being explored as sophisticated 3D tissue models to unravel mechanisms behind tendon homeostasis and repair that shall support the base knowledge to establish rational design criteria for the biofabrication of living tendon substitutes. Overall, our studies demonstrate that magnetic systems might constitute the ultimate tool in tendon tissue engineering to modulate inflammatory response towards regeneration, as opposed to simple tissue repair.

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