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MAGNETIC SCAFFOLDS FOR THE MECHANOSTIMULATION IN TENDON REGENERATION

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Introduction. Tendon pathologies are medical conditions that include ruptures and overuse injuries accompanied by inflammatory and degenerative alterations, such as tendinopathies and tendinitis. The aim of the present work was the development of fibrous scaffolds based on polyhydroxybutyrate (PHB) doped with magnetic iron oxide nanoparticles (Fe_3O_4 NPs) and coated with gelatin (Gel), able to mimic the hierarchical structure of the tendon and to improve the tissue healing potential [1,2].
Experimental methods. The blends were spun using a centrifugal spinning apparatus obtaining PHB, PHB-Fe_3O_4, and PHB-Fe_3O_4-Gel fibers. The systems morphology and the surface wettability were assessed. The scaffolds' superparamagnetic behavior, mechanical properties and weight loss in physiological medium were evaluated. Finally, cell adhesion and proliferation in vitro were tested with and without the application of static magnetic fields of different extent for 21 days of culture.
Results. The systems were characterized by an aligned structure that could mimic the tendon hierarchical organization. Moreover, SEM-EDX showed that Fe_3O_4 NPs were successfully incorporated into the fibers. The presence of magnetite increased the scaffolds' stiffness, probably due to the nanoparticles' distribution into the fibrous matrix [3]. Moreover, the presence of Gel led to a higher fiber swelling and surface wettability, which should result in a more favourable environment for the cells adhesion and proliferation. PHB-Fe_3O_4, and PHB-Fe_3O_4-Gel were characterized by a superparamagnetic behavior at 300K, fundamental to allow the cell mechanostimulation. In fact, when a magnetic field is applied, the scaffolds could respond with vibrations generating a transient physical force that could be transferred to the host cells [4]. On the other hand, the PHB scaffold was characterized by a spectrum typical of not-magnetic samples. The scaffolds also showed a progressive weight loss in physiological medium, demonstrating a degradation capability while maintaining the fibers' morphology and alignment for 3 months. Finally, the scaffolds with Gel were able to enhance cell adhesion and proliferation better than the positive control (cells grown in standard conditions) after 21 days. Interestingly, the application of the magnetic fields also led to a significant increase in cell adhesion and proliferation onto the systems loaded with Fe_3O_4, reaching values considerably higher than those of the control after 21 days of culture. Moreover, the combination of the scaffolds enriched with magnetite together with the application of the magnetic fields led to a significant cell alignment, mimicking the tendon fascicles.
Conclusions. Fibrous scaffolds based on PHB and Gel and doped with magnetite were successfully manufactured, representing an interesting tool to enhance the tendon regeneration when combined with the application of external magnetic fields.

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