Effect of poling state of piezoelectric poly(vinylidene fluoride) films on C2C12 myoblast differentiation for skeletal muscle tissue engineering

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Skeletal muscles, comprising between 40-45% of an adult human body mass, are responsible for generating voluntary movement, postural support, breathing and locomotion. Severe injuries resulting in a muscle mass loss can lead to extensive and irreversible loss of muscle function [1]. In this sense, tissue engineering (TE) and regenerative medicine are growing fields of interest due to promising results in regenerating tissue functions [1]. Adhesion, proliferation and differentiation of specific cells can be promoted and/or improved by the use of active materials. In particular, piezoelectric materials allow incorporating electrical and mechanical stimuli to the cells. This is a recent paradigm with large potential in TE applications [2]. Further, many body tissues are subjected to varying mechanical loads, such as muscle [3], and the charge surface can stimulate cell response. In this sense, the use of polymer based electroactive materials capable to mimic mechanical and electrical biological cues emerged as a novel approach for TE applications.
Poly(vinylidene fluoride) (PVDF) is the biocompatible polymer with the largest piezoelectric response. Thus, piezoelectric polymers proved to be able to induce surface transient charge and induced a higher cell growth and differentiation compared with the non-piezoelectric controls [4]. This work reports the influence of the substrate polarization of electroactive β-PVDF on C2C12 myoblast cells differentiation under static conditions. C2C12 were cultured on different β-PVDF film surfaces(non-poled, "poled -" and "poled +") and C2C12 differentiation was determined using a qualitative indirect immunofluorescence detection of the myosin molecule. It is demonstrated that charged surfaces improve myoblast cell differentiation and the maturation index of myotubes(five or more nuclei) is higher in the charged samples with differentiation medium. Therefore, the potential application of electroactive materials for muscle regeneration is demonstrated.

References:

[1] F.P.W.Melchels et al., Acta Biomaterialia 2010, 6, 4208-4217.
[2] M.E. Gomes et al., Macromolecular Bioscience 2004, 4, 737-742.
[3] N.J. Turner et al., Cell and Tissue Research 2012, 347, 759-774.
[4] P.M. Martins et al., RSC Advances 2013, 3, 17938-17944.

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