Bioengineered electroactive membranes as scaffolds for neural regeneration

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ABSTRACT

Neural network complex physiology often proves to be the target of various pathologies, either as the result of congenital diseases or due to external traumas. Neural tissue has low endogenous regenerative capacity, while extensive damage of neural tissue can lead to irreparable disruption of its base metabolic activities, which can severely hamper the patient's quality of life. To overcome such neural tissue pathologies, neural tissue engineering strives for the development of novel medicinal platforms that expediate healing of native tissue, by eliciting specific biofunctional cues when situated in close proximity to the damaged area. In respect to the outmost importance that electrical conductivity has on the physiological function of nerves, we developed the fabrication of electrospun fibrous membranes, coated with different concentrations of the biocompatible, intrinsically conductive polymer poly(3,4-ethylenedioxythiophene) (PEDOT), as a platform for neural tissue reconstitution. PEDOT was used as blend with polystyrene sulfonate (PSS) to negate its lack of water solubility.

Electrospun scaffolds comprising gelatin and polyvinyl(alcohol) (PVA) were prepared by using a fabrication process developed in our group, and followingly coated with various PEDOT:PSS concentrations. The material characterization of the resulting functional scaffolds, in terms of chemical integrity, morphology, thermal stability and conductivity has been performed. Regarding their biological response, we have examined (i) the in vitro biocompatibility and differentiation potential of two key regulator cell types for remyelination, glial and oligodendrocyte cells, (ii) the in vivo functionality using mice models to illustrate their efficacy as regenerative implants for different neural related anatomical sites, and (iii) the antibacterial effect of the PEDOT:PSS coated scaffolds. Preliminary data have illustrated that the coated scaffolds depict antibacterial properties against Gram positive and Gram negative bacterial strains, while they allow for both glial and oligodendrocytes cell adhesion, and increased proliferation and differentiation.