Biomaterials in axonal regeneration and repair after spinal cord injury

Central nervous system (CNS) is composed of brain and spinal cord, where the brain integrating higher level functions and the spinal cord acting as communication pathway amidst the brain and the periphery. Injury to the spinal cord disrupt ascending and descending pathways, transmitting information from the periphery to the brain and from the brain to the periphery respectively, below the site of injury. Spinal cord injuries (SCI) can be complete and incomplete. Complete spinal injury causes permanent damage to the spinal cord which eliminates the ability of spinal cord to deliver signals below or above the level of injury, and ultimately leads to paraplegia or tetraplegia (Wilson et al, 2012). Incomplete injury refers partial damage to spinal cord, which implies some sensation is still present below the site of injury (Barbeau and Rossignol, 1987). Presently, limited options are available for SCI treatment. However, scientists are optimistic in investigating new treatment therapies to increase the quality of life of patients with SCI. The injured spinal cord creates an inhibitory environment which hampers axonal regeneration. After injury a cavity of fluid is formed which is encircled by glial scar, glycosaminoglycans, reactive astrocytes and other inhibitory factors. All these inhibitory factors hamper neurons from infiltrating from the site of injury, lead to loss of axonal connection. To overcome from the barrier created by inhibitory molecules, neural tissue engineering has recently gained ample attention. Biomaterial scaffolds made up of either natural or synthetic polymers could impede scar tissue formation to some extent. These scaffolds when coated with neurotropic growth factors could work effectively in promoting axonal sprouts and reconnections with neurons at the caudal end of the injury (Smith et al, 2008; Straley et al, 2010). Natural polymer based scaffolds have shown to help in axonal sprout and regeneration are collagen tubes (Spilker et al, 2001), fibrin scaffolds delivering neurotropic factors (Johnson et al, 2009), agarose scaffolds containing a brain-derived neurotrophic factor (BDNF) (Gao et al, 2012) and chitosan tube after being filled with collagen type 1 (Li et al, 2008). Few examples of synthetic polymer based scaffolds which promote axonal regrowth are neural conduits fabricated from Poly(lactic-co-glycolic acid) (PLGA) (Moore et al, 2006; Olson et al, 2009), Poly-L-lysine-coated polycarbonate tubes seeded with Schwann cells (Montgomery et al, 1996), RADA16-I hydrogels (Gao et al, 2007). Combination of biomaterial scaffolds with cell therapy in CNS regeneration has greatly practiced by scientists in recent years. The fusion of these two therapeutic techniques has made it possible to promote significant cell regeneration and tissue reconstruction. Although the application of biomaterial scaffolds and its combination with cell based therapies is encouraging, present methodology promoting regrowth of damaged tissue has compelling limitations. Careful investigations are necessary to achieve the challenging goal.

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