Novel Biodegradable Nerve Conduits for Functional Recovery after Spinal Cord Injury
Matthew Yanni; Xudong Cao, Ph.D.
University of Ottawa

Spinal Cord Injury: Causes and Mechanism

- Estimated 900 Canadians suffer from Spinal Cord Injury each year *
- Causes of SCI can be vehicle accidents, falls, medical, sports, diving and industrial
- Occurs when human spinal cord receives a physical impact that damages cells such as neurons, astrocytes, oligodendrocytes, existing within it
- Formation of glial scar (Secondary Process)
  - Reactive astrocytes, microglia, transmembrane molecular inhibitors
  - Lack of pathway for regenerating axons
  - Inhibitory environment
- SCI leads to paralysis, depending on level of injury on Spinal Cord
  - Paraplegia
  - Quadriplegia

* Canadian Paraplegic Association, 2009

Nerve Conduits

- Desirable properties of an implanted nerve conduit after spinal cord injury:
  - Aid in regeneration of axons
  - Prevent glial scar tissue infiltration
  - Adequate mechanical strength, structural stability
  - Porosity and morphology for exchange of nutrients and waste materials
  - Biodegradable, biocompatible, non-toxic, non-carcinogenic

Fabrication Techniques of Nerve Conduits: Dip-coating Method

Step 1: Preparation of 20% (m/v) poly(lactide-co-glycolic acid) (PLGA) with growth factors EGF and FGFb in chloroform
Step 2: Glass rods are immersed in the PLGA solution
Step 3: PLGA-coated rod is dried by rotating it using a mechanical stirrer for 2 hours. Steps 2 and 3 are repeated 4 more times for a total of 5 dips.
Step 4: The coated rods are dried in a vacuum drier for 48 hours
Step 5: The dried rods are placed in a supercritical CO2 chamber (under 850 psi) for 6 hours.

Fabrication Techniques of Nerve Conduits: Microsphere Fusion Method

Step 1: Preparation of 20% (w/v) PLGA with growth factors in chloroform. Preparation 1% (w/v) and 0.1% (w/v) polyvinyl alcohol (PVA) solutions
Step 2: Emulsionization of all three solution for 3 hours
Step 3: Centrifugation of the microsphere-containing solution with double distilled water
Step 4: Centrifuged microspheres are freeze-dried for 48 hours

Results and Conclusions

- Microsphere fused nerve conduits ensure an equal distribution of growth factor and proteins, while the distribution in dip-coated nerve guides is uneven and unpredictable
- Microsphere fused nerve guides provide a more sustained release of growth factors than the dip-coated nerve guides
- In dip coated nerve guides, a large proportion of contained growth factor was immediately exposed to the surroundings
- Thus, microsphere-fused nerve guides are more promising than dip-coated nerve guides for use in treating for spinal cord injury

Future Work

- In vivo study involving implantation of growth factor-encapsulated microsphere-fused nerve conduits to determine level of spinal cord regeneration

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