Stem Cell Impregnated Carbon Nanofibers/Nanotubes for Treating Neurological Disorders: An in vivo Study

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Statement of Purpose: Numerous neurological disorders (such as stroke or Parkinson's disease) and injuries necessitate a biomaterial which can allow for reestablishment of electrical activity. For these reasons, carbon nanofibers/nanotubes have been of interest since they are electrically active and can be formulated to match the dimensions of components of brain tissue (such as laminin). For this reason, this objective of the present *in vivo* study was to determine the ability of carbon nanofibers/nanotubes impregnated with stem cells to heal damaged neural tissue in rats.

Methods: Carbon nanofibers/nanotubes were obtained from Applied Sciences and possessed a diameter of 60 nm. Neural stem cells were obtained through well-established procedures. Specifically, the brains of 1~3 day old neonates rats were removed from the skull and fragments of subventricular zone encompassing both ependymal and subependymal layers were dissected out of 500 ㎛-thick 2 coronal sections in Hank's solution. The brain was then digested in trypsin 0.025% and EDTA 0.265mM (GIBCO) and triturated.
Resulting neural stem cells were then plated in 6-well plates at a density of 3.0×10^3 cells/ mL.
Upon confluency, neural stem cells were then lifted from cell culture plates and were combined with carbon nanofibers/nanotubes (2μg carbon nanofibers/nanotubes + 0.9 ~ 1.0 ×104 cells/ mL) and were implanted into rat brains which possessed damage (i.e., a transient focal ischemia). Specifically, middle cerebral artery occlusions (MCAO) were created in rat brains by using a well established left intraluminal vascular occlusion procedure for 60 minutes. Rats were then sacrificed at 2, 4, 6, and 8 weeks. After the end of the prescribed time periods, healing of damaged neural tissue was measured from histological sections and T2 weighted magnetic resonance (MR) imaging. Controls consisting of implantation of stem cells without carbon nanofibers/nanotubes were also used.

Results: Compared to controls, results of this *in vivo* study provided evidence that carbon nanofibers/nanotubes aided in the differentiation of stem cells into viable, functioning neurons that reestablished electrical activity in damaged neural tissue (Figures 1 and 2).

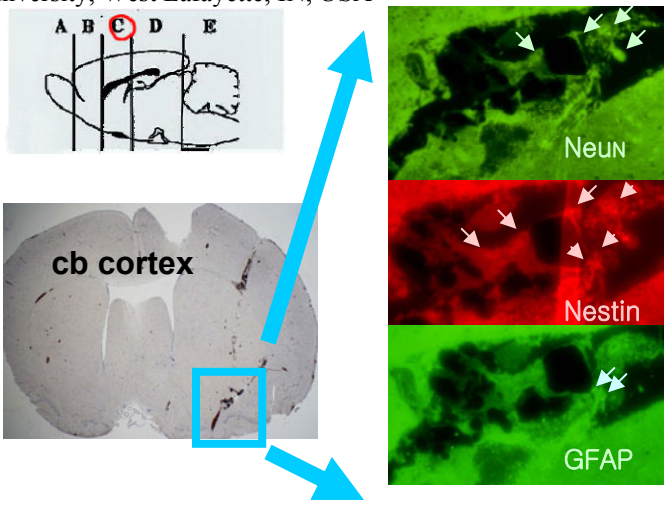

Figure 1: Stem Cell Interaction with Carbon Nanofibers/Nanotubes After 1 Day Implantation. Results of this study showed viable, active neural cells (evidences by NeuN, Nestin, and GFAP) staining which differentiated from stem cells only in the presence of carbon nanofibers/nanotubes (which appear black in the histological sections).

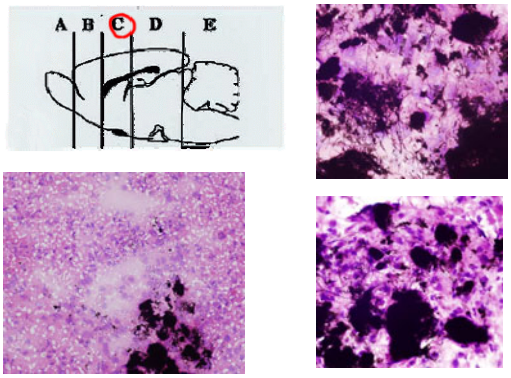

Figure 2: Stem Cell Interaction with Carbon Nanofibers/Nanotubes After 3 Week Implantation. Results of this study showed stem cells which differentiated into neurons intermingled with and around implanted carbon nanofibers/nanotubes (which appear black in the histological sections).

Conclusions: Such data highlights the promise carbon nanofibers/nanotubes have in healing brain damage that may occur due to a number of pathological situations (such as stroke, Parkinson's disease, Huntington's disease, etc.).

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