Tissue Engineered Peripheral Nerve Repair Using a Nanofiber Scaffold

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Abstract Text:

Introduction

Traumatic peripheral nerve injury often leads to disability. Primary nerve coaptation is effective in the repair of short nerve defects, but treatment is limited for more complex nerve injuries. Autologous nerve grafts are limited by finite sources, deficit at the donor site, and donor site morbidity. Nerve conduits lack an aligned internal scaffold to support and guide axonal
regeneration. Nanoscale peptide amphiphiles can self-assemble into aligned fibers and shown to promote nerve regeneration in a central nervous system model. There are no studies to date that examine the ability of PA-nanofibers support peripheral nerve regeneration. We investigate the application of this biomaterial to a peripheral nerve repair model.

Methods

PA-nanofibers were synthesized incorporating cultured rat Schwann cells into aligned fiber construct; adherence, viability, and proliferation of this cells within
the nanofiber aggregates was confirmed. Evaluating peripheral nerve regeneration, PLGA conduits filled with PA-nanofibers were used to reconstruct a rat critical-sized sciatic nerve defect. Motor and sensory function tests evaluate regeneration. Results were compared to defects reconstructed with empty PLGA conduits and autologous nerve grafts. Unrepaired defects served as controls.

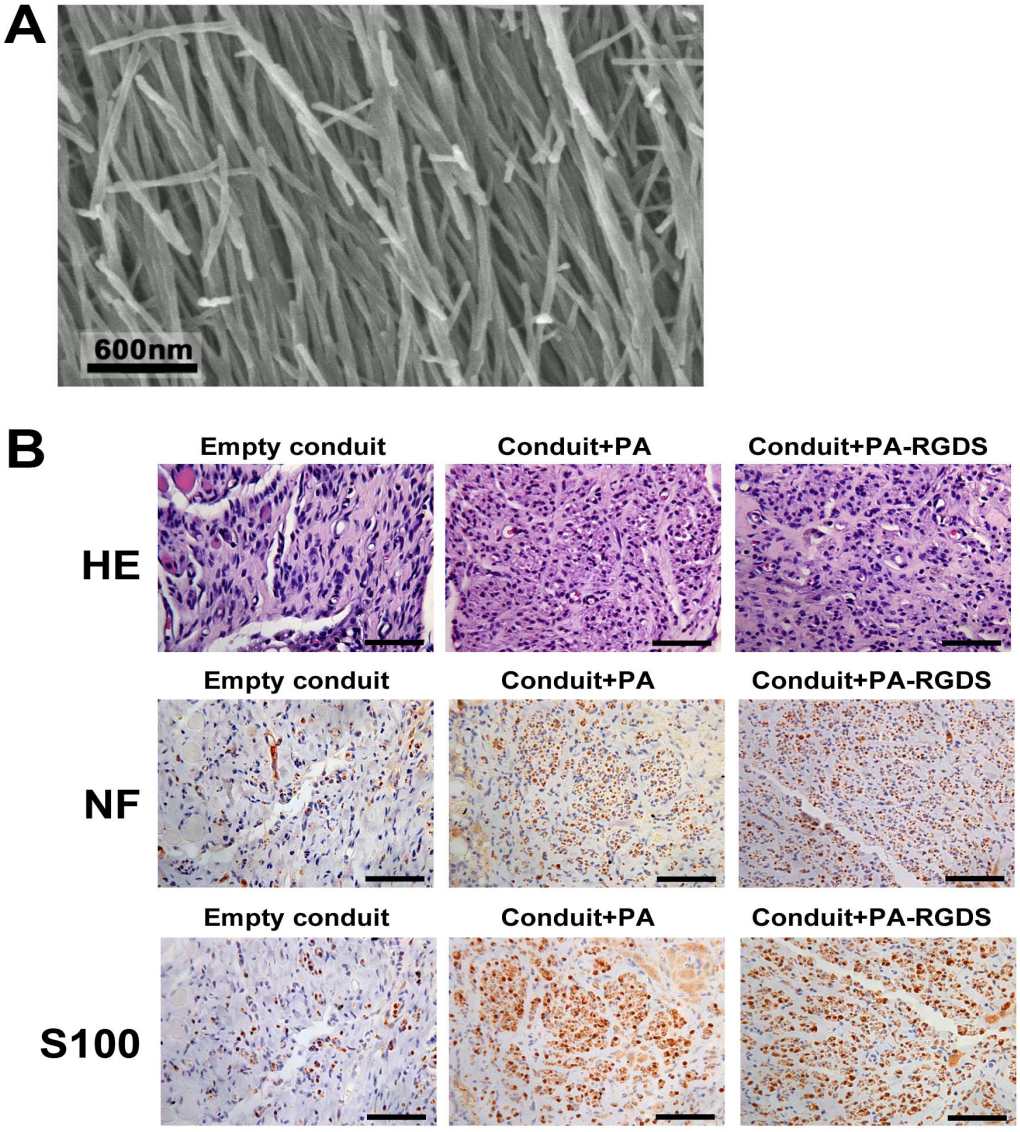
Results

Schwann cells were able to adhere to PA-nanofibers *in vitro*, remaining viable and demonstrating proliferation throughout the culture period. *In vivo*, sciatic nerve defects repaired with PA-nanofibersyielded return of motor and sensory function that was improved relative to controls. Restoration of function in these experimental animals was similar to that seen in animals repaired with autologous nerve graft and improved relative to animals repaired with empty conduit.

Conclusions

PA-nanofiber scaffolds support attachment, survival, and proliferation of Schwann cells *in vitro*. PA-nanofiber constructs support peripheral nerve regeneration *in vivo*. Functional recovery using PA-nanofibersis equivalent to autologous nerve grafting. These findings warrant further investigation of PA-nanofibers to serve as a viable nerve graft substitutes in the treatment of complex peripheral nerve injury.

Image



A: SEM showing aligned PA nanofibers, mimicking peripheral nerve architecture. B: Cross-sectional histological findings at the site of repair of a sciatic nerve defect 12 weeks following surgery. Nerve gaps were repaired with empty conduit, conduit filled with PA nanofibers, and conduit filled with a neurogenic conformation of the nanofiber (PA-RGDS). Immunohistochemistry staining with anti-neurofilament antibody (NF) and Schwann cell marker S-100 shows the density of NF-positive and S100-positive cells to be higher in the conduits filled with either nanofiber conformation. Limited nerve growth was observed in the empty conduits, and growth lacked linear orientation.