FUNCTIONAL RECOVERY OF DENERVATED MUSCLE BY NEUROTIZATION USING NERVE CONDUIT

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Introduction

Direct nerve transplantation into denervated muscle (neurotization) is indicated in patients who lack a distal nerve segment for anastomosis. Until recently, there have been no studies investigating neurotization using a nerve conduit to allow innervation over a long nerve gap in denervated muscle. In this study we investigated whether a nerve conduit could induce regeneration of axon and the neuromuscular junction after implantation into denervated muscle.

Methods

Seventy-two Lewis rats were evaluated in three groups: a normal control group (n=8); a denervated group (n=32); and a neurotization group (n=32). Denervation was created by removing a 10mm segment of the sciatic nerve including the common peroneal nerve, tibial nerve and sensory nerve branch. Neurotization was achieved by connecting a 10 mm nerve conduit from the truncated common peroneal nerve and implanted directly into the native gastrocnemius muscle after excision of tibial nerve and sensory nerve branch. Neurofunctional behavior, including extensor postural thrust (EPT) and withdrawal reflex latency (WRL), compound muscle action potential (CMAP), and histological evaluations including alpha-bungarotoxin, anti-NF-200, and toluidine blue staining were performed at 4, 8, 12 and 20 weeks.

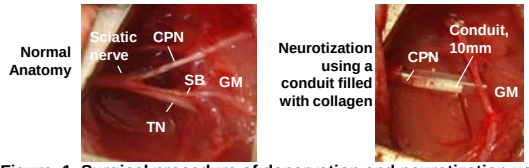

Figure. 1. Surgical procedure of denervation and neurotization using a conduit in a rat model.

Results

EPT and CMAP amplitude were significantly improved in the neurotization group ($P < 0.05$, one-way ANOVA), although at 20 weeks they were still significantly different than the normal control group (EPT, 25.3±2.3 vs 155.0±38.9 *g*, $P < 0.001$; CMAP amplitude, 6.0±3.3 vs 30.2±6.9 mV, $P < 0.001$). Regeneration of axons and the neuromuscular junction were proven histologically in the neurotization group.

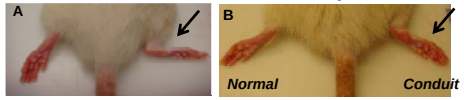

Figure 2. Neurobehavior study: posture of leg of (A) control and (B) neurotization groups.

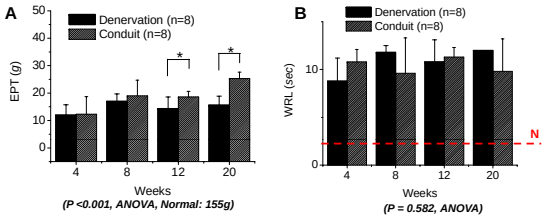

Figure 3. Neurobehavior study: (A) extensor postural thrust motor and (B) withdrawal reflex latency sensory.

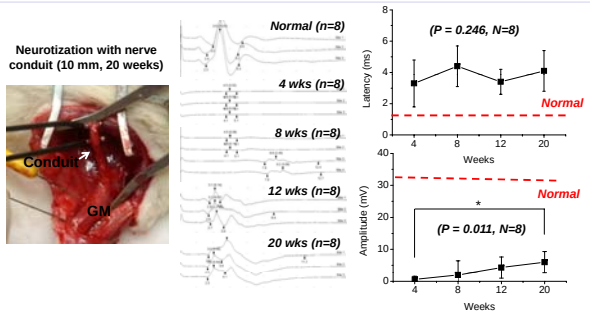

Figure 4. Electrophysiologic study : Experimental groups after neurotization for the evaluation of muscle function recovery.

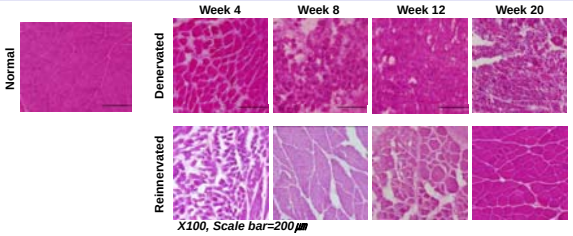

Figure 5. Histological evaluation of reinnervation of denervated muscle with nerve guidance.

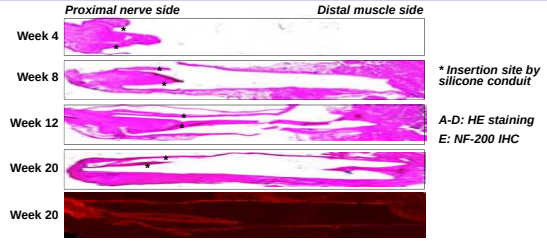

Figure 6. Histological evaluation of reinnervation within nerve guidance.

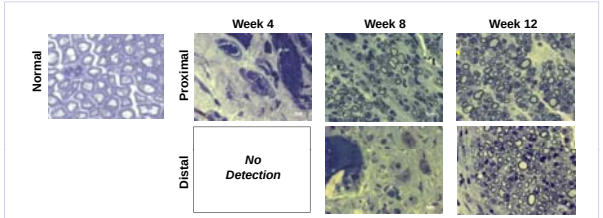

Figure 7. Toluidine blue staining for axon regeneration within nerve guidance channel.

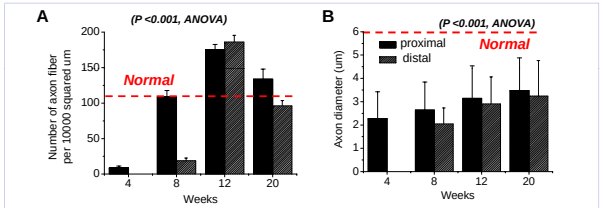

Figure 8. (A) Number of axon and (B) axon diameter.

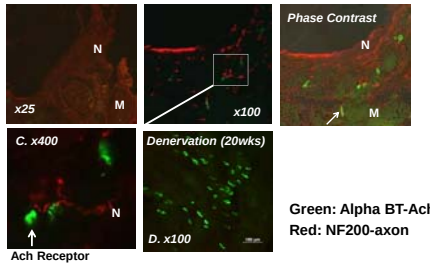

Figure 9. Immunofluorescent staining of neuromuscular junction at 20 weeks after neurotization.

Conclusions

Neurotization using a nerve conduit can regenerate axons and restore neuromuscular junctions in the completely denervated muscle. This study is the first report showing that nerve conduits can be used in neurotization procedures to repair a long nerve gap which lacks a distal nerve segment for anastomosis.

Acknowledgment

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