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Electrical Stimulation of Denervated EDL Muscles of Rats for 15 Weeks Does Not Enhance Recovery of Maximum Force Following Reinnervation

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Introduction: Following peripheral nerve injury and repair, residual muscle weakness hinders effective rehabilitation. Recovery is especially poor if reinnervation is delayed for many weeks. Prolonged periods of denervation result in greater muscle atrophy, which may inhibit functional recovery. Electrical stimulation of denervated muscles reduces atrophy. EDL muscles of rats denervated for 17 weeks maintain only 27% of muscle mass and 2% of maximum force of control muscles. In contrast, electrical stimulation of denervated muscles maintains 99% of the mass and 75% of the force. Our hypothesis is that electrical stimulation of denervated EDL muscles of rats during 15 weeks of peroneal nerve division enhances recovery of muscle mass and maximum force following nerve repair.

Methods: The EDL muscles of 16 rats received one of four experimental treatments.

1. Control: EDL muscle remained innervated (n=6)
2. Immediately-Repaired: peroneal nerve that innervates the EDL muscle was divided and immediately repaired (n=10)
3. Denervated-Repaired: peroneal nerve remained divided for 15 weeks, then repaired (n=7)
4. Stimulated-Denervated-Repaired: peroneal nerve remained divided for 15 weeks while the EDL muscle was electrically stimulated (100 Hz, 20 pulses/contraction, 200 contractions/day) by an implanted stimulator; then the nerve was repaired (n=9)

Functional evaluation occurred 6 months following nerve repair. Maximum force was measured by supramaximal electrical stimulation of the peroneal nerve to generate isometric tetanic contractions measured by a force transducer tied to the exposed and divided distal tendons of the EDL muscle. Afterwards, the EDL muscle was harvested and weighed.

Results: Reinnervation failed in two muscles, one each from the Denervated-Repaired and Stimulated-Denervated-Repaired groups. The table displays results from all other EDL muscles. Muscle mass recovered to a higher level in the Stimulated-Denervated-Repaired group than in Denervated-Repaired, but maximum force recovered no better.

	Muscle Mass (mg)	Maximum Force (mN)
Control	180 ± 4	3092 ± 159
Immediately-Repaired	167 ± 4	2676 ± 77
Denervated-Repaired	93 ± 5	1015 ± 144
Stimulated-Denervated-Repaired	124 ± 12 *	1095 ± 126

*Table: Values given with S.E.M. * denotes difference with Denervated-Repaired ($p < 0.05$).*

Conclusions: The reduced level of atrophy in the denervated EDL muscles that were electrically stimulated during the 15 weeks of nerve division did not enhance recovery of maximum force following nerve repair. The critical issue for recovery following long term denervation and nerve repair appears to not be just the maintanance of muscle mass and maximum force. Other factors not adequately affected by this stimulation protocol limit recovery.