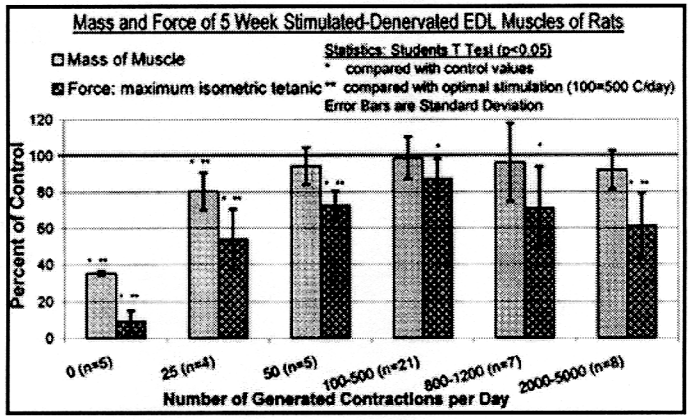
Chronic Electrical Stimulation to Maintain Mass and Force in Denervated EDL Muscles of Rats

Douglas E Dow, M.S., Cheryl A. Hassett, LATG, Paul S. Cederna, M.D., Robert G. Dennis, Ph.D., and John A. Faulkner, Ph.D. Institute of Gerontology, University of Michigan, 300 North Ingalls Building, Ann Arbor, MI 43109-2007

Purpose: Denervated skeletal muscle experiences a progressive decline in muscle mass and force generating capabilities. Though electrical stimulation has been used to prevent these deficits, the stimulation parameters have not been optimized. The purpose was to optimize the parameters, and to evaluate the efficacy of electrical stimulation for prevention atrophy and force deficits.

Methods: The right EDL muscles of 61 rats were permanently denervated and electrically stimulated according to protocols listed in the Figure. An implanted stimulator generated a muscle contraction with 20 pulses at 100 Hz. The left EDL muscles were not denervated or stimulated and served as control. The denervated muscles were stimulated for 5 weeks to optimize the number of contractions/day. The optimal protocol was continued in additional rats for 17 and 32 weeks. To evaluate, the EDL muscles were removed, weighed, and maximum tetanic isometric force was measured *in vitro*.



Results: The Figure displays muscle mass and force values from the 5 week study. Denervated muscles stimulated with the optimal protocol for 17 and 32 weeks maintained muscle mass and force above denervated values (Table).

Variable	5 Week Unstimulated	5 Week Stimulated	17 Week Stimulated	32 Week Stimulated
Mass	35 ± 1%	99 ± 12%	92 ± 15% *	64 ± 12% *
Force	9 ± 6%	87 ± 11% *	58 ± 24% *	29 ± 16% *

*Values are percent of innervated control muscles, with standard deviation. * indicates difference with denervated values ($p<0.05$).*

Conclusion: An electrical stimulation protocol was identified that maintains muscle mass and force of denervated EDL muscles of rats for 5 weeks. When the protocol was continued for 17 and 32 weeks, the mass and force decreased but retained higher values than denervated muscles. Technical difficulties in maintaining constant stimulation partly caused the growing deficits. Long term electrical stimulation may have a beneficial clinical role in maintaining the viability of denervated muscles prior to reinnervation.