DATA SET
EXPLORE 1 LESSON 26

Study 1

Myofibre damage in human skeletal muscle-effects of electrical stimulation versus voluntary contraction

Publish Date: 2007
Journal: Journal of Physiology
Authors: R M Crameri, P Aagaard, K Qvortrup, H Langberg, J Olesen, M Kjaer
Link: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2277245/

Overview of the Study

In this study, researchers wanted to determine what kinds of changes occur to the myofibers of muscles after a single bout of unaccustomed eccentric exercise and if these changes induced delayed onset of muscle soreness. To study this, scientists recruited untrained males (*n* = 8, range 22–27 years) to perform leg extension exercises.

The exercise protocol consisted of two exercise phases: (i) 100 maximal eccentric quadriceps contractions (10 sets of 10 repetitions) at slow contraction speed (knee joint angular velocity 30 deg/s); followed by (ii) 110 maximal eccentric quadriceps contractions (11 sets of 10 repetitions) at high contraction speed (180 deg/s) using an isokinetic dynamometer. Range of motion was from 90 to 10 deg (0 deg = full extension). At the completion of each eccentric contraction, the leg was immediately returned passively to the starting position (10 deg) by the motor of the dynamometer (angular velocity, 60 deg/s), and another eccentric contraction was immediately initiated. A 30-second rest phase was used between each set, and a 5-minute rest period was used between exercise phases (i) and (ii). A total of 210 maximal eccentric muscle contractions were performed.

Assessments from the skeletal muscle were obtained prior to exercise and at 5, 24, 96, and 192 h postexercise. Muscle biopsies were obtained under local anesthetic (1% lignocaine) at a constant depth from the mid-portion of the vastus lateralis muscle in accordance with the needle biopsy technique of Bergstrom (1962). Muscle samples were taken randomly from one leg 48 hours prior to the exercise bout (baseline) and from both legs 5, 24, 96, and 192 hours after the exercise bout. Muscle biopsies were visualized using microscopy.

Note: Myofibre is an alternative spelling of myofiber

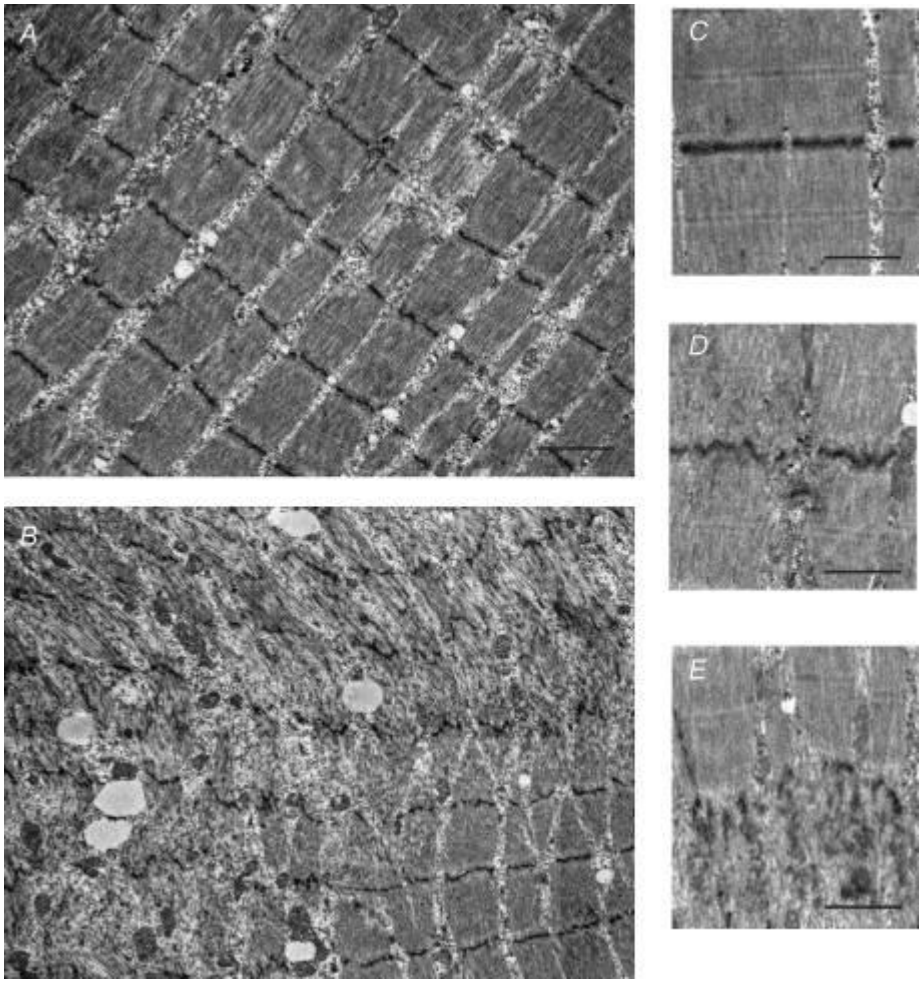

Figure 1 Transmission electron microscopical images of longitudinal sections taken 24 hours post-exercise A and B show predominantly sarcomeric disruption in the VOL muscle (A) and sarcomeric damage in the ES muscle (B). Magnified images of Z-lines taken 24 hours post-exercise show representative images of Z-lines intact (C); Z-lines disrupted (D); and Z-lines destroyed (E). Scale bar for A and B represents 1 µm; scale bars in C–E represent 0.5 µm.

Study 2

Breaking sarcomeres by *in vitro* exercise

Publish Date: 2016
Journal: Scientific Reports
Authors: Zacharias Orfanos, Markus P. O. Gödderz, Ekaterina Soroka, Tobias Gödderz, Anastasia Rumyantseva, Peter F. M. van der Ven, Thomas J. Hawke & Dieter O. Fürst
Link: https://www.nature.com/articles/srep19614

Overview of the Study

This experiment aimed to understand how muscle lesions, which are disruptions in muscle fibers often linked to post-exercise weakness and damage, are formed and behave during muscle contractions. To investigate this, scientists grew myofiber cells in cell culture dishes.

They used electrical pulse stimulation (EPS) to stimulate the muscle cells to contract for five seconds and rest for five seconds, repeating this pattern for up to 30 minutes. This stimulation pattern was intended to mimic exercise in the muscle cells. Scientists took images of the cells every 5 minutes during this EPS protocol.

Figure 1

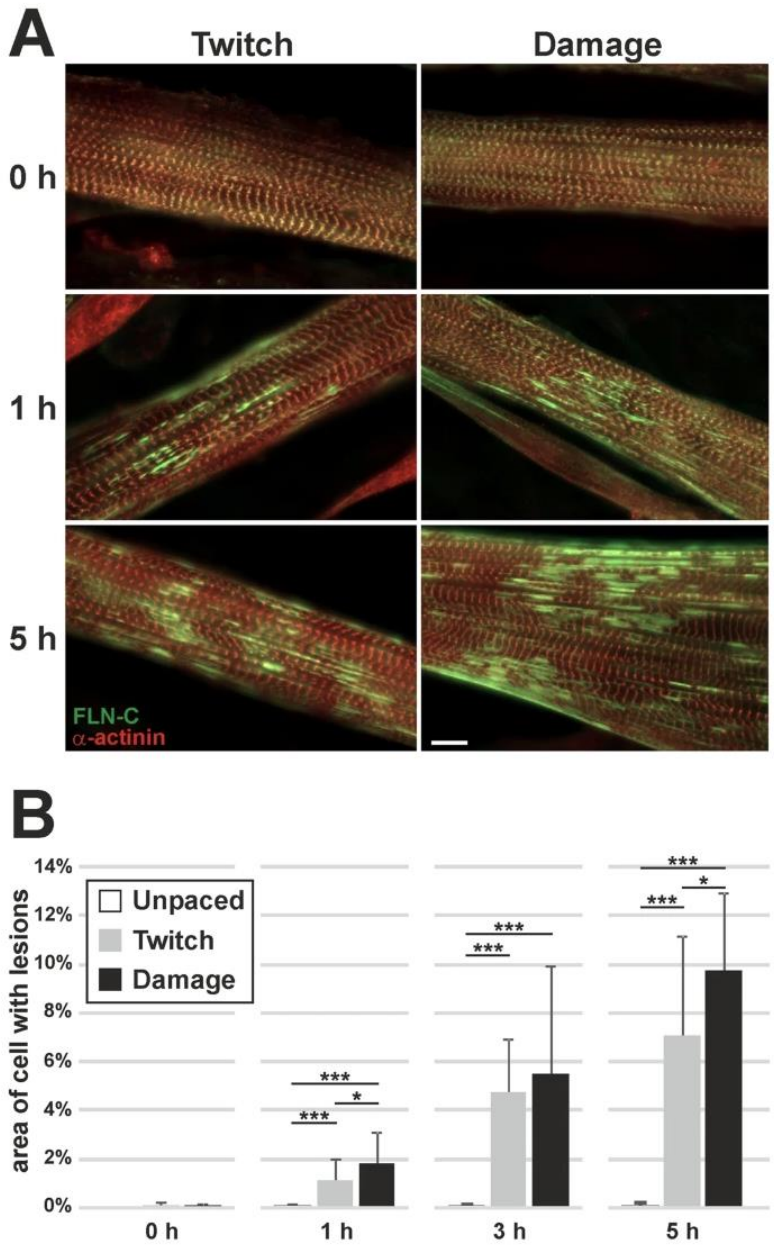

Figure 2 Application of two EPS protocols on C2C12 myotubes leads to the formation of sarcomeric lesions, increasing with time.

(A) Representative images of myotubes treated with EPS, stained for the Z-disc marker α-actinin and the lesion marker FLN-C. The incidence of lesions increases with time of pacing. Note that even before pacing, the myotubes have fully formed and laterally aligned sarcomeres. (B) Quantification of lesion formation, represented as lesion area normalized to the cell area within each photograph (20 cells photographed per time point per treatment). Lesion area significantly increases with pacing, whereas the unpaced controls remain unchanged with time. The damage protocol has a significantly stronger effect than the twitch protocol (error bars represent standard deviation, significance by student's t-test). (Scale bar = 10 µm).