Hindlimb Muscle Morphology and Function in a New Atrophy Model Combining Spinal Cord Injury and Cast Immobilization

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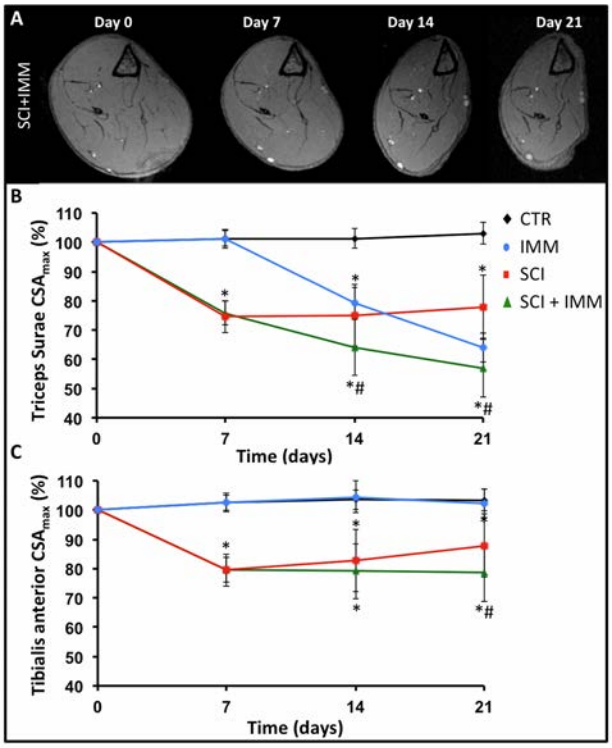
Abstract (from peer reviewed publication)

Contusion spinal cord injury (SCI) animal models are used to study loss of muscle function and mass. However, parallels to the human condition typically have been confounded by spontaneous recovery observed within the first few post-injury weeks, partly due to free cage activity. We implemented a new rat model combining SCI with cast immobilization (IMM) to more closely reproduce the unloading conditions experienced by SCI patients. Magnetic resonance imaging was used to monitor hindlimb muscles cross-sectional area (CSA) after SCI, IMM alone, SCI combined with IMM (SCI+IMM) and in controls (CTR) over a period of 21 days. Soleus muscle tetanic force was measured in situ on day 21, and hindlimb muscles harvested for histology. IMM alone produced a decrease in triceps surae CSA to 63.9±4.9% of baseline values within 14 days. In SCI, CSA decreased to 75±10.5% after 7 days, and recovered to 77.9±10.7% by day 21. SCI+IMM showed the greatest amount of atrophy (56.9±9.9 % on day 21). In all groups, muscle mass and soleus tetanic force decreased in parallel, such that specific force was maintained. EDL and soleus fiber size decreased in all groups, particularly in SCI+IMM. We observed a significant degree of asymmetry in muscle CSA in SCI but not IMM. This effect increased between day 7 and 21 in SCI, but also in SCI+IMM, suggesting a minor dependence on muscle activity. SCI+IMM offers a clinically relevant model of SCI to investigate the mechanistic basis for skeletal muscle adaptations after SCI and develop therapeutic approaches.



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