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Sarcomere heterogeneity during stretches of passive and activated single permeabilized fibers from fast and slow muscles of young and old rats: mechanism of injury

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Following a single stretch of an activated single permeabilized fiber from a given initial length and with a given fiber type, age and history, the immediate force deficit correlates strongly (r^2=0.8) with the work done (force • displacement). Force deficits are five-fold greater for fast compared with slow fibers and two-fold greater for those from old compared with young rats. During stretches of activated fibers, heterogeneity in sarcomere length arises and injury occurs when single sarcomeres are stretched beyond overlap of thick and thin filaments. We tested the hypothesis that muscle fibers that are more susceptible to contraction-induced injury, fast vs. slow and old vs. young, demonstrate greater heterogeneity in sarcomere length during contractions. Single permeabilized fibers were obtained from slow (soleus) and fast (EDL) muscles of young (6 months) and old (28 months) male rats. Fibers were mounted in a chamber at 15°C and sarcomere length was set at ~2.5 μm. While activated maximally, single fibers were stretched through a single strain between 5% and 40% at 0.5 fiber length s^{-1}. Compared with fibers from slow muscles or muscles from young rats, fibers from fast muscles or muscles from old rats showed a greater percentage of stretched regions during isometric contractions. During and following a stretch of an activated fiber, more regions in the fast vs slow and "old" vs "young" fibers had severe disruptions of the diffraction patterns and had greater numbers of damaged sarcomeres identified by electron microscopy. The data supported our hypothesis. Supported by NIH AG-06157.