Study offers new insights into the mechanics of muscle fatigue

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A study in *The Journal of General Physiology* examines the consequences of muscle activity with surprising results, indicating that the extracellular accumulation of potassium that occurs in working muscles is considerably higher than previously thought.

Muscle excitation involves the influx of sodium ions and efflux of potassium ions. Although the fraction of ions that cross the muscle membrane with each contraction is minute, repeated activity can lead to substantial changes in the intracellular and extracellular concentrations of sodium and potassium ions. The extent of these changes, however, has been unclear. Now, Torben Clausen from Aarhus University in Denmark provides quantitative analyses of the changes in intracellular and extracellular ion concentration resulting from stimulation of a leg muscle in rats, providing insight into how they vary with muscle activity.

Clausen measured the changes in concentration of sodium, potassium, and chloride ions in working rat extensor digitorum longus (ESL) muscles. Remarkably, when their muscles were stimulated to fire at a rate of 5 Hz (comparable to that in the legs of a person riding a bicycle) for five minutes, sufficient intracellular potassium was lost to lead to an extracellular concentration that would interfere with further excitation. These results suggest that accumulation of extracellular potassium is a much larger contributor to muscle fatigue than previously thought, which may be of particular importance in such conditions as hyperkalemic periodic paralysis and other channelopathies that affect skeletal muscle. These changes in ion distribution are opposed through the action of the "Na^+/K^+ pump"—which expends energy to move sodium out of the cell and potassium into it—and will therefore be even more pronounced under disease- and injury-related conditions associated with decreased pump activity.

More information: Clausen, T., et al. 2013. J. Gen. Physiol. doi:10.1085/jgp.201210892

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