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### Original Research

## Fatigue and the Electromechanical Efficiency of the Vastus Medialis and Vastus Lateralis Muscles

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### Abstract

**Context:** The relationship between the amplitudes of the mechanomyographic (MMG) and electromyographic (EMG) signals has been used to examine the "electromechanical efficiency" (EME) of normal and diseased muscle. The EME may help us to better understand the neuromuscular relationship between the vastus medialis and vastus lateralis muscles.

**Objective:** To examine the EME of the vastus medialis and vastus lateralis muscles during a fatiguing task.

**Design:** Repeated-measures design.

**Setting:** Research laboratory.

**Patients or Other Participants:** Ten healthy males (age = 23.2 ± 1.2 years) with no history of knee injury.

**Intervention(s):** Seventy-five consecutive, maximal concentric isokinetic leg extensions at a velocity of 180°/s.

**Main Outcomes Measure(s):** Bipolar surface EMG electrodes were placed over the vastus medialis and vastus lateralis muscles, with an MMG contact sensor placed adjacent to the superior EMG electrode on each muscle. The MMG and EMG amplitude values (root mean squares) were calculated for each of the 75 repetitions and normalized to the highest value from the 75 repetitions. The EME was expressed as the ratio of the log-transformed normalized MMG amplitude to the normalized EMG amplitude. For each muscle, the linear relationship for the normalized-group mean EME was determined across the 75 repetitions.

**Results:** Linear regression indicated decreases in torque ( $R^2 = .96$ ), vastus medialis EME ( $R^2 = .73$ ), and vastus lateralis EME ( $R^2 = .73$ ). The slopes for the vastus medialis and vastus lateralis EME were not different ( $P > .10$ ).

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**Conclusions:** The similarities in the fatigue-induced decreases in EME for the vastus medialis and vastus lateralis muscles suggested that symmetry was present between the muscles in the electric and mechanical responses to repeated, maximal muscle actions. The EME measurements may provide a unique insight into the influence of fatigue on the contractile properties of skeletal muscle, including alterations that occur to the intrinsic electric and mechanical components. The EME may be useful in assessing and quantifying clinically relevant asymmetries in vastus medialis and vastus lateralis muscle function in those with knee injuries.

**Keywords:** [mechanomyography](#), [electromyography](#)

Kyle T. Ebersole, PhD, LAT, ATC, and David M. Malek, BS, contributed to conception and design; acquisition and analysis and interpretation of the data; and drafting, critical revision, and final approval of the article.

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