

TITLE: BILATERAL COMPARISONS AND ASSOCIATIONS BETWEEN QUADRICEPS STRENGTH, VOLUNTARY ACTIVATION, AND NEURAL EXCITABILITY WITH KNEE OSTEOARTHRITIS

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ABSTRACT BODY:

Purpose/Hypothesis: Quadriceps weakness is common with knee osteoarthritis (OA) and voluntary activation deficits have been shown to occur in both quadriceps of individuals with knee OA. Cortical and corticospinal excitability mechanisms may underlie these deficits. Active motor threshold (AMT) is a measure of corticospinal excitability. Intracortical facilitation (ICF) and short interval intracortical inhibition (SICI) are measures of intracortical excitability. The purpose of the study was to perform bilateral comparisons and examine associations between the above measures. We hypothesized that lower quadriceps strength and voluntary activation would be associated with lower neural excitability. Specifically, we expected that the more involved (INV) knee compared to the less involved or “uninvolved” (UN) knee would show: 1) lower quadriceps strength; 2) lower quadriceps voluntary activation; 3) higher quadriceps AMT (lower corticospinal excitability); and, 4) lower quadriceps ICF and SICI (lower facilitation/greater inhibition).

Number of Subjects: 14 (4 males, 10 females; age = 62.79 ± 7.55 years; body mass index = 27.65 ± 3.63 kg/m²)

Materials/Methods: Participants with knee OA between 40 and 75 years who reported primarily unilateral symptoms were recruited into this cross-sectional study. Quadriceps strength was recorded as the maximum voluntary contraction (MVC) using a HUMAC dynamometer at 70° of knee flexion. Central activation ratio (CAR), a measure of quadriceps voluntary activation, was determined using the established burst-superimposition protocol. AMT, ICF, and SICI were determined using single- and paired-pulse transcranial magnetic stimulation (TMS) (Magstim BiStim2) over the primary motor cortex and using motor evoked potentials. Two-tailed Wilcoxon Signed Rank tests examined between limb outcome differences and two-tailed Spearman Rank-Order correlations examined between variable associations.

Results: INV limb quadriceps MVC (105.75 ± 50.36 Nm) was less than UN limb (134.60 ± 50.61 Nm; $p = 0.003$). INV limb CAR (86.52 ± 8.58 %) did not differ from UN limb (85.74 ± 10.67 %; $p = 0.27$). INV limb AMT (56.62 ± 12.28 %) did not differ from UN limb (54.85 ± 10.60 %; $p = 0.75$). INV limb ICF (1.85 ± 1.96 μ V) also did not differ from the UN limb (1.60 ± 1.12 μ V; $p = 0.55$). INV limb SICI (0.57 ± 0.24 μ V) was less than the UN limb (0.72 ± 0.31 μ V; $p = 0.023$). INV limb MVC was negatively correlated with INV limb AMT ($r = -0.66$, $p = 0.015$). No associations were found between INV limb MVC and INV limb CAR ($r = 0.26$, $p = 0.42$), ICF ($r = -0.38$, $p = 0.31$), or SICI ($r = -0.55$, $p = 0.125$). No associations were found between INV limb CAR and INV limb AMT ($r = 0.12$, $p = 0.72$), ICF ($r = -0.52$, $p = 0.18$), or SICI ($r = 0$, $p = 1$).

Conclusions: Individuals with knee OA may have lower quadriceps strength (lower MVC) and greater inhibition of intracortical excitability (lower SICI) in their INV compared to UN knees. No other bilateral differences were found; however, mean quadriceps CAR of both knees were about 86%, suggesting bilateral voluntary activation deficits compared to healthy controls, which tends to be > 90% (Pietrosimone et al, 2011). As expected, lower strength was associated with lower corticospinal excitability (higher AMT). This suggests that higher corticospinal excitability may be associated with greater strength, although further research is needed to affirm these relationships.

Clinical Relevance: Individuals with knee OA may demonstrate lower strength, bilateral activation deficits, and differences in neural excitability. Interventions such as repetitive TMS could be used to alter neural excitability and potentially improve these outcomes. Additional study is required to examine treatment effects.

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