

Exploring the Role of Acute Pain on Infraspinatus Motor Excitability: Implications for Understanding Causes of Shoulder Pain Chronicity

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INTRODUCTION: The infraspinatus muscle is an important muscle that provides active stabilization of the glenohumeral joint, and altered neuromuscular functioning of the infraspinatus has the potential to contribute to rotator cuff-related shoulder pain by altering glenohumeral mechanics^{1,2}. Previous work has observed that decreased infraspinatus motor excitability is associated with chronicity of shoulder pain in patients with rotator cuff-related shoulder pain³, but the underlying causes of decreased infraspinatus motor excitability remains unclear. In order to enhance current understanding of the specific effect of pain on infraspinatus motor excitability, this study examined the effect of acute experimental subacromial pain on infraspinatus motor excitability. We hypothesized that infraspinatus motor excitability would be altered in the presence of experimental pain. A secondary aim of this study was to describe the within-session reliability of measures of infraspinatus motor excitability, given that reliability of such measures have not been reported.

METHODS: Institutional review board approval was obtained from the Arcadia University institutional review board. Informed consent was obtained from each participant prior to testing procedures. Participants without shoulder pain underwent up to two sessions of testing involving non-neuronavigated transcranial magnetic stimulation which characterized dominant-arm infraspinatus motor evoked potential (MEP) amplitude following stimulation at 120% active motor threshold. Maximal voluntary isometric contractions were also measured using a force transducer mounted on a custom frame to measure peak external rotation force. The first session aimed to characterize within-session reliability using repeated measures of MEP amplitude at baseline and following a 5 minute seated break. Intraclass correlation coefficients (ICC_{3,1}) were calculated along with MDC₉₅ to describe the degree of reliability in MEP amplitude. The second session aimed to examine the effect of acute experimental subacromial pain on MEP amplitude and peak external rotation strength by measuring at baseline, during pain following a subacromial injection of 5% hypertonic saline solution, and 15 minutes postinjection after pain had resolved. Effect sizes (Cohen's d) and two-sided paired sample t-testing compared MEP amplitude and peak ER force at baseline and during pain, as well as at baseline and following pain resolution.

RESULTS SECTION: 20 participants (13 male, 7 female) underwent testing using experimental shoulder pain. 14 participants (9 male, 5 female) underwent testing for reliability analysis. Compared to baseline, infraspinatus motor evoked potential amplitude was not significantly changed in the presence of experimental pain ($p = 0.12$, $d = 0.35$) nor following pain resolution ($p = 0.13$, $d = 0.38$). Peak external rotation force decreased during pain ($p < 0.01$) and tended to revert to baseline following pain resolution ($p = 0.16$). Motor evoked potential amplitude was measured with good reliability (ICC_{3,1} = 0.98 [0.95-0.99], relative MDC₉₅ = 27%). Motor evoked potential amplitude was increased by an amount that exceeded the relative MDC₉₅ (shown as error bars in figure) in 8 out of 20 participants.

DISCUSSION: Findings from this study suggest that acute pain does not contribute to decreased infraspinatus motor excitability that is seen in those with chronic pain. Instead, acute experimental shoulder pain elicited a small, yet nonsignificant increase in infraspinatus motor excitability that may reflect an adaptive nervous system response to minimize physical stress on subacromial structures secondary to humeral head translation. This work suggests that other factors apart from pain contribute to decreased infraspinatus motor excitability seen in those with chronic rotator cuff-related shoulder pain³, and that previously observed decreases in voluntary activation during experimental pain⁴ do not reflect the excitability of the corticospinal tract, alpha motor neuron, or neuromuscular junction. Discordance between changes in peak ER force and MEP amplitude suggest higher-order neurons such as the premotor areas may be responsible for decreases in voluntary activation seen in previous work. Infraspinatus MEP amplitude is reliably measured within an individual session using conventional transcranial magnetic stimulation and can therefore be used to feasibly characterize infraspinatus motor excitability during trials examining acute changes following interventions or other experimental conditions. Since intrarater reliability within a single session was examined in asymptomatic participants in this study, caution should be taken when generalizing these findings to multiple raters, multiple sessions, and patients with clinical shoulder pathology.

SIGNIFICANCE/CLINICAL RELEVANCE: Since pain appears to influence infraspinatus motor excitability and external rotation force capacity, adequate early pain management may be necessary to minimize maladaptive nervous system responses that may lead to prolonged weakness, decreased motor excitability, and chronic shoulder symptoms. While acute pain does not appear to negatively affect infraspinatus corticospinal tract excitability or peripheral motor neuron excitability, future work appears warranted to identify factors that contribute to decreases in infraspinatus motor excitability in those with chronic shoulder pain and to evaluate any protective effects of interventions on infraspinatus motor excitability.

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