Does upper extremity posture influence corticospinal excitability of the shoulder muscles?

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Summary

The purpose of this study was to assess corticospinal excitability (CSE) of eight muscles surrounding the shoulder complex while resting in several different arm orientations/postures. Ten participants underwent transcranial magnetic stimulation in five shoulder postures: neutral, 45° and 90° of elevation in shoulder flexion and abduction. Surface electromyography was collected from 8 muscles of the dominant arm. Motor evoked potentials (MEP) were elicited as stimulus response curves (SRC) in the resting muscles, with various stimulation intensities. There were posture and stimulus intensity interactions. 90° of shoulder abduction elicited the greatest MEP amplitudes across all stimulus intensities whereas the neutral posture had the lowest MEP amplitudes.

Introduction

The shoulder is a complex musculoskeletal system. Each muscle encapsulating the shoulder responds differently under various postures and force exertions, providing a balance between mobility and stability [1]. The ability to coordinate voluntary movement relies on numerous factors, particularly limb position. Previous work has demonstrated that CSE in the infraspinatus, but not the middle deltoid, were found to be affected by shoulder elevation angle [2]. The purpose of this study was to assess CSE of eight muscles surrounding the shoulder complex in different arm orientations.

Methods

Ten right-handed volunteers (5 male; 24.6 ± 4.83 years, 5 females; 21.8 ± 1.10 years) participated. Disposable bipolar Ag-AgCl surface electrodes (MediTrace 130; Kendall, Mansfield, MA, USA) were applied over the muscle bellies of eight muscles on the participant's dominant arm: biceps brachii (BB), triceps brachii (TB), the anterior (AD), middle (MD), and posterior (PD) heads of the deltoid, supraspinatus (SS), infraspinatus (IF), and the upper trapezius (UT). Electromyography (AMT-8; Bortec Biomedical Ltd, Calgary, AB, Canada) was sampled at 5 kHz using a CED 1401 interface and recorded using Signal 5 software (Cambridge Electronic Design, Cambridge, UK). To measure CSE, MEPs were elicited using a MagStim 200² (MagStim, Dyfed, UK) with a circular coil placed over vertex. Participants were seated upright in a chair, and their right arm was placed in a sling suspended from a custom-built apparatus. The apparatus was designed with a series of adjustments to enable the sling to move and support the arm in two postures: shoulder flexion and shoulder abduction. During the experiment, the arm was positioned at 0°, 45° and 90° of elevation in each posture, resulting in 5 postural conditions (neutral (N), 45° shoulder flexion (45F), 90° shoulder flexion (90F), 45° shoulder abduction (45A), and 90° shoulder abduction (90A)). The experimental conditions were block randomized by arm posture. MEPs were elicited as SRCs in the resting muscles, with intensities of 85/100/115/130/145/160% of resting motor threshold. Statistical comparisons were performed between both MEP amplitudes elicited at different intensities and the area under the curve calculated for each SRC.

Results and Discussion

There was a muscle x stimulation intensity interaction ($p = 0.031$). For all muscles, MEP amplitudes significantly increased with increasing stimulation intensity. There was a posture x stimulation intensity interaction ($p = 0.007$, Figure 1)). CSE was greatest for SS, IF and UT in 45F and 45A, suggesting that muscles in optimal length positions had greater excitability. The AD was least affected by posture. 90° of shoulder abduction elicited the greatest MEP amplitudes across all stimulus intensities and the neutral posture resulted in the lowest MEP amplitudes.

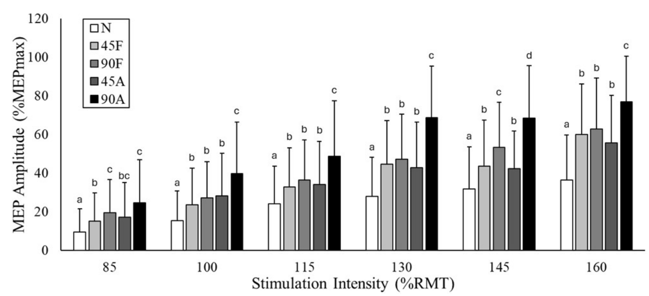

Figure 1. Group (mean ± SD) MEP amplitudes (%MEP_{max}) for each stimulation intensity across all postures (data collapsed across all muscles). Non-matching letters indicate a significant difference in MEP amplitudes between postures.

Conclusions

This work reports the influence of arm orientation on resting corticospinal excitability of muscles surrounding the shoulder complex and demonstrates that CSE of shoulder muscles are posture dependent. This work enhances our understanding of how the nervous system controls and coordinates muscle activity, which is essential for ergonomics, injury prevention and rehabilitation.

Acknowledgments

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References

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