ABSTRACT

**Background:** High level throwing performance requires the development of effective muscle activation within shoulder girdle muscles particularly during forceful internal rotation (IR) motions.

**Study Design:** Controlled Laboratory Descriptive Study

**Purpose:** To investigate activation pattern of 16 shoulder girdle muscles/muscle sub-regions during three common shoulder IR exercises.

**Methods:** EMG was recorded in 30 healthy subjects from 16 shoulder girdle muscles/muscle sub-regions (surface electrode: anterior, middle and posterior deltoid, upper, middle and lower trapezius, serratus anterior, teres major, upper and lower latissimus dorsi, upper and lower pectoralis major; fine wire electrodes: supraspinatus, infraspinatus, subscapularis and rhomboid major) using a telemetric EMG system. Three IR exercises (standing IR at 0° and 90° of Abduction, and IR at Zero-Position) were studied. EMG amplitudes were normalized to EMGmax (EMG at maximal IR force in a standard position) and compared using one-way repeated-measures analysis of variance (ANOVA).

**Results:** There were significant differences in muscles’ activation across IR exercises (p<0.05–p<0.001). Rotator cuff and deltoid muscles were highly activated during IR at 90° of Abduction. Latissimus dorsi exhibited markedly higher activation during IR at Zero-Position. While upper trapezius had the highest activation during IR at Zero-Position, middle and lower trapezius were activated at highest during IR at 90° of Abduction. The highest activation of serratus anterior and rhomboid major occurred in IR at Zero-Position and IR at 90° of Abduction, respectively.

**Conclusions:** Studied exercises have the potential to effectively activate glenohumeral and scapular muscles involved in throwing motions. Results provide further evidence for developing rehabilitation, injury prevention, and training strategies.

**Keywords:** Electromyography; Internal Rotation Exercises; Rehabilitation; Shoulder Muscle Activation

**Level of Evidence:** 4, Controlled laboratory study

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**CORRESPONDING AUTHOR**

Dr Omid Alizadehkhaiyat
School of Health Sciences, Liverpool Hope University
Hope Park, Liverpool L16 9JD, UK
Tel: 0151 291 3262
E-mail: alizado@hope.ac.uk

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1 School of Health Sciences (Sport and Exercise Science), Liverpool Hope University, Liverpool, UK
2 Musculoskeletal Science Research Group, Institute of Translational Medicine, University of Liverpool, Liverpool, UK
3 Department of Musculoskeletal Biology II, Institute of Ageing & Chronic Disease, Faculty of Health & Life Sciences, University of Liverpool, UK