



Original article

Isokinetic clinical assessment of rotator cuff strength in subacromial shoulder impingement

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ABSTRACT

Background: Current conservative management of subacromial shoulder impingement (SSI) includes generic strengthening exercises, especially for internal (IR) and external (ER) shoulder rotators. However, there is no evidence that the strength or the ratio of strength between these muscle groups is different between those with SSI (cases) and an asymptomatic population (controls).

Objective: To identify if isokinetic rotator cuff strength or the ratio of strength is significantly different between cases and controls.

Study design: Case Control Study.

Method: Fifty one cases with SSI and 51 asymptomatic controls matched for age, gender, hand dominance and physical activity level completed isokinetic peak torque glenohumeral IR and ER testing. Within the SSI group, 31 dominant limbs were symptomatic and 20 non-dominant limbs were symptomatic. IR and ER were measured separately using continuous reciprocal concentric (con) and eccentric (ecc) contraction cycles at a speed of 60 degrees per second and again at 120 degrees per second. Values of peak torque (PT), relative peak torque (RPT) and ratios were compared using independent t-tests between the SSI and asymptomatic groups.

Results: Significant strength differences between the two groups were present only when the symptomatic SSI shoulder was the dominant shoulder (con ER PT at 60°/second, ecc ER PT at 120°/second, ecc ER RPT at 120°/second and ecc IR PT at 60°/second and 120°/second).

Conclusions: Changes in rotator cuff strength in SSI may be related to limb dominance, which may have implications for strengthening regimes.

Level of evidence: Level 3a.

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1. Introduction

Subacromial shoulder impingement (SSI) is a common condition characterized by anterolateral catching pain or aching of the shoulder, without a history of trauma. Pain originates from the tissues within the subacromial space including the rotator cuff (N. Hanchard, et al., 2004; J. S. Lewis, et al., 2001). In people with SSI it is proposed rotator cuff muscle weakness develops secondary to inflammation and degeneration that occurs as a result of

mechanical compression from a structure external to the tendon, known as extrinsic SSI (Michener et al., 2003), or as a result of overuse and tension overload affecting the tendons intrinsically, as in tendinopathy, known as intrinsic SSI (Jeremy S Lewis, 2009a,b).

The rotator cuff musculature stabilise as well as move the glenohumeral joint. Subscapularis acts as an internal rotator and infraspinatus, teres minor and supraspinatus act as external rotators (Dark et al., 2007; M.M. Reinold et al., 2004). The rotator cuff has been shown to produce different activity levels dependent on the direction of movement (J. Lewis and Ginn, 2015) and the rotator cuff and biceps have been identified to pre-set prior to actual movement being performed in asymptomatic young male shoulders (David et al., 2000).

Current conservative management of SSI includes generic resistance band strengthening exercises for the rotator cuff particularly shoulder external rotators (ER) (Holmgren et al., 2012;

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Kuhn, 2009). Exercises prescribed for SSI appear to be based on results from EMG studies and the experience and general knowledge of the physiotherapist. (Dark et al., 2007; Holmgren et al., 2012; Michael.M. Reinold et al., 2007; Tate et al., 2010). Previous isokinetic studies comparing rotator cuff strength in a diagnosed SSI group with an asymptomatic group analysed within group differences of the (1) painful versus non-painful shoulder in those with SSI and (2) dominant versus non-dominant shoulder in an asymptomatic group and then (3) compared the values from these two analyses (Leroux et al., 1994; MacDermid et al., 2004; Tyler et al., 2005). Although comparison of dominant and non-dominant limbs have been reported there is no indication that matched dominance was considered in recruitment of symptomatic and asymptomatic group participants in these studies. Greater strength in the dominant upper limb compared to the non-dominant upper limb of the asymptomatic group is expected however this may or may not be the case in a SSI population. Lack of matching for arm dominance limits the opportunity to understand specific variations in strength which may be present due to usual physical activities. Matching of dominance should be an essential component to understand upper limb isokinetic testing results.

Isokinetic testing, performed through an active range at a constant velocity, is a reliable measure of shoulder strength (Land and Gordon, 2011). Internal and external rotation are consistently used to assess the rotator cuff (Ludewig and Cook, 2000; Reddy et al., 2000), with bilateral comparison of concentric peak torque shown to be the most appropriate outcome parameter for comparisons between healthy subjects and those with a painful condition (van Meeteren et al., 2004). A seated testing position with the shoulder positioned in the scapular plane is reported to optimize the length tension relationship of the rotators, maximizing conformity between the humeral head and glenoid and is the most comfortable testing position (Kuhlman et al., 1992). Functionally, EMG studies have identified that during internal rotation pectoralis major muscle activity is greater than subscapularis which is greater than latissimus dorsi expressed as a percentage of maximum voluntary isometric contraction (%MVIC) at low, medium and high exercise intensities (Dark et al., 2007). During external rotation infraspinatus, teres minor and supraspinatus muscle activity (% MVIC) is much greater than deltoid muscle activity at all exercise intensities and when the arm is positioned in the scapular plane (Dark et al., 2007; M.M. Reinold et al., 2004).

Strength changes in SSI not only result from decreased use of the shoulder to avoid pain but also due to altered motor strategies (Roy et al., 2008); decreased central motor corticospinal excitability when symptoms are ≥ 12 months (Ngomo et al., 2015); and inhibition when low to moderate pain levels are present (Dube and Mercier, 2011). Understanding possible muscle strength changes will assist treating clinicians to provide targeted exercise programs and enhance recovery.

The purpose of this study was to compare rotator cuff strength and strength ratios in a group diagnosed with SSI (cases) and a control group, matched for age, gender, hand dominance and physical activity level. The hypothesis was that there would be a difference in muscle strength between the painful shoulder in the SSI group and the dominance matched shoulder in the control group.

2. Method

A case control study, using matched pairs, was conducted to compare rotator cuff muscle strength in those with positive signs of SSI, of gradual onset and without trauma, to an asymptomatic control matched for age, gender, hand dominance and physical activity level.

All testing was performed by an experienced musculoskeletal physiotherapist with over 20 years clinical experience, with both shoulders being measured in all participants.

The recruitment, inclusion and exclusion criteria for this case control study have been previously reported and are provided here for the convenience of the reader.

2.1. Participant information and consent

Ethical approval for this study was granted by the James Cook University (JCU) Human Ethics Committee (approval: H3945). Written informed consent was obtained from each of the participants.

Participants were recruited from the Townsville community and clients presenting to the JCU Physiotherapy Clinic between June 2011 and July 2013. Recruitment for both groups was via emails and word of mouth throughout the University staff, students and their extended networks. In addition, cases were also recruited using an advertisement in the local Townsville press and in the waiting area of the clinic. Cases identified with the advertisement 'Do you feel a sharp catch in your shoulder when raising your arm which eases when you lower your arm down? Is this making it difficult for you to wash your hair or reach up into an overhead cupboard or get your shirt on easily? Is it becoming painful to lie directly onto that shoulder at night?' They then contacted the investigator who arranged an assessment to determine eligibility. Controls were asked to be between 40 and 60 years of age with no history of shoulder, neck or upper back injuries and no reports of painful symptoms in any of these areas in the previous twelve months. Both groups were required to meet the inclusion criteria.

2.2. Power analysis

This study was part of a larger study in which a pre-study sample size calculation was performed, with $\alpha = 0.05$ and power 0.8 (Altman, 1991), which identified a minimum of 45 cases and 45 controls were needed. This sample size was adequate when compared with a calculation based on an isokinetic study comparing rotator cuff strength in a diagnosed SSI group with an asymptomatic group, peak torque external rotation at 60° per second (mean difference 10Nm, standard deviation 2Nm (Leroux et al., 1994)).

2.3. Inclusion and exclusion criteria

Forty to 60 year old participants were recruited to reflect the reported peak age for shoulder impingement (Ostor et al., 2005; van der Windt et al., 1995). Symptom free volunteers as well as people with unilateral shoulder pain completed a screening questionnaire to determine their eligibility for this study. The questionnaire was used to exclude participants, in both the case and control groups, who had:

- Been participating in intense shoulder strength training during the 6 months prior to entering the study. This was defined as high load upper body weight training two or more times per week.
- Recent (within previous two years) or current pregnancy. This exclusion was necessary due to the effect of ligamentous laxity and postural changes associated with pregnancy.
- Previously undergone shoulder surgery or suffered a fracture of the shoulder girdle
- Glenohumeral instability identified by a grade 2 or 3 anterior, posterior or inferior load and shift test (assessed objectively) or a history of shoulder dislocation

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