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ORIGINAL ARTICLE

Accuracy of infraspinatus isometric testing in predicting tear size and tendon reparability: comparison with imaging and arthroscopy

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Background: The purpose of this study was to examine the accuracy of external rotation in neutral (0° external position) and in shortened position (45° external position) in relation to rotator cuff tear size, tendon reparability, and other clinical, surgical, and imaging findings.
Methods: This was a prospective blinded diagnostic study of consecutive surgical candidates for rotator cuff repair using magnetic resonance imaging and arthroscopic surgery as the "gold standards." The area under a receiver operating characteristic (AUROC) curve was calculated for each position.
Results: Eighty-five patients (35 female [41%] and 50 male [59%]; age, 65 years [standard deviation = 10]) were included. Sixty patients (71%) had a minor tear (4 small, 56 moderate), and 25 patients (29%) had a major tear (17 large and 8 massive). Seventy patients (82%) had a full repair, and 15 (18%) patients underwent a partial repair. There were 26 (31%) associated full-thickness tears of the infraspinatus. The isometric strength testing in both positions had good to excellent accuracy (range, 0.80-0.90) for detecting reparability, tear retraction, infraspinatus atrophic changes observed by the clinician, and infraspinatus fatty infiltration on magnetic resonance images. The shortened position had an overall higher accuracy than the neutral position and was more clinically useful for detecting an infraspinatus full-thickness tear (AUROC = 0.84 vs 0.78) and rotator cuff tear size (AUROC = 0.80 vs. 0.75).
Conclusions: The isometric external rotation is an accurate test in diagnosing different aspects of rotator cuff disease and specifically of the infraspinatus muscle. The isometric strength at the shortened position was a better predictor of clinical, surgical, and imaging findings.

This study received ethics approval from the Human Ethics Research Board of the Sunnybrook Health Sciences Centre, Toronto, Canada: REB# 067-2013.

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Clinical tests of the shoulder joint that are based on strength testing have shown acceptable measurement properties in detecting the presence of rotator cuff disease.[4,21-23] One of the most basic rotator cuff clinical tests is the isometric external rotation in neutral position, which examines the integrity of the infraspinatus muscle. This test was formally described by James H. Cyriax, a British orthopedic surgeon, who popularized selective tissue tension testing in the early 1980s.[12] Based on Cyriax's principles, the function of the contractile tissues is better isolated during isometric contraction of the structure in neutral position. Isometric testing in neutral does not affect the inert structures, such as joint capsule, ligaments, or bursae, which helps to more accurately identify the damaged muscle or tendon.[12] The maximum muscle activity of the infraspinatus during external rotation has been confirmed with tomography and electromyographic studies,[28,39] and a small number of studies have examined its validity in relation to presence of tendinitis or full-thickness tear.[25,44]

A decade later, Neer[34] described another test for the infraspinatus muscle, the drop sign, which was conducted at 0° of abduction and 45° of external rotation. In this test, the patient is asked to push against the examiner's hand while maintaining the 45° of external rotation. Presence of a significant tear in the infraspinatus muscle affects the ability of the patient to keep the arm in external rotation when the examiner lets go of the arm, and the forearm is dropped back to neutral position.[43] Two studies have examined the validity of the dropping sign in relation to infraspinatus full-thickness tear.[43,44] However, we are not aware of any studies on validity of isometric strength testing at 45° of external rotation in relation to infraspinatus muscle disease.

The length dependency of isometric force generation is an important feature of a healthy muscle during daily activities.[17] The isometric tension generated by a muscle depends on the length at which the muscle is stimulated, being greatest when the muscle has the same length that it has in the body.[1] As a result of this length-tension relationship, strength is normally decreased at the shorter muscle lengths.[15] The underlying mechanism and physiologic process of the length-tension relationship is a complex phenomenon affected by sarcomere length, muscle fiber heterogeneity, joint angle, and force velocity[1,15,17,30,41] and is beyond the scope of this paper. However, exploration of the length-tension relationship of the isometric force in patients with rotator cuff tears may provide insight into selecting the best position to test the infraspinatus muscle.

Despite a wealth of knowledge related to validity of various shoulder clinical examination tests,[4,21-23] we are not aware of any studies that have quantified isometric strength force or compared the external rotation in neutral (0° of external rotation) with the shortened position (45° of external rotation) in relation to clinical findings, tear size and shape, tendon reparability, fatty infiltration, or muscle atrophy found on imaging. Further study of the subject is therefore warranted as optimizing the rotator cuff examination is expected to lead to improving diagnosis and more efficient management of patients with full-thickness tears.

The primary purpose of this study was to examine the accuracy of 2 positions of isometric external rotation (neutral at 0° and shortened at 45° of external rotation) in detecting rotator cuff tear size and reparability using magnetic resonance imaging (MRI) and arthroscopic surgery as the "gold standards." In addition, the relationship between isometric strength of each position and other relevant clinical, MRI, and surgical findings was explored.

Methods

This was a prospective blinded diagnostic study of consecutive surgical candidates seen at a tertiary shoulder center. Inclusion criteria were persistent pain and functional disability for >6 months, unresponsiveness to conservative intervention (structured rehabilitation, injection or oral medication), and existence of a full-thickness rotator cuff tear diagnosed by MRI and confirmed on arthroscopic assessment. Exclusion criteria included having a previous shoulder operation on the affected side, active work-related shoulder injury, infection, avascular necrosis, and frozen shoulder.

Clinical examination

Clinical examination was conducted by a physiotherapist with 30 years of clinical experience 2 to 3 weeks before surgery. Atrophic changes of the supraspinatus and infraspinatus muscles were documented as none, mild, moderate, and major. Mild diffuse changes in supraspinatus or infraspinatus were categorized as mild. Moderate changes involved visible muscle atrophy with depression of the muscles in the supraspinatus and infraspinatus fossae. Significant loss of muscle bulk in both supraspinatus and infraspinatus muscles was categorized as major atrophy.

We used the Medical Research Council scale for manual muscle strength testing (MMT). Strength of the infraspinatus muscle was categorized on a 5-point scale as normal (5/5), movement against resistance (4/5), movement against gravity (3/5), movement in the absence of gravity (2/5), and trace contraction of the muscle (1/5). The Medical Research Council scale has established reliability and validity in asymptomatic subjects and patients with musculoskeletal conditions.[11]

Maximal voluntary isometric external rotation was measured by a hand-held dynamometer (Lafayette Manual Muscle Test System; Lafayette Instrument Company, Lafayette, IN, USA) in 2 positions, in the neutral position at 0° of abduction and 0° external position and in the shortened position at 0° of abduction and 45° of external