Clinical Biomechanics 28 (2013) 395–401

Contents lists available at SciVerse ScienceDirect

Clinical Biomechanics

journal homepage: www.elsevier.com/locate/clinbiomech

Differences in scapular orientation, subacromial space and shoulder pain between the full can and empty can tests

Mark K. Timmons [a,b,*], Andrea Diniz Lopes-Albers [b,c], Lindsey Borgsmiller [b], Catherine Zirker [d], Jeff Ericksen [e], Lori A. Michener [b]

[a] Interprofessional Polytrauma and Traumatic Brain Injury Rehabilitation, Department of Veterans Affairs, Hunter Holmes McGuire VA Medical Center, Richmond, VA 23249, USA
[b] Department of Physical Therapy, Virginia Commonwealth University, Medical College of Virginia Campus, Richmond, VA 23298, USA
[c] Universidade Federal de Sao Paulo, Departamento de Medicina, Sao Paulo, SP, Brazil
[d] Inpatient Spinal Cord Injury, Craig Hospital, Englewood, CO 80113, USA
[e] Department of Veterans Affairs, Hunter Holmes McGuire VA Medical Center, Physical Medicine and Rehabilitation Section, Richmond, VA 23249, USA

ARTICLE INFO

Article history:
Received 10 February 2012
Accepted 29 January 2013

Keywords:
Scapular orientation
Acromio-humeral distance
Jobe Test
Subacromial impingement syndrome

ABSTRACT

Background: The empty and full can arm positions are used as diagnostic tests and in therapeutic exercise programs for patients with subacromial impingement syndrome. The adverse effects of these arm positions on the rotator cuff have not been fully described. The purpose of this investigation was to compare the acromio-humeral distance, three-dimensional scapular position, and shoulder pain during maximum isometric contractions in the empty and full can arm positions.
Methods: Subjects with subacromial impingement syndrome ($n=28$) and a matched control group without shoulder pain ($n=28$) participated. Acromio-humeral distance, scapular/clavicular positions and shoulder pain were measured during maximal isometric contractions in each position.
Findings: No difference was found in acromio-humeral distance ($P=0.314$) between the arm positions or between the groups ($P=0.598$). The empty can position resulted in greater scapular upward rotation ($P<0.001$, difference = 4.9°), clavicular elevation ($P<0.001$, difference = 2.7°), clavicular protraction ($P=0.001$, difference = 2.5°) and less posterior tilt ($P<0.001$, difference = 3.8°) than the full can position. No differences in the scapular positions were found between the groups. Positive correlations were seen between the scapular positions in the control and not in the subacromial impingement group.
Interpretation: Our results did not show a difference in acromio-humeral distance between the arm positions or groups, indicating that the kinematic differences between the positions are not associated with altered acromio-humeral distance. The increased pain in the EC position might be due to the lack of an association amongst the scapular positions rather than the deficiency of a single scapular motion.

Published by Elsevier Ltd.

1. Introduction

The empty can (EC) and full can (FC) test positions are used as diagnostic tests and as therapeutic exercises in rehabilitation programs for patients with rotator cuff disease. Specifically, the EC position ("Jobe test") is used to assist in the diagnosis of injury to the supraspinatus muscle and is theorized to maximize the activation of the supraspinatus during exercise (Jobe and Moynes, 1982; Kelly et al., 1996; Park et al., 2005). Prior research has indicated that these tests do not differ in supraspinatus muscle activity; therefore one is not recommended over the other to activate the supraspinatus (Boettcher et al., 2009; Takeda et al., 2002). There may be other parameters that differ between the FC and EC positions that will preferentially direct the use of the two arm positions.

* Corresponding author at: Department of Physical Medicine, Hunter Holmes McGuire VA Medical Center, 1201 Broad Rock Blvd, Richmond, VA 23249, USA.
E-mail address: mktimmons@vcu.edu (M.K. Timmons).

0268-0033/$ – see front matter. Published by Elsevier Ltd.
http://dx.doi.org/10.1016/j.clinbiomech.2013.01.015

The EC and FC tests are performed by resisting isometric arm elevation in the scapular plane at 90° elevation; the tests differ in the position of the glenohumeral joint. The EC is performed in glenohumeral internal rotation (thumb pointing down) and the FC is performed in neutral glenohumeral rotation (thumb pointing up). The glenohumeral internal rotation in the EC may place the greater tuberosity of the humerus closer to the acromion, leading to a decrease in the volume of the subacromial space (SAS) and therefore increasing the risk for subacromial impingement of the rotator cuff and producing shoulder pain (De Wilde et al., 2003; Roberts et al., 2002).

The SAS contains the tendons of the rotator cuff and is defined by the borders of the coracoacromial arch and the humeral head. The acromio-humeral distance (AHD) is the linear distance between inferior acromion and humerus. This distance is used to represent the width of the SAS outlet (Fig. 1) (Azzoni and Cabitza, 2004; Azzoni et al., 2004; Desmeules et al., 2004). The SAS outlet allows for the excursion of the supraspinatus tendon into the SAS. Patients with subacromial impingement syndrome (SAIS) have been shown to

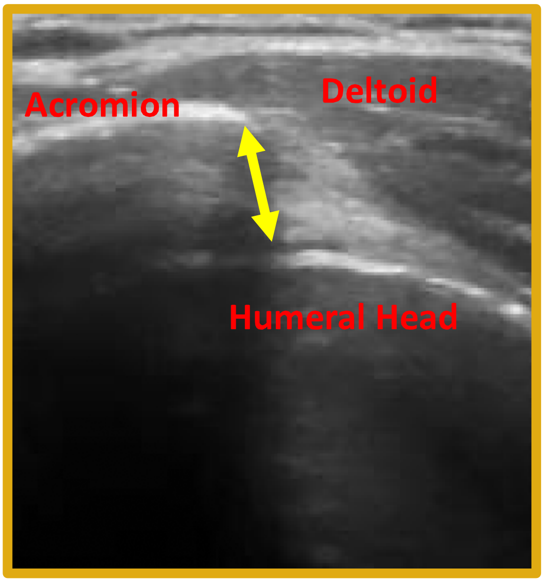

Fig. 1. Acromio-humeral distance with the arm at 90° abduction in the plane of the scapula in the full can position.

have a decreased AHD measurement when compared to patients without SAIS (Graichen et al., 1999b; Hebert et al., 2003). Changes in the AHD measurement may be related to the changes in scapular motion or position (Kalra et al., 2010; Seitz et al., 2011; Silva et al., 2008; Solem-Bertoft et al., 1993).

Decreased scapular posterior tilt, upward rotation, and external rotation have been theorized to cause extrinsic impingement of the rotator cuff tendons by decreasing the size of the subacromial space, (Ludewig and Reynolds, 2009; Michener et al., 2003; Timmons et al., 2012) conversely, increased upward rotation and posterior tilt of the scapula have been theorized to increase the subacromial space (McClure et al., 2006). Evidence indicates that limited scapular upward rotation mobility (Atalar et al., 2009), scapular dyskinesis (Silva et al., 2008), and scapular protraction (Solem-Bertoft et al., 1993) decrease the size of the subacromial space, while a position of increased scapular upward rotation, posterior tilt, (Seitz et al., 2011) and scapular retraction (Kalra et al., 2010; Solem-Bertoft et al., 1993) is associated with an increase in subacromial space. It is unclear if the FC and EC test positions adversely affect scapular kinematics, the subacromial outlet and increasing risk of shoulder pain.

Improved understanding of the effects of positioning the arm in the FC and EC positions during resisted maximal isometric force production on subacromial space outlet and scapular kinematics will assist health care providers in use of the FC and EC positions. The purpose of this investigation was to compare the three-dimensional scapular position, AHD, and shoulder pain during maximum isometric contractions in the EC and FC arm positions. We hypothesized that during the EC there would be increased shoulder pain, decreased acromio-humeral distance, decreased scapular upward rotation and posterior tilt, and increased scapular internal rotation as compared to the FC. Secondarily this investigation had the purpose to determine if scapular position and AHD in the two test positions differ between subjects with and without SAIS.

2. Methods

This was a prospective cross-sectional controlled laboratory study. This study was approved by the Institutional Review Board at the investigator's university. Participating subjects reviewed and signed the informed consent, completed the intake questionnaires and underwent an eligibility examination. Next, subjects underwent study testing in both the FC and EC positions.

2.1. Subjects

Two groups of subjects were recruited to participate in this investigation, a control group not reporting shoulder pain (n = 28) and a group with a clinical diagnosis of SAIS (n = 28). Descriptive data is available in Table 1. The control group and SAIS group were matched based on age (within 5 years), sex, and shoulder tested (dominant or non-dominant side). Control group inclusion criteria were 18–65 years of age without shoulder pain in the previous 6 months. Control group subjects were excluded if they had positive finding on any of the SAIS tests (painful arc, pain or weakness with resisted external rotation, Neer, Hawkins, and Jobe tests) (Michener et al., 2009), a history of upper arm fracture, shoulder surgery, or shoulder pathology. The SAIS group inclusion criteria were pain with resisted arm elevation or external rotation as well as 3 of 5 positive SAIS tests (stated above). In order to assure that subjects did not have adhesive capsulitis; subjects were excluded from the SAIS group if they could not elevate their shoulder greater than 150° nor had a 50% limitation of passive shoulder range of motion in more than 2 planes of motion. Additional exclusion criteria included shoulder pain greater than 7/10, a history of fracture to the shoulder girdle, systemic musculoskeletal disease, shoulder surgery, or a positive clinical examination for a full thickness rotator cuff tear.

2.2. Procedures

Subjects sat with their feet flat on the floor, and shoulder-width apart, and they were instructed to sit up straight with head facing forward. The subject's arm was positioned with the shoulder in 90° of elevation in the scapular plane. The scapular plane is defined as being rotated 40° anterior to the coronal plane. For the FC, the arm was placed in neutral rotation standardized by the thumb pointing towards the ceiling (Fig. 2A). The EC was standardized by the thumb pointing down towards the floor. Arm elevation and scapular plane angles were verified with a digital inclinometer (Acumar, Lafayette Instruments, Lafayette, IN, USA). During 2 trials, each in the FC and EC positions, the subject performed a 6 second maximal voluntary isometric contraction resisted against shoulder elevation. A minimum of a one minute rest was given between the 2 trials. During the isometric contraction, dependent variables were measured including 1 — shoulder elevation force measurements with hand-held dynamometer,

Table 1
Subject demographic information by group (means and standard deviations).

	Control (n = 28, female = 10, male = 18)		SAIS (n = 28, female = 10, male = 18)				
	Mean	SD	Mean	SD	Mean difference	t	*P* value
Age (years)	37.9	14.3	38.7	13.4	0.9	0.221	0.826
Height (cm)	172.8	11.4	174.8	9.1	1.9	0.691	0.492
Mass (kg)	74.1	15.1	82.5	16.1	7.7	1.89	0.064
PENN pain	29.3	1.0	19.9	4.6	9.4	−10.577	<0.001
PENN function	58.8	3.2	42.9	6.9	15.9	−11.784	<0.001
PENN total	97.1	4.2	67.1	10.5	30.0	−14.064	<0.001