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Original article

Subacromial anaesthetics increase asymmetry of scapular kinematics in patients with subacromial pain syndrome

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ABSTRACT

Background: Subacromial pain syndrome (SAPS) and scapular dyskinesis are closely associated, but the role of pain is unknown. We hypothesized that pain results in asymmetrical scapular kinematics, and we expected more symmetrical kinematics after infiltration of subacromial anaesthetics.
Objective: To investigate the effect of subacromial anaesthetics on scapular kinematics in patients with SAPS.
Design: Observational cohort study.
Methods: We evaluated shoulder kinematics in 34 patients clinically and radiologically (magnetic resonance arthrography) identified with unilateral SAPS using three-dimensional electromagnetic motion analysis (Flock of Birds). Scapular internal rotation, upward rotation and posterior tilt of the affected shoulder were compared with the kinematics of the unaffected shoulder and following subacromial anaesthetics. Additionally, the association of pain (Visual Analogue Scale, VAS) and scapular rotation was analysed.
Results: Compared with the contralateral healthy shoulder, 5° more (95% CI 0.4–9.7, $p = 0.034$) scapular internal rotation was observed in the affected shoulder at 110–120° of abduction. Following subacromial anaesthetics in the affected shoulder, internal rotation increased (2°, 95% CI 0.5–3.9, $p = 0.045$) and posterior tilt decreased (3°, 95% CI 1.5–5.0, $p = 0.001$) at 110–120° of abduction. Less scapular upward rotation was significantly associated with higher pain scores before infiltration ($R = 0.45$, $p = 0.013$).
Conclusions: More scapular internal rotation was observed in affected shoulders of patients with SAPS compared with unaffected shoulders. Subacromial infiltration did not restore kinematics toward symmetrical scapular motion. These findings suggest that subacromial anaesthesia is not an effective means to instantly restore symmetry of shoulder motion.

1. Introduction

Subacromial pain syndrome (SAPS), also known as subacromial impingement, has a high prevalence in the general population (van der Windt et al., 1995; Dierckx et al., 2014). SAPS is characterized by shoulder pain, decreased muscle strength and impaired active shoulder function (Harrison and Flatow, 2011). The etiology of SAPS is debated, as multiple factors are advocated to contribute to its pathophysiology (Ludewig and Reynolds, 2009; de Witte et al., 2013; Kibler et al., 2013). These factors include the compression of anatomic structures within the subacromial space, overuse of glenohumeral muscles, dynamic glenohumeral translation by rotator cuff degeneration and scapular dyskinesis (de Witte et al., 2011; Harrison and Flatow, 2011; de Witte et al., 2013).

Quantitative assessment of scapular kinematics with three-dimensional (3D) electromagnetic tracking revealed scapular dyskinesis in patients with SAPS (Lukasiewicz et al., 1999; Ludewig and

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Cook, 2000; McClure et al., 2006). Scapular dyskinesis with increased internal rotation (i.e. protraction), decreased upward rotation (i.e. lateral rotation) and posterior tilt are suggested to reduce the subacromial space and to impinge subacromial tissues (Warner et al., 1992; Solem-Bertoft et al., 1993; Lukasiewicz et al., 1999; Ludewig and Cook, 2000; Endo et al., 2001; Graichen et al., 2001; Hebert et al., 2002). The association between altered scapular kinematics and SAPS led to the application of several treatments targeted at scapular movements (McClure et al., 2004; Camargo et al., 2009; Holmgren et al., 2012). Unfortunately, success rates of treatment vary from 24% to 69% (McClure et al., 2004; Holmgren et al., 2012). The latter underlines the still unclear relation between subacromial shoulder pain and scapular dyskinesis. If scapula dyskinesis, clinically referred to as asymmetry in scapular motion (Uhl et al., 2009), is the consequence of pain, scapular kinematics may return to symmetrical shoulder kinematics after infiltration of subacromial anaesthetics. Ettinger et al. studied the effect of subacromial anesthetics in shoulders with SAPS and compared kinematics in SAPS with kinematics in healthy controls. However, it remains unknown whether kinematics are more symmetrical after subacromial infiltration with anaesthetics (Ettinger et al., 2014).

The purpose of this study is to investigate the effect of subacromial anaesthetics on scapular kinematics in patients with SAPS. We hypothesize that scapular kinematics are asymmetric with more internal rotation, less upward rotation and less posterior tilt in the affected shoulder. Second, we hypothesize that scapular kinematics restore to symmetrical kinematics after infiltration of subacromial anaesthetics in the shoulder with subacromial pain.

2. Materials and methods

Between April 2010 and December 2012 all consecutive patients with the clinical diagnosis SAPS referred to the outpatient clinics of three participating hospitals (Leiden University Medical Center, Medical Center Haaglanden and Rijnland Hospital) were evaluated for inclusion in this cross-sectional biomechanical cohort study (Trial register no. NTR2283). The study protocol has been previously published (de Witte et al., 2011). Eligible patients were invited at the (Leiden University medical Centre, Leiden, the Netherlands) for shoulder evaluation by various experimental set-ups including 3D electromagnetic motion analysis. The institutional medical ethical review board approved this study (P09.227) and written informed consent was obtained for every included patient.

2.1. Participants

Inclusion of patients was based on clinical symptoms, shoulder X-ray's and MR arthrography. Patients, aged 35–60 years, with unilateral shoulder complaints for at least 3 months due to SAPS were eligible for inclusion. SAPS was considered when a positive Hawkins test, a positive Neer impingement test and at least one of the following symptoms were present: pain during daily life activities with arm abduction, extension, and/or internal rotation, pain at night or incapable of lying on the shoulder, painful arc, diffuse pain at palpation of the greater tuberosity, scapular dyskinesis, and positive full or empty can test or positive Yocum test (de Witte et al., 2011).

Exclusion criteria were: insufficient language skills, no informed consent, any form of inflammatory arthritis of the shoulder, clinical signs of glenohumeral or acromioclavicular osteoarthritis, history of shoulder surgery, fracture or dislocation of the affected shoulder, cervical radiculopathy, glenohumeral instability, decreased passive function (e.g. frozen shoulder), and presence of a pacemaker or other electronic implants. Additionally, patients were excluded in case of an alternative diagnosis on radiographs or magnetic resonance (MR) arthrography like: calcific tendinitis, full-thickness rotator cuff tear, partial articular supraspinatus tendon avulsion (PASTA lesion), labrum or ligament pathology, pulley lesion, biceps tendinopathy, os acromiale, tumour, cartilage lesion, and a bony cyst. All MR arthrographies were evaluated by an independent radiologist.

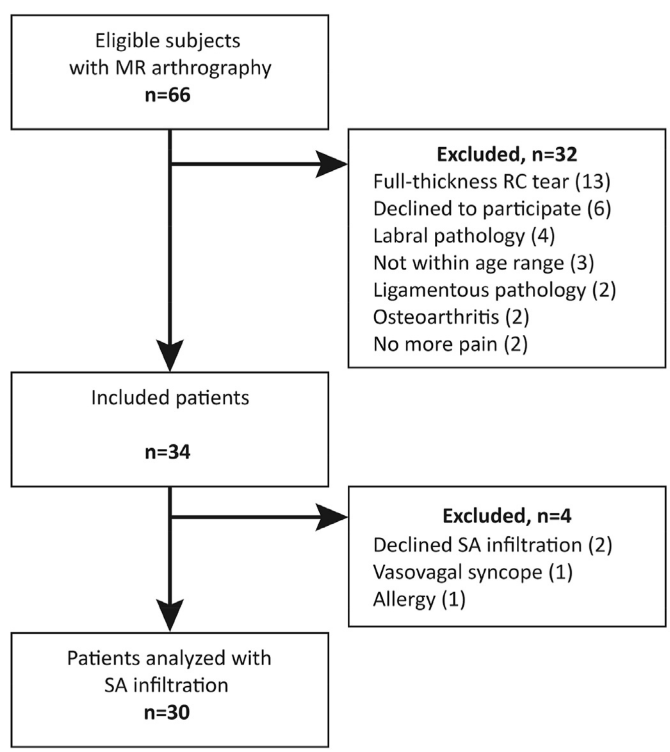
Initially, 66 patients were clinically diagnosed with SAPS and were subsequently scanned with MR arthrography. From these 66 patients, 32 subjects (Fig. 1) were excluded due to an alternative diagnosis on the MR arthrography (32%) or other exclusion criteria (17%), resulting in a total of 34 included patients with SAPS.

2.2. Measurement set-up

Three-dimensional motion was measured using the Flock of Birds electromagnetic tracking system (Ascension Technology Inc., Milton, Vermont, USA). The measurement set-up consisted of an extended range transmitter and six sensors to quantity bilateral shoulder motion in six degrees of freedom. The measurement method and analysis were previously described and validated (Milne et al., 1996; de Groot, 1997; Meskers et al., 1998a,b, 1999; Karduna et al., 2001).

Patients were seated in a standardized measurement set-up. Five wired receivers were attached using either adhesive tape (thorax and bilateral scapulae) or Velcro straps (bilateral distal humeral). The thorax sensor was adhered just above the xyphoid process and the scapular sensors were adhered on the flat cranial surface of the acromion. The humeral sensors were secured at the posterior flat surface of the distal upper arm. Additionally, one sensor was attached to a stylus to digitize bony landmarks.

The global and local Cartesian coordinate systems were described in accordance to the recommended ISB protocol (Wu et al., 2005). Twenty-four bony landmarks were identified by palpation and were digitized using a stylus to determine a local



(n, number; MR, magnetic resonance; RC, rotator cuff; SA, subacromial)

Fig. 1. Flow-chart.