Manual Therapy 21 (2016) 134–143

Contents lists available at ScienceDirect

Manual Therapy

journal homepage: www.elsevier.com/math

Original article

Topographical pressure pain sensitivity maps of the shoulder region in individuals with subacromial pain syndrome

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ARTICLE INFO

Article history:
Received 12 March 2015
Received in revised form
10 June 2015
Accepted 7 July 2015

Keywords:
Glenohumeral
Pressure pain threshold
Scapula
Subacromial

ABSTRACT

Background: Topographical pain maps (TPM) are useful tools to assess deep tissue sensitivity in musculoskeletal pain conditions. There is evidence suggesting bilateral sensitivity in subacromial pain syndrome (SAPS), although it is not widely accepted. No previous study has investigated TPM of the shoulder in SAPS.
Objective: To investigate whether differences for TPM of the shoulder are evident among patients with unilateral SAPS and controls.
Methods: Pressure pain thresholds (PPTs) were assessed 3 times at each point and there was a 20 s rest period between each one. The TPM were calculated using 29 pre-determined points on both shoulders in all groups by inverse distance weighted interpolation of PPT data. Multivariate Analysis of Covariance was applied to detect differences in PPTs between groups, sides, points (gender as covariate).
Results: The results revealed significant differences between points and genders (both, $P < 0.001$), but not between groups ($P = 0.243$) and sides ($P = 0.812$). Heterogeneous distribution of mechanical pain sensitivity was found in both groups as the PPTs were lower on the root spine of the scapula and the posterior border of the acromion (points 5–8, $P < 0.05$), glenohumeral joint (points 17–20, $P < 0.01$) and the anterior deltoid muscle (points 21–25, $P < 0.001$) compared to the average of the other sites on the shoulder. Women exhibited bilateral lower PPTs in all points than men in both groups (all, $P < 0.01$).
Conclusions: This study revealed no differences for mechanical pain sensitivity in patients with SAPS experiencing lower levels of pain compared with matched controls, but showed heterogeneous distribution of PPTs in the shoulder.

1. Introduction

Upper extremity musculoskeletal disorders are usually associated with high social and financial costs showing a prevalence of 36.8% of all the cases in the general population (Huissted et al., 2008). Shoulder pain is one of the most common complaints, comprising 16% of all musculoskeletal symptoms (Urwin et al., 1998; Pope et al., 2001), and subacromial pain syndrome (SAPS) is the most frequent condition for shoulder pain (Lewis, 2011; Tekavec et al., 2012). The etiology of SAPS is not yet understood, but there is evidence showing inflammation and degeneration of the bursa and rotator cuff tendons on the sub-acromial space (Lewis, 2011; Diercks et al., 2014). Furthermore, alterations in kinematics (Ludewig and Cook, 2000; Timmons et al., 2012), muscle activity/performance (Camargo et al., 2008; Phadke et al., 2009) and the presence of active trigger points (TrPs) (Hidalgo-Lozano et al., 2010; Alburquerque-Sendín et al., 2013) have also been reported.

Several studies have demonstrated the impact of shoulder pain on upper extremity function and health-related quality of life (Camargo et al., 2007, 2009). There is evidence suggesting the

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http://dx.doi.org/10.1016/j.math.2015.07.002
1356-689X/

presence of unilateral regional shoulder mechanical hyperalgesia in these patients (Alburquerque-Sendín et al., 2013), whereas multiregional and bilateral shoulder pain hyperalgesia has been also documented (Hidalgo-Lozano et al., 2010; Paul et al., 2012). Both peripheral (Alburquerque-Sendín et al., 2013) and central (Hidalgo-Lozano et al., 2010; Paul et al., 2012) sensitization mechanisms are suggested in playing a role in SAPS.

Peripheral sensitization is mainly caused by endogenous substances related to trauma and inflammation processes that may elicit primary hyperalgesia over the injured area (Curatolo et al., 2006). Central sensitization refers to persistent changes in the central nervous system following prolonged peripheral nociception (Arendt-Nielsen and Graven-Nielsen, 2008). Both peripheral (Alburquerque-Sendín et al., 2013) and central (Hidalgo-Lozano et al., 2010; Paul et al., 2012; Sanchis et al., 2015) sensitizations have already been identified in individuals with SAPS. It is suggested that both mechanisms can contribute to the development and maintenance of chronic pain (Graven-Nielsen and Arendt-Nielsen, 2010).

A number of studies have proposed the utility of topographical pain sensitivity maps as an exploratory method allowing spatial assessment of sensitization mechanisms in several chronic pain disorders, e.g., lateral epicondylalgia (Ruiz_Ruiz et al., 2011), carpal tunnel syndrome (Fernández-de-las-Peñas et al., 2010b), headaches (Fernández-de-las-Peñas et al., 2008; Cuadrado et al., 2010), migraine (Fernández-de-las-Peñas et al., 2009, 2010a), shoulder pain (Ge et al., 2008) or work-related musculoskeletal disorders (Binderup et al., 2011). These studies revealed that mechanical sensitivity depicted by assessing pressure pain thresholds (PPTs) is not uniformly distributed around the same muscle (Fernández-de-las-Peñas et al., 2008; Ge et al., 2008) or around an anatomical area, e.g., the elbow (Ruiz_Ruiz et al., 2011), the hand (Fernández-de-las-Peñas et al., 2010b) or the head (Cuadrado et al., 2010). Furthermore, increased mechanical sensitivity can also occur on the non-affected side as a sign of central sensitization (Ge et al., 2008). Although bilateral hyperalgesia has already been identified in unilateral shoulder pain (Hidalgo-Lozano et al., 2010; Paul et al., 2012; Coronado et al., 2014; Sanchis et al., 2015), results are still conflicting which increases the interest of research in this area.

To the best of the authors' knowledge, no previous study has used topographical pain maps to investigate mechanical sensitivity around the shoulder girdle in individuals with SAPS. Therefore, the aim of the current study was to investigate whether differences for topographical pain sensitivity maps of the shoulder area are evident between patients with unilateral SAPS and healthy people. We hypothesized the presence of heterogeneous topographical pressure pain sensitivity maps of the shoulder area and the presence of regional shoulder pain hyperalgesia in subjects with SAPS compared with controls highlighting different levels of mechanical sensitivity on the shoulder in this patient population.

2. Methods

2.1. Participants

Posters announcing the objectives of the research were put up all around the university and at public places in the community to recruit the symptomatic subjects.

To be included, patients had to fulfill the following inclusion criteria: a) pain in the C5 or C6 dermatome region (McClure et al., 2006); b) at least one positive test: Neer test (Neer, 1972), Hawkins test (Hawkins and Kennedy, 1980), Jobe test (Jobe and Moynes, 1982) as reported in previous studies related to SAPS (Hegedus et al., 2008); c) unilateral painful range of motion during arm elevation or pain during external rotation with the upper extremity in 90° of elevation in the coronal plane; and, d) aged between 18 and 55 years old. Clinical tests for shoulder impingement diagnosis had exhibited either high sensitivity or specificity (Alqunaee et al., 2012). Exclusion criteria included: a) bilateral shoulder symptoms; b) systemic illness, e.g. fibromyalgia, or rheumatoid arthritis; c) history of shoulder adhesive capsulitis; d) pregnancy; e) a previous history of a significant injury to soft tissue or bone structures in the shoulder region; f) ligamentous laxity based on positive sulcus test and apprehension test (Hegedus et al., 2008); g) history of other musculoskeletal diseases of the upper extremity or cervical spine; h) depression (score >11 points on the Beck Depression Inventory (Beck et al., 1988); or, i) history of fractures in the upper extremity; j) previous/current injuries in the lower extremities.

Asymptomatic individuals were recruited from the university and surrounding community. Age- and sex-matched controls without a history of neck or shoulder pain, upper extremity pain-free full range of motion, and no musculoskeletal conditions were recruited. This study protocol was approved by the Ethics Committee (number 162.245). Participants read and signed the informed consent form prior to their inclusion in the study that was conducted according to the Helsinki Declaration.

2.2. Assessment of pain and function

A 10-point numerical pain rating scale (0: no pain, 10: worst pain) was used to assess the intensity of shoulder pain at rest. This scale has been shown to be a valid and reliable tool for individuals with shoulder pain (Jensen et al., 1999).

Shoulder pain and function were assessed using the Disability of the Arm, Shoulder and Hand (DASH) (Orfale et al., 2005) and the Questionnaire and Western Ontario Rotator Cuff Index (WORC) (Lopes et al., 2008, 2006). The DASH questionnaire consists of 30 questions designed to measure physical function, symptoms and social function of the upper extremity. The total score ranges from 0 to 100 where a higher score indicates the worst possible condition (Hudak et al., 1996). This questionnaire has been shown to be a reliable, valid, and responsive outcome (Gummesson et al., 2003; Orfale et al., 2005). The WORC is a self-reported questionnaire with 21 items covering 5 life and health domains: physical symptoms, sports/recreation, work, lifestyle and emotions. Each question is scored on a 0–100 mm visual analog scale. Each domain can be scored separately or a total score ranging from 0 to 2100 can be calculated (Lopes et al., 2008).

2.3. Pressure pain threshold (PPT) assessment

PPT is defined as the minimal amount of pressure when a sensation of pressure changes to pain (Fischer, 1990). A digital pressure algometer (model OE-220, ITO - Physiotherapy & Rehabilitation, Japan) was used. The device consists of a 1 cm^2 rubber disk attached to a strain gauge, which displays values in kg force/cm^2. Data were converted into pressure SI units (kPa). Participants were instructed to press a hand-controlled switch when the sensation first changed from pressure to pain (Vanderween et al., 1996). Pressure was applied at a rate of 1kgf/cm^2/s. The order of the points was randomized before the evaluation. PPTs were measured bilaterally three times for each point by the same assessor and the mean value was used for statistical analysis. A 20sec rest period was allowed between each assessment. This resting period between trials avoids the temporal summation (Nie et al., 2005; Fernández-de-las-Peñas et al., 2010b). The reliability of pressure algometry has been found to be high (intra-class correlation coefficient, ICC: 0.91, 95%CI 0.82–0.97) (Chesterton et al., 2007). Patients were asked not to take analgesics or muscle relaxants at least 72 h before assessment. For each evaluation, the