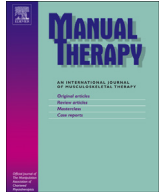




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Original article

Mechanical properties of the trapezius during scapular elevation in people with chronic whiplash associated disorders – A case-control ultrasound speckle tracking analysis

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ABSTRACT

Background: Approximately 50% of people with Whiplash Associated Disorders (WAD) report long-standing symptoms. The upper trapezius is commonly painful yet its mechanical properties are not fully understood.

Objectives: This study examined the deformation of different depths of the upper trapezius muscle during a scapular elevation task (shoulder shrugging) before and following loaded arm abduction.

Design and Methods: A cross-sectional case-control study of 36 people (26 female and 10 male, mean age 38 (SD 11)) with chronic WAD and 36 controls, matched for age and gender. Real-time ultrasound recordings of upper trapezius were taken during both scapular elevation tasks. Post-process speckle tracking analysis was undertaken of three different sections of the upper trapezius muscle (superficial, middle, deep).

Results: The WAD group had lower deformation of the superficial section of the upper trapezius compared to the control group in both concentric and eccentric phases of scapular elevation ($p < 0.05$) especially before the loaded arm abduction. After arm abduction, the deformation of the trapezius was reduced in both groups but only significantly in the WAD-group ($p = 0.03$). Within-group analysis revealed that the control group least engaged the deep section of upper trapezius during the task ($p < 0.01$).

Conclusion: This study, measuring mechanical deformation of the upper trapezius during a scapular elevation task indicates that persons with WAD may display different patterns in engagement of the muscle sections than those in the control group. Further research is needed to replicate and understand the reasons for and implications of this possible change in motor strategy within upper trapezius.

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1. Introduction

Approximately 50% of people with Whiplash Associated Disorders (WAD) continue to report neck pain one year after their injuries (Carroll et al., 2008). Changes in muscle morphology and function seem to be important features. For example, widespread fatty infiltrate in neck muscles has been found in those patients with persisting moderate to severe pain levels (Elliott et al., 2011). Likewise altered cervical muscle activation patterns have been

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shown in people with chronic WAD (Falla et al., 2004; Jull et al., 2004; Woodhouse and Vasseljen, 2008).

Muscles such as the upper trapezius are often painful and tender in chronic WAD (Siegmund et al., 2009). Electromyography (EMG) studies of the upper trapezius have shown its lesser ability to relax and either decreased or increased activity during functional tasks (Nederhand et al., 2000, 2002; Elert et al., 2001; Falla et al., 2004). Reduced activation may be a compensation for painful muscles (Falla et al., 2004), while the increased activity in the upper trapezius may be protective of a sensitive brachial plexus or an expression of central nervous system hypersensitivity which is commonly found in chronic WAD (Coppieters et al., 2001; Sterling et al., 2002).

While EMG can inform on altered trapezius muscle activity, it is unable to inform on mechanical properties of the muscle (shortening or elongation). An insight into muscles' mechanical properties can be gained with speckle tracking which is an analysis from which muscle deformation identified in ultrasound recordings can be measured during movement (Gronlund et al., 2013). The muscle deformation measure of speckle tracking has been examined against estimated measures of multidimensional strain of both electrically induced and voluntary muscle contraction. The measure was found to be both a reproducible and practically feasible method (Lopata et al., 2010). To our knowledge, the only other study examining mechanical properties of upper trapezius using real-time ultrasound during movement is a pilot study by Peolsson et al. (2008). It revealed decreased trapezius muscle deformation after pain provoking exercise in people with trapezius myalgia but not in healthy control subjects.

The aim of this study was to examine deformation in the upper trapezius muscle at different depths of the muscle during scapular elevation (shoulder shrugging) before and after the participant performed a set of arm abductions while holding a weight. The latter was investigated to determine any influence of a movement often used in daily life on the mechanical properties of upper trapezius. Our hypothesis was that there would be different deformation characteristics within the upper trapezius muscle in people with chronic WAD compared to people without neck pain during scapular elevation, both before and after the arm adduction task.

2. Methods

2.1. Participants

Individuals with WAD were recruited from persons participating in an ongoing randomized controlled trial (RCT). They were aged 18–63 years with neck pain originating from whiplash trauma, at least 6, but no more than 36 months prior to inclusion (Peolsson et al., 2013; Ludvigsson et al., 2015). Additional inclusion criteria for the RCT were pain >20 mm on 100 mm Visual Analogue Scale (VAS) and/or disability >20% on the Neck Disability Index (Vernon and Mior, 1991). Exclusion criteria were: previous neck trauma with persistent neck problems; prior neck pain causing more than one month's work absence the year before the whiplash injury; previous cervical spine surgery; direct head trauma and/or unconsciousness/loss of memory following the trauma; myelopathy; spinal infection or tumor; generalized or more dominant pain elsewhere in the body; ongoing malignancy; diseases or other injuries that might prevent full participation in the main exercise study; diagnosed severe psychiatric disorder; known drug abuse or insufficient knowledge of the Swedish language. For the current ultrasound study, only right handed individuals were included and persons were not considered if they had more dominant pain on the left side of the neck or were obese (Body Mass Index > 35).

Forty-two consecutive, eligible volunteers with chronic WAD (30 female and 12 male, mean age 38 (SD 11), range 18–60) were recruited from RCT participants. A convenience sample of 42 right handed, age and sex-matched controls without neck pain were recruited among volunteers who were mainly hospital and university staff. The study was approved by the regional ethics committee. All participants signed informed consent.

2.2. The scapular elevation task

Participants were instructed to stand in an upright position. A custom made contact switch was strapped to the palmar side of the right wrist, with a matching part secured by a belt at a corresponding position on the right hip. A trigger signal from the switch registered the start and finish of the scapular movement on the ultrasound recording. Before recording, participants practiced pace and performance using their contralateral (left) shoulder to avoid inducing pain or fatigue of the muscles to be tested. For the tests, participants held a dumbbell (men 2 Kg, women 1 Kg) in their right hand and were asked to perform a smooth scapular elevation of 3 cm, without abducting the arm, to reach an adjustable horizontal bar (reference point, the acromio-clavicular joint) (Fig. 1). The pace of the movement was standardized with a metronome set at 30 beats/minute (about 4 s for a movement task). The participant started on a metronome beep and one scapular elevation movement was recorded. After the first test, participants were instructed to abduct their right arm 5 times to 90° shoulder abduction with the elbow straight and holding the dumbbell. Each repetition was performed at the same pace following the metronome without any rest between repetitions. No recordings were made during this task. Participants then performed scapular elevation for the second time (test 2) as previously described. Ultrasound measures were recorded during both experimental tasks.



Fig. 1. Ultrasound examination of the trapezius during scapular elevation.

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