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Multifidus muscle size changes at different directions of head and neck movements in females with unilateral chronic non-specific neck pain and healthy subjects using ultrasonography

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A B S T R A C T

Objective: The aim of the study was to compare the dimensions of cervical multifidus muscle (CMM) in different conditions.
Methods: Twenty five women with neck pain and 25 healthy subjects participated in this study. The dimensions of the CMM were measured at rest, 50% and 100% maximum isometric voluntary contraction (MIVC) at six directions of neck movements, using ultrasonography.
Results: The size of multifidus was smaller in patients than healthy individuals at rest state ($P < 0.05$). A significant smaller CMM dimension was found in the affected side compared with unaffected side in patients group ($P < 0.05$). The result of ANOVA for MLD showed a significant difference for contraction levels ($P < 0.001$) and neck movements ($P < 0.001$) in both groups. The MLD of the CMM was significantly different between CMM at rest and 50%, and 100% MIVC ($P < 0.001$). No significant differences were found between the groups at 50% and 100% MIVC ($P > 0.05$ in both instances). The most prominent CMM size change was observed during neck extension, flexion, ipsilateral lateral-flexion, and ipsilateral rotation, respectively ($P < 0.05$).
Conclusions: Results of the present study indicate that the size of CMM was decreased in patients with neck pain in rest state. The size of CMM changes in all directions of neck movements, although the most prominent was during neck extension. This points out CMM stabilization role's in different directions of neck movements.

1. Introduction

As an increasing musculoskeletal disorder worldwide, neck pain is experienced in about 67%–71% of people through their lifetime (Fejer et al., 2006; Cote et al., 1998). In cervical region, about 20% of the head weight is tolerated by bones and ligamentous structures, while the rest is tolerated by paraspinal muscles (Panjabi et al., 1998). Weakness and atrophy of segmental paraspinal muscles, abnormal cervical lordosis, fat deposition, delayed muscular activity, compromised proprioception, and changes in muscular fibers type have been reported in patients with chronic neck pain (Uhlig et al., 1995; Kristjansson and Jonsson, 2002; Falla et al., 2004; Elliott et al., 2006; Wu et al., 2007; Fernández-de-las-Peñas et al., 2008; Lee et al., 2009; O'Leary et al., 2009; Chae et al., 2010; Rezasoltani et al., 2010; Javanshir et al., 2011; Amiri Arimi et al., 2016). Biomechanical models demonstrated that activity and function of the short and deep paraspinal muscles, especially the cervical multifidus muscle (CMM), is essential for spinal stability (Cholewicki and McGill, 1996; Panjabi et al., 1998; Kristjansson, 2004; Lee et al., 2007; Ward et al., 2009).

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Regarding the changes in muscle size as a measure of mechanical activity, ultrasonography is considered as a common reliable, valid, and available method to evaluate muscular atrophy or hypertrophy in different musculoskeletal conditions (Hides et al., 1995; Rezasoltani, 2003; Rankin et al., 2005; Fernández-de-las-Peñas et al., 2008; Javanshir et al., 2010; Ghamkhar et al., 2011; Rahmani et al., 2015). Cross-sectional area (CSA) of CMM has been reported to be smaller in patients with bilateral chronic neck pain compared to healthy subjects (Fernández-de-las-Peñas et al., 2008). As the correlation between CMM thickness and an isometric extension force of the head and neck is concerned, the most prominent change in CMM thickness was recorded when the effort was less than 50% of maximum isometric voluntary contraction (MIVC) (Lee et al., 2009).

CMM is located in the posterior part of the cervical spine and appears to be active only during extension movement. Earlier studies were conducted on CMM during rest status or extension movement (Kristjansson, 2004; Rankin et al., 2005; Lee et al., 2007; 2009, Fernández-de-las-Peñas et al., 2008), while the CMM is regarded both as a static (Panjabi et al., 1998; Kristjansson and Jonsson, 2002; Ward et al., 2009) and dynamic stabilizer of the cervical spine (Lee et al., 2009). It seems that CMM is also active during other neck movements such as flexion, lateral flexion, and rotation in order to stabilize cervical spine. In the present study, we made an attempt to assess the size of CMM in women suffering from unilateral chronic non-specific neck pain compared to the asymptomatic subjects. Moreover, we evaluated the CMM size changes during isometric contraction in six different directions of head and neck movements, at three contractile levels (0%, 50%, and 100% MIVC) in all participants.

2. Methods

2.1. Participants

This cross-sectional study was performed on 25 women with unilateral chronic non-specific neck pain and 25 healthy women. They participated in this study voluntarily. The samples were recruited by a questionnaire and physical examination provided by a governmental organization. Both groups were computer users who worked for more than 4 h a day. In the patient group, individuals had experienced chronic unilateral non-specific neck pain lasting for at least 12 weeks. Mechanical or non-specific neck pain was defined as a pain in the neck or shoulder regions, elicited by the prolonged constant positioning of the neck, cervical movements, or palpating the local musculature (Fernández-de-las-Peñas et al., 2008). Exclusion criteria were history of any conditions such as bilateral neck pain, cervical radiculopathy, whiplash injury, fibromyalgia, myelopathy, severe osteoarthritis, cervical rib, spinal surgery, history of head and neck trauma or fracture, prior physical treatments during the previous six months, wound in the skin of the neck, systemic or autoimmune disease and pregnancy. The Spurling test (Cleland et al., 2005), as well as X-rays, were used to exclude those with any referred pain or evident degenerative findings. All participants were asked to refrain from any extra physical activity for three days before the test. The control group also performed their overall healthy and daily activities without pain in the last year. The aims and methods of the study were explained to all the participants. All the participants signed a consent form. Demographic data were collected through a general questionnaire. Additionally, in the patient group, the visual analogue scale (VAS) (Jensen et al., 1999; Bijur et al., 2001) and the neck disability index (NDI) (Hains et al., 1998; Mousavi et al., 2007; Cleland et al., 2008) were used to assess the pain intensity and functional disability, respectively. The present study also received ethical approval from the Medical Sciences' Ethical Committee at Shahid Beheshti University of Medical Sciences, Tehran, Iran.

2.2. Procedure of ultrasonographic measurements

In the present study, a SIUI ultrasound device with the 80 mm convex probe and 5 MHz frequency was used to assess CMM size. The participants were asked to sit on a chair and keep trunk upright, with head and neck in neutral position (Lee et al., 2007; Rezasoltani et al., 2010). Thoracic and pelvic girdle were fastened at the level of scapular spine and iliac crest, respectively (Rezasoltani et al., 2002). In all measurements, both hands were on the thighs, the knees were extended, and the feet were resting on a stool with 15 cm height (Fig. 1) (Rezasoltani et al., 2002; Lee et al., 2007).

The size of CMM was assessed bilaterally at the rest, at the level of fourth cervical vertebrae that was defined using manual palpation by an experienced physiotherapist (Kristjansson, 2004; Lee et al., 2007). A probe was placed on one side of the C4 spinous process, perpendicular to the vertical axis of the neck and muscle fibers (Fernández-de-las-Peñas et al., 2008). CMM is located lateral to the junction of the vertebral lamina and spinous process, and anterior to the semispinalis cervices muscle (Lee et al., 2007). Anterior-posterior dimension (APD) and a lateral dimension (LD) were measured. Then, multiplied linear dimensions (MLD) (APD × LD) (Rezasoltani et al., 2002, 2010), and shape ratio (LD/APD) were computed (Kristjansson, 2004; Lee et al., 2007; Fernández-de-las-Peñas et al., 2008; Rezasoltani et al., 2010). The CMM size was first recorded at rest status. An experienced musculoskeletal operator (at least for 2 years) performed the ultrasound examination.

2.3. Dynamometry

The maximum isometric force of the cervical flexor, extensor, left and right lateral flexors, and left and right rotator muscles were assessed using the isometric measurement device designed for the purpose of the study. It is notable that the high reliability of the

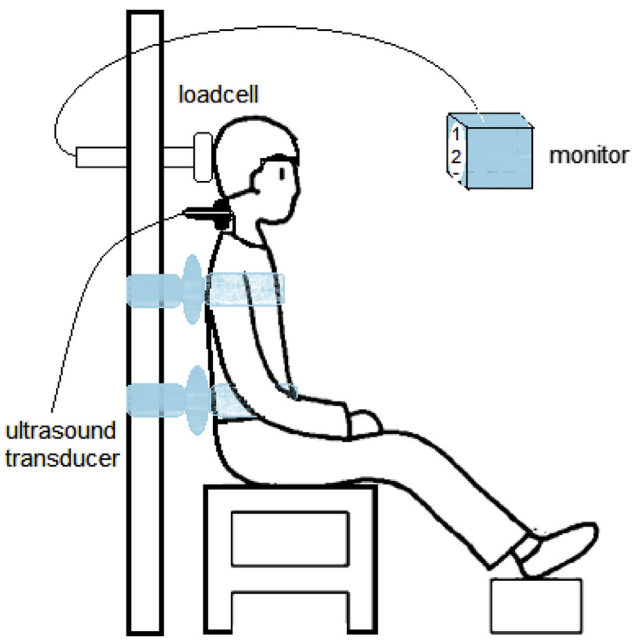

Fig. 1. Experimental set up of the study.

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