



Original research

Multifidus muscle size and symmetry among elite weightlifters

Patraporn Sitalertpisan^{a,*}, Julie Hides^{b,c}, Warren Stanton^{b,c}, Aatit Paungmali^a, Ubon Pirunsan^a^a Biomedical Sciences Program, Department of Physical Therapy, Faculty of Associated Medical Sciences, Chiang Mai University, 110 Intravarorot St., Suthep, Muang, Chiang Mai 50200, Thailand^b School of Physiotherapy, Australian Catholic University, Brisbane Campus (McAuley at Banyo), Queensland, Australia^c Mater Back Stability Clinic, Mater Health Services, South Brisbane, Queensland, Australia

ARTICLE INFO

Article history:

Received 16 September 2010

Received in revised form

10 February 2011

Accepted 20 April 2011

Keywords:

Low back pain

Ultrasound imaging

Weightlifting

ABSTRACT

Objectives: To examine muscle cross-sectional areas (CSA) and symmetry of lumbar multifidus (LM) muscles in elite weightlifters.**Design:** Cross-sectional observational study**Setting:** Neuromuscular and Pain Research Unit.**Participants:** Thirty-one elite weightlifters (15 males) participated in the study, representing the population of Thai weightlifters eligible for national selection.**Main outcome measures:** Resting CSA of the LM muscle were assessed bilaterally at 4 lumbar vertebral levels using ultrasound imaging. The between side differences (relative to the side of the preferred hand) were used to determine the asymmetry.**Results:** The between side differences (relative to the preferred hand) of the LM muscle CSA were less than 3% for all vertebral levels and suggested symmetry between sides ($p > .05$). No difference was found between weightlifters with unilateral or bilateral pain symptoms.**Conclusion:** This study provides new information on resting CSA for the LM muscle in elite weightlifters. Future studies could investigate other aspects of neuromotor control of the LM muscle to determine if there are impairments which could be addressed in an attempt to decrease the high prevalence of LBP in this population.

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1. Introduction

Competitive weightlifting is a sport that exposes the spine to extreme forces (Cholewicki, McGill, & Norman, 1991). Injury reports conducted over a six year period among weightlifters at Olympic Training Centers showed that the low back was the most commonly injured area (23.1%) of the body (Calhoun & Fry, 1999). The prevalence of LBP was shown to be even higher (41.67%) among Thai weightlifters (Paungmali et al., 2007). In addition, former weightlifters had a higher rate and more severe degenerative changes in the upper lumbar spine (Videman et al., 1995). It has been reported that weightlifters have a 36.2% incidence of spondylolysis (Rossi, 1978), in comparison with a rate of 3–7% in other sports and general populations (Calhoun & Fry, 1999). Weightlifting may predispose the athlete to spondylolysis (Goertzen, Schoppe, Lamge, & Schultz, 1989; Granhed & Morelli, 1988; Mundt et al., 1993) due to high compressive loads on the spine. Cholewicki et al. (1991)

measured forces at the L4–L5 motion segment in 57 competitive weightlifters. The average compressive loads were $>17,000$ N. Given the high incidence of low back pain (LBP) among weightlifters, it would seem appropriate to examine muscles which have potential for protecting the spine in this group.

During lifting, many muscles are recruited and good technique is required. It has been suggested that an emphasis should be placed on achieving correct motor patterns before substantial weight is attempted. Preserving a neutral lumbar spine is thought to be essential for safe lifting (McGill, 2002). In one study of the mechanics of power lifters spines' (Cholewicki & McGill, 1992) during the execution of a lift, one lifter reported discomfort and pain. On examination of the video fluoroscopy records, one of the lumbar joints (L2–3) went into full flexion, while all other joints maintained their static position, resulting in a buckling of the spine and injury. It was hypothesized that an error in motor control of a segmental muscle such as the lumbar multifidus (LM) resulting in a temporary reduction in activation and rotation at that single joint.

There is considerable evidence for the role of the LM muscle in segmental stabilization of the lumbar spine. Biomechanical studies have highlighted the role of the LM muscle in provision of

* Corresponding author. Tel.: +66 81 7721244; fax: +66 53 946042.

E-mail address: asphi010@chiangmai.ac.th (P. Sitalertpisan).

segmental stiffness (Panjabi, 1992a; Wilke, Wolf, Claes, Arand, & Wiesend, 1995) control of the spinal segment's neutral zone (Panjabi, 1992b; Panjabi, Abumi, Duranceau, & Oxland, 1989) and its capacity to stabilize the spine when spinal stability is challenged (Keifer, Shirazi-Adl, & Parnianpour, 1997; Keifer, Shirazi-Adl, & Parnianpour, 1998). Furthermore, the LM muscle has been shown to contribute to proprioception of the lumbar spine (Brumagne, Cordo, Lysens, Verschueren, & Swinnen, 2000).

Imaging studies have been used to document normal morphology (Hides, Cooper, & Stokes, 1992; Hides, Gilmore, Stanton, & Bohlscheid, 2008b; Hides, Stokes, Saide, Jull, & Cooper, 1994; Stokes, Rankin, & Newham, 2005), and impairments in terms of decreased cross sectional area (CSA) of the LM muscle in non-athletic populations (Barker, Shamley, & Jackson, 2004; Danneels, Vanderstraeten, Cambier, Witvrouw, & De Cuyper, 2000; Hides et al., 2008b; Wallwork, Stanton, Freke, & Hides, 2009), and athletic populations with LBP (Hides, Stanton, McMahon, Sims, & Richardson, 2008c). There is evidence that the CSA of the LM muscle is selectively decreased compared with other lumbopelvic muscles in patients with chronic LBP (Danneels et al., 2000). Atrophy of the LM muscle is a common radiological finding (Karder, Wardlaw, & Smith, 2000). Elite Cricketers with LBP demonstrated localized atrophy and between-side asymmetry of the LM muscle, despite continued strength and cardiovascular training (Hides et al., 2008c).

Between-side asymmetry in the LM muscle CSA could be an indication of atrophy from dysfunction or hypertrophy secondary to handedness and sport specific tasks. In weightlifting, hand dominance would be more relevant during pulling the weight. Most of the load goes through the arms and transfers to the trunk in which it needs to counter the force and stabilize rotation. However, no study has evaluated the resting CSA and symmetry of the LM muscle in weightlifters. The aim of this study was to compare the resting CSA and symmetry of the LM muscles among elite weightlifters.

2. Methods

2.1. Participants

The participants in this study were 31 elite weightlifters (15 males and 16 females) who were selected to attend a national training camp. This sample represented the population of Thai weightlifters eligible for national selection. Participants performed regular weightlifting training programs which consisted of one hour of cardiovascular and strength training and three hours of skill training per day, 6 days per week. The sample mean $\pm$ standard error (SE) of age, weight and height were 21.42 ± 0.59 years, 72.32 ± 3.69 kg, 162.09 ± 1.91 cm. The exclusion criteria were observable spinal abnormalities, previous spinal or abdominal surgery and pregnancy. The study was approved by the Human Research Ethical Committee of the Institution. Informed consent was obtained from all participants.

2.2. Procedures

All participants completed a self administered questionnaire. Hand preference was defined as the hand that was used for writing and tasks during activity daily living (Bishop, Ross, Daniels, & Bright, 1996). LBP was defined as pain localized between T12 and the gluteal fold (Mazanec, 2004). Participants who did not report LBP on a body chart and pain provocation on manual examination, were coded as 'asymptomatic'. Weightlifters, who reported current LBP plus pain provocation on manual examination were allocated to the "LBP group". Weightlifters with LBP rated their pain intensity

on a Visual Analogue Scale (VAS, rated 0–10), reported the duration of symptoms (in months) and the site of LBP was drawn on a body chart. The grouping of cases as 'bilateral' or 'unilateral' pain was based on body chart reports of LBP.

The resting CSA of the LM muscles were measured using a Toshiba ultrasound scanner (Toshiba, Famiio 8, SSA-530A) set in B-mode with a 5-MHz curvilinear transducer. Measurement of the LM muscle was performed with subjects in the prone position with a pillow placed under the abdomen to minimize the lumbar lordosis. The spinous processes of the L2–L5 vertebrae were palpated and marked on the skin with a pen. The electro-conductive gel was applied on the skin and the ultrasound transducer was placed longitudinally along the midline of the lumbar spine to confirm the location of each lumbar spinous process. The transducer was rotated in transverse section and placed in the middle of each spinous process. The left and right LM muscles were captured once, with both sides on the same image. The ultrasound images were taken from L2–L5 with subjects in a relaxed state and images were stored for offline analysis (Fig. 1).

The program Image J was used to calculate the resting CSA of the LM muscle (version 1.36b, <http://rsb.info.nih.gov/ij>) at the vertebral levels of L2–L5. The measurement was carried out 3 times on one image and averaged for each image.

Prior to the data collection of the main study, reliability of measurements (CSA of the LM muscle) were conducted in eight subjects. The CSA of the LM muscle were assessed bilaterally at L2, L3, L4 and L5 vertebral levels in the prone position. The same investigator performed repeated measurements of the same image after resetting the calipers.

2.3. Statistical analysis

Analysis of variance (ANOVA) was used to initially test for group similarity in age, height, weight, BMI and maximum lifting performance. In addition, the duration of pain and level of pain

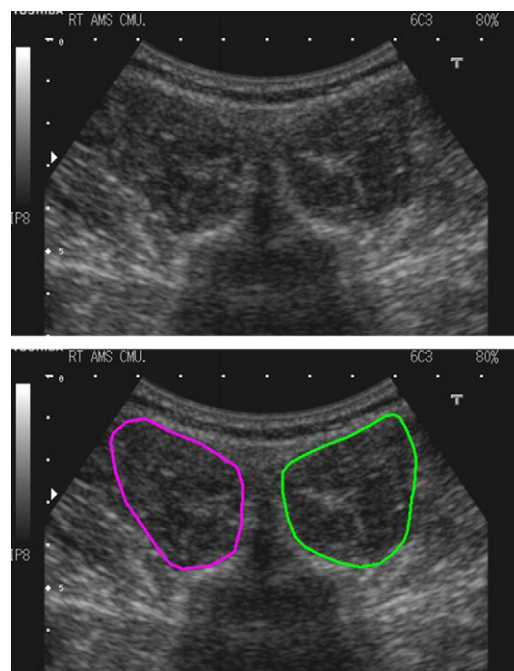


Fig. 1. Bilateral transverse image at the L3 vertebral level showing the shadow of the spinous process in the center of the image and the lumbar multifidus muscle, with and without the CSAs traced.

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