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Original research

Symmetry, not asymmetry, of abdominal muscle morphology is associated with low back pain in cricket fast bowlers

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ABSTRACT

Objectives: Although abdominal muscle morphology is symmetrical in the general population, asymmetry has been identified in rotation sports. This asymmetry includes greater thickness of obliquus internus abdominis (OI) on the non-dominant side in cricketers. Cricket fast bowlers commonly experience low back pain (LBP) related to bowling action, and this depends on trunk muscle control. This study aimed to compare abdominal muscle thickness between fast bowlers with and without LBP.
Design: Cross sectional descriptive study.
Methods: Twenty-five adolescent provincial league specialist fast bowlers (16 with and 9 without LBP) participated. Static ultrasound images (US) of OI, and obliquus externus (OE) and transversus abdominis (TrA) were captured on the dominant and non-dominant side in supine.
Results: Total combined thickness of OE, OI and TrA muscles was greater on the non-dominant than dominant side ($p = 0.02$) for fast bowlers without LBP, but symmetrical for those with pain. Total thickness was less on the non-dominant side for bowlers with pain than those without ($p = 0.03$). When individual muscles were compared, only the thickness of OI was less in bowlers with LBP than those without ($p = 0.02$). All abdominal muscles were thicker on the non-dominant side in controls ($p < 0.001$) but symmetrical in LBP.
Conclusions: Asymmetry of abdominal muscle thickness in fast bowlers is explained by the asymmetrical biomechanics of fast bowling. Lesser OI muscle thickness in fast bowlers with LBP suggests modified trunk control in the transverse/frontal plane and may underpin the incidence of lumbar pathology. The implications for rehabilitation following LBP in fast bowlers require further investigation.

1. Introduction

Although asymmetry of the trunk muscles has been linked to low back pain (LBP) in the general population,[1,2] in individuals who participate in specific sports this may be adaptive in order to meet the asymmetrical demands of sport-specific skills.[3,4] This is particularly relevant for sports such as cricket, in which fast bowlers use asymmetrical motion of the body to accelerate the ball. Fast bowling in cricket is associated with a high risk of lower back injury[5,6] and the biomechanics of the bowling action has been highlighted as a major contributor.[6,7] Increased counter-rotation of the shoulders during the delivery stride has been highlighted as a variable associated with LBP[6,8] and is dependent on control of trunk rotator muscles. The relationship between symmetry/asymmetry of the trunk muscles, and fast bowling and low back pain remains contentious.

The asymmetrical action of cricket fast bowling combines the movements of lumbar flexion, extension, rotation and side flexion, factors which have been identified generally in the aetiology of LBP.[9] High volume of cricket bowling is also a risk factor for LBP and would encourage muscle asymmetry.[10] Consequently asymmetry of lumbar muscles is commonly observed in cricket fast bowlers.[11–13] In a group of cricket players including spinners, pace bowlers and batsmen, cross-sectional area of the quadratus

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lumborum (QL) and multifidus/erector spinae muscles on the dominant side, and psoas major and obliquus internus abdominis (OI) muscles on the non-dominant side is greater than the contralateral muscle.[12] Some aspects of trunk muscle asymmetry have been linked to pain and/or injury.[11] QL asymmetry has been associated with the development of a pars interarticularis lesion in cricketers in a single study[11] but this finding has not been supported by later research.[3,14] In the general population, asymmetry of the multifidus[2,15] and psoas major[1] muscles is present in individuals with acute and chronic LBP. Taken together these data imply that asymmetry of trunk muscle morphology has negative impact on the health of the spine.

Although implementation of an exercise programme can train symmetry of multifidus in the general population[16] and cricketers,[17] the relevance of asymmetry/symmetry is contentious. Asymmetry might imply abnormal load on the spine and warrant intervention to correct, but alternatively, it may be a necessary adaptation for the demands of the sport. Recent work reports that decreased asymmetry of QL was linked to pars defects in fast bowlers.[14] Yet considering their critical contribution to the control of rotational forces the lateral abdominal muscles have received surprisingly limited attention in the cricket literature. A previous investigation in cricketers which included a small group of fast bowlers ($n = 9$) showed thicker OI on the non-dominant side.[18] The relevance of these muscles to the control of asymmetrical rotation in the bowling action means investigation of symmetry/asymmetry of this muscle group is likely to provide important insight into its relevance for pain.

This study aimed to compare the thickness of the abdominal muscles (measured with ultrasound (US) imaging) between the dominant and non-dominant sides of representative adolescent cricket fast bowlers, and to compare this between fast bowlers with and without LBP.

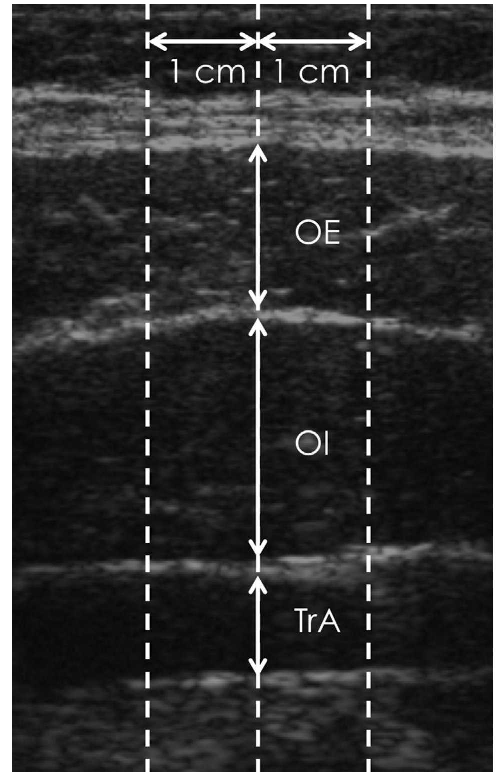

Fig. 1. Measurement of muscle thickness from ultrasound imaging. Measurements of the thickness of transversus abdominis (TrA), obliquus internus abdominis (OI), obliquus externus abdominis (OE) were made in the middle of the image and at 1-cm intervals on either side.

2. Methodology

Twenty-five adolescent cricket fast bowlers were recruited for this study. The group consisted of 16 fast bowlers with chronic LBP and 9 fast bowlers with no history of previous or current injury to the lower back (non-low back pain [NLBP]). Participants were between 14 and 18 years old and were currently playing representative cricket at a provincial level.

The inclusion criteria for the LBP group included, players currently experiencing LBP (for a minimum of 6 weeks) associated with the activity of fast bowling, players were currently playing cricket but the pain was of sufficient severity that it had caused them to miss a game or practice in the previous 6 weeks. Exclusion criteria for both groups included previous lower back surgery or facet blocks with local anaesthetic or back pain in the last 2 years. Participants were included in the NLBP group if they had no history of LBP in the past 2 years (self-reported). This 2 year period was chosen as the long term changes in the function, and hence possibly morphology, have been previously described.[19] The Research Ethics Committee of the University of Cape Town approved the study. The participants and a guardian provided written informed consent prior to the study. Independent t-tests showed no statistical differences between groups for age, height, weight and years bowling (LBP – 17(1) years, 179(7) cm, 75(7) kg, 7(2) years bowling; NLBP – 16(1) years, 175(7) cm, 67(13) kg, 7(3) years bowling, respectively).

Real-time US imaging (Sonoline G50, Siemens Medical Solutions USA, Inc.) with a 12 MHz linear transducer was used to assess the thickness of the lateral abdominal muscles. Thickness was used rather than cross sectional area as it was not possible to visualize the entire muscles in the US Image.[20]

The US transducer was placed transversely, approximately 2.5 cm anterior to the mid-point between the ribs and the inferior border of the iliac crest. The medial edge of the transducer head was positioned approximately 10 cm from the midline. This position allowed simultaneous imaging of the TrA, OI, and OE muscles.[21,22]

Participants were positioned supine with the hips flexed to ~45° and knees flexed to ~90° to ensure a neutral position of the lumbar spine and relaxation of the abdominal muscles. Once accurate visualization of the three abdominal muscles (OE, OI, TrA) was obtained the image was frozen at the end of a normal quiet expiration and saved for analysis. Thickness of the three abdominal muscles was measured on both sides of the trunk and designated as non-dominant and dominant based on the arm used when bowling.

Thickness of the three lateral abdominal muscles was measured using image-J software (NIH, USA). The calliper function was used to measure thickness at three sites, at 1-cm intervals on either side of, and including, the middle of the image (Fig. 1). The callipers were placed on the inner border of the hyperechoic regions related to the fascia separating the muscle layers. The three thickness values obtained for each muscle were averaged and converted to millimetres using the calibration scale on each image. The total combined thickness of all abdominal muscles was also calculated by summing the values for each muscle.

Statistical analysis was performed using the Statistica software package, version 7 (Statsoft Inc., Tulsa, Ok, USA). Statistical significance was set at $p < 0.05$. Thickness of the abdominal muscle layers was compared between Muscles (OE, OI, TrA), Group (LBP vs. NLBP) and Sides (dominant vs. non-dominant) with an analysis of variance (ANOVA). A separate ANOVA was used to compare total combined thickness. The Bonferroni test was used for post hoc analysis where appropriate.