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Clinical Study

Fat infiltration of paraspinal muscles is associated with low back pain, disability, and structural abnormalities in community-based adults

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Abstract

BACKGROUND CONTEXT: Low back pain and disability are major public health problems and may be related to paraspinal muscle abnormalities, such as a reduction in muscle size and muscle fat content.

PURPOSE: The aim of this study was to examine the associations between paraspinal muscle size and fat content with lumbar spine symptoms and structure.

STUDY DESIGN/SETTING: This was a community-based magnetic resonance imaging (MRI) cohort study.

PATIENT SAMPLE: A total of 72 adults not selected on the basis of low back pain were included in the study.

OUTCOME MEASURES: The outcomes measured were lumbar modic change and intervertebral disc height. Pain intensity and disability were measured from the Chronic Pain Grade Questionnaire at the time of MRI.

METHODS: The cross-sectional area (CSA) and amount of fat in multifidus and erector spinae (high percentage defined by >50% of muscle) were measured, and their association with outcome was assessed.

RESULTS: Muscle CSA was not associated with low back pain/disability or structure. High percentage of fat in multifidus was associated with an increased risk of high-intensity pain/disability (odds ratio [OR], 12.6; 95% confidence interval [CI], 2.0–78.3; p=.007) and modic change (OR, 4.3; 95% CI, 1.1–17.3; p=.04). High fat replacement of erector spinae was associated with reduced intervertebral disc height (β=−0.9 mm; 95% CI, −1.4 to −0.3; p=.002) and modic change (OR, 4.9; 95% CI, 1.1–21.9; p=.04).

CONCLUSIONS: Paraspinal fat infiltration, but not muscle CSA, was associated with high-intensity pain/disability and structural abnormalities in the lumbar spine. Although cause and effect cannot be determined from this cross-sectional study, longitudinal data will help to determine

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whether disabling low back pain and structural abnormalities of the spine are a cause or result of fat replacement of paraspinal muscles.

Keywords: Lumbar; Intervertebral disc; Modic; Muscle; Fat; Low back pain; Disability

Introduction

In the Global Burden of Disease Study, low back pain was ranked highest for disability of all 261 diseases examined, with disability-adjusted life years increasing from 58.2 million in 1990 to 83 million in 2010 [1]. In the United States, the prevalence of chronic low back pain has risen significantly, with a substantial proportion of the rise in healthcare costs attributable to increased disease prevalence [2]. In both Australia and the United States, the point prevalence of low back pain is approximately 20% to 25% of the general adult population [3,4]. Targeting modifiable risk factors associated with chronic low back pain may therefore be important in reducing the burden of this common disease.

It is well established that among people with chronic low back pain, the size of paraspinal muscles is reduced [5–8]. In particular, studies of low back pain have predominantly focused on two major muscles: erector spinae and multifidus [5–14]. Nevertheless, measuring the size of a muscle as a surrogate for muscle atrophy fails to capture internal derangements in muscle architecture, such as fat replacement. Although fat infiltration is a sign of muscle atrophy [10,13], the replacement of muscle with fat may not significantly alter the cross-sectional area (CSA) of a muscle [15]. Studies that have investigated the size of paraspinal muscles [5–8] have tended to recruit people with chronic low back pain. Such an approach may be problematic because fear of movement is common among people with chronic low back pain [16], and high levels of inactivity may select people with more pronounced muscle atrophy. A more conservative approach may be to examine adults within the general population not selected on the basis of having low back pain, with the presumption that the point prevalence of pain will approximate the rate in the general adult population (~20%–25%) [3,4].

There is growing interest in the role of fat infiltration of paraspinal muscles and the pathogenesis of low back pain. Histologic studies have demonstrated concordance between muscle fat detected by magnetic resonance imaging (MRI) and intraoperative specimens of paraspinal muscles [9], with other studies corroborating MRI as a valid method of identifying the amount of fat in skeletal muscle [17,18]. In various studies, fat infiltration of multifidus was associated with low back or leg pain [10–13]. Nevertheless, no study has examined whether paraspinal muscle fat infiltrate is associated with a composite score of low back pain and disability.

Although both intervertebral disc height and modic change have been associated with low back pain [19–23] and instability [19,24], few studies have examined whether paraspinal muscle characteristics are associated with structural change in the spinal column (see Table 1). Whereas one MRI study found only a tendency toward a significant association between multifidus fat replacement and nerve root compression, herniated nucleus pulposus, and the number of degenerated discs [11], a computerized tomography (CT) study found that a density change in paraspinal muscles was associated with lumbar spine facet joint osteoarthritis, spondylolisthesis, and disc narrowing [14]. No study has examined the associations between paraspinal muscle properties and MRI-determined intervertebral disc height and lumbar vertebral end plate bone marrow lesions, termed ‘‘modic’’ change [26].

The aim of this 3.0-T MRI study was to examine the associations between paraspinal muscle properties and the presence of low back pain, disability, and lumbar structural changes in a community-based population. We hypothesized that reduced CSA and higher fat presence in paraspinal muscles will be associated with low back pain and disability, as well as reduced intervertebral disc height and modic change.

Methods

Participants

Seventy-two community-based individuals recruited through local media and weight loss clinics were examined as part of a study of obesity and musculoskeletal health. Participants were recruited without reference to whether they had or did not have low back pain for inclusion in the study. Participants were excluded if they had a history of malignancy, significant systemic condition (eg, cerebrovascular accident, movement disorder, connective tissue disease, etc), or inability to understand English. Participants gave written informed consent. The study was approved by the Human Research Ethics Committees of the Alfred Hospital and Monash University.

Magnetic resonance imaging

Magnetic resonance imaging was performed using a 3.0-T magnetic resonance unit (MAGNETOM Verio, A Tim System; Siemens, Erlangen, Germany). The participant was positioned in supine, and the following scans were performed: sagittal T1 images from T12 to the sacrum (time to recovery: 670 ms, time to echo: 12 ms, and slice thickness: 4 mm); sagittal T2 images from T12 to sacrum (time to