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SHORTER LUMBAR PARASPINAL FASCIA IS ASSOCIATED WITH HIGH INTENSITY LOW BACK PAIN AND DISABILITY

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Abstract

Study Design: A cross-sectional, community-based study

Objective: To investigate the relationship between structural features of the **thoracolumbar fascia** and low back pain and disability.

Summary of Background Data: The thoracolumbar fascia plays a role in stabilisation of the spine by transmitting tension from the spinal and abdominal musculature to the vertebrae. It has been hypothesised that the fascia is associated with low back pain through the development of increased pressure in the paraspinal compartment which leads to muscle ischaemia.

Methods: 72 participants from a community-based study of musculoskeletal health underwent Magnetic Resonance Imaging from the T12 vertebral body to the sacrum**.** The length of the paraspinal fascia and cross-sectional area of the paraspinal compartment were quantitatively measured from axial images at the level of the transverse processes and the Chronic Pain Grade Scale was used to assess low back pain intensity and disability.

Results: A shorter length of fascia around the parapsinal compartment was significantly associated with high intensity low back pain and/or disability, after adjusting for age, gender and body mass index (right odds ratio (OR) 1.9 95%CI 0.99 to 3.8, p=0.05; left OR 2.6 95%CI 1.2 to 5.6, p=0.01)**.** Further adjustment for the cross-sectional area of the compartment strengthened the associations between fascial length and low back pain/or disability (right OR 8.9 95%CI 1.9 to 40.9, p=0.005; left OR 9.6 95%CI 1.2 to 42.9, p=0.003)**.**

Conclusions: This study has demonstrated that a shorter lumbar paraspinal fascia is associated with high intensity low back pain and/or disability among community-based adults. While cohort studies are needed, these results suggest that structural features of the fascia may play a role in high levels of low back pain and disability.

Key Words: Low back pain; disability; thoracolumbar fascia; epidemiology; spine structure; paraspinal compartment

Level of Evidence: 3

Introduction

Although the Global Burden of Disease Study has demonstrated that low back pain is the leading cause of disability, the aetiology of low back pain remains poorly understood [1]. There is an urgent need to better understand factors associated with disabling low back pain so that targeted prevention strategies for primary health care can be developed. Previous studies have found structural abnormalities of the lumbar spine to be associated with low back pain and disability [2-4], and a recent systematic review and meta-analysis reported that magnetic resonance imaging (MRI) findings of disc protrusion, nerve root displacement or compression, disc degeneration, and high intensity zone taken together are associated with low back pain [5]. While further investigation is required, these findings suggest that targeting structural factors may assist in reducing the huge burden of low back pain and disability.

There is growing evidence to suggest that the thoracolumbar fascia, an extensive connective tissue structure that attaches the muscles of the abdominal wall to the thoracolumbar spine and encases the paraspinal muscles, may have a role in low back pain. Studies of the fascia have examined its anatomical attachments and the effects of fascial tension on the lumbopelvic region, with results indicating that the fascia contributes to lumbar stability at a segmental level [6]. Although the fascia can be visualised on MRI, few MRI studies have examined its association with spinal pain. Of these, most have used qualitative descriptors, such as flat, convex or sagging, to grade features of the fascia [7,8]. Given preliminary data suggest that structural features of the fascia may be associated with degenerative lumbar conditions, it is plausible that examining a measure, such as its length, provides the opportunity to sensitively examine a new structural feature and its relationship with low back pain.

The aim of this cross-sectional study was to examine the relationship between the length of the lumbar fascia and low back pain and disability using MRI.

Materials and 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 not required to have low back pain or a history of low back pain for inclusion in the study. Exclusion criteria included malignancy, significant systemic condition, contraindication to MRI and inability to understand English. Participants gave written informed consent. The study was approved by the Human Research and Ethics Committees of the Alfred Hospital and Monash University.

Anthropometric variables

Age, gender, height (cm) and weight (kg) were measured and body mass index (BMI, $kg.m^{-2}$) was calculated.

Magnetic resonance imaging

MRI was performed using a 3.0-T magnetic resonance unit (MAGNETOM Verio, A Tim System; Siemens, Erlangen, Germany) in 2012. The participant was positioned in supine and the following scans were performed: (1) sagittal T1 images from T12 to the sacrum (time to recovery 670ms; time to echo: 12 ms, slice thickness: 4mm), (2) sagittal T2 images from T12 to sacrum (time to recovery: 3000-3600 ms; time to echo: 87-114 ms, slice thickness: 4 mm), and (3) axial T2 images from L1 to L3 and L3 to S1 (time to recovery: 3000-3600 ms; time to echo: 87-114 ms, slice thickness: 4 mm).

Fascial Length and Cross-sectional Area of the Compartment

Fascial length was measured from the tip of the transverse process to the tip of the spinous process using MR images viewed in OsiriX computer program (v4.0, Pixmeo, Geneva, Switzerland) (Figure 1A). The cross-sectional area (CSA) of the compartment was measured by tracing the full perimeter of the compartment on the MR images (Figure 1B). The images were assessed in the transverse plane and measures were taken at the level of the transverse processes. All the images were measured by one investigator (TR) and seventy-five (21%) randomly selected images were reassessed one week later. The intra-rater reliability of the measures at each vertebral level was high, with intra-class correlation coefficients (ICCs) ranging from 0.83-0.98 for the fascial length measures and 0.97 to 0.99 for the compartment cross-sectional area measures.

Low back pain and disability

The Chronic Pain Grade Questionnaire (CPG) was administered at the time of the MRI to obtain information on low back pain intensity and disability over the past 6 months. The CPG is a reliable and valid instrument for use in population surveys of low back pain [9]. It has seven questions which are used to provide a grade from 0 (pain free) to 4 (high disability severely limiting). Grades 2, 3 and 4 were considered to represent those with high intensity pain and/or disability and so were combined for analysis.

Statistical analyses

Logistic regression analyses were used to examine the associations between fascial length and high pain intensity and/or disability. We conducted two multivariate analyses, in the first adjusting for age, gender and BMI, and in the second adjusting for age, gender, BMI and CSA of the compartment. Average values of compartment CSA and length of fascia from the left and right sides were compared by paired t-test. A p-value of less than 0.05 (two-tailed) was regarded as statistically significant. All analyses were performed using the SPSS statistical package (standard version 20.0 SPSS, Chicago, IL, USA).

Results

The characteristics of the 72 study participants are shown in Table 1. The majority of participants were female (68.1%), with an average age and BMI of 48.7 years (SD 8.3) and 29.2 (7.9) $kg.m^{-2}$ respectively. High intensity low back pain and disability was reported in 15 (20.5%) participants. The mean fascial length was 12.9 cm (1.2) and 12.9 cm (1.4) on the right and left respectively. The mean CSA of the right and left paraspinal compartments was 25.0 cm^2 (4.6) and 24.8 cm^2 (4.1) respectively.

The univariate analyses showed a trend for a shorter fascial length to be associated with an increased risk for high intensity low back pain and/or disability (right p=0.09; left p=0.065). In multivariable analyses, adjusting for age, gender and BMI, the relationship between fascial length and high intensity low back pain and/or disability was significant (right OR 1.9 95%CI 0.99 to 3.8, p=0.05; left OR 2.6 95%CI 1.2 to 5.6, p=0.01, Table 2). Moreover, when the average CSA of the paraspinal compartment was added to the regression equation (model 2), the results remained statistically significant (right OR 8.9 95%CI 1.9 to 40.9, p=0.005; left OR 9.6 95%CI 1.2 to 42.9, p=0.003). When the association between the fascial length and high intensity pain and disability at each lumbar level was examined, results were statistically significant except at L5 (right OR 2.4 95%CI 0.8 to 7.4, p=0.14; left OR 1.5 95%CI 0.5 to 4.6, p=0.51).

There was a strong association between compartment CSA and average fascial length in both univariate and multivariable (adjusting for age, gender and BMI) analyses (right: beta 0.25 95%CI 0.21 to 0.29, p<0.0001), left: (beta 0.39 95%CI 0.23 to 0.35, p<0.0001).

Discussion

This study has demonstrated that a shorter lumbar paraspinal fascia is associated with high intensity low back pain and/or disability among community-based adults. Although longitudinal studies are needed, the finding suggests that the length of lumbar paraspinal fascia may represent a novel determinant of low back pain and disability.

Previous MRI studies have examined the association between the lumbar fascia and spinal structural pathology [7,8]. These studies found sagging lumbar fascia to be associated with adjacent lumbar segment disease [8] and a flattened lumbar fascia to be associated with lumbar degenerative kyphosis [7]. While these observations have implicated the fascia as a potentially important determinant of structural disease, in the current study we have extended these findings by using a quantitative, rather than a qualitative measure of fascial length and demonstrating that this is associated with pain.

No previous study has examined the relationship between lumbar paraspinal fascia and pain. In this study we found that a shorter fascial length in the lumbar spine was associated with low back pain and/or disability. There have been a number of case reports in the literature that have hypothesised that low back pain may be the result of a compartment syndrome in the paraspinal compartment, whereby pressure in the compartment increases leading to muscle ischaemia [10,11]. This is consistent with evidence from physiological studies in cadavers which show that increases in experimentally induced, supraphysiological pressure revert to normal when the fascia is cut [12,13]. It is possible that in people with a shorter length of fascia the compartment is predisposed to increased pressures and subsequent pain. This is consistent with our finding that the relationship between shorter paraspinal fascia length and pain was stronger after adjusting for compartment cross sectional area.

Alternatively it may be that fascial shortening is associated with low back pain as the muscle CSA is reduced in these individuals [14-16]. Such a reduction may result in an apparent shortening of the fascia. However, this is unlikely as our results showed that the association with low back pain and fascial length was independent of cross-sectional area.

In this study the average paraspinal fascia length was associated with high intensity low back pain and disability at each vertebral level, with the exception of L5 (Table 2). Our previous study found significant associations between obesity and lumbar intervertebral disc height at all levels except L5 [17] and hypothesised that this may be attributable to the difference in surface area of the superior and inferior aspects of the L5 vertebral body [17]. Measures at L5 had to account for the extent of the iliac crest above the level of the transverse processes. This is likely to have affected our results at this spinal level and may account for the lack of significance. Nevertheless, the magnitude and direction of the results at this level was similar to other levels.

This study has a number of limitations. We had a modest sample size. Despite this, we identified consistent and statistically significant relationships between paraspinal fascia and low back pain. Participants were on average overweight (29.2 ±7.1kg.m^{-2}), which may reflect a selection bias as participants were recruited, in part, from weight-loss clinics. However, during the period of data collection 62.8% of Australians were overweight or obese, so the

BMI in our community-based sample was not dissimilar to the majority of Australians [18]. Obesity (measured by BMI) has been shown to be associated with low back pain [19]. In our analyses, we have adjusted for BMI and our results therefore suggest that fascial length is associated with pain, independent of BMI.

This study was strengthened by use of a validated questionnaire for assessment of low back pain intensity and disability [9] and quantitative, repeatable measures of fascial length and paraspinal compartment CSA. In addition, use of a community-based cohort and the similarity in BMI between our cohort and the general population enhances the generalisability of our findings.

This study has demonstrated that a shorter lumbar paraspinal fascia is associated with high intensity low back pain and/or disability in community-based adults. Longitudinal studies are required to help better understand the potential for cause or effect. If a reduced baseline fascial length perimeter is shown to precede back pain, then efforts to minimise fascial length shortening through conservative means such as exercise, may have a role in reducing the burden of chronic low-back pain.

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Figure 1a. Axial MRI image shows the measurement taken (green line) of the length of the paraspinal fascia from the tip of the spinous process to the tip of the transverse process.

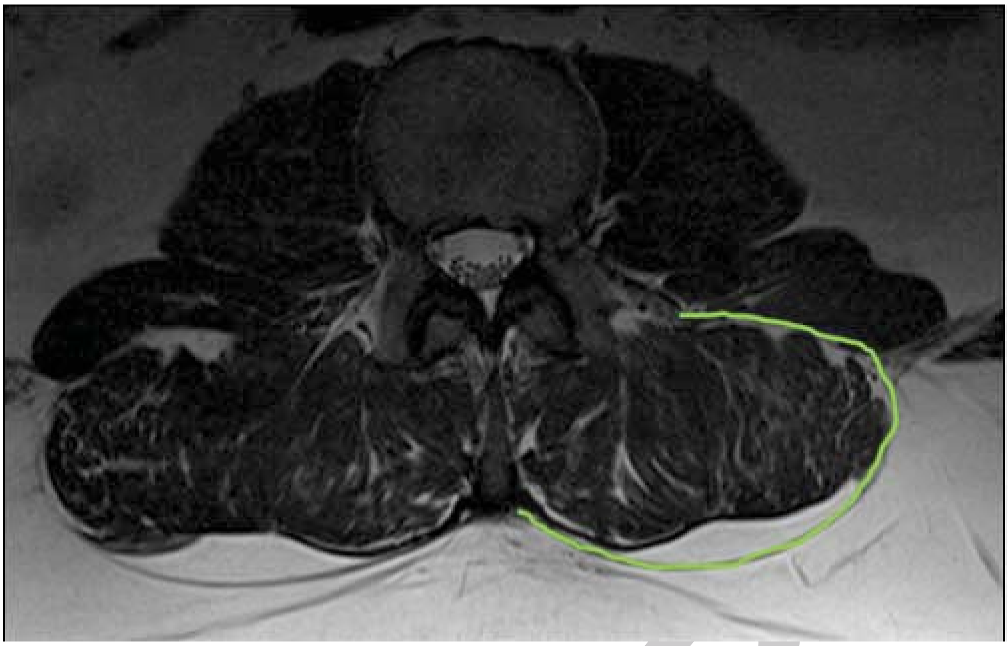

Figure 1b. Axial MRI image shows the measurement of the cross-sectional area of the paraspinal compartment (shaded green area).

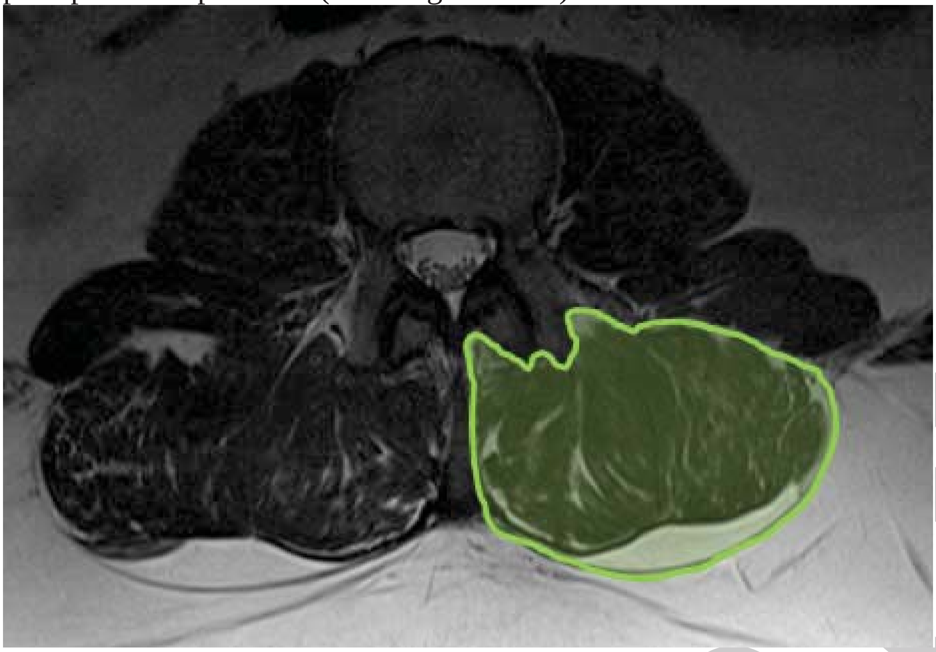

TABLE 1 - Participant characteristics (n=72)

Age (years)	48.7 (8.3)	
Gender (n, % female)	49 (68.1)	
Weight (kg)	82.7 (23.5)	
Height (m)	1.7 (0.1)	
BMI (kg.m^{-2})	29.2 (7.9)	
	Right	**Left**
Epaxial fascial length (cm)		
Average	12.9 (1.2)	12.9 (1.4)
L1	14.1 (1.7)	14.4 (2.5)
L2	13.2 (1.7)	13.4 (2.4)
L3	12.6 (1.5)	12.5 (1.3)
L4	12.9 (1.4)	12.8 (1.2)
L5	11.0 (1.2)	11.6 (1.1)
Epaxial compartment CSA (cm^2)		
Average	25.0 (4.6)	24.8 (4.1)
L1	21.8 (4.9)	21.9 (4.6)
L2	24.2 (5.4)	24.2 (5.1)
L3	26.5 (5.6)	26.5 (4.9)
L4	28.2 (5.4)	28.1 (5.0)
L5	24.5 (4.0)	23.4 (3.5)
Chronic pain grade questionnaire		
0 - Pain free	14 (19.2)	
1 - Low disability, low intensity	44 (60.3)	
2 - Low disability, high intensity	5 (6.8)	
3 - High disability, moderately limiting	5 (6.8)	
4 - High disability, severely limiting	5 (6.8)	
High intensity pain/disability, n (%)	15 (20.5)	

Results presented as mean (standard deviation) unless otherwise stated

TABLE 2 - The association between shorter paraspinal lumbar fascia and high intensity low back pain and/or disability

	Univariate analyses (OR, 95%CI)	P Value	Multivariate analyses 1 (OR 95%CI)	P value	Multivariate analyses 2 (OR 95% CI)	P value
RIGHT						
Average	1.5 (0.9, 2.6)	0.09	1.9 (0.99, 3.8)	0.05	8.9 (1.9, 40.9)	0.005
L1	1.3 (0.9, 1.9)	0.17	1.5 (0.84, 2.6)	0.18	2.1 (1.0, 4.4)	0.04
L2	1.5 (1.0, 2.4)	0.048	1.9 (1.0, 3.4)	0.04	2.9 (1.2, 7.0)	0.02
L3	1.5 (1.0, 2.3)	0.054	2.1 (1.1, 3.9)	0.02	3.8 (1.4, 10.9)	0.01
L4	1.3 (0.8, 2.0)	0.25	1.5 (0.8, 2.7)	0.16	3.4 (1.2, 10.2)	0.026
L5	1.1 (0.7, 1.9)	0.58	1.3 (0.7, 2.1)	0.40	2.4 (0.8, 7.4)	0.14
LEFT						
Average	1.6 (1.0, 2.8)	0.065	2.6 (1.2, 5.6)	0.01	9.6 (2.1, 42.9)	0.003
L1	1.4 (0.9, 2.0)	0.10	1.9 (1.0, 3.6)	0.04	2.0 (1.0, 3.8)	0.048
L2	1.5 (1.0, 2.3)	0.044	2.4 (1.2, 4.5)	0.009	4.1 (1.6, 10.8)	0.004
L3	1.6 (1.0, 2.5)	0.06	2.5 (1.3, 5.0)	0.008	6.0 (1.6, 22.2)	0.007
L4	1.6 (1.0, 2.6)	0.055	2.7 (1.3, 5.5)	0.008	5.5 (1.6, 18.5)	0.006
L5	1.1 (0.6, 1.8)	0.81	1.2 (0.7, 2.1)	0.58	1.5 (0.5, 4.6)	0.51

Multivariate adjusting for age, gender and BMI (1) and age, gender, BMI and CSA of compartment (2)