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Diastasis of rectus abdominis muscles in low back pain patients

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Abstract.
BACKGROUND: Abdominal muscles are important spinal stabilizers and its poor coordination, as seen in diastasis of rectus abdominis (DRA), may contribute to chronic low back pain (LBP). However, this has not yet been studied directly.
OBJECTIVES: To conduct a pilot study to examine the association between DRA and LBP.
METHODS: Using a digital caliper, standard clinical DRA measurement was performed in 55 participants with and 54 without chronic LBP.
RESULTS: Participants were on average 55 years old, 69 (63%) were women. Among the 16 participants with DRA, 11 (69%) had chronic LBP; among the 93 participants without DRA, 44 (47%) had LBP. Among men, 7 of 9 (77%) with DRA had LBP and 14 of 31 (45%) without DRA had LBP. Among women, 4 of 7 (57%) with DRA had LBP and 30 of 62 (48%) without DRA had LBP. BMI was the strongest correlate of DRA and may explain the relation between DRA and chronic LBP.
CONCLUSIONS: DRA and LBP may be interrelated, especially among men. This may be a function of greater BMI in individuals with chronic LBP. Understanding the association between DRA, LBP, and BMI may have important implications for treatment of LBP and for intervention.

Keywords: Rectus abdominis diastasis, body mass index (BMI), intra-abdominal pressure, spinal stabilization, low back pain

1. Introduction

Diastasis of the rectus abdominis muscles is defined as separation of the recti, usually as a result of the linea alba thinning and stretching [1]. According to Rath et al. [2] only separation exceeding 10 mm above the umbilicus, 27 mm at the umbilical ring and 9 mm below the umbilicus should be considered abnormal in subjects younger than 45 years, the corresponding values for an older population to be 15 mm, 27 mm and 14 mm respectively. However, clear consensus does not exist and different authors suggest little different norms to define DRA [3].

DRA is common in pregnancy and post-partum women [4–6]. However, it is also known to occur in men [7]. Causes of DRA maybe multifactorial including an increased volume of the abdominal cavity and hormonal changes in pregnancy [4–6], neurodevelopmental aspects [8] or the abdominal wall laxity [9]. According to some authors this condition has no clearly associated morbidity or mortality, it does not necessarily require repair which is mostly done due to cosmetic reasons, and conservative management may be an alternative [4]. However, DRA may add to non-optimal strategies for posture, trunk stability, and movement, creating failed load transfer which can lead to painful

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syndromes including LBP [6]. Research on DRA targets mostly pregnant and post-partum women and is ambivalent on its relation to LBP or its occurrence in men. For example, Fernandes da Mota et al. [5] found that women with remaining DRA post-partum were not more likely to suffer from low back pain (LBP) while Parker et al. [10] reported that women with a DRA tended to have a higher degree of abdominal or pelvic region pain, which may also signal LBP. Spitznagle et al. [11] suggest that urinary stress incontinence and other support-related pelvic floor dysfunction occur in individuals with DRA as a result of weaker pelvic floor muscles. A crucial aspect in this regard may be that pelvic floor muscles have important sphincter and support function, but they also act as critical postural stabilizers. Coordination among lumbopelvic and abdominal muscles and fascia play a significant role in continence, respiration and musculoskeletal function including postural stabilization [6]. Back pain, discomfort, pain from the abdomen and impairment of physical exercise have previously been identified as DRA-related symptoms [12]. Another proposed mechanism for the relationship between DRA and back pain is the excess skin after extensive weight loss after bariatric surgery and/or diet or after pregnancy [13]. Such skin redundancy and fascial laxity in the abdominal area has been shown to cause back strain and pain [14]. According to Gitta et al. [15] not just low back pain but also decreased quality of life may occur in patients with DRA.

Given research suggesting that DRA may compromise postural stabilization strategies [16], it is also possible that it is related to LBP. However, to our knowledge no study has been done yet to examine specifically the association between DRA and LB in general population, not just postpartum or pregnant women. We set out to investigate whether chronic LBP may be associated with greater likelihood of DRA in a pilot study measuring DRA in 69 women and 40 men with and without LBP using a digital caliper.

2. Material and methods

2.1. Subjects

Fifty-five patients, aged 18–65, 34 females and 21 males with at least 3 months history of LBP all treated for LBP at a time of measurement were involved in experimental group. In all these participants imaging studies (X-ray, CT or MRI) confirmed lumbar degeneration disease such as disc degeneration, osteophytes, non-congenital spinal stenosis, spondylolisthesis, or spinal joints osteoarthritis. Individuals with morphological changes of other then degenerative origin (traumatic, inflammation, tumor, congenital abnormalities) were excluded from the study. Fifty-four individuals, 35 females and 19 males, with no history of LBP were recruited based on similarity in age to participate as controls.

2.2. Methods

This study was approved by the institutional ethics committee. All subjects were questioned to ensure that they met the inclusion criteria of the study. The testing procedure was thoroughly explained to the participants. All subjects reported that they understood the test procedures and gave informed consent.

Prior to DRA measurement all subject filled a personal history questionnaire reporting any surgeries, injuries, chronic diseases, female reported a number and a type (vaginal or cesarean section) of child births. Experimental group individuals reported duration and frequency of LBP.

Each individual's height and weight was taken and BMI was calculated. Standard clinical procedure [17, 18] to measure DRA using a digital caliper [19] has been performed. The subject was supine on massage table, both legs flexed at hips and knees, soles of both feet supported on the table, upper limbs relaxed along the body. Then she or he was instructed to perform trunk flexion to the point when inferior angles of the scapulae were just off the table. Medial edges of the two rectus abdominis muscle were palpated. If DRA was identified, the medial edges were marked and then in relaxed supine posture, using a digital caliper we measured supraumbilical (4.5 cm above the umbilicus), subumbilical (4.5 cm bellow the umbilicus) and umbilical width as suggested by Rath et al. [2]. Classification according to Rath et al. [2] was applied for statistical analysis, i.e. for subjects younger then 45 years DRA was considered as a separation of the two rectus mm. exceeding 10 mm above the umbilicus, 27 mm at the umbilical ring and 9 mm below the umbilicus; in subjects over 45 years of age the corresponding values were 15 mm, 27 mm and 14 mm respectively.

2.3. Statistical analysis

SAS software version 9 (SAS Institute, Cary, NC) was used. Sample characteristics were presented sep-

Table 1
Descriptive characteristics of participants without and with low back pain

	Without low back pain $n = 54$				With low back pain $n = 55$				
	Mean	SD	Min	Max	Mean	SD	Min	Max	p-value
Age	53.7	12.2	28.0	74.0	55.4	10.6	31.0	72.0	0.445
Female, n (%)	34 (62)				35 (65)				0.747
Height (cm)	170.2	10.3	150.0	200.0	174.0	9.8	156.0	200.0	0.049
Weight (kg)	71.2	13.2	50.0	104.0	78.6	15.9	48.0	110.0	0.009
Body mass index	24.4	2.8	20.3	34.1	25.9	4.4	19.0	37.2	0.038
Distasis recti, n (%)	11 (20)				5 (9)				0.115

Notes. SD = standard deviation; p-values are based on student t-test statistic when comparing means, chi-square statistic for comparing distribution of men and women, and Fisher's exact test when comparing frequencies of diastasis (due to the low cell count among those without low back pain).

Table 2
Descriptive characteristics by diastatis recti

	With DRA $n = 16$				Without DRA $n = 93$				
	Mean	SD	Min	Max	Mean	SD	Min	Max	p-value
Age	59.5	9.8	39.0	72.0	53.7	11.5	28.0	74.0	0.059
Female, n (%)	7 (44)				62 (67)				0.079
Height (cm)	173.5	10.8	150.0	190.0	171.9	10.1	153.0	200.0	0.560
Weight (kg)	85.8	16.3	48.0	110.0	73.1	14.1	50.0	105.0	0.002
Body mass index	28.2	4.5	19.7	37.2	24.6	3.4	19.0	33.6	< 0.001
Low back pain, n (%)	11 (69)				44 (47)				0.115

Notes. SD = standard deviation; p-values are based on student t-test statistic when comparing means, chi-square statistic for comparing distribution of men and women, and Fisher's exact test when comparing frequencies of diastasis (due to the low cell count among those without low back pain).

arately for those with vs. without LBP, who were recruited to be of similar age and sex, and for those with vs. without DRA. Mean differences for age, height, weight, and BMI were compared to LBP status and to DRA status with student t-test statistic; differences between proportions were assessed with the chi-square test. Finally, we used binary logistic regression in SAS procedure LOGISTIC to estimate the likelihood of DRA in relation to LBP and BMI. Based on power calculation using G*Power software [20], the above analysis was powered at about 40% to reach statistical significance greater odds of DRA in relation to LBP or BMI at 0.05 level. This low power reflects the combination of a relatively small sample size and low frequency of DRA both in the sample and in the population in general. Therefore, in order to reduce the bias toward Type II error, the threshold for statistical significance was set at 0.10 instead of the more conventional 0.05.

3. Results

Sample characteristics are shown by presence/absence of LBP (Table 1) and of DRA (Table 2). As shown in Table 1, participants with vs. without LBP did not differ significantly with respect to age or sex, but participants with LBP were somewhat taller, but also substantially heavier, resulting in greater BMI in the group with LBP.

As shown in Table 2, while there were marginal differences in mean age and in the number of men and women in the groups of participants with vs. without DRA, the group with DRA had a substantially greater average BMI than the group without DRA.

Among the 16 participants with DRA, 11 (69%) had chronic LBP; among the 93 participants without DRA, 44 (47%) had LBP. In the binary logistic regression analysis, LBP was associated with about 2.5 times greater odds of DRA; however, the association approached but did not reach statistical significance, possibly due to low power (odds ratio [OR] = 2.45, $p =$ 0.121).

BMI varied as a function of both LBP (Table 1) and DRA (Table 2). Therefore, we proceeded by examining the association between BMI and DRA and by adjusting the association between LBP and DRA by BMI. First, each additional BMI point was associated with 26% greater odds of DRA (OR = 1.26, p = 0.001). Then, with both LBP and BMI as independent variables, the odds ratio for association between LBP and DRA was reduced from 2.45 to 1.64, suggesting that LBP may relate to DRA through BMI. The association between BMI and DRA stayed essentially intact (OR $= 1.24$, $p = 0.004$).

When considering men and women separately, some differences emerged. Among men, 7 of 9 (77%) with DRA had LBP and 14 of 31 (45%) without DRA had LBP. In a logistic regression, this difference was statistically significant, corresponding more than 4 times greater odds of chronic LPB in the presence of DRA in men (OR $= 4.25$, $p = 0.099$). Among women, 4 of 7 (57%) with DRA had LBP and 30 of 62 (48%) without DRA had LBP. Therefore, in women, DRA was not significantly associated with odds of chronic LBP (OR $= 1.44$, $p = 0.662$).

4. Discussion

We set out to examine the association between DRA and chronic LBP overall and in men and women separately. Overall, we found that DRA was about 2.5 times more common in patients with chronic LBP compared to controls without LBP, although this result did not reach statistical significance. When we examined the same association in men and women separately in secondary analyses, we found that the increased odds of chronic LBP with the occurrence of DRA was mostly attributable to the association between DRA and LBP in men, not in women.

Further, we observed that BMI was strongly and independently associated with DRA. BMI also explained most of the association between LBP and DRA, suggesting that overweight may offer one mechanism through which LBP relates to DRA, a notion with important clinical implications that should be tested further.

If the observed association between LBP and DRA does exist, it may be that LBP occurs more frequently with DRA because of overuse of the back musculature resulting from efforts to compensate for lost abdominal wall stability [21]. The fact that the association between DRA and chronic LBP was observed mainly in men provides some support for this possibility as men tend to engage in more strenuous activities, increasing the change of back musculature overload. Future research should test how DRA interacts with low back stabilization mechanisms during postural loading. Further, perhaps only large separation of the two parts of rectus abdominis that increases significantly during postural tasks truly compromises low back stability and results in LBP.

Abdominal wall muscle coordination and fascia play an important role in postural stabilization [6,22]. Muscles of the abdominal wall work in concert with diaphragm and pelvic floor regulating intra-abdominal pressure (IAP) that increases stiffness of the lumbar spine [23]. Rectus abdominis muscle is an important part of complex muscular system regulating IAP [24], balancing upright posture and allowing task-specific trunk stabilization [25]. Therefore, it can be expected that DRA may compromise IAP regulation and spinal stabilization, making DRA a potential contributor to chronic LBP. The relationship between insufficient IAP and LBP is often discussed in the literature [26,27] but, to our knowledge, it has not been examined whether individuals with LBP are overrepresented among those with DRA.

It is also important to examine whether DRA repair alleviates LBP, likely via improvement in IAP spinal stability. Currently available research shows that IAP does not significantly change after DRA surgical repair [28,29]. Rodrigues et al. [28] state that DRA width does not interfere with the increase of the IAP when the application of the anterior aponeurosis is performed. Al-Basti [30] also reports only minimal IAP change after abdominoplasty. But alleviation of chronic LBP has been reported after abdominoplasty surgical procedures [16,31,32]. The reason maybe that the surgical repair does not change muscle coordination and IAP neural control, it only targets biomechanical but not the neurophysiological aspect of IAP regulation. As Temel suggests [16], the positive effect of surgical DRA correction on LBP may result from postural changes, such as decreased thoracic kyphosis, lumbar lordosis and lumbosacral angle improving posture by tightening the thoracolumbar fascia. Unfortunately, in our study only small number of participants presented with DRA ($n = 16$) and therefore we could not test the influence of DRA size and dynamics on LBP. This should be a subject of future research.

An important result of this study is that BMI was a strongly and independently related to DRA. In addition, BMI was also related to LBP and a large proportion of the (non-significant) association between DRA and LBP was explained by BMI. This suggests that overweight may be the mechanism relating LBP with DRA. It has been reported previously that obese patients have a larger DRA [33] but its relationship to LBP was not explored. There is some limited research [5] examining this relation in pregnant and postpartum females in which no significant differences in pre-pregnancy BMI and weight gain between women with and without DRA at 6 months postpartum was reported. In addition, women with DRA at 6 months postpartum were not more likely to report lumbo-pelvic pain than women without DRA [5]. Temel states that substantial fluctuations in body weight can result in DRA [16] and reports significant improvements in posture, lumbar pain reduction and quality of life improvement after abdominoplasty in a group of 40 women. Extensive research explores relationship between BMI and LBP [34–36] but, to the best of our knowledge, this is the first study attempting to link BMI, DRA and LBP in a general sample, not just pregnant or postpartum women.

Future research needs to explore whether BMI affects the association between DRA and LBP in a linear fashion or whether there is a threshold beyond which the influence of BMI grows exponentially. Further, it is important to learn other clinical details that help link DRA with LBP. Finally, it needs to be studied whether, besides surgical repair, a conservative treatment or rehabilitation targeting stabilization of the muscles that regulate IAP may help to reduce both DRA and LBP.

There are several limitations to this study. First, the sample of participants in both groups is rather small and the total number of DRA individuals is only 16, resulting in low power to detect results as statistically significant. However, the fact that the association between DRA and chronic back pain was still significant in men, albeit with a reduced threshold may indicate that DRA may be one important factor in chronic LBP in men. Second, DRA measurement was performed only manually using a digital caliper, more sophistic methods such as ultrasound or MRI DRA evaluation were not done, but caliper was proved as an adequate method to assess DRA [19]. Third, the group of individuals with chronic low back pain consisted of individuals with various types of lumbar degeneration disease and various degree of pain.

5. Conclusion

This study explored the interrelationship between DRA and chronic LBP. We found that DRA and LBP may be related, especially in men, possibly due to greater BMI in patients with chronic LBP. This research may help target LBP treatment in individuals with DRA more specifically.

Conflict of interest

There is no conflict of interest.

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