Association between abdominal muscles recruitment with clinical outcomes and prognostic risk in patients with chronic non-specific low back pain: a preliminary study

Associação entre recrutamento de músculos abdominais com desfechos clínicos e risco prognóstico em indivíduos com dor lombar crônica não específica: estudo preliminar

Asociación entre el reclutamiento de músculos abdominales con resultados clínicos y riesgo pronóstico en sujetos con dolor lumbar crónico inespecífico: estudio preliminar

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ABSTRACT | This study investigated the association between clinical trials, clinical outcomes and prognosis risk of patients with chronic non-specific low back pain. Methodology: Twenty patients, older than 18 years, were selected by convenience and submitted to evaluation of clinical outcomes through a numeric pain rating scale and a disability questionnaire. To classify prognostic risk, we used the STarT Back questionnaire, and to evaluate transverse abdominal muscle recruitment, we used the following clinical tests: clinical rating scale (CRS); and measure of the thickness of the abdominal muscles using ultrasonography images (MEM-US). The tests were performed in a single day by a trained evaluator in random order. Pearson (r) and Spearman (rs) correlations were used to investigate the association. Results: The associations between the prognostic risk of low back pain with clinical outcomes, pain and disability, were moderate (r=0.68 and r=0.57, respectively). For CRS, associations with disability and prognosis risk were considered reasonable (r=-0.34 and r=-0.36, respectively). There were no associations with the MEM-US. In the low prognostic risk sample, the CRS's relationship with disability was considered from moderate to good, while pain correction was reasonable (rs=-0.62; and rs=-0.24, respectively). Conclusion: We observed an association between CRS and clinical outcomes and

prognostic risk, with stratification, according to prognostic risk, that increases the relationship observed. Future studies should be conducted with new measures for the evaluation of abdominal muscle recruitment with larger samples.

Keywords | Low back pain; Abdominal Muscles/ ultrasonography; Prognosis.

RESUMO | Este estudo investigou a associação entre testes clínicos, desfechos clínicos e risco prognóstico de pacientes com dor lombar crônica não específica. Para esta pesquisa, 20 pacientes, maiores de 18 anos, foram selecionados por conveniência e submetidos à avaliação dos desfechos clínicos por meio de Escala numérica de dor e Questionário de incapacidade. Para classificação de risco prognóstico utilizou-se o questionário STarT Back, e para avaliar o recrutamento do músculo transverso do abdome foram utilizados os seguintes testes clínicos: Escala de classificação clínica (ECC); e medida da espessura dos músculos do abdome por meio de imagens ultrassonográficas (MEM-US). Os testes foram realizados em um único dia por avaliador treinado, e a ordem dos testes foi aleatória. Os coeficientes de correlação de Pearson (r) e Spearman (rs) foram utilizados para investigar a associação. Os resultados mostraram que as associações entre o risco prognóstico

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de dor lombar com os desfechos clínicos, dor e incapacidade foram moderadas (r=0,68 e r=0,57, respectivamente). Para ECC, as associações com incapacidade e risco prognóstico foram consideradas razoáveis (r=-0,34 e r=-0,36, respectivamente). Não houve associações com a MEM-US. Na amostra de baixo risco prognóstico, a relação do ECC com a incapacidade foi considerada moderada para boa, enquanto para dor a correlação foi razoável (r_S=-0,62 e r_S=-0,24, respectivamente). Concluímos que existe associação entre ECC com desfechos clínicos e risco prognóstico, e a estratificação, segundo o risco prognóstico, aumenta a relação observada. Futuros estudos devem ser conduzidos com novas medidas para avaliação do recrutamento muscular abdominal com amostras maiores.

Descritores | Dor Lombar; Músculos Abdominais/ultrassonografia; Prognóstico.

RESUMEN | En este estudio se examinó la asociación entre las pruebas clínicas, los resultados clínicos y el riesgo pronóstico en sujetos con dolor crónico inespecífico. Para la investigación, se eligieron 20 sujetos, mayores de 18 años, por conveniencia, y se les sometieron a evaluación de resultados clínicos a través de la Escala numérica de dolor y del Cuestionario de incapacidad. Para clasificar el riesgo pronóstico, se empleó el cuestionario STarT Back, y para evaluar el reclutamiento del músculo transverso del abdomen se emplearon las siguientes pruebas clínicas: la Escala de clasificación clínica (ECC); y la medición de la espesura de los músculos del abdomen a través de imágenes ecográficas (MEM-ES). Las pruebas fueron aplicadas en un solo día por un evaluador entrenado, y el orden de las pruebas fue aleatorio. Se emplearon los coeficientes de correlación de Pearson (r) y Spearman (r_S) para investigar la asociación. Los resultados mostraron que fueron moderadas las asociaciones entre el riesgo pronóstico de dolor lumbar con los resultados clínicos, dolor e incapacidad (r=0,68 y r=0,57, respectivamente). Para la ECC, se consideraron razonables las asociaciones entre incapacidad y riesgo pronóstico (r=-0,34 y r=-0,36, respectivamente). Con la MEM-ES no hubo asociaciones. En el muestreo de bajo riesgo pronóstico, la relación de la ECC con la incapacidad fue considerada de moderada a buena, mientras que fue razonable la correlación para dolor (r_S=-0,62 y r_S=-0,24, respectivamente). Se concluyó que hay asociación entre la ECC y los resultados clínicos y riesgo pronóstico, y la estratificación, según el riesgo pronóstico, aumenta la relación observada. Deben llevarse a cabo nuevas investigaciones con nuevas mediciones para evaluar el reclutamiento del músculo abdominal con muestras mayores.

Palabras clave | Dolor Lumbar; Músculos Abdominales/ultrasonografía; Pronóstico; Ecografía.

INTRODUCTION

About 70% of the world's population will have low back pain at some point in their lives[1]. After the onset of an episode of low back pain, 90% of cases achieve recovery regardless of treatment[1]. However, despite this favorable prognosis, some cases incapacitate individuals for long periods of time[2].

The disability caused by back low back pain affects the quality of life[3] considerably and causes direct (e.g., treatment costs) and indirect costs (e.g., decreased productivity at work) for them, their families and society[4].

In the lumbar spine, segmental stability of the vertebrae is caused by the contraction of the transverse abdominal muscle (TVA) and the deep muscle fibers of the multifidus[5]. In this context, alterations to the recruitment of these stabilizing muscles of the spine can generate compensatory recruitment of other superficial muscles, increasing the risk of a new episode of low back pain or worsening its prognosis[5-12].

Clinical tests have been used to evaluate the recruitment of stabilizing muscles of the spine[12-16]. Among them, we have the clinical rating scale (CRS)[5], recommended as an easy to operate and low cost tool, intended for the assessment of the suction maneuver, following 5 criteria (quality, replacement, symmetry, breathing, and maintenance) by palpatory techniques; and the measurement of the thickness of the abdominal muscles using ultrasonography images (MEM-US)[12-17].

In individuals with low back pain, the evaluation of the stabilizing muscles of the lumbar spine and other biopsychosocial factors, using clinical trials or valid and reliable questionnaires, is important to determine prognosis and achieve a suitable decision-making[18-19].

The hypothesis of this preliminary study is that there is a relationship between changes in the recruitment of the spine stabilizing muscles with higher levels of disability, pain and risk of poor prognosis in patients. Therefore, the aim of this study was to investigate the correlation between CRS and MEM-US tests, clinical

outcomes of pain and disability and prognosis risk of patients with chronic non-specific low back pain.

METHODOLOGY

Sample and procedures

We selected, for convenience, 20 people from Presidente Prudente, São Paulo, Brazil, over the age of 18 years, who had chronic non-specific low back pain (low back pain present for at least 12 weeks). As a criteria for inclusion, participants had to report at least two points on the numeric pain rating scale (NRS), which ranges from 0 to 10[20] and two points on the Roland Morris disability questionnaire (RMDQ), which ranges from 0 to 24[21]. Eligible patients were also those classified with low back pain prognosis risk considered low (n=10) and medium (n =10), using the STarT Back questionnaire[19]. Since the main focus of this study was to investigate the association of a physical factor (recruitment of the spine stabilizing muscles), patients at high risk of poor prognosis were not included due to a strong influence of psychological factors[19].

After sample selection, two tests assessed the recruitment of the stabilizing muscles of the lumbar spine (CRS[5] and MEM-US[12]) of the participants. The tests were performed in a single day by a trained evaluator in random order. The reliability of the evaluator was tested after completion of training through a test-retest and resulted in an ICC of 0.91 for the CRS and 0.62 for the MEM-US. The project was approved by the Research Ethics Committee and the participants agreed to participate (CAAE 14814313.6.0000.5402).

Instrumentation

Clinical Rating Scale (CRS)

The CRS was used to evaluate the recruitment of stabilizing muscles of the lumbar spine, including the TrA[5] (Chart 1). This scale has the purpose of evaluating the dynamic motor control of the pelvis, involving the activity of deep (TrA) and superficial abdominal muscles (external oblique). The test is performed by palpation and visual observation of the muscles during suction maneuver with the patient in supine position, with lower limbs partially flexed. The scale is divided into five sessions: the first session evaluates the recruitment quality of stabilizing muscles and ranges

from 0 to 3 points; the second session evaluates possible compensation and ranges from 0 to 3 points; the third session evaluates the symmetry and ranges from 0 to 2 points; the fourth session evaluates the breathing pattern and ranges from 0 to 1 point; and the fifth session evaluates the maintainability of recruitment and ranges from 0 to 1 point. The test is interpreted by adding the points of all sessions, with the total score ranging from 0 to 10 points. When the sum is 0, recruitment capacity of the deep stabilizing muscles of the lumbar spine (TrA) is inadequate, while higher values mean adequate recruitment capacity.

Chart 1. Clinical Rating Scale (CRS) to evaluate the quality of contraction of the abdominal muscles

Criteria	Score
Quality of contraction	
No contraction;	0
Quick and superficial contraction;	1
Only perceptible contraction;	2
Mild and slow contraction.	3
Compensation	
Compensation during rest;	0
Mild to intense compensation;	1
Subtle compensation;	2
No compensation.	3
Symmetry	
Unilateral contraction;	0
Bilateral, though asymmetrical contraction;	1
Symmetrical contraction.	2
Breathing	
Incapacity or difficulty breathing while in contraction;	0
Able to keep contraction while breathing.	1
Contraction upkeep	
Less than 10 seconds;	0
Equal or over 10 seconds.	1

Measure of the thickness of the transverse abdominal muscle using ultrasonography images (MEM-US)

The thickness measurement of the TrA muscle was performed using a multifrequency transducer 13.5 MHz, coupled to an ultrasound device from Siemens (Issaquah, WA, USA), Sonoline Sienna model. The test was performed according to the protocol validated by Ferreira et al.[12]. The test records TrA images at rest and during involuntary muscle activation due to the flexion and isometric knee extension with the participant in the supine position. The images were analyzed by a collaborator (blinded), who measured the thickness of the TrA muscles using the Ultrametrics software. TrA muscle thickness was reported in percentage of change during activation compared to the measurement at rest. Thus, a percentage change of 0% would mean that no

TrA recruitment was observed, while higher values would mean higher recruitments.

Questionnaire STarT Back

The STarT Back questionnaire version adapted to Brazilian Portuguese[19] was used to evaluate the prognosis of low back pain of the participants[22]. This questionnaire aims to classify people with low back pain according to their risk of worse prognosis. It has nine questions and a subscale (questions 5-9) used to classify people in low (score ≤3), medium (score ≥4 and ≤3 in the subscale) or high (score ≥4 and ≥4 in the subscale) risk of poor prognosis.

Roland Morris disability questionnaire (RMDQ) and numeric pain rating scale (NRS)

Versions adapted to Brazilian Portuguese of the RMDQ[21] (score ranges from 0 to 24, with higher values meaning greater disability) and NRS[20] (score ranges from 0 to 10, with higher values meaning more pain in the last 24 hours) were used to verify eligibility of participants and assess the clinical outcomes, disability and pain of interest in this study.

Statistical analysis

The Shapiro-Wilk test showed normal distribution for disability and one of the recruitment measurements (MEM-US) and not normal for pain, prognosis and other measurements of recruitment (CRS).

Pearson (r) and Spearman (rs) correlations were used to investigate the association respectively. We considered correlation values of 0.00 up to 0.25 as no or little association, values of 0.26 up to 0.50 as reasonable association, values of 0.51 up to 0.75 as moderate to good association, values above 0.75 as good to excellent association and 1.00 as perfect association[23].

RESULTS

Sample characteristics

The sample was composed of people with a mean age (standard deviation) of 43.8 (17.1) years and predominantly female (Table 1). Of the total participants, 25% were obese. We observed mean disability (standard deviation) of 10.2 (6.2) points, showing that the participants had moderate disability

resulting from low backache. The median (interquartile range) of pain was 3.5 points (4.0), representing a moderate level. Regarding recruitment of the stabilizing muscles of the lumbar spine, the median (interquartile range) found by the CRS was 5.0 points (2.0) from a total of 10 points, and the mean (SD) of the percentage of thickness change of the TrA muscles found by MEM-US was 6.6% (14.0).

Table 1. Sample characterization

	Patients (n= 20)	Low risk (n= 10)	Medium risk (n= 10)
Age (years), M (SD)	43,8 (±17,1)	33(±14,7)	54,6(±11,8)*
Sex (n, % female)	14 (70)	7(50)	7(50)
Weight (kg), M (SD)	72,3 (±13,2)	74(±17,4)	70,7(±7,8)
Height (m), M (SD)	1,6 (±0,09)	1,68(±0,11)	1,61(±0,07)
BMI (k/m²), M (SD)	26,7 (±4,3)	26,05(±5)	27,5(±3,7)
BMI classification (n, %)			
Normal	9 (45)		
Overweight	6 (30)		
Grade I obesity	4 (20)		
Grade II obesity	1 (5)		
NRS (0-10), Me (IQR)	3,5 (IIQ:4,0)	2,0 (IIQ:3,0)	6,5 (IIQ:4,3)
RMDQ (0-24), M (SD)	10,2 (±6,2)	7,7 (±6,6)	12,7 (±5,0)
CRS (0-10), Me (IQR)	5,0 (IIQ: 2,0)	5,5 (IIQ:4,5)	4,0 (IIQ:2,3)
MEM-US (%), M (SD)	6,6 (±14,0)	4,9 (±12,0)	9,0 (±17,1)

Acronyms: M (SD) (mean, standard deviation), Me (IQR) (medians, interquartile range), n (number of participants), BMI (body mass index), NRS (numeric pain rating scale), RMDQ (Roland Morris disability questionnaire), CRS (Clinical Rating Scale), MEM-US (Measure of the thickness of the transverse abdominal muscle using ultrasonography images), Low and medium risk (Stratification of patients using the STarT Back questionnaire.)
*= statistically significant difference between Low and Medium Risk

The sample classification (n=20) in groups of low (n=10) and medium (n=10) risks for poor prognosis suggests that the low-risk group was younger when compared to participants of medium risk. However, both groups had similar values for height, weight and body mass index (BMI). The estimates found for the two groups suggest that participants in the medium-risk group have higher levels of pain and disability and lower values for TrA recruitment when assessed by CRS. However, CRS findings were not consistent with those found in the MEM-US test. The percentage of change in the thickness assessed by MEM-US in the medium risk group was higher when compared with the value found in the low-risk group for poor prognosis. We would like to remind that this is a preliminary study with an insufficient sample size, so it is not possible to infer anything on these results.

Association between recruiting stabilizing muscles of the lumbar spine, clinical outcomes and prognosis of low back pain

The correlation values found are shown in Table 2. The correlation between pain and disability was excellent (r=0.82). When we investigated, in general, the prognosis of low back pain associated with clinical outcomes of our interest (sum of the STarT Back, where higher values mean higher risk of a poor prognosis), we found moderate correlations with pain (r=0.68) and disability (r=0.57).

The correlation between TrA recruitment, measured by the CRS, with disability and prognosis was reasonable (r=-0.34 and r=-0.36, respectively). No association was observed between TrA recruitment, measured by the CRS, and pain. The percentage of change in thickness, evaluated by the MEM-US, showed no association with pain, disability and prognosis of low back pain.

Table 2. Correlation coefficient (r) between CRS (Clinical Rating Scale), MEM–US (Muscle Thickness Measured by ultrasonography images), RMDQ (Roland Morris Disability Questionnaire), NRS (numeric pain rating scale) and STarT Back questionnaire (n=20)

	CRS	MEM–US	RMDQ	NRS
CRS	-			
MEM–US	0,26	-		
RMDQ	-0,34	0,01	-	
NRS	-0,08	-0,05	0,82*	-
StarT Back	-0,36	0,05	0,57*	0,68*

* Statistically significant difference (P<0.05)

The data presented in Table 3, about the correlation analysis between tests to assess recruitment of the stabilizing muscles of the lumbar spine (CRS and MEM-US) and the clinical outcomes of interest (pain and disability), take into account the subdivision of the sample (n=20) in groups of low (n=10) and medium (n=10) risk of poor prognosis for lower back pain.

Table 3. Correlation coefficient (r) between CRS (Clinical Rating Scale), MEM-US (Muscle Thickness Measured by ultrasonography images), RMDQ (Roland Morris Disability Questionnaire), NRS (numeric pain rating scale) considering the stratification of the sample using the STarT Back questionnaire with low (n=10) and medium risk (n=10) of a poor prognosis

Prognosis Risk		MEM–US	RMDQ	NRS
Low (n = 10)	CRS	0,39	-0,62*	-0,24
	MEM – US	-	0,02	0,24
Medium (n = 10)	CRS	0,23	-0,10	0,36
	MEM – US	-	-0,13	-0,067

* Statistically significant difference (P<0.05)

In the low-risk group, the correlation of TrA recruitment, measured by the CRS is moderate to high (p≤0.05) for disability and reasonable (p>0.05) for pain (rs=-0.62 and rs=-0.24, respectively). In the medium-risk group, we observed the correlation of TrA recruitment, measured by the CRS, as reasonable for pain (rs=0.36; p>0.05). No association was observed between percentage of change in thickness, when measured by MEM-US, and outcomes of disability and pain.

DISCUSSION

Understanding the possible interaction between clinical trials and prognostic screening during the process of clinical decision-making can increase efficiency in the evaluation and treatment of low back pain[24]. We postulate that changes in the recruitment of primary stabilizers of the spine may generate compensatory co-contraction of the superficial muscles and increase the vulnerability of the spine[8-16], and may be related to the incidence of chronic low back pain[6-9,12].

This is a preliminary study that considered only low back pain patients with low and medium risk for poor prognosis, according to the STarT Back questionnaire, for correlation analysis between outcomes, clinical trials and prognosis risk.

The result regarding the two clinical trials shows that only the CRS showed reasonable correlation with disability and the STarT Back questionnaire (r=-0.34 and r=-0.36, respectively). Similar results were found in the study by Pinto et. al., 2011[27], which also used the clinical scale to evaluate the coordination of the abdominal muscles and found a reasonable correlation between the clinical scale and functional disability (r=0.42). The negative correlation value means that higher values were observed in the CRS scale (which means greater ability to properly contract the TrA muscle), while lower values were found in RMDQ (meaning less functional disability).

On the other hand, the MENM-US test showed no correlations with clinical outcomes and the STarT Back questionnaire. This thickness measurement test of the abdominal muscles was used in our study, given that it has been validated by Ferreira et al.[12], showed good reproducibility, and the ability to discriminate against people with and without low back pain and moderate correlation with incapacity[30]. However, the reported

result does not support the hypothesis of associated involuntary recruitment of TrA fibers and the degree of functional disability, pain severity, and prognosis risk. A recent study (2012)[29] and a systematic review[28] also demonstrate the lack of relationship between change in thickness of the transversus abdominis and the improvement of disability and pain intensity in patients with chronic low back pain.

Considering the stratification of patients with low back pain in low and medium risk of poor prognosis, according to the STarT Back questionnaire, we observed that in the medium-risk subgroup, there were no major changes in correlation with clinical outcomes. However, for low-risk patients, there was an increase relationship between the CRS and functional disability and pain intensity (rs=-0.62; p=0.05 to rs=-0.24, respectively), demonstrating that in this group there is a relationship between clinical outcomes and recruitment of the abdominal muscles. This result is in accordance with current[19,24,26] trend of addressing patients with chronic non-specific low back pain in sub-groups so that we can improve assessment and intervention procedures.

Although a preliminary study with a small sample, the results show that the clinical outcomes of pain and disability have excellent correlation (r=0.82; p<0.01) and is in accordance with expectations from the clinical point of view and with the literature[25]. Similarly, the STarT Back questionnaire of our sample for low and medium risk for poor prognosis correlated moderately with pain and disability (r=0.68 and r=00:57, respectively). Our findings are in agreement with the study of Fritz et al. (2011), which showed a correlation between the prognosis risk with disability and pain intensity[26]. This reinforces the consistency of the sample selected for this study. However, the presence of 25% of the total sample composed of obese participants must be considered as a limitation of the study, which may have influenced mainly the lack of association of measurements by the MEM-US test.

Thus, the results should be carefully interpreted and translated for future studies, since a major limitation of this study was the small size of the sample. Future studies should investigate possible correlations between recruitment of the abdominal muscles and clinical outcomes in larger samples and then investigate possible predictive capabilities of the variables regarding certain types of interventions.

CONCLUSION

We found correlation evidence for the CRS clinical trial for the disability outcome and the prognosis risk of patients with chronic non-specific low back pain. The stratification of the sample puts in evidence the correlation observed between the CRS clinical trial and the disability clinical outcome (RMDQ) for the low-risk group of patients. We did not observe any correlation between CRS clinical tests and MEM-US; and the MEM-US with pain and disability clinical outcomes (NRS and RMDQ). Future designs should be conducted investigating new abdominal muscle recruitment measures with larger samples to confirm the findings of this study.

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