

Original article

doi: 10.35366/109808

Spine stabilization exercises are not superior to flexion exercises for ultrasound-detected muscle thickness changes in patients with chronic low back pain and lumbar spondylolisthesis

Los ejercicios de estabilización de la columna vertebral no son superiores a los ejercicios de flexión para los cambios de grosor muscular detectados por ecografía, en pacientes con lumbalgia crónica y espondilolistesis lumbar

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ABSTRACT. Introduction: exercise programs can reduce pain and improve functionality in patients with degenerative spondylolisthesis and chronic low back pain. However, there is still no consensus surrounding the superiority of any specific routine for exercise-induced trophic changes of lumbar muscles. The aim was to compare the changes in the primary lumbar stabilizing muscle thickness after spine stabilization exercises and flexion exercises in patients with spondylolisthesis and chronic low back pain. **Material and methods:** prospective, longitudinal and comparative study was carried out. Twenty-one treatment-naïve patients with a diagnosis of both

RESUMEN. Introducción: el ejercicio reduce el dolor y mejora la funcionalidad en pacientes con dolor crónico lumbar y espondilolistesis degenerativa. Sin embargo, no existe a la fecha un consenso sobre la superioridad de algún programa de ejercicio para inducir cambios tróficos de los músculos estabilizadores lumbares, por lo que el objetivo fue comparar el trofismo de estos músculos mediante ultrasonido, con dos programas de ejercicio distintos: estabilización vertebral versus ejercicios flexores. **Material y métodos:** estudio prospectivo, longitudinal y comparativo, en veintiún pacientes mayores de 50 años, con dolor crónico lumbar y espondilolistesis degenerativa. Se entrenó a los pa-

Level of evidence: II. Prospective, longitudinal and comparative study.

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Received: 10-20-2021. Accepted: 12-01-2022.

How to cite: Nava-Bringas TI, Trani-Chagoya YP, Ventura-Ríos L, Hernández-Díaz C, Romero-Fierro LO, Macías-Hernández SI. Spine stabilization exercises are not superior to flexion exercises for ultrasound-detected muscle thickness changes in patients with chronic low back pain and lumbar spondylolisthesis. Acta Ortop Mex. 2022; 36(4): 230-233. <https://dx.doi.org/10.35366/109808>



chronic low back pain and degenerative spondylolisthesis over the age of 50 were included. A physical therapist taught participants either spine stabilization exercises or flexion exercises to execute daily at home. The thickness of the primary lumbar muscles was measured through ultrasound (at rest and contraction) at baseline and three months. A Mann-Whitney U test and Wilcoxon signed-rank test were performed for comparisons, and Spearman's rank correlation coefficients were calculated for associations. **Results:** we did not find statistically between the exercise programs: all patients presented significant changes in the thickness of the multifidus muscle but in none of the other evaluated muscles. **Conclusion:** there is no difference between spine stabilization exercises and flexion exercises after three months in terms of the changes in muscle thickness evaluated by ultrasound.

Keywords: spinal stabilization, chronic pain, ultrasound, low back pain, lumbar spondylolisthesis.

cientes para la ejecución diaria de ejercicio: estabilización lumbar o ejercicios flexores, los cuales fueron asignados por aleatorización como parte de un ECA en desarrollo. El trofismo muscular fue evaluado mediante ultrasonido al inicio y a tres meses. Las pruebas de U de Mann-Whitney y prueba de Wilcoxon se usaron para comparaciones entre grupos y para correlaciones se usaron los coeficientes de correlación de Spearman. **Resultados:** todos los pacientes presentaron ganancia en el trofismo de los músculos multifidos a tres meses, pero sin diferencias entre grupos de tratamiento. No se detectaron cambios significativos en el resto de los músculos evaluados. **Conclusión:** no encontramos diferencia significativa entre los ejercicios de estabilización lumbar y los ejercicios flexores, a tres meses de seguimiento, en términos de los cambios tróficos medidos por ultrasonido de los músculos estabilizadores lumbares.

Palabras clave: estabilización de columna, dolor crónico, ultrasonido, lumbalgia, espondilolistesis lumbar.

Introduction

Since the 1980's, spine stabilization exercises have been the most popular exercise routine for treating patients with non-specific chronic low back pain (CLBP). While spine stabilization exercises were thought to be superior over other exercise therapies, recent literature reviews have cast doubt in the field, finding that spine stabilization exercises may not in fact be superior to other exercises.^{1,2,3}

While extensive evidence associates the atrophy of the stabilizing muscles-primarily the multifidus- with the persistence of CLBP,^{4,5} few studies compare the effects of spine stabilization exercises against other exercises in multifidus trophism. Those that have, used magnetic resonance imaging or computed tomography in people with chronic non-specific pain or healthy controls.^{1,6} In degenerative spondylolisthesis, a previous study demonstrated that lumbar stabilization exercises and flexion exercises offer a similar response for controlling pain and improving disability; however, trophic changes in response to the exercise program were not analyzed.⁷

Ultrasound is an increasingly popular and affordable alternative for evaluating the musculoskeletal system,⁸ and has proven to be a reliable and accurate tool for the measurement of muscle thickness of the lumbar segment.^{9,10} The present study therefore aimed to evaluate-by ultrasound-the changes of the thickness of the main lumbar stabilizing muscles after twelve weeks of performing spine stabilization exercises and to compare these changes with another classical exercise routine (flexion exercises) in patients with CLBP and lumbar spondylolisthesis.

Material and methods

A nested longitudinal and observational study with three months of follow-up was conducted at the «Luis

Guillermo Ibarra Ibarra» National Institute of Rehabilitation (INRLGII, for its initials in Spanish) in Mexico City. The protocol was approved by the institute's Ethics and Research Committee prior to commencing the recruitment process in January 2017, and was conducted as a add-study research in a randomized clinical trial already in the active recruitment phase evaluating the clinical response of the spine stabilization exercises vs flexion exercises (registration number 19/15 and clinicaltrials.gov database (ID NCT02664688)).⁷

All procedures performed on the participants were in accordance with the Committee's ethical standards and with the 1964 Helsinki Declaration and its later amendments. All participants provided written informed consent before study commencement and received a printed copy for their records.

Study participants. For the present study, the inclusion criteria included being a first-time patient at the research institute's Spinal Rehabilitation Outpatient Department, being above 50 years of age, having a radiologic confirmation of degenerative spondylolisthesis at L4-L5 intervertebral segment, and having suffered from CLBP. Patients with a history of lumbar surgery, rheumatic inflammatory diseases or diabetic polyneuropathy, cauda equinae symptoms, or ischemic heart disease were excluded. Patients were also excluded if they had received previous exercise treatment of any type.

Exercise program. The treatment assignment was made based on the RCT in progress, by simple randomization with the delivery of a sealed envelope to each participant that contained in the exercise program what could be the «lumbar stabilization exercises» or the «Williams flexors exercises». The envelopes were only opened by the physical therapist that taught the exercise program to each patient. Only two physical therapists participated in the study, with a designated therapist for each participant to ensure consistency. The therapists taught each participant the

assigned exercise program in a three 60-minute private sessions (spaced 4 weeks apart), and instructed the participants to continue daily at home with the program learned until completion at 12 weeks follow-up. Both programs were preceded by the use of a hot pack for 15 minutes in the lumbosacral region.

Ultrasound evaluation. Two medical specialists in musculoskeletal ultrasound performed all ultrasound measurements. Siemens Acuson Antares® equipment with a 7 MHz linear probe was used. The muscle thickness of the transverse abdominal, internal oblique, external oblique, and multifidus at L5 were measured bilaterally in greyscale at rest and contraction and recorded in millimeters. Abdominal and lumbar multifidus muscle measurements were performed in accordance with Wilson et al.¹¹ The inter and intra-reader reliability of the ultrasound was evaluated by repeated measurement on two occasions by both physicians.

Statistical analysis

Data were first described through medians and interquartile ranges. A Mann-Whitney U test was performed for comparisons between groups, a Wilcoxon signed-rank test for related samples was applied for the 3-month evaluation of change. Alpha level was set at 0.05, and version 10.0 of the STATA statistical software package was utilized for the calculations.

Table 1: Clinical data and ultrasonographic measurements at baseline.

	Williams' exercises (N = 8) Median (range)	Stabilization exercises (N = 13) Median (range)	p
Age [years]	62 (50-76)	57 (50-78)	0.48
Evolution time	26.8 (3.1-62.2)	11.4 (6.1-60)	0.11
BMI [kg/m ²]	34.3 (24.9-37.1)	30.1 (24.4-35)	0.14
VAS [mm]	66 (46-77)	67 (8-89)	0.91
ODI (%)	31 (16-62)	28 (2-52)	0.79
RM-r	13.4 (6.8-22.8)	18.2 (6-34.7)	0.31
RM-c	15.6 (7.6-34)	21.7 (8.4-38.5)	0.23
LM-r	12.9 (8.3-24.6)	22.0 (7.6-32.6)	0.16
LM-c	15.7 (9.3-27.6)	26.3 (9.5-37)	0.06
REO-r	3.9 (2.9-8.6)	6.5 (1-9.5)	0.37
REO-c	4.3 (3-7.4)	6.5 (2.4-8.3)	0.33
RIO-r	6.4 (3.9-10.4)	6.1 (3.9-11.3)	0.91
RIO-c	7.3 (5.1-10.9)	8.3 (5.6-13.1)	0.21
LIO-r	6.2 (5-8.2)	6.6 (5-11)	0.89
LIO-c	4.2 (2-6.1)	6.0 (2.8-6.9)	0.06
RTrA-r	7.2 (3.9-13.2)	8.7 (3.6-12.1)	1.00
RTrA-c	8.9 (5-15.4)	10.8 (4.4-15)	0.91
LTrA-r	7.2 (4.9-12.1)	5.4 (3.2-13.7)	0.18
LTrA-c	9.0 (5.4-12.8)	8.9 (4.7-15.6)	0.97

VAS = visual analogue scale. ODI = Oswestry Disability Index. RM = right multifidus. LM = left multifidus. REO = right external oblique. LEO = left external oblique. RIO = right internal oblique. LIO = left internal oblique. RTrA = right abdominal transverse. LTrA = left abdominal transverse. c = in contraction. r = in relaxation.

Table 2: Median changes in ultrasonographic measurements of the multifidus and abdominal muscles at 3 months for all participants. N = 21.

Muscle thickness (mm)	Initial	3 months	p*
RM-r	15.4 (6-34.7)	24.7 (7.4-36.7)	0.001
RM-c	19.7 (7.6-38.5)	32.6 (8.6-48.3)	0.001
LM-r	18 (7.6-32.6)	27.7 (9.2-38.7)	0.001
LM-c	21.3 (9.3-37)	34.0 (10.4-45.0)	0.001
REO-r	5.3 (1-9.5)	3.6 (1.2-16.3)	0.570
REO-c	5.2 (2.4-8.3)	4.3 (1.5-9.5)	0.360
LEO-c	5.1 (1.8-9.1)	4.2 (2.2-10)	0.430
LEO-c	5.2 (2-6.9)	3.5 (1.9-7.9)	0.060
RIO-r	6.1 (3.9-11.3)	7.1 (2.7-9.5)	0.800
RIO-c	7.7 (5.1-13.1)	7 (2.8-10.8)	0.330
LIO-r	6.5 (5-11.1)	7.1 (3.7-9.9)	0.800
LIO-c	7.9 (5.4-12)	7.9 (5.4-12)	0.210
RTrA-r	7.9 (3.6-13.2)	8.6 (3.5-13.1)	0.660
RTrA-c	9.7 (4.4-15.4)	9.2 (4.8-18)	0.680
LTrA-r	6.3 (3.2-13.7)	8.3 (2.5-17.5)	0.230
LTrA-c	8.9 (4.7-15.6)	9.3 (4.3-18.3)	0.240

RM = right multifidus. LM = left multifidus. REO = right external oblique. LEO = left external oblique. RIO = right internal oblique. LIO = left internal oblique. RTrA = right abdominal transverse. LTrA = left abdominal transverse. c = in contraction, r = in relaxation.

* Wilcoxon for related samples.

Results

Twenty-one participants (17 women and 4 men), thirteen from the stabilization group and eight from the flexion exercise group, completed the follow up. Baseline results on clinical characteristics and ultrasonographic measurements did not show significant differences between treatment groups as shown in [Table 1](#). No differences were found considering sex, for any of the variables ($p \geq 0.05$). According to the Meyerding Classification, spondylolisthesis was grade I for 12 patients and grade II for 9 patients, without finding grade III or IV cases.

Ultrasonographic measurements obtained intra-reader kappa values of 0.76 (95% CI 0.58-.94) and inter-reader kappa values of 0.66 (95% CI 0.34-0.84), both reliable measures according to Landis and Koch's classification.

After twelve weeks of treatment, all participants presented significant changes in the multifidus size as measured by ultrasound, but none in abdominal muscles ([Table 2](#)). No significant differences were found between the exercises groups for any of the variables of interest ($p \geq 0.05$).

Discussion

Although exercise is known to be the most effective intervention for treating CLBP, the superiority of any particular program is still in debate.¹² This has been because few studies compared the effects of the spine stabilization exercises program on muscle thickness against other

therapeutic exercises. To our knowledge, this is the first study to do so in CLBP and degenerative spondylolisthesis.

In the present study, all participants showed significant changes in multifidus thickness, however, no differences were found between exercise groups, as Akbari et al.¹³ reported in their eight-week clinical trial for patients with a diagnosis of non-specific CLBP. In counterpart, no differences were found in abdominal muscles in this study, which differed from previous studies that found detectable changes in the abdominal muscles after executing exercise routines.^{14,15,16} The divergence could be attributed to variations in follow-up time between the studies, and the fact that patients with chronic nonspecific pain are typically younger than patients with degenerative spondylolisthesis, or that previous reports of abdominal muscles has been performed comparing people with CLBP vs healthy population,¹⁷ and the present study did not include a group of asymptomatic participants.

While our results confirm the usefulness of ultrasound for detecting early changes in multifidus thickness and serve as a preliminary comparison between types of exercises, it also has certain limitations. A small sample and a short follow-up time of 12 weeks were our main limitations and implied that we were unable to conclude if there are no long-term differences between exercise programs. Further studies are needed with larger sample sizes and longer follow-up periods to evaluate muscle thickness, clinical characteristics, and other variables of interest.

Conclusion

All participants presented significant changes in the thickness of the multifidus muscles without difference between spine stabilization exercises and flexion exercises. Not significant changes were detected for the rest of the evaluated muscles at twelve weeks of follow up.

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Conflict of interest: the authors has no competing interests or financial benefits to declare; no funding, grants or equipment were provided for this project.