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Journal of Neurology & Stroke

Literature Review

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Evaluation of the abdominal transverse muscle in individuals with low back pain: a literature review

Abstract

Introduction: Low back pain is the leading cause of years lived with disability in the world. Despite the relevance of the subject in the literature, some authors have criticized and conducted studies without methodological criteria for the evaluation of the transverse abdominis muscle, creating a gap in knowledge and divergences in evidence-based practice.

Objective: The aim of the study was to carry out a literature review, looking for studies that observed changes in the Transverse Abdominal muscle in individuals with low back pain.

Methods: The following keywords were used as methodology: Low back Pain, Lumbago, Transverse Abdominal, Transversus Abdominis, Transverse Abdominals, In the following databases: Pubmed 137 studies, Web of Science 625 studies, Scopus 228 studies. Inclusion criteria: Studies that evaluated the Transverse Abdominal muscle in individuals with pain were selected for analysis of the results. Exclusion criteria: Studies that evaluated only healthy individuals, studies that addressed treatment or therapeutic intervention, studies conducted before 2016, duplications by authors, or those that did not use evaluation as methodology were excluded.

Results: Finding a total of 990 studies, after elimination for duplication, 725 articles remained. After being analyzed and selected by the inclusion and exclusion criteria, 18 studies were selected.

Conclusion: The Transverse Abdominal muscle showed changes in its muscle thickness, neuromuscular activation, motor control, between healthy individuals and individuals with low back pain, being evaluated in different postures and populations. It is suggested that the evaluation of the transverse abdominal muscle should be performed in patients with low back pain, as an important dysfunctional diagnostic tool for these patients.

Keywords: low back pain, abdominal transverse muscle, abdominal muscles, chronic pain, pain, physical therapy

Volume 12 Issue 4 - 2022

João Rafael Rocha da Silva
Physiotherapist graduated from Universidade São Francisco USF Bragança Pta, Brazil

Correspondence: João Rafael Rocha da Silva, Rua Emidio fazzio número 274 bairro Alvinopolis Atibaia, São Paulo Brasil Cep 12942420, Brazil, Email joaorafael_rs@hotmail.com

Received: July 22, 2022 | **Published:** August 10, 2022

Introduction

Low back pain is a worldwide health problem; it is estimated that 70% of the population in developed countries have this symptom at some point in their lives, and it is among the most frequent causes of medical care. According to U.S. government statistics, the individual cost per person with low back pain is $8,000, and the total annual cost of this condition ranges from $38 to $50 billion.[1] Low back pain is the leading cause of years lived with disability in the world.[2]

Paul W. Hodges defined that the Transverse Abdominal muscle has as its physiological action, the activation of the muscle contraction milliseconds before the movement of the arm, and in individuals with a history of low back pain this activation was altered, with a delay in the activation of the Transverse Abdominal muscle.[3]

According to Hodges et al. pain alters motor control and neuromuscular activation of the Transverse Abdominal muscle, which in their experiment after applying an intervention for evoked pain, a decrease in neuromuscular activation was observed.[4] Despite the relevance of the theme in the literature, some authors have criticized and conducted studies without methodological criteria for the evaluation of the transverse abdominis muscle, creating a gap in knowledge and divergences in evidence-based practice.[5] The objective of the study was to conduct a literature review, looking for studies that observed changes in the Transverse Abdominal muscle in individuals with low back pain.

Method

This is a study with data collection from secondary sources, by means of a bibliographical survey and based on the experience of the author, when he carried out an integrative review. After approval of the topic by the coordination of the pain course of the Hospital das Clinicas of the University of São Paulo, a literature review was conducted on February 25, 2019, at the library of the medical school of the University of São Paulo (USP). The work was carried out according to the standards described by M. T. D. Souza et al, who, based on their research, described their recommendations for conducting an integrative literature review.[6]

The guiding question for the search was: What are the alterations that we can find in the transverse abdominal muscle in individuals with low back pain? Using the PICO strategy to structure this question, having: (P) individuals with low back pain, (I) transverse abdominal muscle assessment, (C) healthy individuals, (O) changes and methods of assessment of the transverse abdominal muscle.

A literature review was performed using the following keywords: Low back Pain, Lumbago, Transverse Abdominal, Transversus Abdominis, Transverse Abdominals. The search was conducted in the Pubmed, Web of Science, and Scopus databases.

An experienced librarian assisted in the choice of key words and search strategy, and no descriptors were found for the term "Transverse Abdominal", using the descriptor "Low Back Pain" for

low back pain. The following search strategy was used in Pubmed: ((“Low Back Pain*”[Title/Abstract] OR Lumbago [Title/Abstract])) and (“Transverse Abdominal” or “Transversus Abdominis” or “Transverse Abdominals”) in Humans.

In the Web of Science the following search strategy was used: TOPIC: (“Low Back Pain*” or Lumbago) and topic: (“Transverse Abdominal” or “Transversus Abdominis” or “Transverse Abdominals”) Refined by: DOCUMENT TYPES: (Article or Review) and document types: (Article or Review) AND [excluding] Web of Science Categories: (Veterinary Sciences).

In Scopus the following search strategy was used: (Title-Abs-Key (“Low Back Pain*” Or Lumbago) And Title-Abs-Key (“Transverse Abdominal” Or “Transversus Abdominis” Or “Transverse Abdominals”)) And (Limit-To (Doctype, “Ar”) Or Limit-To (Doctype, “Re”)) And (Limit-To (Language, “English”) Or Limit-To (Language, “Portuguese”) .

The inclusion criteria defined for the selection of articles were: articles published in Portuguese and English, full articles that portrayed the theme of the integrative review, studies that used as methodological criterion the evaluation of the Transverse Abdominal Muscle in individuals with low back pain or with diagnoses associated with spinal pathologies. Published and indexed in said databases in the last four years until the month of February 2019.

Studies that did not use as methodological criterion the evaluation of the transverse abdominis muscle in individuals with low back pain or with diagnoses associated with spinal pathologies, studies that addressed treatment as a therapeutic intervention, studies conducted before 2016, duplications by authors, and studies with high risk of bias and low methodological quality were excluded. Data were collected regarding the type of study, year of publication, author, population, assessment methods, and results regarding changes in the transverse abdominis muscle.

The analysis of the selected studies, in relation to the research design, was based on the criteria suggested by M. T. D. Souza et al, following the recommendations of evidence-based practice (EBP).[6] Making it possible to observe, count, describe and classify the data in order to gather the knowledge produced on the theme explored in the review.[6]

Results

A total of 990 studies were found in the Web of Science, Pubmed, and Scopus databases, and after elimination for duplication, 725 studies remained. These were analyzed and selected by inclusion and exclusion criteria, and 30 studies were selected that used as methodological criterion the evaluation of the Transverse Abdominal muscle in individuals with low back pain. Of the selected studies, 12 were excluded due to low methodological quality, and for performing therapeutic intervention as anticipatory voluntary activation of the Transverse Abdominal muscle in the evaluation (feedforward). After being reviewed and selected by the inclusion and exclusion criteria, 18 studies were selected (Figure 1 & Chart 1). Pubmed databases, about manual therapy in pain treatment, and their classification according to their level for clinical practice:

Article Title:	Authors	Journal (year; vol, no, pg,):	Population	Type of study	Considerations and Recommendations for clinical practice
Preparatory brain activity and anticipatory postural adjustments accompainied by externally cued weighted-rapid arm rise task in non-specific chronic low back pain patients and healthy subjects.[7]	Mehdi Sadeghi et al.	Springerplus 2016;5:18.	29 males with a mean age of 28.9 years with chronic low back pain, and 28 males with a mean age of 29.2 years without low back pain.	Cortical-motor evaluation of lumbar stabilizer muscles with electroencephalography, and of lumbar stabilizer muscle activation with electroneuromyography, during the functional activity of unilateral arm raising (shoulder flexion), after audible stimulation.	Significant changes in the delay of activation of the Transverse Abdominal and Oblique muscles ($p < 0.05$) in subjects with low back pain, and an anticipation of activation of the lower limb muscles.
Are lumbar Multifidus fatigue and Transversus Abdominis activation similar in patients with lumbar disc herniation and healthy controls? A case control study.[8]	Luiz Armado Vidal Ramos et al.	Eur Spine J. 2016 May;25(5):1435–1442.	30 subjects with herniated lumbar disc and 30 subjects without low back pain.	Neuromuscular activity assessment by electroneuromyography, Sorenson stress test and Transverse abdominal assessment with pressure beofeedback, pain assessment by analog pain scale and Macgill questionnaire, disability assessment with oswestry questionnaire and Borg stress scale.	Individuals with lumbar disc herniation show increased neuromuscular activation of the lumbar Multifidus and decreased activation of the transverse abdominis, when compared to healthy individuals.

Chart Continued...

Article Title:	Authors	Journal (year; vol, no, pg,):	Population	Type of study	Considerations and Recommendations for clinical practice
Influence of chronic low back pain and fear of movement on the activation of the transversely oriented abdominal muscles during forward bending.[9]	Hugo Massé-Alarie et al.	J Electromyogr Kinesiol. 2016;27:87–94.	12 subjects with chronic low back pain and 13 subjects without low back pain.	Evaluation of the activation of the lumbar stabilizing musculature, during flexion and extension of the spine. Evaluated by electroneuromyography and the Tampa Scale of kinesiophobia.	Individuals with low back pain showed increased neuromuscular activation of the Transverse Abdominal and Internal Oblique muscles at the end of trunk flexion, while healthy individuals showed a decrease.
Lumbopelvic motor control and low back pain in elite soccer players: a cross-sectional study.[10]	Stephanie Grosdent et al.	J Sports Sci. 2016;34(11):1021–1029.	43 male professional soccer players, 43% of the athletes had acute low back pain.	Cross-sectional study, evaluation of motor control of lumbar stabilizer muscles during 5 motor control tests, evaluation of Abdominal Transverse with pressure beofeedback.	Athletes with a history of low back pain showed significant changes ($p< 0.01$) with lower scores on the motor control tests.
Symmetry, not asymmetry, of abdominal muscle morphology is associated with low back pain in cricket fast bowlers.[11]	Janine Gray et al.	J Sci Med Sport. 2016;19(3):222–226.	25 professional Cricket players 16 with low back pain and 9 without pain.	A cross-sectional descriptive study, assessing the symmetry of the lumbar stabilizer muscles in cricket athletes. Using ultrasound to measure the thickness of the muscles.	No changes were found in the Transverse Abdominal muscle between the groups, finding significant differences in the Internal Oblique muscle, decreased on the non-dominant side of the athletes with pain.
Reliability and Validity of Standing Back Extension Test for Detecting Motor Control Impairment in Subjects with Low Back Pain.[12]	Gauri A Gondhalekar et al.	J Clin Diagn Res. 2016;10(1):KC7-KC11.	50 subjects, 25 subjects with non-specific low back pain (12 male and 13 female) and 25 healthy subjects (12 male and 13 female).	Validation of the lumbar spine extension test in orthostasis, evaluating inter-rater reliability. Evaluating the transverse abdominal muscle as a stabilizer in motion control with ultrasound.	Changes in Transverse Abdominal muscle motor control (ability to control lumbar extension movement on eccentric muscle activation) were correlated with individuals with pain.
Ultrasound measurement of deep and superficial abdominal muscles thickness during standing postural tasks in participants with and without chronic low back pain.[13]	Fatemeh Ehsani et al.	Manual Therapy. 2016;23:98–105.	90 female subjects, 45 with chronic low back pain and 45 healthy.	Evaluation of transverse abdominal muscle thickness using ultrasound during orthostatic postural tasks.	A lower percentage of change in thickness of the Transverse Abdominal muscle and higher for the External Oblique muscle, was observed in subjects with low back pain compared to healthy subjects during all tests.
Ultrasound Measurement of Abdominal Muscle Thickness With and Without Transducer Fixation During Standing Postural Tasks in Participants With and Without Chronic Low Back Pain: Intrasession and Intersession Reliability.[14]	Fatemeh Ehsani et al.	Pm&R. 2016;8(12):1159–67.	23 subjects with chronic low back pain and 23 healthy subjects.	Evaluation of lumbar stabilizer muscle thickness using ultrasound in dorsal decubitus and different stabilization supports.	The authors reported no significant differences between the subjects, validating ultrasonography as an effective method for evaluating the Transverse Abdominal muscle.

Chart Continued...

Article Title:	Authors	Journal (year; vol, no, pg,):	Population	Type of study	Considerations and Recommendations for clinical practice
Methodological consistency and measurement reliability of transversus abdominis real time ultrasound imaging in chronic low back pain populations: a systematic review.[15]	Connie Jean Whittle et al.	Physical Therapy Reviews. 2017;22(1-2):48-59.	Individuals with low back pain and individuals without low back pain.	Systematic reviews evaluating the reliability of ultrasound assessment as a tool to evaluate lumbar stabilizing muscles (Transverse Abdominal).	Inconsistent methodological quality was observed in the studies, and better methodological quality is needed to conduct new studies.
Comparing the reliability of abdominal muscles thickness using ultrasonography in adolescents with low back pain and healthy adolescents.[16]	Nahid Rahmani et al.	Journal of Babol University of Medical Sciences. 2017;19(8):12–19.	160 adolescents 80 males and 80 females, 50% of the participants (40 boys and 40 girls) with low back pain and 50% healthy.	Evaluation of Transverse Abdominal Muscle Thickness Using Ultrasonography.	Significant changes ($p< 0.05$) were observed in the groups, with the low back pain group showing less thickness of the Transverse Abdominal muscle.
Trunk Postural Muscle Timing Is Not Compromised In Low Back Pain Patients Clinically Diagnosed With Movement Coordination Impairments.[17]	Rupal Mehta et al.	Motor Control. 2017;21(2):133–157.	21 subjects with acute and subacute low back pain and 21 subjects without low back pain.	Evaluation of the synchronism of the trunk stabilizer muscles (Transverse Abdominal) using electroneuromyography.	Task performance was similar between the groups. Finding no significant changes between the groups.
Difference of the thickness and activation of trunk muscles during static stoop lift at different loads between subjects with and without low back pain.[18]	Hoe-Song Yang.	J Back Musculoskelet Rehabil. 2018;31(3):481–488.	28 subjects with low back pain and 28 healthy subjects.	Evaluation of muscle thickness using ultrasound and recruitment pattern with electroneuromyography of the lumbar stabilizer muscles, during functional activity of lifting a weight, in three conditions 0%, 10% and 20% of body weight.	Change in neuromuscular activation, with increased activation of the Oblique and difference in thickness of the Transverse Abdominal (decreased) in subjects with low back pain.
Changes in muscle thickness across positions on ultrasound imaging in participants with or without a history of low back pain.[19]	Mark A. Sutherlin et al.	J Athl Train. 2018;53(6):553–539.	34 subjects without low back pain and 25 subjects with low back pain, with BMI (body mass index) ranging from 23.7 to 25 and age between 22 and 25 years.	Cross-Sectional Study. Evaluation of lumbar stabilizer muscle thickness with ultrasound in different postures in healthy subjects and subjects with a history of low back pain.	Individuals with low back pain voluntarily reduced Transverse Abdominal thickness modulations compared to those who reported no history of low back pain.
Altered trunk muscle recruitment patterns during lifting in individuals in remission from recurrent low back.[20]	Tadanobu Suehiro et al.	J Electromyogr Kinesiol. 2018;39:128–133.	25 subjects with chronic low back pain and 20 subjects without pain.	Evaluation of the difference in recruitment of trunk stabilizer muscles using electroneuromyography between individuals with recurrent low back pain and healthy individuals upon standing up.	Changes in neuromuscular activation with delayed onset of activation of the transverse abdominis and lumbar stabilizers muscles, and increased electromyographic amplitude during contraction.

Chart Continued...

Article Title:	Authors	Journal (year; vol, no, pg,):	Population	Type of study	Considerations and Recommendations for clinical practice
A Comparison of the Abdominal and Lumbar Multifidus Muscle Size in Patients With Lumbar Spondylolisthesis and Healthy Patients at Rest and During Contraction Using Ultrasonography.[21]	Ailin Shadani MSc. Et al.	J Manipulative Physiol Ther. 2018;41(8):691–297.	25 healthy subjects and 25 subjects with lumbar spondylolisthesis.	Analytical, non-experimental case-control study. Ultrasound-assisted evaluation of lumbar transverse abdominal and multifidus muscle thickness between healthy subjects and subjects with spondylolisthesis.	There was a significant difference in the size of the lumbar stabilizer muscles between the healthy and spondylolisthesic groups, both at rest and in contraction.
Co-contraction characteristics of lumbar muscles in patients with lumbar disc herniation during different types of movement.[22]	Wenjing Du et al.	Biomed Eng Online. 2018;17:20.	26 subjects with lumbar disc herniation 15 female and 11 male, 28 healthy subjects 16 female and 12 male.	Evaluation using electroneuromyography of the neuromuscular activation of the lumbar stabilizers (Transverse Abdominal and Multifidus, Internal and External Oblique), between subjects with herniated disc and healthy subjects.	Changes in muscle activity of lumbar agonist and antagonist muscles (increased neuromuscular activation of antagonists and decreased activation of agonists) when compared to the healthy control group were significant ($p< 0.05$).
Different ways to balance the spine in sitting: Muscle activity in specific postures differs between individuals with and without a history of back pain in sitting.[23]	André P. Claus et al.	Clin Biomech. 2018;52:25–32.	10 male subjects averaging 25 years old with chronic low back pain, and 14 healthy male subjects aged 22 to 28 years old.	A cross-sectional study using Electroneuromyography to assess neuromuscular activation patterns of stabilizing muscles (Transverse Abdominal, Iliocostal, Latissimus Dorsi, Longuissimus Thoracicus, Multifidus Lumborum) in healthy subjects and subjects with chronic low back pain.	The individuals with low back pain had stabilizing muscles with lower recruitment and higher activity of the longus thoracic muscles to maintain the physiological lumbar curvature, not being able to maintain the physiological lumbar curvature for a long time in the sitting position.
Activity of deep and superficial abdominal muscles during stable and unstable sitting positions in individuals with chronic low back pain.[24]	Amir Massoud Arab et al.	J Bodyw Mov Ther. 2018;22(3):627–631.	40 subjects, 20 with low back pain and 20 healthy.	A cross-sectional study using ultrasound to evaluate the stabilizing muscles while sitting on a stable (chair) and unstable (ball) surface.	Change in activation of the transverse abdominis muscle (smaller thickness and increased diameter during contraction) in individuals with chronic low back pain compared to controls during sitting on an unstable surface.
Comparison of Selective Local and Global Muscle Thicknesses in Females with and without Chronic Low Back Pain.[25]	Mahnaz Aboufazeli et al.	Ortop Traumatol Rehabil. 2018;20(3):197–204.	60 subjects: 30 subjects with low back pain, mean age 34.6 years, and 30 healthy subjects, mean age 36.7 years.	A case control study evaluating using ultrasound the stabilizing muscles (Transverse Abdominal, Gluteus Medius, Lumbar Quadrate, and Lumbar Multifidus) between healthy subjects and subjects with low back pain. Individuals were evaluated during muscle contraction and at rest.	Individuals with low back pain had a decreased thickness of the stabilizer muscles during muscle contraction compared to the control group.

Chart 1 Articles surveyed in the Scopus, Web of Science and Pubmed, on manual therapy in pain management, and their classification according to their level of clinical practice.

Citation: da Silva JRR. Evaluation of the abdominal transverse muscle in individuals with low back pain: a literature review. *J Neurol Stroke.* 2022;12(4):106–112. DOI: 10.15406/jnsk.2022.12.00511

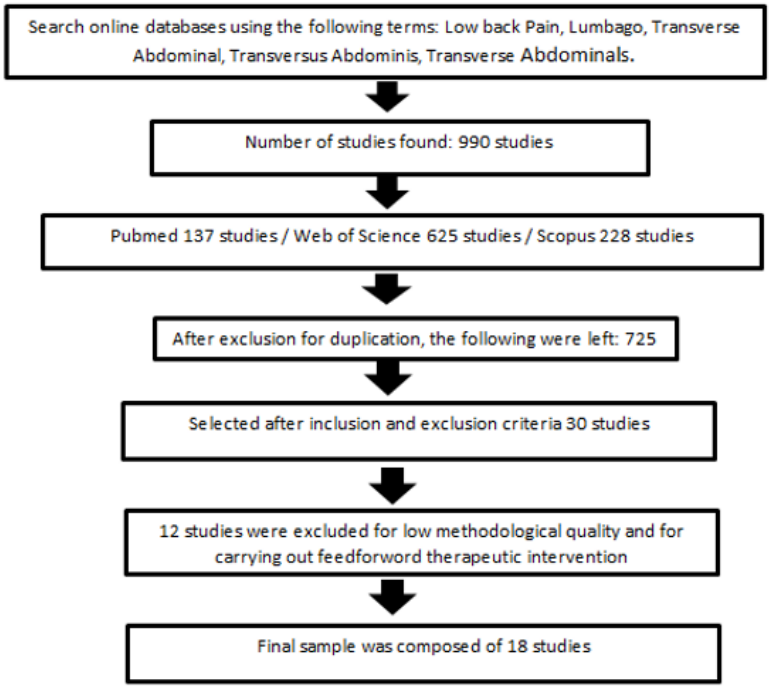

Figure 1 Flowchart of study selection.

Discussion

The following will present clinical recommendations of the methods validated by the literature to perform the evaluation of the Transverse Abdominal muscle in individuals with low back pain, and their possible dysfunctions. There is a divergence in the literature regarding the scientific evidence of therapeutic interventions using voluntary anticipatory activation of the transverse abdominis muscle (feedforward) in the treatment of individuals with low back pain, so a better understanding of the dysfunctions of this muscle is necessary for a more adequate therapeutic approach. The studies presented three dysfunctional changes of the Transverse Abdominal muscle in individuals with low back pain: thickness, neuromuscular activation, and motor control.

Its thickness was evaluated at rest or in contraction, varying in different static postures, dynamic, with load, on stable or unstable surfaces. Ultrasound was the most commonly used resource for muscle thickness assessment, being used in ten studies, with one systematic review for assessment of the Transverse Abdominal muscle.[11–16,19,21,24,25.]

The changes observed in the thickness of the Transverse Abdominal muscle associated with the maintenance of static posture showed differences with smaller muscle diameters in patients with low back pain when compared to the control group, which may be related to decreased muscle tone.[12,13,16,19,21,24,25] When the individuals with low back pain were placed on an unstable surface (ball) it was observed that the muscle diameter increased, and the same changes were not observed in the control group.[25]

Two studies did not observe alterations between the groups; one study evaluated individuals in dorsal decubitus at rest, and the other evaluated athletes whose sports gesture is trunk rotation, and observed only alterations in the oblique muscle biomechanically responsible for rotation control.[11,14]

Anticipatory neuromuscular activation was assessed at the beginning of the movement, during the movement, and at the end of the movement, associating movements of the spine, upper limbs, and lower limbs. Electroneuromyography was the most widely used method for assessing neuromuscular muscle activation, being used in 8 studies, but no review study was observed for validation of the method.[7–9,17,18,20,22,23] Regarding the alterations in neuromuscular activation it was observed that individuals with pain present a delay in the anticipatory neuromuscular activation at the beginning of the movement of the lower limbs, when getting up and during long periods in the sitting position.[7,8,20,23] These situations have been reported as frequent complaints from patients with pain. It was also observed an increase in neuromuscular activation of the transverse abdominis muscle in an exacerbated form, after the beginning of the standing up movement, and at the end of trunk flexion in individuals with low back pain, observing a decrease in activation in the control group.[9,20]

One study evaluated the activation of the stabilizing musculature in different situations, evaluating the neuromuscular activation during eccentric activity, observing that there was an increase in the activation of the antagonist (Transverse Abdominal) during spinal extension compared to the control group.[22] In individuals with acute and subacute low back pain, no change in neuromuscular activation was observed between the groups, suggesting that these changes may be related to the process of pain chronification.

Motor control was evaluated in static and dynamic postures, with pressure biofeedback and by the lumbar extension test in bipedestation. To evaluate the segmental stability of the lumbar spine, changes in lumbar curvature associated with inhibition of the Transverse Abdominal muscle were observed. The lumbar extension test was validated for its Inter-rater reliability, showing good sensitivity for motor control evaluation.[8,10,12]

Individuals with low back pain presented alterations in motor control with increased lumbar lordosis when performing extension

in bipedestation, and decreased muscle tone, with low scores in the functional tests.[8,9,12] The Macgill, Oswestry and Tampa Scale Kinesiophobia questionnaires were the most commonly used questionnaires for the assessment and classification of pain and dysfunction, of the individuals.[8,9] The changes found in the Transverse Abdominal muscle were also seen in other spinal stabilizing muscles, such as Gluteus Medius, Oblique, Multifidus, and Lumbar Quadrate.

Implications for clinical practice

It is necessary for clinicians to evaluate all possible dysfunctions of the Transverse Abdominal muscle for the best therapeutic approach. We must consider the different situations in which individuals with low back pain exhibit inhibition or increase in neuromuscular activity, as well as in the modulation of muscle contraction, using therapeutic interventions for both situations.

Limitations of the study

Many studies did not randomize the intervention and control groups, increasing the risk of bias in publications.

Conclusion

The Transverse Abdominal muscle showed changes in its muscle thickness, neuromuscular activation, and motor control, between healthy subjects and subjects with low back pain, being evaluated in different postures and populations. It is suggested that assessment of the transverse abdominal muscles should be performed in patients with low back pain, as an important dysfunctional diagnostic tool for these patients.

Acknowledgments

None.

Conflicts of interest

The authors declare no conflicts of interest.

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