

Effectiveness of Transverse Abdominis Activation on Lumbar Stiffness, Flexibility and Functional Stability in Patients with Low Back Pain

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ABSTRACT

BACKGROUND: Low back pain (LBP) is one of the main causes of disability worldwide, significantly impairs physical function and quality of life. The delayed and inadequate activation of deep abdominal muscles, particularly the Transverse Abdominis (TrA), is one of the main causes of persistent low back pain.

OBJECTIVE: To evaluate the combined effect of Abdominal Drawing-In Maneuver (ADIM) for Transverse Abdominis activation and stretching on lumbar stiffness, flexibility, and functional stability in individuals with low back pain.

METHODOLOGY: A quasi-experimental trial was conducted with 60 participants aged 20-30 years who experienced lumbar stiffness and low back pain. After meeting the inclusion and exclusion criteria, data were collected from female students living in the Government College University Faisalabad females' hostels. The experimental group received intervention twice a day for two weeks, followed by sessions on alternate days for the next two weeks. Then, one session per week for follow-up. The study was conducted for six months in total. Outcome measures included Modified

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Oswestry Disability Index (MODI), Numeric Pain Rating Scale (NPRS), and Goniometric assessment. Statistical analysis was performed using SPSS version 27.

RESULTS: Lumbar spine range of motion, lumbar stiffness, lumbar flexibility, and pain were all significantly improved. NPRS scores reduced ($p < 0.001$), MODI scores improved ($P < 0.001$), and ROM in all directions increased significantly.

CONCLUSIONS: The combined application of Transverse Abdominis activation exercises and stretching is effective in improving lumbar flexibility, reducing stiffness, and enhancing functional stability in patients with low back pain.

Keywords—Low Back Pain, Range of Motion, Transversus abdominis, Abdominal Muscles, Postural balance, Pain Measurement

Introduction

One of the most prevalent musculoskeletal conditions in the general population is low back pain (LBP). Over 23% of adults suffer from chronic low back pain, which renders 11-12% of people disabled⁽¹⁾. In patients with CLBP, prolonged contraction of the superficial paraspinal muscles may increase compressive stress, exacerbating disc compression and delaying stature recovery. Although it has been proposed that spinal shrinking is required to maintain proper disc functioning, the inability to restore stature is problematic and a hallmark of CLBP in all individuals⁽²⁾. Individuals with LBP had higher resting lumbar muscular stiffness than asymptomatic controls, which is associated with self-reported pain and impairment but not physical test outcomes⁽³⁾. We predicted that both forms of LBPs would result in an equivalent rise in lumbar stiffness and a comparable decrease in trunk muscle activity. The idea states that LBPs cause an equal increase in intra-abdominal pressure, which causes lumbar stiffness and relieves the load on the trunk muscles from maintaining intra-abdominal pressure⁽⁴⁾. For the pelvis, spine, and kinetic chain to properly balance loads, core stability is necessary. One kind of exercise program utilized to address LBP concerns is core stability exercise (CSE)⁽⁵⁾.

Changes in muscle tone can lead to discomfort, poor posture, and a loss of control over movement. According to recent research, the pain-spasm-pain loop that results in chronic pain may have an effect on excessive muscular tone⁽⁶⁾. The transversus abdominis muscle is significantly stimulated while the superficial trunk muscles are minimally activated during the abdominal drawing-in Maneuver (ADIM) technique⁽⁷⁾. Disability for LBP was measured using the Oswestry Disability Index (ODI), a "functional scale," derived from the self-reported Oswestry Low Back Pain Questionnaire⁽⁸⁾. The co-contraction of the abdominal muscles, which improves lumbar stability through feedforward motor control, can be trained using a lumbar stabilization exercise program⁽⁹⁾. The abdominal drawing-in maneuver (ADIM), which activates the deep core tissues, causes the transversus abdominis and the multifidus to co-contract, which reduces pain and improves symmetry when walking in people with low back pain⁽¹⁰⁾.

A spine splinting process that increases trunk stiffness and shields the spine from

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harmful stimuli and abnormal loads is represented by increased muscular activity⁽¹¹⁾. The physiologic tonic activation of transversus abdominus was lost by CLBP during locomotion and extremity movement, and the activation of lumbar multifidi and transversus abdominus was either delayed or decreased⁽¹²⁾. Core stability exercises and dynamic stretching improve thoracolumbar range of motion, pain threshold, and functional impairments in patients with chronic low back pain⁽¹³⁾. The trunk muscles' contractions are the main source of stability for the lumbar spine. This explains how the stability exercises support range of motion in the lumbar spine⁽¹⁴⁾. This impairment of trunk neuromuscular control should be seen in people who have experienced low back pain in the past⁽¹⁵⁾. The lumbopelvic muscles facilitate proprioceptive stimulation, postural stability, and promotion of energy transmission between the upper and lower limbs⁽¹⁶⁾.

Previous studies have shown that patients with chronic non-specific LBP have significantly higher ankle proprioception signals than healthy controls because of delayed activation of the deep trunk muscles⁽¹⁷⁾. Reduced lumbar range of motion, limited trunk flexion, postural control problems, and muscle stiffness are all characteristics of people with LBP⁽¹⁸⁾. It is commonly known that, in addition to work-related circumstances, risk factors for LBP include smoking, vibration, a deterioration in cardiovascular endurance, and a progressive loss of back and stomach muscular strength and flexibility⁽¹⁹⁾. Core stability significantly improves the prevention of lumbar lordosis and lower back pain⁽²⁰⁾. Reduced postural control in LBP patients can lead to discomfort, disability, and recurrent injuries⁽²¹⁾.

METHODOLOGY:

Eligibility criteria: This study was a Quasi-experimental trial having 60 individuals between 20-30 years, all females, who had impaired lumbar range of motion, an NPRS of at least 5, and a MODI score of at least 20% were recruited. Previous abdominal and spinal surgery, spinal abnormalities, traumatic back injuries, pregnancy, cancer, disc prolapse, ligament laxity, radiculopathy, and hip dislocation were among the exclusion criteria. After ethical approval and informed consent, participants were enrolled in a 6-week TrA activation program.

Drawing-in maneuver and stretching were among the interventions used. The Abdominal Drawing-In Maneuver was performed by asking the patient to lie on his back with knees bent and feet flat on the floor. He placed his hands on their lower abdomen or just above the pelvic bones for tactile feedback. The patient was instructed to take a deep breath, then exhale gently while drawing the lower abdomen inward towards the spine without moving the chest, pelvis, or upper abdomen. This position was maintained for 5-10 seconds. Knee to chest, Lumbar rotation, piriformis stretch, and child pose exercises were used as stretching exercises. The experimental group received intervention two sessions per day for two weeks, followed by sessions on alternate days for the next two weeks. Then, one session per week for follow-up. Outcomes measures included Modified Oswestry Disability Index for functional disability, Numeric Pain Rating Scale for pain, and range of motion (ROM) measurements of the lumbar spine (flexion, extension, and lateral flexion) using a

goniometer.

Data was analyzed using SPSS version 27. Paired sample t-tests were used to compare pre- and post-intervention results. A p-value of <0.05 was considered statistically significant.

RESULTS:

The inclusion and exclusion criteria were used to evaluate the eligibility of 60 patients in total. During the intervention or follow-up period, three participants left the study. As a result, the final analysis contained data from all 60 individuals. Lumbar stiffness and discomfort levels significantly decreased as a result of the intervention, while lumbar flexibility and functional stability improved statistically significantly. MODI and NPRS scores showed a significant improvement before and after the intervention.

		Paired Differences		95% Confidence Interval of the Difference		T	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper		
PNumeric Pain Rating Scale pre- i Numeric Pain Rating Scale post 1	1.877	.734	.097	1.683	2.072	19.3618	<.001
PModified Oswestry Disability Index pre- i Modified Oswestry Disability Index post 2	1.684	.659	.087	1.509	1.859	19.297	<.001
PRange of Motion pre- i Range of Motion Flexion post 3	-1.281	.881	.117	-1.515	-1.047	-10.970	<.001
PRange of Motion pre- i Range of Motion Extension post 4	-.211	.491	.065	-.341	-.080	-3.240	.002
PRange of Motion pre- i Range of Motion Lateral Flexion post 5	-.368	.747	.099	-.567	-.170	-3.723	<.001

Table 2 shows that according to the paired sample t-test, the pre-and post-intervention changes in all outcome measures were statistically significant ($p < 0.05$). Significant increases in spinal range of motion, functional impairment, and pain reduction were observed.

Table 3: Descriptive statistics of Pain, Disability, and Lumbar Range of Motion Pre-And Post-Intervention

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Numeric Pain Rating Scale pre	2.58	57	.498	.066
	Numeric Pain Rating Scale post	.70	57	.462	.061
Pair 2	Modified Oswestry Disability Index pre	3.74	57	.768	.102
	Modified Oswestry Disability Index post	2.05	57	.692	.092
Pair 3	Range of Motion Flexion pre	1.53	57	.504	.067
	Range of Motion Flexion post	2.81	57	.953	.126
Pair 4	Range of Motion Extension pre	1.54	57	.503	.067
	Range of Motion Extension post	1.75	57	.635	.084
Pair 5	Range of Motion Lateral Flexion pre	1.58	57	.625	.083
	Range of Motion Lateral Flexion post	1.95	57	.934	.124

Table 3 shows that the Modified Oswestry Disability Index and Numeric Pain Rating Scale scores significantly decreased after the intervention, according to descriptive statistics. Changes in mean scores demonstrated improvement in the range of motion for lumbar flexion, extension, and lateral flexion after treatment.

DISCUSSION:

The results of this study highlight the value of focused physiotherapy techniques, particularly the combination of the Abdominal Drawing-In Maneuver (ADIM) and stretching in enhancing functional stability, decreasing stiffness, and improving lumbar flexibility in people with low back pain (LBP). Early activation of the deep core muscles, especially the Transverse Abdominis (TrA), through the Abdominal Drawing-

In Maneuver (ADIM), significantly improves spinal stability and neuromuscular control. When combined with stretching, this technique helps patients with persistent LBP by addressing postural abnormalities and muscular tightness in addition to improving segmental control. Integrating these two approaches lessens compensatory movement patterns, which are frequently the cause of deteriorating musculoskeletal dysfunctions. The study's post-intervention results showed improvements in a number of parameters, such as range of motion (as measured by a goniometer), pain (NRS), and disability (MODI). These findings are consistent with earlier studies that demonstrated that core stability exercises lessen pain severity and disability in both acute and chronic LBP⁽²²⁾. With a mean pre-post difference of 1.88 points ($p < 0.001$), the current study showed a statistically significant decrease in pain intensity based on the Numeric Pain Rating Scale (NPRS). The Modified Oswestry Impairment Index (MODI), which measures functional impairment, also showed a substantial improvement, with a mean difference of 1.68 ($p < 0.001$). Post-intervention tests revealed improved lumbar range of motion, which further supported these positive outcomes.

Exercise therapy, including core stabilization and flexibility training, is highly recommended as the initial treatment for LBP by evidence-based clinical guidelines⁽²³⁾. The National Institute for Health and Care Excellence (NICE, 2016) emphasizes that individualized physiotherapy combined with early intervention enhances functional results and lowers chronicity. Epidemiological evidence suggests that a large proportion of individual with LBP seek physical treatment, particularly if their symptoms are chronic. Research indicates that prompt physiotherapy referral shortens the duration of pain and lowers the requirement for more complex medical or surgical procedures⁽²⁴⁾. These results highlight the value of organized, research-based physical therapy in the treatment of LBP. The current study contributes to the increasing amount of data that supports the inclusion of flexibility exercise and core muscle activation in LBP rehabilitation regimes. To investigate long-term advantages and therapeutic applications, more studies with larger sample numbers and longer follow-up are advised.

The transversus abdominis is the central core stabilizer technique that must be recruited in order to manage low back pain, according to prior research. The abdominal drawing-in maneuver was found to be more effective than general core stabilization techniques at activating the transversus abdominis. These studies support the current study's findings by showing that targeted core training can result in better functional outcomes, decreased discomfort, and increased lumbar flexibility¹⁰. This emphasizes how deep trunk muscles like the TrA are for maintaining lumbar stability and how crucial it is to activate them to treat chronic LBP. Following the intervention, both lumbar flexion and extension showed statistically significant, but moderate, improvements. For flexion and extension, the mean pre-post difference was -1.281 and -0.211, respectively ($p < 0.001$ and $p = 0.002$). The lateral flexion range of motion also showed a significant increase, with a mean difference of -0.368 ($p < 0.001$), suggesting improved spinal mobility after sessions. All of these findings showed that the intervention was successful in helping people with low back pain by lowering pain, increasing functional ability, and extending range of motion.

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When combined with conventional therapy techniques, core stabilization exercises are more effective in reducing pain and enhancing patients' functional status in patients with non-specific LBP⁽²⁵⁾. This previous research of Shoukat et al supports the findings of the current study. Their research found that when core stability exercises were combined with traditional physiotherapy, pain reduction and functional recovery improved more significantly than when core stabilization was used alone. This is consistent with our findings, which showed improved functional status and lumbar flexibility after a combined intervention strategy. In the treatment of mechanical low back pain, the therapeutic significance of combining core muscle activation with conventional physiotherapy techniques is supported by the consistency of both investigations.

This study has a few limitations, including the fact that there is a lack of a control group, which limits the capacity to make direct comparisons because the study is a single-group quasi-experimental design. It was also unable to evaluate the long-term durability of the reported benefits because the follow-up was restricted to the length of the treatment period. To confirm and build on these findings, more research involving randomized controlled trials and longer follow-up periods is advised. Deep core muscular activation and focused stretching should be a part of regular physiotherapy regimens in order to effectively treat mechanical low back pain.

CONCLUSION:

We conclude that patients with low back pain showed improvements in lumbar stiffness, flexibility, and functional stability through the combined intervention of transverse abdominis activation with stretching exercises. The Modified Oswestry Disability Index, the Numeric Pain Rating Scale, and goniometric measures all showed a significant increase in functional results and pain reduction. According to these results, deep core muscular activation and focused stretching should be a part of regular physiotherapy regimens in order to effectively treat mechanical low back pain.

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