Effect of Neuromuscular Re-education and Core Strengthening Exercise on Pain and Function in Chronic Low Back Pain: An AI-Assisted RCT

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Abstract. Affecting almost 80% of individuals at some point low back pain is the leading cause of disability globally. Numerous conditions can cause low back pain, such as herniated discs, muscular strains, ligamentous sprains, and degenerative alterations to the spine. Rick factors include age, obesity, a sedentary lifestyle, and bad posture. People between the ages of 20 and 59 had a prevalence of 19.6%, while those between the ages of 24 and 39 had a prevalence of 4.2% chronic LBP. The random sample approach will be used to choose 50 participants in total, based on the criteria for inclusion and exclusion from the study mentioned above. Following a 20–30-minute treatment session, the participants will be separated into two groups. The experimental group was received neuromuscular re-education exercise for 6to 8 repetitions. The control group was received the core strengthening exercise for 6 to 8repetition.All metrics were measured for mean and standard deviation (SD). Pairing the test with the post-test allowed for the analysis of significant differences between the two sets of data. An unpaired t-test was run to look for noteworthy variations in between the two teams. P-value less than 0.001 were significant in statistics. The study reported that both experimental and control group has better improvement in experimental group and positive result means of functional ability.

Keywords: chronic low back pain, Painchek AI, Oswestry disability index.

1 Introduction

Low back pain is the most common cause of disability worldwide, affecting over 80% of people at some time. It is an issue for global health. Herniated discs, ligament sprains, muscle strains, and degenerative changes in the spine are some of the conditions can cause low back discomfort. Age, sedentary lifestyle, bad posture and obesity are risk factors for back pain. It includes psychological and social problems in addition to worry and stress related to the workplace. If LBP is not properly managed, it can lead to effects like persistent pain, decreased mobility, and a general decline in quality of life.[1] Chronic low back pain is correlated with physical alterations and histomorphology in the paraspinal muscles. Future musculoskeletal system abnormalities, such as increased muscle density, reduced range of motion, and altered lumbar proprioception also correlated with back pain. Numerous neuromuscular variables, such as muscular imbalance, poor postural control, diminished proprioception accuracy, and sacroiliac joint dysfunction, might be the cause of chronic low back pain (LBP).[2] The frequency

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of back pain increases up to age 80, with the largest age range for patients occurring between 50 and 55. The prevalence of back pain is higher in women. LBP causes around 619 million individuals worldwide it leads to disability. It represents a serious threat to public health. LBP frequently results in a decrease in work productivity, which places a heavy financial burden on both people and society as a whole.[3]. People between the ages of 20 and 59 had a prevalence of 19.6%, while those between the ages of 24 and 39 had a prevalence of 4.2% for chronic low back pain [4]. 48% (95% CI 40–56%), 51% (95% CI 45–58%), and 66% (95% CI 56–75%) of LBP were found in India during the course of lives.[5] In combining connective tissue plasticity mechanisms with many well-established cLBP study areas—pain psychology, postural control, and neuroplasticity—this article offers a novel, testable pathophysiological model. According to our theory, fear brought on by pain sets off a chain reaction that results in reduced mobility, inflammation, connective tissue remodeling, sensitization of the nervous system, and more decreased mobility.[6] Depending on the results of a history and physical examination, individuals may be classified as having the following conditions can induce low back pain: 1. nonspecific; 2. radiculopathy; 3. back pain arising from a nonspinal source 4. back pain linked to the condition. CT or magnetic resonance imaging may be used to diagnose and direct treatment for individuals with back pain is related to cause such as spinal stenosis, radiculopathy, etc. The absence of evidence for superior outcomes suggests delaying lumbar spine radiography in patients for at least one to two months.[7] Neuromuscular (NMS) workouts stimulate afferent signals and the responses of central mechanisms for dynamic joint control, hence increasing the subconscious motor response. Deep sensory function, strength, range of motion, and coordination can all be enhanced with NMS exercises. Flexibility, central stability, balance, strength, agility, and plyometric training are all included in NMS workouts. These exercises improve the receptors for sensory input in the joints, which take in information about the body's position and motion. Increasing the lumbar muscles' strength, flexibility, and control is the aim of NMS exercises. Warmth, prevent tiredness, and a boost in the load capacity of musculoskeletal systems are some advantages of NMS. A synopsis of the function of NMS exercises in LBP is missing.[8] Muscles can be divided into two groups based on their anatomical, biomechanical, and physiological characteristics: mobilisers and stabilisers. Patients with CLBP had decreased gluteus maximus muscle activation. Reduced lumbar flexibility and dysfunction of the hip (gluteus maximus), transversus abdominis, and back (multifidus) muscles are the main causes of chronic low back pain, a complex disorder. The thoracolumbar fascia is directly related to the transversus abdominis muscle, and the TLF's shear strain is reduced when this muscle is weak. Increasing intra-abdominal pressure (IAP) is the purpose of TLF. In cases of TrA weakness, increased IAP may help unload and stabilize the lumbar spine, causing the IAP to drop and the lumbar spines to become unstable and experience loading.[9] It is quick and simple to use, and PainChek can detect pain even in situations where it is not readily apparent. Using AI-powered facial recognition, the smartphone camera captures an image of the subject's face. Facial muscle movements that indicate discomfort are automatically detected and recorded by it. In order to make pain assessment easier for everyone, pain check universal combines the pain check app with a numerical pain rating scale. Using artificial intelligence (AI), PainChek Infant analyses and recognises an infant's face automatically. The fascial action Coding System classifies these facial behaviours as particular muscular contractions or relaxations. With consideration for the facial expressions that are frequently linked to pain in this demographic, the instrument has

been especially created to evaluate pain in new-borns (ages 1-3 months). [10] The level of impairment experienced by LBP patients is an important outcome indicator in clinical practice and research. The Oswestry Impairment Index scale is used to measures for evaluating the impairment associated with LBP. The ODI consists of ten questions that assess how much back (or leg) pain has interfered with everyday activities. The 10 parts address a variety of themes, including pain severity, personal cleanliness, sleeping, lifting, moving, sitting, standing, having sex, going out, and travelling, as well as everyday functioning aspects. Every item on the 6-point rating scale (0–5) is assigned a score; a higher score indicates a higher degree of LBP-related disability.[11] The purpose of this study was to evaluate whether neuromuscular re-education and core strengthening exercises affected the functional improvement and pain alleviation of individuals with chronic low back pain.

2 Methods

According to the inclusion and exclusion criteria of the study, 50 individuals in total will be chosen at random. Before beginning, each participant will be explained the study and requested to sign an informed consent form. Two sets of research participants will get therapy for 20 to 30 minutes each. Neuromuscular re-education exercises will be performed on the experimental group six to eight times. The core strengthening exercise will be performed six to eight times for the control group. Over the course of four weeks, all participants will engage in three days of exercise per week. Advanced pain assessment technology (pain check AI) and functional disability (ODI) were used to measure the pre-test. This will be tested before treatment begins and again after 4 weeks as post-test levels.

2.1 Inclusion Criteria: Age between 20-50, both genders (female and male), More than 3 months low back pain and Oswestry disability index score of greater than or equal to 20

2.2 Exclusion Criteria: Acute spinal injury, Spinal surgery within 6months, Pregnancy, Severe comorbidities and Uncontrolled psychological conditions.

2.3. Outcomes measures:
Primary outcome: Advanced pain assessment technology (Painchek Ai)
Secondary outcome: Oswestry Disability Index

3 Procedure

Patients have been separated into two groups experimental group and control group. The experimental group (n=25) will undergo neuromuscular re-education exercise.

McGill curl-up (modified curl-up): Individuals lie on their backs with their hands beneath their lumbar lordosis, one leg fully straight, and one knee bent. The lumbar spine was not compressed when performing curl-ups.

Bird Dog Stretch: To stabilize the shoulder area and neutralize the lumbar vertebrae, participants maintained a four-point kneeling position, pressing their hands and knees to the floor. The test was done on both sides, with one leg extended straight backward and one hand stretched straight forward to accomplish the stretch.

Side bridge: In order to raise their bodies so that only their foot and forearm touched the floor (side bridge), the participants were instructed to either lie on one side with their legs straight and press their forearmonto the floor, orthey asked to lie on one side with their legs bent at the knee and press their forearm onto the floor so that only their lower leg, forearm, and knee touched the floor.

Shoulder bridge: Raise the pelvis while keeping the spine neutral from a supine crook laying posture, then raise one heel offthe floor without rotating the pelvis as you do so.

Hamstrings stretch: Keep your spine neutral while flexing and pointing your ankle eight times. Then switch legs and repeat.

Whereas control group(n=25) will be receiving core strengthening exercise.

Bridge Track (Physio-Ball Routine and Floor): Patients use a physio-ball or the floor to perform the Bridge Track exercise, which is an organized series of movements designed to improve lumbopelvic mobility and strengthen and stabilize the core. In the beginning, the patient actively seeks a neutral lumbar spine, engages the abdominal muscles, and explores lumbopelvic motion. The patient then elevates their pelvis to its highest point while keeping their spine neutral, which starts an active gluteal contraction. These basic motions can be executed with ease. integrated into several bridge configurations, guaranteeing a thorough approach to lumbar support stabilization.

Dead Bug Track (Physio-Ball and Floor Routine): The Dead Bug Track emphsises abdominal exercise that integrates limb motions with a special emphasis on spine stability maintenance. It is appropriate for both physioball and floor exercises. With your knees bent and your arms by your sides, start the exercise in a supine posture. The series of diagonal isometric holds uses combined arm and leg movements in opposing and alternating motions to target the oblique abdominal muscles.

Track with four rows (Floor Routine): The floor-based Quadruped Track uses alternating arm and leg motions to improve stability and core strength. Alternate leg movements with a stable trunk and opposing arm and leg (cross crawl) motions can be added to the program while the quadruped position is maintained, with hands aligned under shoulders and knees beneath hips.

Supine Track: Exercises for Physio-Ball physio-ball exercises on the Supine Track are intended to improve core stability and strength. To start the exercise, the patient lies on his or her back with the knees and hips slightly bend and feet flat on floor. The arms can be positioned in progressively more challenging ways during the exercise, such as bending forward, crossing behind the head, crossing over the chest, and lifting the elbows above the head. The crunch's concentric phase is considered to have concluded when the scapula's inferior angle rises off the ground.

Side Support Track (Floor Routine): A floor exercise that targets the quadratus lumborum muscles is the side-support track. Important components of this exercise include keeping the hips slightly expanded and creating a straight line between the ankles, knees and shoulders. The elbows should be immediately beneath the shoulder and 90 degrees bent for optimal effect. After that, the spine is straightened by raising the pelvis.

4 Statistical analysis

A tabulation and analysis were performed on the gathered data. All metrics were measured for mean and standard deviation (SD). Pairing the test with the post-test allowed for the analysis of significant differences between the two sets of data. An unpaired t-test was run to look for noteworthy variations between the two groups (fig.1), (Table1). Statistics were deemed significant when the P-value was < 0.001.

Table 1. comparing clinical outcomes post-test values between groups

Outcome Measures	Control Group		Experimental Group		P Value
	Mean	Sd	Mean	Sd	
PAINCHEK AI	2.68	1.31	4.08	0.81	<0.0001
ODI	25.00	3.24	40.32	3.31	<0.0001

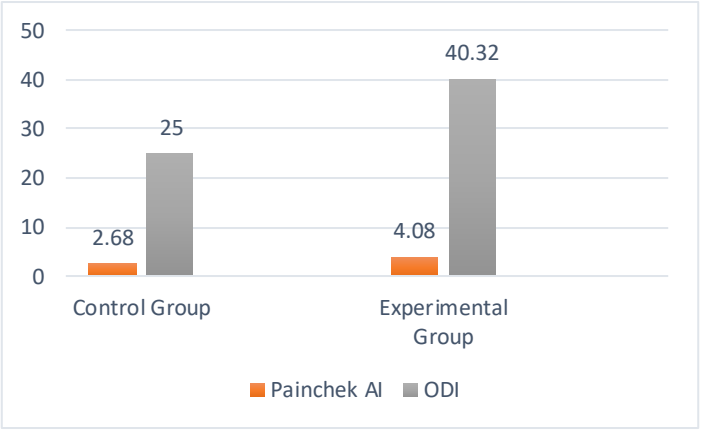

Fig. 1. Post test comparison between the groups for Painchek AI and ODI

5 Result

Post-test assessments indicated significant variations in Painchek Ai and ODI scale scores patients with chronic low back pain. The mean post values of Paincheck Ai for the control and experimental groups are 4.08 and 2.68, respectively, and the mean post values for the ODI for the control and experimental groups are 25.12 and 40.32, respectively. The detailed results were tabulated in tables with respective for each outcome measure.

6 Discussion

Kotteeswaran K, et al; The current study comes to the conclusion that, when it comes to managing subjects with mechanical low back pain, muscle energy technique in conjunction with neuromuscular re-education and resistance training is more effective than these methods alone in terms of reducing pain and disability and enhancing functional activities.[12] Venkatesan P, et al; The result of this study may be useful in determining how yoga and DNS exercises affect the thoracolumbar fascia and lumbar multifidus in the treatment of chronic low back pain.[13] Taulaniemi A, et al; This study was concluded that Pain was reduced and lumbar movement control, abdominal strength, and physical functioning in nursing chores were improved by the neuromuscular training.[14] Russo M, et al; The study comes to concluded that the significant number of patients with mainly nociceptive CLBP have pain which is primarily caused by decreased neuromuscular regulation of the lumbar spine's main stabilising muscles, particularly the lumbar multifidus. These individuals are inadequately treated by current therapy and are typically not candidates for surgery. Most people found it challenging or unable to consciously contract the MF, despite some research showing that exercise treatment is useful in improving neuromuscular control of the MF. Exercise treatment cannot be applied to the MF since it is not usually receptive to voluntary control and may be susceptible to arthrogenic muscle inhibition.[15] Wang XQ, et al According to the study's findings, people with chronic low back pain may have a brief increase in physical function and a decrease in discomfort when performing core stability exercises as opposed to general exercise. Yet, patients who performed core stability exercises compared to those who performed general exercise did not show any appreciable long-term variations in the intensity of their discomfort.[16] Puntumetakul R, et al; This result indicates that both strengthening and core stabilisation activities reduce discomfort, the former is more effective than the latter. Patients with subacute NSLBP benefit from treatment in terms of reduced functional impairment and movement anxiety, as well as improved proprioception, balance, and percentage change of muscle thickness of TrA and LM.[17]

Aly SM, et al; This result indicates that the exercises for core stability help to build stamina and strength in the trunk muscles. The CLBP patients' strength and endurance improved more with the core stabilisation exercises than with the dynamic strengthening program. As part of the treatment plan for people with low back pain, core stability exercises ought to be included.[18] Compared to patients who continued their regular exercise regimen, core strengthening exercises were beneficial in lowering in-flight pain and resulted in a reduction in pain symptoms and disability over the 12-week trial period.[19]

Calatayud J, et al; The greatest workouts to activate the abdominal muscles are modified curl-ups, front planks, and front planks with braces. The best exercise for engaging the external oblique is the front plank with bracing, squat and bird-dog exercise is excellent for lumbar erector spinae stimulation. Guidelines can be derived from muscle activity levels and tolerability.[20]

The evidence in this review shows that machine learning, data mining, and natural language processing have been utilised to enhance the effectiveness of pain assessment and recognition, analyse self-reported pain data, forecast pain, and assist patients and doctors in managing chronic pain [21]. Coppieters MW et, al; In dementia patients, there was a correlation between six distinct facial expressions and pain levels. The results imply that a computer generated real-time facial detection technique is a practical way to assess pain. Before it can be utilised for clinical practice decision-making, it must first be validated by human observers.[22]

Hughes JD This investigation shows the accuracy and precision of the instrument at the specified cut off score and offers information on the viability of utilising Pain Chek Infant for procedure pain assessment and monitoring in clinical practice.[23]

Vianin M A valid in clinical settings, the ODI is a reliable evaluation tool. It records therapy outcomes, is easy to administer and evaluate, and objectifies clients' issues.[24]

7 Conclusion

The study result that there is an improvement in both experimental and control group, which has shown statical analysis of value of p 0.001 and comparatively has better improvement in experimental group.

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