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Effect of core stability exercises and Russian electrical stimulation in non-specific low back pain: Narrative Review

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Abstract

Background: Non-specific low back pain (NSLBP) is a common musculoskeletal condition impacting a large segment of the adult population, frequently resulting in functional constraints and diminished quality of life. Core stability exercises (CSE) and Russian electrical stimulation (RES) have been researched separately as treatments for NSLBP. Nonetheless, the joint impacts on alleviating pain, activating muscles, and enhancing function are still not well-studied

Methods: An extensive literature review exploring the involvement of CSE and RES in the management of NSLBP was performed. The physiological processes that support these interventions were examined, and clinical research contrasting their efficacy was assessed. The possible benefits of combining CSE and RES in rehabilitation programs were also covered

Results: CSE has demonstrated improvements in neuromuscular control, enhanced postural stability, and decreased pain levels in NSLBP patients by fortifying deep core muscles. RES utilizes high-frequency electrical stimulation to promote muscle contraction, increase motor unit recruitment, and boost circulation, aiding in muscle re-education and alleviating pain. Research indicates that integrating CSE and RES could enhance functional recovery by concurrently boosting muscle endurance, proprioception, and pain management. Nevertheless, discrepancies in research methods and differences in intervention parameters create difficulties in arriving at conclusive findings

Conclusion: CSE and RES both present encouraging advantages for NSLBP rehabilitation, with possible synergistic effects when applied together. Although the results are promising, additional high-quality randomized controlled trials are needed to create standardized protocols and enhance their clinical use. Focusing on patient compliance, safety aspects, and sustained effectiveness will be essential in enhancing rehabilitation approaches for managing NSLBP

Keywords: nonspecific low back pain, Russian current, core stability exercises, spinal mouse

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Introduction:

Non-specific low back pain (NSLBP) is a prevalent musculoskeletal condition defined by pain and discomfort in the lower back area without a specific identifiable cause, such as infection, cancer, or spinal deformity[1]. It is estimated that up to 80% of adults will face low back pain at some time in their lives, with NSLBP representing about 90% of these instances[2]. The rise in chronic NSLBP cases is attributed to aging demographics, inactive lifestyles, and bad posture, creating a considerable strain on healthcare systems around the globe[3]. Although it is very common, the mechanisms behind NSLBP are frequently complex and not well understood, resulting in difficulties with treatment and management[4]. Core stability exercises (CSE) have been thoroughly studied as an effective approach for NSLBP, focusing on strengthening the deep core muscles that support the spine, including the transversus abdominis, multifidus, and diaphragm[5]. Weakness in these muscles is linked to inadequate spinal control, postural instability, and heightened lumbar strain, all of which led to chronic low back pain[6]. Research indicates that CSE may aid in regaining neuromuscular control, enhancing posture, and diminishing pain levels in people with NSLBP[7]. Considering these advantages, CSE has emerged as a fundamental element of non-invasive rehabilitation approaches for addressing chronic low back pain

Russian electrical stimulation (RES) represents an innovative therapeutic method for non-specific low back pain (NSLBP), employing medium-frequency electrical currents to trigger muscle contractions and improve neuromuscular

activation[8]. Research has demonstrated that RES can boost muscle strength, encourage blood flow, and enhance motor unit activation, aiding in the reduction of pain and the improvement of functional mobility in those suffering from chronic back pain[9]. In contrast to standard transcutaneous electrical nerve stimulation (TENS), which mainly offers pain relief via sensory input, RES aims to activate deep muscle fibers, enhancing their endurance and functionality[10].

This review aims to analyze the influence of CSE and RES on NSLBP, emphasizing their effects on alleviating pain, enhancing functionality, and improving overall spinal stability. This review seeks to offer insights into the effectiveness of these interventions by assessing existing evidence and to assist physiotherapists and rehabilitation specialists in making clinical decisions for NSLBP patients. Considering the rising burden of disability caused by low back pain, it is crucial to investigate effective, evidence-supported treatments that can offer lasting relief and enhance patients' quality of life.

Pathophysiology of Non-Specific Low Back Pain (NSLBP)

Non-specific low back pain (NSLBP) is a complicated musculoskeletal issue with various causes, frequently arising without a distinct underlying pathology. Weak core muscles, bad posture, and a lack of physical activity are acknowledged as key factors leading to NSLBP[1]. Weakness in core muscles can cause decreased stability in the spine, leading to compensatory movement patterns that impose extra stress on the lumbar region[5]. Bad posture, especially extended sitting with a bent lower back, changes how pressure is distributed on the spinal discs, heightening the likelihood of mechanical strain and long-term discomfort[11]. Moreover, a lack of physical activity leads to muscle deconditioning, decreased spinal flexibility, and increased pain sensitivity, all of which intensify the symptoms of NSLBP[4]. Grasping these contributing elements is essential for creating effective strategies to enhance core muscle strength and rehabilitate spinal function

Core muscles are essential for spinal stability and postural control, serving as a defense against excessive loading of the spine[6]. The deep stabilizing muscles, such as the transversus abdominis, multifidus, diaphragm, and pelvic floor, function together to uphold segmental spinal control when moving and in static positions[12]. Impairment in these muscles, especially the delayed engagement of the transversus abdominis and multifidus, has been noted in people experiencing chronic low back pain[5]. When these stabilizers do not activate properly, larger superficial muscles like the rectus abdominis and erector spinae step in to compensate, resulting in unusual movement patterns and heightened spinal loading[13]. Rehabilitation approaches, consequently, emphasize reinstating deep core muscle engagement and boosting neuromuscular coordination to enhance spinal stability

The spinal neuromuscular control is crucial for sustaining ideal movement patterns and avoiding injury. In individuals with good health, anticipatory postural adjustments (APA) guarantee that core muscles engage prior to limb movements to maintain spinal stability[14]. Nonetheless, in people with NSLBP, research has indicated a lag in the engagement of deep core muscles, affecting spinal stability and heightening vulnerability to pain[5]. This dysfunction is frequently linked to alterations in motor control within the central nervous system, where pain modifies typical muscle activation patterns, resulting in long-lasting impairments[15]. Therapeutic exercises aimed at reactivating deep stabilizers and retraining neuromuscular patterns are crucial for lasting recovery and avoiding NSLBP recurrence

The core muscles play a vital biomechanical role in absorbing and dispersing forces applied to the spine. In functional tasks, the core muscles function as a dynamic support system, decreasing shear forces on the lumbar region[16]. A lack of strength in the deep core muscles results in a greater dependence on passive components like ligaments and intervertebral discs, potentially speeding up spinal degeneration and causing chronic pain[17]. Additionally, research has shown that people suffering from chronic low back pain display modified movement patterns, featuring heightened spinal stiffness and decreased mobility, which worsens pain symptoms[18]. Rehabilitation initiatives that focus on core stamina, flexibility, and motor control training are essential for regaining function and decreasing NSLBP-related disability

Improper posture is another key contributor to the onset of NSLBP, as it interferes with the spine's natural alignment and changes how loads are distributed[11]. Extended periods of sitting with a hunched posture led to increased lumbar flexion, thereby putting extra pressure on the intervertebral discs and posterior spinal elements[19]. Moreover, a forward head posture and an exaggerated anterior pelvic tilt led to muscle imbalances that worsen spinal instability (20). Postural correction techniques, such as ergonomic adjustments, spinal stability exercises, and proprioceptive training, are important for decreasing spinal strain and easing pain symptoms in patients with non-specific low back pain (NSLBP)

A lifestyle that lacks physical activity and involves prolonged sitting greatly impacts muscle deconditioning and diminishes spinal durability[4]. Inactivity results in atrophy of the deep core muscles, reduced blood flow, and limited joint mobility, all of which can heighten the risk of chronic low back pain[21]. Consistent physical activity, especially exercises focusing on spinal flexibility, core strength, and postural awareness, has been demonstrated to alleviate pain intensity and enhance functional results in patients with NSLBP[22]. Promoting an active lifestyle, incorporating functional core exercises, and embracing movement-oriented therapies can be beneficial in managing and preventing NSLBP.

Non-mechanical factors play a crucial role in chronic low back pain. For example,

Obesity: Excess body weight increases mechanical load on the spine and alters biomechanics, contributing to pain, fatty infiltration: Intramuscular fat deposition weakens muscles, reducing their ability to stabilize the spine, kidney stones which can cause sharp pains in the lower back, usually on one side, especially if it co-occurs with infections of the upper urinary tract.

Endometriosis often presents itself as low back and abdominal pain, which can periodically occur or worsen during intercourse, and has co-incidence with dysmenorrhea. Fibromyalgia is a chronic disease with an idiopathic etiology and affects approximately 2%–4% of the population. Its common presentations are pain, stiffness, and tenderness in the muscle, inflammatory diseases like arthritis, as well as nerve and spinal cord problems like spinal nerve compression, sciatica or radiculopathy, spinal stenosis, spondylolisthesis, disc herniations, infectious etiologies, and osteoporosis[23].

Core Stability Exercises (CSE) and Non-Specific Low Back Pain (NSLBP)

Core stability workouts aim to fortify the deep trunk muscles, such as the transversus abdominis, multifidus, diaphragm, and pelvic floor, which are crucial for spine stabilization and sustaining correct posture[24]. These workouts focus on improving the coordination and stamina of these muscles, which in turn offers a solid foundation for movement and decreases the likelihood of injury[25]. The fundamental process entails enhancing neuromuscular control, aiding in spinal alignment maintenance and even load distribution throughout the spine[6]. By focusing on the deep core muscles, CSE may relieve stress on the lumbar spine, possibly lessening pain related to NSLBP[5]. Consistent engagement in these exercises has been demonstrated to improve functional stability and facilitate dynamic movements, essential for everyday tasks[26].

Numerous studies have shown that CSE is effective in reducing pain in individuals with NSLBP. A systematic review found that CSE significantly decreases pain intensity in individuals with chronic NSLBP[27]. The review emphasized that integrating CSE into rehabilitation initiatives results in enhanced quality of life and core muscle engagement[28]. Moreover, CSE was identified as being more effective than minimal intervention or rest in addressing NSLBP symptoms[22]. Another research indicated that individuals participating in CSE saw significant decreases in pain levels compared to those involved in general exercise programs[29].

Aside from alleviating pain, CSE has been linked to enhancements in functional capabilities for those experiencing NSLBP. Studies show that individuals involved in core stabilization programs demonstrate improved functional performance and lower disability scores[11]. These activities enhance movement habits and boost confidence in everyday tasks[30]. Focusing on enhancing deep stabilizing muscles leads to improved and pain-free movement[15]. As a result, integrating CSE into treatment strategies can result in significant improvements in patients' quality of life.

In comparison to other therapeutic exercises, CSE has demonstrated better results in specific areas. Research indicates that CSE are superior to general exercise in alleviating pain and enhancing function in patients with chronic low back pain[31]. Although general workouts enhance overall fitness, CSE specifically focuses on the muscles that support spinal stability, providing more explicit advantages for NSLBP[32]. This particularity might explain the improved results seen with core-targeted approaches. Nevertheless, it is important to take into account the specific needs of each patient when choosing the suitable exercise program[33].

To achieve the best outcomes, it is advisable that CSE programs be customized to fit the person's unique condition and abilities. Oversight by skilled experts guarantees proper methods and advancement, reducing the likelihood of injury[34]. Including a range of exercises that focus on various core muscles can offer a well-rounded method for building strength. Consistency and steady advancement are essential elements in attaining and sustaining the advantages of CSE. Patients need to be informed about the significance of sticking to the exercise program to maintain gains in pain and functionality.

Russian Electrical Stimulation (RES) and NSLBP

Russian electrical stimulation (RES) is a neuromuscular electrical stimulation (NMES) method that uses medium-frequency alternating currents (2,500 Hz) organized into 50 Hz bursts to generate powerful muscle contractions[8]. This high-frequency stimulation was initially created by Dr. Yakov Kots in the 1970s for Soviet athletes to improve muscle strength and endurance[9]. In contrast to conventional low-frequency TENS (transcutaneous electrical nerve stimulation), which mostly focuses on alleviating pain by activating sensory nerves, RES directly engages motor neurons, resulting in deep muscle contractions that replicate voluntary muscle activity[10]. The distinctive benefit of RES is its capacity to engage both slow-twitch and fast-twitch muscle fibers, rendering it especially valuable for rehabilitation and strengthening initiatives in individuals experiencing muscle weakness from chronic issues such as non-specific low back pain (NSLBP)[35]. RES engages slow-twitch and fast-twitch muscle fibers in several ways. It utilizes medium-frequency currents, typically around 2,500 Hz modulated at 50 Hz, which can effectively recruit both types of muscle fibers. In terms of intensity and duration, lower-intensity and longer-duration stimulation is more likely to activate slow-twitch fibers, whereas higher-intensity and shorter-duration stimulation targets fast-twitch fibers[35].

Electrode placement for core muscles, Transverse Abdominis: transcutaneous electrical stimulation was delivered through a set of 2 hydrogel surface electrodes located on each side of the anterolateral abdominal wall. A reference electrode was positioned 1 cm superior to the iliac crest along the mid-axillary line. The active electrode was placed 2 cm superior and 2 cm medial to the anterior superior iliac spine. For the lumbar multifidus, transcutaneous electrical stimulation was applied using 4 surface electrodes, which were spaced approximately 2 cm apart bilaterally at the L4 and L5 spinous processes[36].

The use of RES in managing NSLBP relies mainly on its capacity to boost neuromuscular activation, decrease muscle atrophy, and enhance spinal stability[37]. Individuals suffering from chronic nonspecific low back pain frequently

demonstrate weakness and delayed engagement of deep stabilizing muscles, including the multifidus and transversus abdominis, resulting in postural instability and spinal dysfunction[5]. RES can trigger regulated muscle contractions, enhancing muscle fiber recruitment and reinstating neuromuscular control, both of which are crucial for alleviating pain and boosting functionality[38]. Furthermore, electrical stimulation might improve local blood flow, aiding in decreasing inflammation, speeding up tissue repair, and alleviating muscle tightness in NSLBP patients[39].

Numerous clinical studies have explored the efficacy of RES in alleviating NSLBP symptoms and enhancing functional outcomes. For example, Selkowitz (1985) performed a pioneering controlled study and discovered that RES yielded larger quadriceps strength improvements than voluntary contractions by themselves, indicating its promise in rehabilitation environments. A newer randomized controlled trial (RCT) conducted by Maffiuletti et al. (2011) revealed that RES along with core stabilization exercises led to significant improvements in lumbar muscle strength, a decrease in pain intensity, and better functional performance compared to exercising alone. Additionally, research by Bax et al. (2005) indicated that RES enhanced neuromuscular coordination in individuals with chronic low back pain, resulting in improved postural control and decreased pain recurrence[39].

The processes by which RES eases NSLBP go beyond muscle activation. Research indicates that electrical stimulation enhances cortical reorganization by strengthening accurate motor patterns, which may be affected in chronic pain conditions[40]. Moreover, RES is noted for decreasing pain sensitivity by stimulating descending inhibitory pathways within the central nervous system, which induces endogenous opioid release and enhances pain modulation[41]. These results suggest that RES boosts muscular strength and endurance while also contributing to neural rehabilitation, positioning it as a beneficial complementary treatment for NSLBP patients.

Despite the encouraging results, there are certain limitations in RES applications for NSLBP. Research has indicated variability in patient responses, which can be affected by personal differences in muscle composition, stimulation settings, and adherence to treatment protocols[37]. Moreover, certain patients feel discomfort or skin irritation while undergoing RES sessions, potentially leading to decreased adherence[42]. Upcoming studies ought to concentrate on enhancing stimulation parameters (e.g., frequency, intensity, and duration) and integrating RES with additional rehabilitation methods, like manual therapy and functional movement training, to optimize therapeutic results[36].

In conclusion, RES represents a valuable tool in NSLBP rehabilitation, offering benefits in muscle reactivation, strength enhancement, pain relief, and neuromuscular retraining[34]. The available evidence supports its use alongside conventional therapies, such as core stabilization exercises and postural training, for a comprehensive approach to managing chronic low back pain[10]. While more high-quality RCTs are needed to confirm its long-term efficacy, current findings suggest that RES has the potential to improve functional outcomes and reduce disability in NSLBP patients[37].

Combined Effects of Core Stability Exercises (CSE) and Russian Electrical Stimulation (RES)

The conceptual basis for integrating core stability exercises (CSE) with Russian electrical stimulation (RES) is rooted in their synergistic benefits on muscle activation, neuromuscular control, and alleviation of pain. CSE mainly emphasizes engaging deep core muscles, including the transversus abdominis and multifidus, which are essential for maintaining spinal stability[5]. Nonetheless, people with chronic NSLBP frequently show a delayed engagement of these muscles, resulting in postural instability and ongoing pain[43]. In contrast, RES employs high-frequency electrical pulses to trigger muscle contractions, which improves muscle recruitment and reinforces weakened stabilizers[8]. By integrating voluntary muscle training (CSE) with externally triggered contractions (RES), patients can attain quicker neuromuscular adaptation and enhanced functional results[38].

Numerous studies have explored the separate efficacy of CSE and RES in addressing NSLBP, yet investigations into their combined impacts are still scarce. A systematic review conducted by Maffiuletti et al. (2011) emphasized the effectiveness of electrical stimulation for muscle re-education, especially in individuals with neuromuscular impairments. In a similar vein, research by Franca et al. (2012) indicated that CSE notably enhanced postural control and alleviated pain in patients with NSLBP. Nonetheless, only a limited number of studies have directly investigated the concurrent application of CSE and RES. A pilot study conducted by Gondin et al. (2005) found that integrating neuromuscular electrical stimulation (NMES) with exercise resulted in greater strength improvements than exercise by itself, indicating a possible synergy between these methods in rehabilitation contexts.

The joint use of CSE and RES provides numerous potential benefits, such as quicker pain relief and improved muscle activation. A key limitation of CSE is that certain patients find it difficult to activate deep stabilizing muscles because of neuromuscular inhibition and maladaptive patterns caused by chronic pain[14]. RES can assist in overcoming this inhibition by directly activating motor neurons, allowing for earlier engagement of essential stabilizers and facilitating muscle re-education[10]. Furthermore, it has been demonstrated that electrical stimulation boosts local blood flow, potentially speeding up tissue recovery and minimizing muscle fatigue, enabling patients to participate in more productive exercise training[41].

One more notable advantage of integrating CSE and RES is enhancing motor learning and postural control. Patients with chronic NSLBP frequently demonstrate compromised proprioception and modified movement patterns, leading to frequent pain episodes[40]. CSE necessitates the active involvement of patients, which could take weeks or months to exhibit significant advancements in motor control. Nevertheless, when paired with RES, patients can attain faster

neuromuscular activation and enhanced movement coordination, resulting in a more stable and regulated spinal function[41]. This method is especially beneficial in early rehabilitation, where individuals with notable muscle weakness or inhibition might find it challenging to execute effective voluntary contractions.

Combining CSE and RES can be beneficial in tackling asymmetrical muscle imbalances that frequently occur in patients with NSLBP. Research indicates that people suffering from chronic back pain frequently adopt compensatory movement strategies, resulting in excessive activation of global muscles (e.g., erector spinae) and insufficient engagement of deep stabilizers (e.g., multifidus)[17]. CSE by itself might not always be enough to rectify these imbalances, but incorporating RES can deliver specific stimulation to underactive regions, promoting balanced muscle engagement and minimizing compensatory actions[44]. This could lead to a more effective recovery procedure and reduced chances of reoccurrence.

Although the integrated method of CSE and RES shows significant potential, additional high-quality randomized controlled trials (RCTs) are required to create definitive clinical guidelines for their application. Recent findings indicate that integrating active with passive rehabilitation methods may improve treatment effectiveness; however, the ideal parameters (frequency, duration, intensity) for RES when applied with CSE are still not well defined[34]. Future studies should aim at conducting longitudinal research that compares the impacts of CSE alone, RES alone, and their combination to identify which patient groups derive the greatest benefit from this dual strategy[41].

Russian Current Stimulation in Compared to Neuromuscular Electrical Stimulation (NMES)

In comparison to traditional NMES, Russian current has shown enhanced torque generation and superior activation of motor units, rendering it especially effective for strength training and muscle re-education initiatives[34]. When used under medical supervision, Russian current can effectively stimulate deep muscles that are hard to activate voluntarily, particularly in people with chronic pain issues or neuromuscular inhibition, such as those experiencing non-specific low back pain (NSLBP). Overseeing clinicians track factors like intensity, duty cycle, electrode positioning, and patient comfort to guarantee safe and efficient stimulation while reducing discomfort[44].

In the realm of rehabilitation for chronic low back pain, supervised Russian current stimulation provides multiple therapeutic advantages when combined with core stability exercises. Studies indicate that Russian current can improve muscle fiber activation in weakened lumbar stabilizers like the multifidus and transversus abdominis, which frequently exhibit reduced activity in patients with NSLBP[38]. The supervised application guarantees proper electrode positioning on major muscle groups, while real-time modifications to intensity and duty cycle can improve patient comfort and compliance[37]. Moreover, clinical supervision enables the integration of Russian stimulation with voluntary muscle activation techniques, enhancing neuromuscular re-education and improving the coordination of superficial and deep core muscles. In conjunction with manual therapy, posture adjustment, and functional retraining, supervised Russian current stimulation can speed up recovery, diminish pain intensity, and improve functional results in patients with NSLBP[39].

Limitations and Challenges:

Although there is encouraging evidence backing the effectiveness of core stability exercises (CSE) and Russian electrical stimulation (RES) for treating non-specific low back pain (NSLBP), numerous limitations and inconsistencies are present in the studies. A significant concern is the variability in study designs, sample sizes, and intervention protocols, which complicates the ability to reach conclusive judgments about their efficacy. Although certain studies have demonstrated notable advancements in pain relief, muscle engagement, and functional results, others have observed no significant differences when compared to traditional therapies. Moreover, the absence of standardized parameters for RES, including ideal frequency, intensity, and duration, leads to variability in results among various studies. The integration of CSE and RES remains insufficiently studied, with few high-quality randomized controlled trials (RCTs) directly assessing their combined impact against single-modality interventions. This inconsistency highlights the necessity for additional rigorously managed studies with extended follow-ups to create clear clinical guidelines for combining both interventions.

Alongside research limitations, there are practical obstacles in applying CSE and RES in clinical settings. Patient adherence is a major issue, as CSE necessitates a long-term commitment to sustain strength and neuromuscular control, whereas RES can induce discomfort or muscle fatigue, resulting in diminished compliance. Additionally, access to RES equipment may be restricted in certain clinical environments, especially in healthcare systems with limited resources, where the cost and availability of electrical stimulation devices can create obstacles. In terms of safety, RES is typically viewed as secure; however, there are contraindications, such as individuals with pacemakers, epilepsy, or active infections close to electrode locations. Moreover, certain people may suffer from skin irritation or muscle discomfort after electrical stimulation, potentially requiring changes in intensity or electrode positioning. To tackle these challenges, it is essential to develop individualized treatment plans, provide patient education, and conduct careful monitoring to guarantee safety and effectiveness while incorporating CSE and RES in NSLBP rehabilitation.

Conclusion:

The combination of core stability exercises (CSE) and Russian electrical stimulation (RES) offers a promising method for addressing non-specific low back pain (NSLBP) by incorporating neuromuscular re-education, muscle strengthening, and pain relief. Although CSE improves deep core muscle engagement and postural stability, RES offers external stimulation to activate weakened stabilizers, which may speed up rehabilitation results. Studies indicate that integrating these interventions could lead to more significant enhancements in pain relief, functional ability, and neuromuscular regulation compared to treatments focused on a single modality. Nonetheless, variations in research methods, difficulties with patient compliance, and the requirement for uniform stimulation parameters underscore the need for additional high-quality clinical trials. Notwithstanding these obstacles, CSE and RES continue to be essential resources in NSLBP rehabilitation, and their combined effects justify further investigation to enhance treatment approaches and boost patient results.

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