Comparison Between Transcutaneous Electrical Nerve Stimulation and Stabilization Exercises in Fatigue and Transversus Abdominis Activation in Patients With Lumbar Disk Herniation: A Randomized Study

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Abstract

Objective: The purpose of this study was to compare transcutaneous electrical nerve stimulation (TENS) and stabilization exercises in an attempt to prevent fatigue and improve muscle activation in patients with lumbar disk herniation associated with low back pain.

Methods: This study involved 29 patients (age range 25-58 years) randomized into 2 groups: the segmental stabilization group (n = 15), who received stabilization exercises on the transversus abdominis (TrA) and lumbar multifidus muscles; and the TENS group (n = 14), who received electrotherapy. Groups underwent 16 sessions, for 60 minutes, twice per week, and they were evaluated before and after intervention. Pain was measured using a visual analog scale, functional disability using the Oswestry Disability Index, muscle activation and fatigue with electromyography, and patients' ability to contract the TrA with a pressure biofeedback unit. Analyses within and between groups were performed.

Results: The stabilization group improved lumbar multifidus fatigue (median frequency [MF] initial [$P = .002$], MF final [$P < .001$], MF slope [$P = .001$], and resistance time [$P < .001$]), ability to contract the TrA ($P < .001$), pain ($P < .001$), and functional disability ($P < .001$). TENS only was effective for pain ($P = .012$).

Conclusion: Although it relieved pain, TENS was not effective as a single treatment to prevent fatigue, increase TrA contraction, and reduce functional disability in herniated disk patients. Stabilization exercises alone improved all measured outcomes. (J Manipulative Physiol Ther 2018;41:323-331)

Key Indexing Terms: *Muscle Fatigue; Abdominal Muscles; Transcutaneous Electrical Nerve Stimulation; Intervertebral Disk Displacement*

Introduction

Disk herniation can be defined as displacement of disk material beyond the margins of the intervertebral disk space.[1] It is considered the most frequent cause of lumbosacral radiculopathy.[2] Lumbar disk herniation (LDH) affects about 39% of chronic low back pain (cLBP) patients.[3] Lumbar stabilization treatment has recently been shown to be effective in treating cLBP.[4-6] This method focuses on retraining the deep muscles of the trunk and abdomen, lumbar multifidus (LM), and transversus abdominis (TrA), responsible for the stability and control of the spinal segment.[4,7] Studies show that these muscles are preferentially affected in cLBP, in the form of atrophy or decrease in activation speed.[8,9] Surface electromyography (sEMG) has been used to study fatigued LM muscles during sustained activities of the spine in

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participants with LDH, because they present less resistance in muscles to perform isometric contractions.[10,11]

Studies about the activity of the deep trunk muscles, particularly the TrA, have used needle electromyography (EMG).[12,13] This kind of analysis is invasive, painful, and carries risk of infection. Therefore, an alternative was developed to analyze the TrA muscle through a pressure biofeedback unit (PBU).[14] Some studies report that patients with cLBP have difficulty depressing the abdominal wall, which is associated with a weakening TrA muscle.[14,15]

In recent clinical trials on patients with lumbar disk degeneration, a reduction in pain intensity and improvement in functional disability was observed after 10 sessions of transcutaneous electrical nerve stimulation (TENS) alone in 1 trial and a combination of TENS with interferential current in another.[16,17] However, the benefit of TENS in reducing muscular fatigue is conflicting in literature, because there is evidence that this type of therapy stimulates a change in the biochemical and physiological muscular conditions, which leads to muscle relaxation.[18] No study was found to determine conclusively the effect TENS has on muscles with cumulative fatigue LDH patients.

The aim of the present study was to compare TENS and stabilization exercises for preventing fatigue and improving muscle activation capacity in patients with LDH associated with cLBP. It was hypothesized that due to its electrical and chemical effects on tissue, TENS may assist the healing process by returning damaged muscle tissues to a normal state, which would result in pain reduction and, consequently, prevention of muscle fatigue and improvement in other outcomes. It was further hypothesized that these beneficial effects may also be demonstrated in patients that underwent stabilization exercises.

Methods

Trial Design

The study was a randomized, controlled, assessment-blind study comparing 2 parallel groups. This study was approved by the Ethics Committee of the University Hospital (Protocol 1014-10) and the School of Medicine (Protocol 081-10), University of São Paulo, Brazil. All participants gave their informed consent before participation, and the trial was prospectively registered through Clinical Trial Registry (ID: NCT01640431).

Participants

Assessments were performed by a researcher who was not involved in the recruitment of the participants, using balanced randomization (1:1) with Microsoft Excel for Windows 10 edition (Windows, Redmond, Washington). Participants were allocated in 1 of the 2 groups secretly by a random number sequence, using sealed, opaque envelopes, containing a letter stating to which group the patient belonged. The sample was selected from a list of patients of the Department of Orthopedics of University Hospital at University of São Paulo. Patients with LDH associated with low back pain and diagnosed by magnetic resonance imaging or computed tomography were included. Participants diagnosed only radiologically or with myelography were not eligible to participate in the study because these techniques do not directly visualize disk herniation.[1] We included patients with disk herniation associated with cLBP (pain for more than 3 months) and disk protrusion or herniation diagnosed by magnetic resonance imaging or computed tomography. The exclusion criteria included previous lumbar surgery; carcinoma; rheumatologic diseases; patients involved in sports or load training for the spine over the 3 months prior to beginning treatment; or other causes of back pain, spinal stenosis, or lumbar spondylolisthesis. In addition, to avoid bias and interference in the present results, patients who received prior treatment (ie, manual therapy, traction, therapeutic exercise, biofeedback, cognitive behavioral therapy, etc) were excluded from the study.

Twenty-nine participants were randomized into 1 of 2 groups: the segmental stabilization (SS) group performed exercises for TrA and LM muscles (n = 15), and the TENS group received electrotherapy (n = 14).

Interventions

Interventions were conducted over 8 weeks, twice per week, with each session lasting 60 minutes. The sessions were supervised by the investigator, and the participants were instructed to report any adverse event, whether or not it was related to exercises or electrotherapy. Participants were instructed not to participate in any other physical training program during the study. In the SS group, exercises focused on the TrA and LM muscles. Transcutaneous electrical nerve stimulation current was used in the TENS group for 60 minutes, with a frequency of 20 Hz[17] (Fig 1).

Outcomes Measurements

Participants were assessed for fatigue of LM, TrA activation capacity, severity of pain, and functional disability at baseline and at the end of treatment by an investigator (physical therapist) blinded to the randomization.

LM Muscular Fatigue. Electromyography of the LM was conducted using equipment (EMG System of Brazil, São José dos Campos, Brazil), which consists of an 8-channel analogic-digital converter with 16-bit resolution and an input ranging from -12 to +12 volts. Each channel is coupled to 2 active bipolar circular electrodes (Medi-Trace Ag/AgCl) with a 10-mm diameter. They were placed in pairs, separated by 2 cm. The reference electrode was positioned on the spinous process of C7, according to the recommendations of Surface EMG for Non-Invasive Assessment of Muscles.[19]