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The effect of lumbar stabilization and stretching exercises on pain, disability, and characteristics of the lumbar paraspinal muscles in chronic nonspecific low back pain: a randomized controlled trial

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Abstract

Background: Chronic nonspecific low back pain (CNSLBP) is a challenging clinical condition with a lack of specific therapies. It is closely related to impaired lumbar stability, which is associated with paraspinal muscle dysfunction. This study is designed to investigate the effect of lumbar stabilization and stretching exercises (LSSE) on pain, disability, and characteristics of lumbar paraspinal muscles in CNSLBP.

Methods: Eligible patients with CNSLBP were randomly allocated (1:1) to one of two groups. The control group (CON) received health education only. The intervention group (EX) received both LSSE and health education. The intervention period lasted for one month for both groups. The primary outcome was visual analog scale (VAS) score for pain intensity. Secondary outcomes included the Oswestry Disability Index (ODI) and characteristics of paraspinal muscles. Muscle stiffness (elasticity) and the cross-sectional area (CSA) of the multifidus at the lower lumbar spine were assessed using musculoskeletal ultrasound. Additionally, magnetic resonance imaging (MRI) was used to evaluate the CSA and fatty infiltration (quantified by gray-scale value) of the multifidus and erector spinae muscles at the lower lumbar spine. All assessments were conducted at baseline and immediately after the 1 month intervention.

Results: This trial enrolled 60 CNSLBP patients. Fifty-four participants completed the study, with identical dropout rates of 10% (3/30). There were no significant differences in age, gender, BMI, waist, duration between the two groups (All $P > 0.05$). After 1 month intervention, the Mann-Whitney U test revealed significantly greater improvement in both VAS and ODI scores in the EX group than in the CON group (All $P < 0.05$). And we performed paired-sample t-tests to evaluate the within-group differences in MRI outcomes. The results in the EX group showed significant CSA increases of multifidus at bilateral L4/L5 (left side: $P = 0.002$, Cohen's $d = 0.291\text{cm}^2$, 95% Confidence Interval (CI) - 0.245, 0.827, right side: $P = 0.001$, Cohen's $d = 0.326\text{cm}^2$, 95% CI - 0.211, 0.863) and L5/S1 (left side: $P = 0.001$, Cohen's $d = 0.427\text{cm}^2$, 95% CI - 0.112, 0.966, right side: $P < 0.001$, Cohen's $d = 0.459\text{cm}^2$, 95% CI - 0.081, 0.999), along with reduced grayscale values at bilateral L5/S1 level (left side: $P = 0.003$, Cohen's $d = -0.705$, 95% CI - 1.255, -0.155; right side: $P = 0.002$, Cohen's $d = -0.778$, 95% CI - 1.331, -0.225), indicating decreased fatty infiltration. Similarly, the erector spinae in the EX group showed a significant increase CSA increased at the bilateral L4/5 level (left side: $P < 0.05$, Cohen's $d = 0.34\text{cm}^2$, 95% CI - 0.202, 0.872; right side: $P < 0.05$, Cohen's $d = 0.33\text{cm}^2$, 95% CI - 0.211, 0.863) and L5/S1 level (left side: $P < 0.05$, Cohen's $d = 0.26\text{cm}^2$, 95% CI - 0.272, 0.8; right side: $P < 0.05$, Cohen's $d = 0.38\text{cm}^2$, 95% CI - 0.163, 0.913), while the gray-scale values decreased at the bilateral L5/S1 level (left side: $P < 0.05$, Cohen's $d = -0.51$, 95% CI - 1.052, 0.032; right side: $P < 0.05$, Cohen's $d = -0.42$, 95% CI - 0.957, 0.121). And the independent samples t-test revealed a significant between-group differences for the lumbar multifidus at right L5/S1 level ($P <$

0.05, Cohen's $d = 0.676\text{cm}^2$, 95% CI 0.128, 1.224). No other outcome measures showed statistically significant differences between two groups.

Conclusion: LSSE significantly reduced pain and improved function in patients with CNSLBP. The significant between-group increase in the CSA of the right L5/S1 multifidus suggests that muscle hypertrophy at lower lumbar levels may be one mechanism for these clinical benefits.

Trial registration: The trial was registered at www.chictr.org.cn, identifier ChiCTR2300068836.

Keywords: Chronic nonspecific low back pain; Erector spinae; Exercise; Multifidus; Musculoskeletal ultrasound; Randomized controlled trial.

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