# CORE TRAINING UNDER SUSPENSION EXERCISE THERAPY ON TREATMENT OF LOW BACK PAIN

*TREINAMENTO DE CORE COM TERAPIA DE EXERCÍCIOS DE SUSPENSÃO PARA A DOR LOMBAR*

*ENTRENAMIENTO DEL CORE CON TERAPIA DE EJERCICIOS EN SUSPENSIÓN PARA EL DOLOR LUMBAR*

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## ABSTRACT

Introduction: The main clinical feature of chronic nonspecific low back pain (CNLBP) is lower back pain, and suspension sports therapy has a specific effect in this case. Objective: To investigate the changes of flexion-relaxation phenomenon in patients with lower back pain after core control training of suspension exercise therapy (SET). Methods: 84 subjects who met the inclusion and exclusion criteria of chronic low back pain in this experiment were randomly divided into an experimental group and a control group. The experimental group was treated with suspension training. The control group only received acupuncture. We then determined the muscle fascia tension and core stability of the lower lumbar region. Results: The visual analog scale (VAS) and Oswestry dysfunction index (ODI) evaluations of the two groups of patients were different. Conclusion: Suspended core stabilization training has a significant long-term effect in reducing lower back pain and improving waist function in patients with chronic nonspecific low back pain. ***Level of evidence II; Therapeutic studies - investigation of treatment results.***

**Keywords:** Back pain; Sports; Hindlimb suspension.

## *RESUMO*

*Introdução: A característica clínica principal da dor lombar crônica não especifica (CNLBP) é dor na região lombar. A terapia esportiva por suspensão tem um efeito específico neste caso. Objetivo: Investigar as mudanças do fenômeno flexão- relaxamento em pacientes com dor lombar após treinamento de controle core com terapia de exercícios de suspensão (SET). Métodos: 84 indivíduos que preencheram os critérios de inclusão e exclusão para dor lombar crônica neste experimento foram aleatoriamente divididos em um grupo experimental e um grupo de controle. O grupo experimental foi tratado com treinamento de suspensão. O grupo de controle recebeu apenas acupuntura. Determinamos então a tensão da fáscia muscular e a estabilidade core da região lombar. Resultados: Avaliações da escala visual analógica (EVA) e do índice de incapacidade Owestry (ODI) dos dois grupos de pacientes tiveram resultados diferentes. Conclusão: O treinamento de estabilização do core por suspensão tem efeito de longo prazo considerável na redução de dor lombar e a recuperação da função da cintura em pacientes com dor lombar não especifica crônica.* ***Nível de evidência II; Estudos terapêuticos – investigação de resultados de tratamento.***

***Descritores:*** *Dor nas costas; Esportes; Elevação dos Membros Posteriores.*

## RESUMEN

*Introducción: La característica clínica principal del dolor lumbar crónico inespecífico (CNLBP) es dolor en la región lumbar. La terapia deportiva en suspensión tiene un efecto específico en este caso. Objetivo: Investigar los cambios del fenómeno flexión-relajamiento en pacientes con dolor lumbar tras el entrenamiento de control de core con terapia de ejercicios en suspensión (SET). Métodos: Se dividió aleatoriamente los 84 individuos que rellenaron los criterios de inclusión y exclusión para dolor lumbar crónico en este experimento en un grupo experimental y un grupo de control. El grupo experimental fue tratado con entrenamiento en suspensión. El grupo de control recibió apenas acupuntura. Determinamos, entonces, la tensión de la fascia muscular y la estabilidad core de la región lumbar. Resultados: Evaluaciones de escala visual analógica (EVA) y del índice de discapacidad Owestry (ODI) de los dos grupos tuvieron resultados diferentes. Conclusión: El entrenamiento de estabilización del core por suspensión tiene efecto de largo plazo considerable en la reducción de dolor lumbar y la recuperación de la función de la cintura en pacientes con dolor lumbar inespecífico crónico.* ***Nivel de evidencia II; Estudios terapéuticos – investigación de resultados de tratamiento.***

***Descriptores:*** *Dolor en la espalda; Deportes; Suspension des membres postérieurs.*



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## INTRODUCTION

The main clinical features of chronic nonspecific low back pain (CNLBP) are waist pain, waist muscle tension or sensation, and pain for more than 3 months. The current incidence of CNLBP is as high as 85%. The patient's clinical symptoms may disappear after symptomatic treatment of acute low back pain, but the function of the core muscles has not been fully restored.[1] Certain inducements can induce it. In this study, a suspension system was used to train the core muscles combined with acupuncture to treat CNLBP. We evaluated the clinical efficacy by visual analog scale (VAS) and Oswestry dysfunction index (ODI).

## METHOD

### General information

We selected 84 inpatients in the Department of Rehabilitation Medicine of our hospital from February 2017 to February 2018. They all meet the diagnostic criteria for CN-LBP of the American Physical Therapy Association. Inclusion criteria: 1) Pain and discomfort in the lumbosacral buttocks, lasting 3 to 24 months. 2) Age 18~60 years old. 3) There is no obvious abnormality in imaging examination. 4) Sign the informed consent form. Exclusion criteria: 1) Have nerve root irritation symptoms. 2) Complicated with pathological changes of the lumbar spine (fracture, lumbar disc herniation, infection, tumor, etc.).[2] (Table 1)

### Method

The control group received only acupuncture treatment, and the observation group was given suspension exercise training based on acupuncture.

### Acupuncture treatment

1) The patient chooses a conventional position. After the acupoints are disinfected, we use acupuncture needles with a diameter of 0.25mm and 40mm to directly puncture the bilateral L1-5 Jiaji points, Sanjiaoshu, Shenshu, Qihaishu, Dachangshu, Guanyuanshu, and Weizhong. Sanjiaoyu and Guan Yuanyu on the same side are a set of electrodes for electrical stimulation. 2) The patient chooses a conventional position. After the acupoints are disinfected, the acupuncture needles directly puncture Tianshu (double), Blindshu (double), Guanyuan, Qihai, and waterway (double). Bilateral Tianshu is a set of electrodes for electrical stimulation. Once a day, keep the needle for 30 minutes, 6 times a week.

### Suspension training

We use suspension exercise training (SET) equipment to perform painless weight-bearing training on the distal limbs of patients under unstable conditions. Before training, perform a weak chain test and observe the patient's lumbar spine core muscles.[3] At the same time, we determine the difference in the strength of the lumbar spine's left and right flexor groups to formulate a corresponding treatment plan.

During training, we take the form of load isometric contraction to combine closed-chain and open-chain exercises. We increase the training load by reducing the elastic rope, increasing the auxiliary movement, increasing the asymmetry, or increasing the instability of the fulcrum (air cushion). Each group of exercises is maintained for about 30s. Each group is repeated 4 to 5 times, with a rest between 30 to 60 seconds.[4] We mainly train multifidus, hamstrings, quadratus lumborum, gluteus maximus, gluteus medius, erector spinae, internal and external obliques, rectus abdominis, iliac ribs, and transverse abdominis. Before training, we performed a relaxing massage on the waist and abdomen muscles of the patient for 5 minutes and then carried out suspension exercise training. The specific training actions are as follows (one side as an example).

1. Raise the pelvis in the supine position: the patient lies in the supine position. We put the narrow sling on the right popliteal and the wide sling on the pelvis.

**Table 1.** Comparison of general information between the two groups.

| Group | n | male | Female | Age(year old) | The course of disease (months) |
|---|---|---|---|---|---|
| Control group | 42 | 24 | 18 | 41.45±10.23 | 11.25±5.53 |
| Observation group | 42 | 23 | 19 | 42.63±9.60 | 11.20±5.61 |
| $\chi$2/t value | | 0.048 | | 0.716 | -0.53 |
| P value | | 0.5 | | 0.478 | 0.599 |

Action essentials: Straighten the right knee joint, raise the left lower limb, and be parallel to the right lower limb. Elevate the pelvis to straighten the body by pressing the suspension belt down on the right lower limb. Mainly train the core muscles of the rear kinematic chain.

2. Raise the pelvis in the lateral position: the patient is in the lateral position. The sling is placed on the middle of the right calf and the pelvis. Action essentials: maintain the waist in a neutral position, raise 5cm, raise the left lower limb, and be parallel to the right lower limb. Elevate the pelvis to straighten the body by pressing the suspension belt down on the right lower limb. Mainly train the core muscles of the side sports chain.

3. Bypass in the prone position: the patient is in the prone position. After the forearm is supported, we put an air cushion under the abdomen to avoid excessive lordosis of the lumbar spine, and the narrow sling is placed at the left knee joint.

Action essentials: Raise the right lower extremity and parallel to the left lower extremity. Keep your body in a straight position by pressing down on the sling with your left lower limb. Mainly train the core muscles of the front kinematic chain.

### Observation indicators

We use VAS to assess the patient's pain level and ODI to assess the patient's quality of life. The patients were evaluated before treatment, at 1 month and 3 months follow-up. We use a unified evaluation form.

Suspension exercise training predicts and simulates the safety of lumbar spine force

Assume that $\rho$ represents the initial density of the lumbar muscles.[5] We use the following formula to give the pressure and density of the patient's lumbar spine under different conditions

$$\omega(N)=\frac{\lambda\otimes\rho}{\delta[\eta]}*\varepsilon(H)\times\rho \tag{1}$$

The formula $\varepsilon(H)$ represents the anterior and posterior longitudinal ligaments between the internal energy of the lumbar spine. IV represents the fibers of the degenerated intervertebral disc. $\partial$ represents the volume correction factor. $S_1$, $S_2$, $S_3$ represents the stress value of the uncinate joint and facet joint under the corresponding physiological load.[6]

$$\partial^{n}(\varpi)=\frac{\vartheta(\varepsilon)\times\mu(\hbar)}{[S_1\times S_2\times S_3]}\otimes k(\eta)\times\upsilon \tag{2}$$

$\mu(\hbar)$represents the force of suspension exercise training on the lumbar spine. Which is concentrated in the middle and lower part of the cervical spine, $\iota(p)$ represents the trend of strain in the vertebral body.[7] Then we use the following formula to express the movement difference of the patient's left and right lower limbs and pelvis with an arbitrary shape network

$$\varpi(\eta)=\frac{q(\xi)\otimes\iota(p)}{\hbar(\delta)}\otimes\eta(p)\times p[\gamma] \tag{3}$$

$\eta(p)$ means that the stress is more tremendous on the compression side. The compressive stress is the displacement state of the stress to the central area during lateral flexion. The smooth function is represented by $w_{ij}$. Then we use the following formula to calculate the stress distribution caused by the impact load of the lumbar spine under different stages of suspension exercise training

$$h_i^{n+1}(R,h)=\frac{w_{ij}\times\varpi(\eta)\times p[\gamma]}{W(R,h)} \tag{4}$$

$p[\gamma]$ represents the unbalanced state of different lumbar spine forces during the suspension exercise training stage. $T_Q$ represents the different states of scoliosis. We use the following formula to calculate the displacement trend of each element of the pelvis under stress

$$P(\eta) = \frac{\Psi \times T_Q}{k(\Delta)} * \rho(o) \times h_i^{n+1}(R,h) \quad (5)$$

Based on the formula (5), a finite element model of the force exerted on the lumbar spine can be constructed.

### Statistical analysis

All data were analyzed using SPSS19.0 statistical software. The enumeration data used the χ2 test. When the data are normally distributed, and the variances are homogeneous, the t-test is used, and when the variances are not homogeneous, the corrected t-test is used. Significance level α=0.05.

## RESULTS

### VAS

There was no significant difference in VAS scores between the two groups before treatment (P>0.05). (Table 2)

### ODI

There was no significant difference in ODI scores between the two groups before treatment (P>0.05). (Table 3)

**Table 2.** Comparison of VAS scores between the two groups before and after treatment.

| Group | Control group | Observation group | t value | P value |
|---|---|---|---|---|
| n | 42 | 42 | | |
| Before treatment | 7.02±1.07 | 7.19±1.58 | 1.638 | 0.109 |
| Treatment for 1 month | 2.02±0.84 | 1.10±0.79 | -7.182 | <0.001 |
| 3 months follow-up | 2.33±0.93 | 1.02±0.75 | | |
| t value | -18.484 | -29.479 | | |
| P value | <0.001 | <0.001 | | |
| t value | 3.87 | 1.138 | | |
| P value | <0.001 | 0.262 | | |

**Table 3.** Comparison of ODI scores between the two groups before and after treatment.

| Group | Control group | Observation group | t | P |
|---|---|---|---|---|
| n | 42 | 42 | | |
| Before treatment | 22.57±4.33 | 21.81±4.16 | -1.2 | 0.237 |
| Treatment for 1 month | 10.21±2.24 | 9.29±2.08 | -3.535 | 0.001 |
| 3 months follow-up | 11.05±2.30 | 8.95±1.70 | | |
| t | -15.753 | -18.278 | | |
| P | <0.001 | <0.001 | | |
| t | 2.219 | -1.738 | | |
| P | 0.039 | 0.09 | | |

## DISCUSSION

Panjabi first proposed the concept of core stability. It refers to the stable control of the muscles of the pelvis and trunk during exercise. Under normal circumstances, before the movement that affects the spine's stability occurs, the local stabilizing muscles of the core muscle group will contract in advance to enhance the stability of the spine. After acute low back pain, local stabilizer muscle function is inhibited, and core muscle group recruitment is lacking. It manifests as insufficient core stability. If the local stabilizing muscles are not dysfunctional for a long time, the stability of the spinal segments will be reduced. This leads to waist injuries, degeneration of intervertebral discs, and decreased muscle function, leading to chronic low back pain. Therefore, chronic low back pain can be considered as long-term instability of the lumbar structure and the gradual loss of spine stability. It cannot bear the load on the lumbar spine. The clinical manifestations are mainly pain. Therefore, the treatment of CNLBP should first treat local stable muscle dysfunction. In this way, the stability of the spine segments is restored.

The core area in the process of human motion is the center of human motion. Its stability directly affects the movement function of the limbs. The regular contraction of the core muscle group can establish a fulcrum for the limb muscles and effectively transfer sports energy. Core muscle training is a relatively novel technique for treating chronic low back pain. It includes muscle strength training in the traditional sense, and Core stability training can improve the endurance and balance of the lower back muscles. It can promote the input of proprioceptive stimulation at the waist, activate more deep muscle groups, and strengthen the active and neural control subunits involved in maintaining the spine's stability. This can reduce the stimulation of pain receptors in the tissues, reduce inflammatory substances and relieve pain. In this study, the SET suspension device was used as the treatment platform. This training can highlight the comprehensive training of motor sensation and emphasize the instability of the training state. This training exercises important core muscle groups such as multifidus, transversus abdominis, and gluteus medius by continuously increasing the load in the open-chain and closed-chain exercise modes. While promoting blood circulation strengthens sensorimotor muscle stimulation and relieves the tension and spasm of superficial motor muscles so that that movement can be controlled typically. Studies have shown that strength training under unstable conditions can stimulate neuromuscular coordination between the trunk muscles and the body's major muscle groups.

Acupuncture can excite various receptors in the deep. Acupuncture can increase the content of central serotonin, acetylcholine, and other neurotransmitters and blood morphine substances to inhibit pain. Acupuncture can also transmit information to the brain area to produce a central analgesic effect. Electro-acupuncture at acupoints on the lower back can improve local blood circulation, promote the dissipation of inflammatory and pain-causing chemicals, and inhibit the pain center. It can increase the body's pain threshold and enhance the body's immunity to reduce pain.

## CONCLUSION

In this study, a randomized controlled study was used to compare the clinical efficacy of suspension exercise training combined with acupuncture and acupuncture alone in the treatment of CNLBP. The results showed that both treatments have clinical effects. But the former treatment effect is more pronounced. But the efficacy of the patients in the control group was reduced. This suggests that the long-term effect of suspension exercise training combined with acupuncture is more pronounced. Therefore, suspension exercise training combined with acupuncture can better improve the function of the local stable muscles of the core muscles. This can reduce the clinical symptoms of CNLBP. It also has a significant long-term effect.

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All authors declare no potential conflict of interest related to this article

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## ERRATUM

In the article entitled "CORE TRAINING UNDER SUSPENSION EXERCISE THERAPY ON TREATMENT OF LOW BACK PAIN" authored by Lei Ye, published in Rev Bras Med Esporte [online] 2021, vol.27, n.7. DOI: https https://doi.org/10.1590/1517-8692202127072021_0336, page 697, by request of the author.

- Where it reads: The study was partly supported by the grant III47015 of the Research Council of the Republic of Serbia.

- Read: The research investigators thank all The participants for their engagement in this study.