

# Clinical research on lumbar oblique-pulling manipulation in combination with sling exercise therapy for patients with chronic nonspecific low back pain

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## SUMMARY

**OBJECTIVE:** To investigate clinical curative effects of lumbar oblique-pulling manipulation in combination with sling-exercise-therapy training on chronic nonspecific lower back pain.

**METHODS:** A total of 60 patients with chronic nonspecific lower back pain in the Outpatient Department were included in this study. These patients were randomly divided into two groups: the observation group and the control group. The control group adopted a single sling-exercise-therapy training three times a week, while the observation group adopted lumbar oblique-pulling manipulation in combination with manipulation treatment once a week. The course of treatment lasted for four weeks.

**RESULTS:** (1) Before and after treatment, the ODI score was compared within the group. A remarkable statistical significance was observed from the third day ( $P < 0.05$ ). At the third month of follow-up, the difference in ODI scores between these two groups was statistically significant ( $P < 0.05$ ). (2) Before and after treatment, it was observed that differences in VAS scores from the third day were statistically significant ( $P < 0.05$ ). (3) The difference in muscle strength between these two groups had remarkable statistical significance in the third month of follow-up ( $P < 0.05$ ).

**CONCLUSION:** The effective rehabilitation function of lumbar oblique-pulling manipulation in combination with sling-exercise-therapy training in patients with CNLBP is superior to that of sling-exercise-therapy training alone.

**KEYWORDS:** Back pain. Low Back Pain. Exercise Therapy/methods. Back Muscles.

## INTRODUCTION

Low back pain is classified into three categories, according to existing clinical guidelines: specific spinal marrow pathological lower back pain, nerve root lower back pain, and non-specific lower back pain. Recognizable pathological lower back pain (e.g., infection, tumor, osteoporosis, bone fracture, and deformation), nerve root pain, and cauda equina syndrome are not within the scope of non-specific lower

back pain. Chronic nonspecific low back pain (CNLBP) refers to pain or discomfort that continuously persists for  $\geq 12$  weeks in the area between the inferior margin of the 12<sup>th</sup> costal arch and hip horizontal grain, which is accompanied or not by relevant low back pain symptoms<sup>1</sup>. Its population mainly includes middle-aged and elderly people over 40 years old, and 11-12% of patients with low back pain present

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disordered functional activities. The incidence rate of CNLBP accounts for over 85% of low back pain, which severely affects the quality of life and working and labor abilities of these patients.

There are various CNLBP rehabilitation therapies, but rehabilitation methods with evidence based on medical science remain limited<sup>2,3</sup>. As one of the exercise therapies, sling-exercise-therapy (SET) is a new and modern rehabilitation method that enhances core muscles. The efficacy of this method has been verified through clinical practice and has been widely applied at home<sup>4</sup>. SET<sup>5</sup> improves the balance and control ability of the body under an unstable status by enhancing trunk muscles and the exercise ability of the unilateral limbs.

As one of the complementary and alternative therapies, lumbar manipulation (LM) is a conventional therapy, with lumbar oblique-pulling manipulation as a representative. Determining how to improve rehabilitation efficacy has been a critical problem in traditional Chinese medicine (TCM) and Western medicine rehabilitation studies on CNLBP.

## MATERIALS AND METHODS

### General Data

Sixty patients with CNLBP in the department from March 2014 to October 2014 were included in this study. These patients were randomly divided into two groups ( $n=30$ , each group): observation and control. (1) Observation group: This group was comprised of 19 male and 11 female patients, with an average age of  $(30.45 \pm 5.55)$  years old. The course of treatment lasted for  $(11 \pm 3.5)$  months. (2) Control group: This group was comprised of 17 male and 13 female patients, with an average age of  $(32.01 \pm 4.59)$  years old. The course of treatment lasted for  $(12 \pm 2.1)$  months. Differences in general data between these two groups were not statistically significant.

## METHODS

The observation group adopted lumbar oblique-pulling manipulation in combination with SET, while the control group adopted single SET. Basic actions for the training: (1) Bilateral training in the spinal position: Inelastic slings were used to hang both legs, and elastic slings were added at the waist and pelvis for assistance, when appropriate. Patients were advised to tighten the abdomen and contract

the anus, elevate the pelvis and maintain the posture, or repeat the actions. (2) Unilateral intensive training in the spinal position: Elastic and inelastic slings were used to hang both lower limbs, respectively; and elastic slings were added at the waist and pelvis for assistance, when appropriate. Patients were advised to make the above actions. (3) Training in the spinal position: Inelastic slings were used to hang both legs, and elastic slings were added at the waist and pelvis for assistance, when appropriate. With the upper arms propped up on the bed, and patients were advised to tighten the abdomen and contract the anus, elevate the pelvis and trunk and maintain the posture, or make curling-up actions. Sling-exercise-therapy training was carried out every other day for 20 minutes, three times a week.

The observation group adopted SET and received lumbar oblique-pulling manipulation.

*Lumbar oblique-pulling manipulation (Standardized manipulation specified in "the 11<sup>th</sup> Five-Year Plan" support plan project of the Ministry of Science and Technology)*

(1) Relaxation manipulation: Massage, roll or push pain points in the lumbar and surrounding regions for 5-15 minutes to fully relax the spastic muscles.

(2) Pulling technique: In the lateral position, the patient bends the hip and knees of the lower limb upwards, and naturally extends the lower limb downwards. The physician stands by the bedside to support the patient's front shoulder by one elbow or hand and support the hip by the other elbow or hand. Either elbows or hands were used to apply force in opposite directions, in order to turn around the waist until obvious resistance was identified. With a stable touch, a sudden and large-scale pulling motion was applied, and "Kata" sounds were heard, as shown in Figure 1.

After successfully performing this technique, the



**FIGURE 1.** LUMBAR SPINE INCLINED, PULL TECHNIQUE

same method was conducted for the opposite side. Lumbar oblique-pulling manipulation was performed every week for 20 minutes.

The observation group adopted SET every other day for 20 minutes, three times a week. During the first treatment of the week, SET was performed, and lumbar oblique-pulling manipulation was carried out. The course of treatment lasted four weeks.

### Diagnostic criteria

Currently, there are no consistent diagnostic criteria for CNLBP. According to existing international guidelines and local literature, the main diagnostic criteria remain as follows: medical history, physical examination, and necessary auxiliary imaging examination.

(1) Main symptoms include pain and discomfort that continuously persists for  $\geq 3$  months in the low back, lumbosacral portion and hip. No pain or numbness discomfort was observed in the lateral or bilateral lower extremities (below the knee joints), and no intermittent claudication was observed.

(2) Physical examination indicates that sensorimotor function in both lower extremities was normal, and the straight-leg-raising test was negative.

(3) X-ray examination of the lumbar vertebrae indicated that the sequence of the vertebral body was normal. No significant abnormalities were observed in the lumbar spinal vertebrae and sclerotin of the annexes. No significant abnormalities were identified in the shape and width of all intervertebral spaces. No remarkable abnormalities were found in the size and shape of each intervertebral foramen. Spinal fracture, deformation, osteoporosis, as well as spondylolysis, were excluded.

(4) Computed tomography (CT) did not indicate any significant abnormality in the intervertebral discs, and no obvious oppression was found in the nerve roots.

(5) Magnetic resonance imaging (MRI) did not reveal any significant abnormality in the paravertebral soft tissues, no stenosis was found in the spinal canal, and no abnormalities were identified in signals of the spinal canal and bone marrow. Spinal tumors and protrusion of the intervertebral disc were excluded.

### Inclusion criteria

- (1) Conforms to the diagnostic criteria above;
- (2) Patients aged 18-65 years old;

(3) The course of treatment is  $>3$  months (including the three months);

(4) If patients received other manipulation or rehabilitation therapies, they would go through a washout period of  $>5$  days.

### Exclusion criteria

(1) Imaging examination indicating significant abnormalities including compression fracture of the lumbar vertebra, lumbar disc herniation, lumbar spinal stenosis, lumbar spondylolisthesis, spinal tumor, infection, and tuberculosis.

(2) Patients suspected of spinal injuries in addition to spinal cord injury.

(3) Patients with severe cardiac, pulmonary, cerebral, and blood system diseases, as well as diabetes mellitus, ankylosing spondylitis, rheumatoid arthritis, and severe osteoporosis.

(4) Patients with severe skin injuries or skin disease in the treatment areas.

(5) Patients who received lumbar surgery and patients with lumbar deformation.

1.4 Assessment criteria (1) The degree of low back pain was evaluated according to the Visual Analogue Scale (VAS) researched and formulated by The National Institutes of Health Clinical Center: a score of 0 represents no pain, and a score of 10 expresses the most severe pain. (2) The internationally recognized and improved Oswestry Disability Index (ODI) was adopted for the evaluation; it includes 10 items of different function evaluations. A 6-grade scoring method was used for scoring (0-5). A score of 0 represents no functional disorders, and a score of 5 indicates significant functional disorders. The scores of these 10 items were added up, and the percentage of the sum of the highest scores of the 10 items (50 score) was the ODI of the functional disorders. The higher the score, the more severely the patients suffered from these functional disorders. (3) The linear constant-speed training system for the abdomen and back (Taiwan) was used to measure the maximum muscle strength value of the low back muscle (unit: kg).

### Statistical Method

SPSS 16.0 was used for the statistical analysis of the data, and descriptive analysis was adopted for gender, age and the course of treatment. Measurement data were expressed as the mean ( $\bar{x} \pm SD$ ). The t-test was performed for obeyed normal distribution, and the rank-sum test was used for non-normal dis-

tribution. The correlation test adopted a bivariate correlation analysis. If two variables had measurement data and conformed to the normal distribution, Pearson's rank correlation coefficient was used for the description. Measurement data and ranked data that could not conform to the normal distribution were described using Spearman's and Kendall's rank correlation coefficient.

## RESULTS

1. According to the comparison of ODI scores before and after the treatment, through paired *t*-test, significant statistical differences were observed from the third day between the two groups, compared with that before treatment ( $P<0.05$ ). At the third month of follow-up, the difference in ODI scores between the two groups was statistically significant ( $P<0.05$ ); and the observation group was found to be superior to the control group.

2. According to the comparison of ODI scores before and after the treatment, through paired *t*-test, significant statistical differences were observed from the third day between the two groups, compared with that before treatment ( $P<0.05$ ). Differences in VAS scores between the two groups were statistically significant at all times ( $P>0.05$ ), but the improved value in the observation group was superior to that in the control group from the second week (Table 1).

3. According to the comparison of muscle strength value before and after treatment, through paired *t*-test, significant statistical differences were

observed from the third day between the two groups, compared with that before treatment ( $P<0.05$ ). Differences in muscle strength value between the two groups were statistically significant ( $P<0.05$ ). The value of the observation group was superior to the control group (Table 2).

## DISCUSSION

Low back pain refers to a syndrome of pain and discomfort in the lower back, lumbosacral portion, and hip; these are the main symptoms. According to statistical analysis, approximately 7-11% of patients with lower back pain can be converted into non-specific low back pain, which often lasts for more than 12 weeks<sup>12</sup>. At present, CNLBP has often been used as one of the exclusion diagnoses in clinical practice and refers to lower back pain caused by unknown causes, other than lumbar disc herniation, fracture of the lumbar vertebra, lumbar spondylolisthesis, tumors, and organic diseases such as fracture, osteoporosis, ankylosing spondylitis, root inflammation, or cauda equina syndrome<sup>3</sup>. Hence, it differs from specific lower back pain. Specific pain areas are not affirmed, and the pathogenesis cannot be clearly obtained through objective examination methods. In recent years, various studies have indicated that disorders of the transverse abdominal muscle and multifidus muscle function are closely correlated with CNLBP<sup>4</sup>. Recently, more local and foreign scholars have continuously conducted further studies on CN-

**TABLE 1** COMPARISON OF THE VAS SCORE BETWEEN THE TWO GROUPS

Follow-up time	Group	N	missing	±SD	Z	P
Second week	Observation group	30	0	2.86±1.36	-1.03	0.310
	Control group	30	0	2.50±1.36		
Third week	Observation group	30	0	4.21±1.92	-0.60	0.551
	Control group	30	0	3.93±1.57		
Fourth week	Observation group	30	1	5.07±1.75	-0.31	0.757
	Control group	30	1	4.93±1.62		

According to the T-test, the difference in VAS score at each time between the two groups was not significant ( $p>0.05$ ), but there was an improvement in the observation group starting from the second week.

**TABLE 2** COMPARISON OF THE MUSCLE STRENGTH VALUE BETWEEN THE TWO GROUPS

Follow-up time	Group	N	missing	±SD	Z	P
First month	Observation group	30	1	16.28±12.92	-0.41	0.685
	Control group	30	1	12.83±5.54		
Third month	Observation group	30	1	19.26±16.00	-2.45	0.014
	Control group	30	1	13.90±5.25		

Via the rank sum test, the difference in muscle strength between the two groups had remarkable statistical significance at the third month of follow-up ( $P<0.05$ ), and the muscle strength value of the observation group was significantly better than the control group.

LBP. Results of various studies have indicated that disorders of the transverse abdominal muscle and multifidus muscle function account for the highest percentage among the causes of CNLBP. Therefore, improving the function of core muscles and enhancing the strength of core muscles have been the key for treatment of CLNBP.

The present situation of treatments: The treatment of CNLBP can be performed through drugs, patient education/behavioral treatment, physical rehabilitation, and exercise treatment. Drug therapies include non-steroid anti-inflammatory drugs, muscle relaxants, antidepressant drugs, and epidural cavity/intervertebral joints steroid drugs. Among these, non-steroidal anti-inflammatory drugs have achieved significant efficacy in relieving pain; but great disputes exist regarding other drugs. The efficacy of basic treatments and painkillers is not significant, and there are few comprehensive rehabilitation regimens pertaining to TCM and Western medicine rehabilitation technologies.

Panjabi proposed the concept of core stability for the first time in 1992 and established the three-subline model for maintaining the stability of the spine: passive subline, active subline, and nerve control subline. Passive subline is composed of the vertebral body, small joints, joint capsules, and ligaments. Active subline is composed of muscles and tendons, which coordinate with the nerve control subline to jointly maintain the stability of the spine. Active subline is composed of the core muscles and muscles around the spine, which include deep and shallow muscles. Deep muscles are local stable muscles that play a major role in maintaining the stability of the spine. Shallow muscles are overall movement muscles and source of the power demands of body movement, thus playing an auxiliary role in maintaining the stability of the spine. Akuthota and Nadler<sup>5</sup> believe that the area from the ribs to the pelvis is the core of the body, and muscles in this area, which are responsible for maintaining the stability of the spine, are called core muscles. The decreased contraction ability of lumbar muscles can lead to decreased stability of the spine, which interacts with low back pain. Transverse abdominal muscles and multifidus muscles are the most important stable muscles of the spine, and patients with chronic low back pain present with the insufficient control of transverse abdominal muscles and delayed contraction<sup>6</sup>. The atrophy degree of the multifidus muscles is positive-

ly correlated with the duration and degree of lower back pain and the degree of function disorders<sup>7</sup>. The study conducted by Eash et al.<sup>8</sup> revealed that intensive muscle strength training of the core muscles can improve spinal stability in patients with lower back pain, and optimize segmental motion control. SET can improve the balance ability and trunk stability of the body by increasing the strength of the core muscles. In the treatment and rehabilitation process of CNLBP in clinical practice, the key is to restore the function of the core muscles, soothe nerve conduction pathways, and increase the stability of the spine; medication alone could not fully meet these clinical demands. Therefore, European guidelines for the management of nonspecific low back pain favor exercise therapy as the first choice. The test conducted by the rehabilitation team under the lead of Professor Chang<sup>4</sup> revealed that exercise therapy technology with sling training as the core can effectively improve the clinical symptoms of patients with CNLBP and decrease its recurrence rate.

Under an unstable environment, SET can be used to determine the weak chain structure of patients through the weak chain test and closed chain training, and enhance muscle strength, in order to improve balance ability and control ability under an unstable status. However, this training under an unstable support status can coordinate multiple proprioceptors in exercise organs at the same time, and continuously repeated muscle training actions can gradually correct the control ability of nerves on the muscles. The normal muscle exercise control mode has been reconstructed to increase the stability of the spine and normalize the control ability of the local trunk stable muscles, and muscle sensation exercises<sup>9</sup>. Long-term SET can gradually restore the flexibility of lumbodorsal muscles, improve the relative position and mechanical relationship between lumbar muscles and bone joints, and the stability of the spine, consequently reducing episodes of lower back pain, prolonging the interval between these episodes, and improving long-term efficacy<sup>10</sup>.

For patients with central nerve injuries, the purpose of SET is to break through the abnormal exercise mode, improve proprioception function, and restore neuromuscular control ability, establishing a normal exercise mode. The improvement of the stability of the trunk and pelvis can maintain standing balance and relax motion muscles, such that a separation movement occurs, and limb function can be



stably implemented. Furthermore, SET can improve the control ability, walking function, and balance function of stroke patients<sup>11,12</sup>.

Puncture is one of the common methods for treating lower back pain. Modern studies have indicated that the mechanism of relieving lower back pain may include the induction of 5-hydroxytryptamine (serotonin) neurons and the suppression of the passing of the thalamus and spinal marrow pain<sup>13</sup>. However, traditional puncture can only relieve lower back pain symptoms for a short period of time, and studies have indicated that even though low back pain symptoms are reduced, the function of stable muscles of the spine could not be restored<sup>14-16</sup>.

The manipulation method can promote blood circulation to remove blood stasis, soothe the vessels, resolve tetany and relieve pain, and lubricate the joints. From the perspective of modern medicine, manipulation can improve blood circulation, relax spastic muscles, remove abnormal stress points of the spine, and reconstruct the mechanical balance of soft tissues. However, manipulation is a passive treatment, and its long-term use would generate dependence and not relieve lower back pain by restoring the internal stability of the spine<sup>17-20</sup>. In clinical practice, physicians have always used manipulation to treat cervical and spinal diseases, and they consider that the “dislocation” of the spine is divided into two categories: the “external force” dislocation caused by overexertion and an excessively large movement range or uncoordinated movement of the spine, which is correlated with the acceleration movement of the spine; and the “internal force” dislocation, in which the degeneration of the intervertebral disc results in movable and static force imbalance between the three support points of the motion segment, and significant changes could be observed in the stress distribution of the intervertebral disc, posterior joints, and ligament. Adaptive changes can be found in the surrounding ligament tissues of the posterior joints, and the adaptive structure of joints and the vertebral body is also changed; for example, the contraction and relaxation of the ligament. Thus, the deep ontology sense organ and non-scabard fine fiber are stimulated, which lead to reflective continuous muscular tension and pain. Therefore, the pathological essence of CNLBP remains as a secondary soft tissue disease.

Sun Shuchun, a successor of the Qingkong Zhenggu School is good in treating tendon inju-

ries. Sun thinks that “bone correction must be performed before the treatment of tendon injury, and tendon regulation must be implemented before bone correction”; hence, “bone correction softens the tendons.” The results of this study show that statistical differences are observed in the scores and efficacy between the observation group and control group, indicating that these two groups achieve significant efficacy in treating CNLBP. Through the comparison of ODI efficacy, VAS scores, and maximum bucking strength between the two groups, lumbar oblique-pulling manipulation, in combination with SET, is significantly superior to SET alone. Lumbar oblique-pulling manipulation can effectively improve the disorders of the anatomical structure of posterior lumbar joints, in combination with the activation of lumbar core muscles by SET, which summarized the idea behind the treatment: “attach equal importance to the tendon and bone” (bone correction by manipulation, tendon regulation through SET), and “correct bones soften the tendons”. Lumbar oblique-pulling manipulation in combination with SET not only treats symptoms of the disease but also re-adjusts the muscle strength balance of the back, preventing recurrence and further improving the quality of life and working ability of patients. This method deserves promotion and application in clinical practice.

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## RESUMO

**OBJETIVO:** Investigar os efeitos curativos da manipulação lombar com o movimento de puxar oblíquo combinado a terapia por exercícios de sling-training para dor lombar baixa crônica não específica.

**METODOLOGIA:** Um total de 60 pacientes com dor lombar baixa crônica não específica no ambulatório foram incluídos neste estudo. Esses pacientes foram divididos aleatoriamente em dois grupos: o grupo de observação e o grupo de controle. O grupo de controle aderiu apenas à terapia por exercícios de sling-training três vezes por semana, enquanto o grupo de observação aderiu à manipulação lombar com o movimento de puxar oblíquo combinado à terapia por exercícios de sling-training uma vez por semana. O tratamento durou quatro semanas.

**RESULTADOS:** (1) Antes e após o tratamento, o escore de ODI foi comparado no grupo. Uma significância estatística notável foi observada a partir do terceiro dia ( $P < 0,05$ ). No terceiro mês de acompanhamento, a diferença nos escores de ODI entre os dois grupos foi estatisticamente significativa ( $P < 0,05$ ). (2) Antes e após o tratamento, observou-se que diferenças nos escores de VAS a partir do terceiro dia foram estatisticamente significantes ( $P < 0,05$ ). (3) A diferença de força muscular entre os dois grupos apresentou significância estatística notável no terceiro mês de acompanhamento ( $p < 0,05$ ).

**CONCLUSÃO:** A função de reabilitação efetiva da manipulação lombar com o movimento de puxar oblíquo combinada à terapia por exercícios de sling-training em pacientes com dor lombar baixa crônica não específica é superior à da terapia por exercícios de sling-training sozinha.

**PALAVRAS-CHAVE:** Dor as costas. Dor lombar. Terapia por exercícios/métodos. Músculos das costas.

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