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Clinical Investigation into the Functional Rehabilitation of Patients with Chronic Low Back Pain Utilizing Core Stability Training Combined with Conventional Rehabilitation

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Abstract [**Objectives**] To investigate the clinical efficacy of core stability training combined with conventional rehabilitation in the functional recovery of patients suffering from chronic low back pain. [**Methods**] A randomized controlled trial design was employed in this study. Ninety patients with chronic low back pain were recruited and randomly assigned to either a control group ($n = 45$), which received conventional rehabilitation, or an experimental group ($n = 45$), which received conventional rehabilitation combined with core stability training. Both groups underwent treatment for 6 weeks. Assessments were conducted using the visual analogue scale (VAS), Oswestry disability index (ODI), and finger-to-floor test prior to treatment, 6 weeks following treatment, and during the follow-up period, respectively. [**Results**] Prior to treatment, no statistically significant differences were observed between the two patient groups in terms of general information and various baseline measurements ($P > 0.05$). Following 6 weeks of treatment and throughout the follow-up period, both groups demonstrated significant improvements in VAS scores, ODI scores, and lumbar anteflexion range of motion compared to baseline measurements ($P < 0.05$). Notably, the magnitude of improvement in the experimental group exceeded that of the control group, with this inter-group difference reaching statistical significance ($P < 0.05$). No serious adverse reactions were reported during the treatment process. [**Conclusions**] Core stability training combined with conventional rehabilitation can significantly enhance the alleviation of pain and functional impairments in patients suffering from chronic low back pain. This approach holds valuable implications for the optimization of rehabilitation treatment protocols.

Key words Chronic low back pain, Core stability training, Functional impairment, Pain

1 Introduction

Chronic low back pain is a prevalent musculoskeletal disorder encountered in clinical practice, primarily manifested by persistent low back pain, restricted mobility, and functional impairment. This condition is notable for its high incidence, prolonged duration, and elevated recurrence rate, all of which significantly diminish patients' quality of life and work capacity[1-2]. With the aging population and evolving lifestyle factors, the incidence of this condition is increasing, emerging as a significant health concern within the field of rehabilitation medicine. Currently, chronic low back pain is primarily managed through conservative treatments, with rehabilitation therapy playing a crucial role in pain relief and functional improvement[3-4]. Conventional rehabilitation treatments primarily utilize physical factor therapy, stretching exercises, and general functional training. While these approaches can alleviate symptoms to some degree, they exhibit limitations in enhancing lumbar stability, restoring trunk control, and correcting abnormal movement patterns. Consequently, some patients experience suboptimal functional recovery and are susceptible to symptom recurrence[5]. Research indicates that the onset and progression of chronic low back pain are influenced not only by local soft tissue injury and degeneration but also by impaired function of core muscles, diminished neuromuscular control, and inadequate lumbar and pelvic stability[6]. Core stability training, which specifically targets the activation of deep core muscles such as transversus abdominis and multifidus, enhances trunk stability and motor control. Therefore, it is considered a crucial intervention in the rehabilitation of chronic low back pain. Nevertheless, the clinical efficacy of a comprehensive intervention model that integrates core stability training with conventional rehabilitation therapy for the functional recovery of patients suffering from chronic low back pain requires further validation[7]. Accordingly, this study employed a randomized controlled trial design to investigate the clinical effects of core stability training combined with conventional rehabilitation on the functional rehabilitation of patients with chronic low back pain. The objective was to provide evidence to inform the optimization of rehabilitation treatment protocols.

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2 Materials and methods

2.1 General information A total of 90 patients diagnosed with chronic low back pain were recruited from individuals who attended the Department of Rehabilitation Medicine at China Resources Wisco General Hospital between January 1 and December 31, 2025. All patients met the established clinical diagnostic criteria for chronic low back pain and had a disease duration of at least 12 weeks. The patients were allocated to either the control group or the experimental group using a random number table method, with 45 participants in each group. There were no statistically significant differences between the two groups regarding general information, including gender, age, disease duration, and various functional indicators prior to treatment ($P > 0.05$), indicating comparability. This study received approval from the hospital ethics committee, and all patients provided informed consent.

2.2 Inclusion and exclusion criteria

2.2.1 Inclusion criteria. Patients aged between 18 and 70 years; diagnosed with chronic nonspecific low back pain with a disease duration of at least 12 weeks; presenting with varying degrees of lower back pain and functional impairment; a pre-treatment visual analog scale (VAS) score of 3 or higher; and the ability to comprehend the study procedures and to cooperate in completing rehabilitation training and related assessments.

2.2.2 Exclusion criteria. Individuals with combined lumbar fractures, tumors, infections, or severe intervertebral disc protrusion; those exhibiting progressive neurological deficits; patients with a history of lumbar spine surgery; individuals suffering from severe insufficiency of cardiac, pulmonary, hepatic, or renal functions; and those with cognitive impairments, mental illnesses, or an inability to participate in rehabilitation training.

2.3 Intervention methods

2.3.1 Control group (conventional rehabilitation group). The patients in the control group underwent standardized routine rehabilitation treatment 3 times per week over 6 weeks. The treatment protocol included the following aspects: physical factor therapy, wherein one modality was selected based on the patient's specific condition—hyperthermia, ultrashort wave therapy, or transcutaneous electrical nerve stimulation—each administered for 15 – 20 min per session; stretching exercises targeting the lumbar and back muscles, iliopsoas muscles, and hamstrings; and general functional guidance, which encompassed training to improve the range of motion of the lumbar region as well as instruction on activities of daily living.

2.3.2 Experimental group (combined intervention group). Based on the treatment administered to the control group, structured phased core stability training program was incorporated. Each session lasted approximately 30 min and was conducted 3 times per week over 6 weeks. The core stability training was implemented in distinct phases, with the specific content outlined as follows. Phase 1 (weeks 1 to 2) constituted the core muscle activation phase, with the primary objective of activating the deep core muscles and establishing proper motor control. The training regimen included abdominal breathing exercises, isometric contraction training targeting the transversus abdominis and multifidus muscles, pelvic tilt control exercises, and low-load trunk stability training performed in the supine position. Throughout the training process, emphasis was placed on movement quality to prevent the induction of significant pain. Phase 2 (weeks 3 to 4) focused on core stability and endurance training. Following significant pain relief, the training intensity was progressively increased. Exercises such as bridge training, contralateral limb lifting in the four-point support position (bird-dog), and side bridge training were implemented to improve trunk stability and enhance the endurance of the core muscles. Phase 3 (weeks 5 to 6) constituted the functional integration training phase. This phase involved dynamic core stability exercises and functional movement training—such as sit-to-stand transfers, squatting, and weight control exercises—tailored to the patient's daily activity requirements. The objective was to facilitate the transfer of core stability skills to everyday functional tasks.

2.4 Observation indicators and evaluation

2.4.1 Degree of pain. The severity of lumbar pain was assessed using the VAS score, which ranges from 0 to 10. A score of 0 represents the absence of pain, while a score of 10 denotes the most severe, unbearable pain.

2.4.2 Degree of functional impairment. The Oswestry disability index (ODI) was employed to evaluate the extent of functional impairment in patients experiencing low back pain. Higher scores indicate greater severity of functional impairment.

2.4.3 Range of motion for lumbar anteflexion. The range of motion for lumbar anteflexion was assessed using either the finger-to-floor test or the modified Schober test, with the final value determined by calculating the average of three measurements.

2.4.4 Evaluation time point. The aforementioned indicators were assessed for the two patient groups prior to treatment, 6 weeks following treatment, and during follow-up period, respectively.

2.5 Statistical methods Data analysis was performed using SPSS 28.0. Measurement data were presented as mean ± standard deviation ($\bar{x} \pm s$). Paired *t*-tests were employed for intra-group comparisons, while independent samples *t*-tests were utilized for inter-group comparisons. Repeated measures analysis of variance was applied for comparisons across multiple time points. Categorical data were analyzed using the *chi*-square (χ^2) test. Statistical significance was defined as a *P*-value less than 0.05.

3 Results and analysis

3.1 Comparison of general information A total of 90 patients with chronic low back pain were enrolled in the study, with 45 patients assigned to the control group and 45 to the experimental group. No statistically significant differences were observed between the two groups regarding general information, including gender, age, and disease duration ($P > 0.05$), indicating that the groups were comparable (Table 1).

Table 1 Comparison of general information between the two groups of patients ($\bar{x} \pm s$, $n = 45$)

Group	Age // year	Disease duration // week	Gender (male/female)
Control	54.8 ± 8.2	16.1 ± 5.3	25/20
Experimental	55.2 ± 7.9	15.7 ± 5.0	24/21
P	0.78	0.69	0.84

3.2 Comparison of pain degree (VAS score) Prior to treatment, no statistically significant difference was observed in VAS scores between the two patient groups ($P > 0.05$). Following 6 weeks of treatment and throughout the follow-up period, VAS scores in both groups were significantly reduced compared to baseline measurements ($P < 0.05$). Moreover, the experimental group exhibited significantly lower VAS scores than the control group, with this difference reaching statistical significance ($P < 0.05$, Table 2).

Table 2 Comparison of VAS scores between the two groups of patients prior to and following treatment ($\bar{x} \pm s$, points)

Group	Prior to treatment	6 weeks following treatment	Follow-up period
Control	6.3 ±0.9	4.3 ±0.8	4.1 ±0.7
Experimental	6.4 ±1.0	2.9 ±0.7 *	2.7 ±0.6 *

NOTE * denotes a statistically significant difference compared to the control group at the corresponding time point ($P<0.05$). The same below.

3.3 Comparison of the extent of functional impairment (ODI score) Prior to treatment, no statistically significant difference was observed in the ODI scores between the two patient groups ($P>0.05$). Following 6 weeks of treatment and throughout the follow-up period, the ODI scores in both groups decreased significantly compared to baseline measurements ($P<0.05$). Moreover, the experimental group demonstrated significantly lower scores than the control group ($P<0.05$, Table 3).

Table 3 Comparison of ODI scores between the two groups of patients prior to and following treatment ($\bar{x} \pm s$, points)

Group	Prior to treatment	6 weeks following treatment	Follow-up period
Control	39.2 ±6.7	27.8 ±6.1	26.1 ±5.9
Experimental	39.6 ±6.9	19.4 ±5.6 *	17.8 ±5.2 *

3.4 Comparison of lumbar anteflexion range of motion Prior to treatment, no statistically significant differences were observed between the two patient groups in the lumbar anteflexion range of motion ($P>0.05$). Following 6 weeks of treatment and throughout the follow-up period, both groups exhibited significant improvements in lumbar anteflexion range of motion compared to baseline measurements ($P<0.05$). Moreover, the magnitude of improvement in the experimental group was significantly greater than that in the control group ($P<0.05$, Table 4).

Table 4 Comparison of lumbar anteflexion range of motion between the two groups of patients prior to and following treatment ($\bar{x} \pm s$, cm)

Group	Prior to treatment	6 weeks following treatment	Follow-up period
Control	5.5 ±1.3	8.0 ±1.6	8.4 ±1.5
Experimental	5.6 ±1.4	9.9 ±1.7 *	10.5 ±1.6 *

3.5 Safety analysis During the treatment process, no serious adverse reactions were observed in either patient group. Some patients experienced mild lumbar muscle soreness and distension at the onset of training. Following appropriate adjustments to the training intensity, these symptoms resolved spontaneously and did not interfere with subsequent treatment.

4 Discussion

The research findings indicate that integrating core stability training with conventional rehabilitation treatment significantly alleviates lower back pain in patients with chronic low back pain, enhances functional capacity, and increases lumbar range of motion. The combined approach demonstrated a superior overall therapeutic effect compared to conventional rehabilitation treatment alone, underscoring the beneficial role of core stability training in the rehabilitation of chronic low back pain. Regarding pain improvement, the VAS scores for both patient groups were significantly reduced following 6 weeks of treatment and throughout the follow-up period compared to baseline measurements. Notably, the experimental group exhibited lower VAS scores at corresponding time points than the control group, suggesting that incorporating core stability training alongside conventional rehabilitation contributes to enhanced pain relief. This phenomenon may be attributed to the fact that core stability training enhances trunk stability and mitigates abnormal stress distribution in the lumbar vertebrae. Regarding functional improvement, the ODI scores of the experimental group, both following treatment and during the follow-up period, were lower than those of the control group, indicating that core stability training offers distinct benefits in enhancing patients' daily functional abilities. The underlying mechanism may involve the activation of deep core muscles, including transversus abdominis and multifidus, thereby enhancing trunk control. Regarding lumbar range of motion, both patient groups exhibited improvements in lumbar anteflexion following treatment, and the experimental group demonstrated a more pronounced enhancement. These findings suggest that core stability training not only improves lumbar stability but also facilitates the restoration of normal range of motion. In clinical practice, core stability training combined with conventional rehabilitation is characterized by ease of implementation and high patient compliance, offering valuable insights for optimizing rehabilitation protocols for chronic low back pain. However, this study has several limitations, including its single-center design, limited sample size, and relatively short follow-up duration. Additionally, it did not assess long-term efficacy or recurrence rates, nor analyzed changes in core muscle function using objective indicators. Further research is warranted to validate these findings.

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4.4 Prevention of infection Due to the underlying diseases of critically ill children, intestinal flora translocation, immune system damage caused by ECMO, and microbial colonization of catheters, children have a high risk of acquired nosocomial infections, which threaten their lives[10]. Therefore, active prevention and control of nosocomial infections are essential. After ECMO initiation, the child was given piperacillin/sulbactam prophylactically to prevent infections, but prophylactic use of antibiotics cannot completely prevent nosocomial infections during ECMO support. To this end, the child was placed in a single room, and sufficient rapid hand sanitizers were provided at the door, beside the bed tower, and other locations to facilitate hand hygiene among medical staff, reducing the possibility of nosocomial infections from the source. At the same time, in strict accordance with relevant guidelines and standards, we strengthened infection prevention for three major catheters (endotracheal tube, urinary catheter, central venous catheter, and ECMO catheter) to avoid nosocomial infections caused by human factors. In addition, the quality of basic nursing also affects the occurrence of nosocomial infections to a certain extent. Therefore, under the guidance of the Nursing Department, the ECMO nursing team formulated a detailed basic nursing plan, including eye care, oral care, body wiping with chlorhexidine solution, and skin care. Through the joint efforts of all medical staff, the child had no nosocomial infections during hospitalization.

5 Summary

Pediatric ECMO technology is still in its infancy in China. The entire operation process is extremely challenging and complex, requiring high comprehensive technical and collaborative capabilities of the management team, often necessitating strong collaboration among multiple disciplines, professions, and departments[11]. The child in this case had acute fulminant myocarditis with rapid progression. The multidisciplinary collaborative team leveraged their respective advantages to quickly initiate treatment. Through a series of refined management measures, the child successfully withdrew from ECMO and was discharged with full recovery.

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