Clinical Investigation of Shoulder Joint Function and Pain Alleviation in Patients with Rotator Cuff Injuries via Structured Phased Rehabilitation Training

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Abstract [**Objectives**] To investigate the clinical effects of implementing structured phased rehabilitation training, in addition to conventional rehabilitation, on shoulder joint function and pain alleviation in patients with rotator cuff injuries managed conservatively. [**Methods**] Eighty patients diagnosed with rotator cuff injury were selected and randomly assigned to either the control group or the experimental group, each comprising 40 individuals. The control group received conventional rehabilitation treatment, whereas the experimental group underwent phased rehabilitation training in addition to the conventional treatment for 6 weeks. Assessments were conducted prior to treatment, 6 weeks following treatment, and 8 weeks after the completion of treatment (follow-up period). The visual analogue scale (VAS) was employed to evaluate pain intensity, the Constant-Murley score was utilized to assess shoulder joint function, and the shoulder joint range of motion was measured. [**Results**] Prior to treatment, no statistically significant differences were observed between the two patient groups across all measured indicators ($P>0.05$). Following 6 weeks of treatment and throughout the follow-up period, both groups exhibited significant reductions in VAS scores compared to baseline measurements, alongside improvements in Constant-Murley scores and shoulder joint range of motion ($P<0.05$). Furthermore, the magnitude of improvement in the experimental group was significantly greater than that in the control group ($P<0.05$). [**Conclusions**] Phased rehabilitation training can enhance shoulder joint function and alleviate pain in patients with rotator cuff injuries beyond the effects of conventional rehabilitation treatment, demonstrating notable clinical application value.

Key words Rotator cuff injury, Phased rehabilitation training, Shoulder joint function, Pain, Randomized controlled trial

1 Introduction

Rotator cuff injury is a prevalent shoulder joint disorder encountered in clinical practice, particularly among middle-aged and elderly individuals, as well as those engaged in prolonged repetitive upper limb activities. The primary clinical manifestations include shoulder pain, restricted shoulder joint mobility, and functional impairments, which significantly diminish patients' quality of life[1-2]. With the aging population and evolving lifestyle patterns, the incidence of rotator cuff injuries is increasing, rendering it a critical concern in the field of rehabilitation medicine. Currently, treatment approaches for rotator cuff injuries primarily encompass surgical and conservative methods. Conservative treatment is preferred for the majority of patients owing to its minimal trauma and lower risk[3]. Rehabilitation therapy, a critical element of conservative management, significantly contributes to pain relief and functional improvement[4]. However, conventional rehabilitation programs, including physical factor therapy and passive activities, frequently encounter challenges such as inadequate standardization, a lack of systematic progression, and insufficient focus on scapular kinematics and neuromuscular control. These limitations may result in incomplete functional recovery or persistent pain in certain patients[4-5].

The restoration of shoulder joint function occurs in distinct phases, encompassing several stages including inflammation management, restoration of range of motion, enhancement of muscle strength and stability, and functional reintegration. Research indicates that a phased rehabilitation program grounded in biomechanical principles more effectively restores scapulohumeral rhythm and reestablishes the dynamic stability of the shoulder joint, thereby leading to improved clinical outcomes[6-7]. Currently, in China, there is a lack of well-defined, highly operational, and standardized phased rehabilitation programs, as well as high-quality evidence supporting their efficacy, for patients with rotator cuff injuries undergoing conservative treatment. Therefore, this study aims to evaluate, through a randomized controlled trial, whether the addition of a structured phased rehabilitation training program to standardized routine rehabilitation can provide superior pain relief and functional improvement in patients with rotator cuff injuries.

2 Materials and methods

2.1 General information A total of 80 patients diagnosed with rotator cuff injuries were selected from those who visited the Department of Rehabilitation Medicine at Taihe Hospital in Shiyan City between January 1 and December 31, 2025. The diagnosis of rotator cuff injury was established based on clinical symptoms and confirmed through imaging examinations (MRI or ultrasound). The patients were randomly assigned to either the control group or the experimental group using a random number table method, with 40 cases in each group. There were no statistically significant differences between the two groups regarding general information such as gender, age, affected side, and disease duration ($P>0.05$), indicating comparability. This study received approval from the Ethics Committee of Taihe Hospital in Shiyan City, and all patients provided informed consent.

Received: November 10, 2025 Accepted: December 30, 2025

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2.2 Inclusion and exclusion criteria

2.2.1 Inclusion criteria. Participants aged 18 to 70 years; those who met the clinical and imaging diagnostic criteria for rotator cuff injury; a disease duration of at least 4 weeks; presence of shoulder pain accompanied by varying degrees of limited shoulder joint mobility or functional impairment; and the ability to comprehend the research content and cooperate in completing rehabilitation training and related assessments.

2.2.2 Exclusion criteria. Individuals with combined shoulder joint fractures, dislocations, or severe bony joint lesions; those who had previously undergone shoulder joint surgery; individuals with severe neurological disorders or rheumatic immune diseases; those with significant insufficiency of cardiac, pulmonary, hepatic, or renal functions; and individuals with cognitive impairments, mental illnesses, or an inability to cooperate with rehabilitation training.

2.3 Treatment methods All treatments were administered by a consistent team of rehabilitation therapists who had undergone standardized training.

2.3.1 Control group (conventional rehabilitation group). The control group underwent standardized routine rehabilitation treatment 3 times per week over 6 weeks. The treatment protocol was as follows: physical factor therapy involved selecting one modality—ultrashort wave, infrared, or ultrasound therapy—based on the patient's specific condition, with each session lasting 15 to 20 min. Joint range of motion training focused on enhancing shoulder joint anteflexion, abduction, and external rotation, ensuring that movements remained within the patient's tolerance. Additionally, muscle stretching targeted the rotator cuff and the muscle groups surrounding the scapula.

2.3.2 Experimental group. Building upon the conventional rehabilitation treatment administered to the control group, structured phased rehabilitation training was incorporated. Each training session lasted approximately 30 min and was conducted 3 times per week over 6 weeks. The progression of the training adhered to dual criteria based on "symptoms and functions". The detailed plan was outlined as follows.

(i) Phase 1 (weeks 1 to 2) focused on pain management and the restoration of shoulder joint range of motion. The intervention included pendulum exercises for the shoulder, passive and assisted movement training, fundamental scapular control exercises, and low-intensity isometric contractions targeting the rotator cuff muscles. Throughout this phase, exercise intensity was carefully regulated to avoid eliciting significant pain or exacerbating symptoms.

(ii) Phase 2 (weeks 3 to 4) involved muscle strength and stability training. Building upon significant pain relief and improved joint range of motion, training intensity was gradually increased. This phase included rotator cuff resistance exercises, elastic band training, and scapular stability exercises, with an emphasis on strengthening the supraspinatus, infraspinatus, teres minor, and periscapular muscle groups to enhance the dynamic stability of the shoulder joint.

(iii) Phase 3 (weeks 5 to 6) constituted the functional integration training phase. This phase involved closed-chain exercises, coordination training, and functional movement simulations—such as lifting, pushing, and pulling—tailored to the patient's daily activities and functional requirements, with the aim of facilitating comprehensive recovery of shoulder joint function.

2.4 Observation indicators

2.4.1 Degree of pain. The severity of shoulder pain was assessed using the visual analogue scale (VAS), 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 Shoulder joint function. The Constant-Murley shoulder joint score was employed to evaluate shoulder joint function. This scoring system encompasses pain, activities of daily living, joint range of motion, and muscle strength, with a maximum total score of 100. Higher scores indicate better shoulder joint function.

2.4.3 Shoulder joint range of motion. The range of shoulder joint anteflexion, abduction, and external rotation was assessed using a protractor, with the mean of three measurements calculated to determine the final value.

2.5 Evaluation time point The patients were evaluated at three time points: prior to treatment, 6 weeks following treatment, and 8 weeks after the completion of treatment (follow-up period).

2.6 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 80 patients with rotator cuff injuries were enrolled in the study, with 40 patients assigned to the control group and 40 to the experimental group. No statistically significant differences were observed between the two groups regarding general information, including gender, age, affected side, 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 ($\bar{x} \pm s$, $n = 40$)

Group	Age // year	Disease duration // week	Gender (male/female)
Control	55.6 ± 7.8	14.2 ± 4.6	22/18
Experimental	54.9 ± 8.1	13.8 ± 4.9	21/19
P	0.68	0.71	0.82

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	6.4±0.9	4.1±0.8	3.9±0.7
Experimental	6.5±1.0	2.9±0.7*	2.6±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 shoulder joint function (Constant-Murley score) Prior to treatment, no statistically significant difference was observed in the Constant-Murley scores between the two patient groups ($P>0.05$). Following 6 weeks of treatment and throughout the follow-up period, the Constant-Murley scores in both groups increased significantly compared to baseline measurements ($P<0.05$). Moreover, the experimental group demonstrated significantly higher scores than the control group ($P<0.05$, Table 3).

Table 3 Comparison of Constant-Murley 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	52.3±6.5	68.4±7.2	70.1±7.0
Experimental	53.0±6.8	79.2±6.9*	82.4±6.5*

3.4 Comparison of shoulder joint range of motion Prior to treatment, no statistically significant differences were observed between the two groups in the shoulder joint anteflexion, abduction, and external rotation ($P>0.05$). Following 6 weeks of treatment and throughout the follow-up period, both groups exhibited significant improvements in shoulder joint range of motion across all directions 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 shoulder joint range of motion between the two groups of patients prior to and following treatment ($\bar{x}\pm s$, °)

Indicator	Group	Prior to treatment	6 weeks following treatment	Follow-up period
Anteflexion	Control	98.6±12.4	132.5±15.3	135.2±14.8
	Experimental	99.2±11.8	150.6±14.7*	155.8±13.9*
Abduction	Control	92.4±10.6	125.3±14.1	128.6±13.7
	Experimental	93.1±11.0	145.8±13.9*	150.4±13.2*
External rotation	Control	38.5±6.8	52.6±7.4	54.2±7.1
	Experimental	39.1±7.0	62.8±7.6*	65.3±7.3*

3.5 Safety analysis During the treatment process, no serious adverse reactions were observed in either patient group. Some patients experienced mild shoulder 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 the implementation of phased rehabilitation training, in addition to conventional rehabilitation treatment, further alleviates shoulder pain in patients with rotator cuff injuries and enhances shoulder joint function and range of motion. The therapeutic effect of this combined approach was superior to that of conventional rehabilitation treatment alone, suggesting that phased rehabilitation training offers distinct advantages in the rehabilitation of rotator cuff injuries. In terms of pain alleviation, the VAS scores of patients in both groups were significantly reduced following treatment compared to baseline measurements. Notably, the experimental group exhibited significantly lower VAS scores at 6 weeks following treatment and throughout the follow-up period relative to the control group. These findings suggest that incorporating phased rehabilitation training alongside conventional rehabilitation therapy may more effectively mitigate shoulder pain. The observed effects may be attributed to the appropriate regulation of training load, enhancement of joint mobility, and reduction of tissue stimulation during the early stages[6]. Regarding the recovery of shoulder joint function, the Constant-Murley scores of the experimental group, both following treatment and throughout the follow-up period, were significantly higher than those of the control group. This finding suggests that phased rehabilitation training positively contributes to the comprehensive functional recovery of the shoulder joint. This training protocol progressively incorporates rotator cuff resistance exercises and scapular stability training during the intermediate and later phases, which facilitates the enhancement of dynamic shoulder joint stability and improves functional capacity in daily activities[7]. Regarding the improvement in shoulder joint range of motion, both groups exhibited significant increases in anteflexion, abduction, and external rotation following treatment compared to baseline measurements, with the experimental group demonstrating a more pronounced improvement. The findings suggest that phased rehabilitation training, which involves the gradual restoration of joint range of motion combined with functional exercises, has been shown to prevent joint stiffness and compensatory movements, thereby facilitating the comprehensive recovery of shoulder joint mobility. Regarding clin-

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another type of psychiatric comorbidity requiring focused attention in psoriasis patients, in addition to depressive disorders. The underlying mechanisms may involve broader immune-inflammatory dysregulation and overlapping genetic susceptibility, though further research is needed to elucidate these pathways.

However, we did not find significant genetic causal associations between psoriasis and schizophrenia or anxiety disorders in this study. This suggests that the correlations reported in previous observational studies may be more influenced by non-genetic factors such as environmental exposures, psychological stress, and disease burden[7-8]. In the PsA subgroup, genetic susceptibility was significantly associated with the risk of bipolar disorder, indicating that psoriasis patients with articular involvement may face a higher risk of psychiatric comorbidity. In clinical management, enhanced screening and early intervention for mental health should be implemented for such patients, with particular attention to symptoms related to emotional disorders.

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ical significance, phased rehabilitation training establishes distinct training objectives aligned with the stages of rotator cuff injury recovery, emphasizing both safety and efficacy. The training protocol is highly practical and does not require specialized equipment, thereby facilitating its clinical implementation and broader application. Concerning research limitations, this study was conducted at a single center with a relatively small sample size and a brief follow-up duration, whereas long-term efficacy was not assessed. Consequently, further studies are necessary to validate these findings.

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