

SYSTEMATIC REVIEW

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The clinical efficacy of proprioceptive neuromuscular facilitation technique in the treatment of scapulohumeral periarthritis: a systematic review and meta-analysis

Chengyu Zhu¹, Xueyan Huang¹, Jiaying Yu², Ying Feng¹ and Haifang Zhou^{1*}

Abstract

Background Scapulohumeral periarthritis (SP) is a disease caused by chronic inflammation of the shoulder soft tissue area, which is characterized by shoulder pain and limited mobility. Due to the long course of disease, it often has a great impact on the life and work of patients.

Objectives The purpose of this study was to systematically evaluate the effect of proprioceptive neuromuscular facilitation (PNF) stretching technique in the treatment of SP.

Methods A systematic search of 10 databases such as China National Knowledge Infrastructure (CNKI), China Biomedical Literature Database, Weipu, Wanfang, PubMed, Embase, Web of Science, Cochrane Library, Clinical Trials, and China Clinical Trial Registry Platform was performed. The retrieval time was from inception to January 2024. Two researchers screened the literature according to the inclusion and exclusion criteria, extracted the data, and evaluated the quality. Revman5.3 software was used for meta-analysis, and only descriptive analysis was performed on the outcome indicators of the number of literature ≤ 2 .

Results A total of 12 articles were included, including 968 patients. The results of Meta-analysis showed that PNF technique could reduce pain intensity (Visual analog scale (VAS) score (SMD = -0.67, 95% CI [-1.18, -0.15], $P=0.03$), Japanese Orthopaedic Association (JOA) score (subjective pain score standard) (SMD = 0.79, 95% CI [0.23, 1.35], $P<0.01$), improve the shoulder function of patients (SMD = 1.13, 95% CI [0.96, 1.31], $P<0.01$), and improve the patient's daily living ability (SMD = 1.06, 95% CI [0.77, 1.34], $P<0.01$). The results of descriptive analysis showed that the PNF technique could improve the psychological state of patients with scapulohumeral periarthritis to a certain extent.

Conclusion The PNF technique can help patients with scapulohumeral periarthritis to relieve pain, improve shoulder function, and strengthen daily living ability. In addition, a good psychological state is conducive to better recovery of patients' health. In clinical work, medical staff should pay attention to the psychological state of patients with SP.

Clinical trial number Not applicable.

*Correspondence:
Haifang Zhou
783206521@qq.com

Full list of author information is available at the end of the article



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Keywords PNF, Proprioceptive neuromuscular facilitation, Scapulohumeral periarthritis, Stretching technique, Clinical efficacy, Meta-analysis

Introduction

Scapulohumeral Periarthritis (SP) is also commonly called “shoulder frozen syndrome”, which is a chronic inflammatory disease in the soft tissue area of the shoulder, characterized by shoulder pain and limited mobility [1]. At present, the real cause of scapulohumeral periarthritis is not yet clear. Modern medicine believes that the cause of periarthritis of the shoulder is pathological changes such as adhesion, inflammation, or edema in the shoulder tissue, and the contracture of different structures in the joint capsule is the main pathological cause [2]. Studies have shown that the incidence of periarthritis of the shoulder is increasing year by year. The total incidence of periarthritis of the shoulder in the world is as high as 5%, and about 42% of shoulder diseases are periarthritis of the shoulder [3], the number of female patients is more than that of men (3: 1) [4]. The age of patients with periarthritis of the shoulder is generally about 50 years old, and it shows a trend of rejuvenation. Most of these patients have a long course of disease, which often has a serious impact on their life and work [5].

Exercise intervention is a method to assist disease treatment and behavioral intervention through sports [6]. Ibrahim found that exercise intervention can not only effectively relieve pain, but also improve the joint mobility of patients with scapulohumeral periarthritis [26]. Therefore, it is particularly important to actively find a suitable exercise intervention for patients with scapulohumeral periarthritis. At present, the exercise intervention of scapulohumeral periarthritis is mainly based on rehabilitation exercises. The common traditional rehabilitation exercises include pendulum exercises, wall climbing exercises, ring pulling exercises, etc [7]. Compared with traditional rehabilitation exercises, proprioceptive neuromuscular facilitation therapy takes autonomous stretching and painless stretching as the main principles, which is conducive to promoting better rehabilitation of patients with scapulohumeral periarthritis. Proprioceptive neuromuscular facilitation (PNF) is a critical technique utilized in rehabilitative manual therapy [8]. It is a stretching technique that has been demonstrated to enhance muscle flexibility and improve both active and passive range of motion in scapulohumeral periarthritis patients [9–11]. The PNF technique uses a spiral diagonal movement pattern to promote the recovery of limb motor function, which is easy to learn, less restrictive, and more operable [12].

The PNF technique is mainly used to treat various neurological or cerebral diseases. In recent years, researchers

have used the PNF technique for the treatment of frozen shoulder, but there are still problems such as a small number of studies, few endpoints, variable treatment effects, and controversial clinical effectiveness. Hwang’s study found that the PNF technique can significantly improve the range of motion (ROM) of patients with scapulohumeral periarthritis and the therapeutic effect is great [25]. Lin’s study found that the PNF technique can be used as an adjunctive treatment for scapulohumeral periarthritis [23]. Therefore, this study analyses the effects of the PNF technique on patients with scapulohumeral periarthritis through evidence-based analysis and provides an evidence-based basis for the treatment of scapulohumeral periarthritis and the promotion of the PNF technique in the future.

Method

Study protocol

This systematic review was performed following Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2020 guidelines (PRISMA 2020) [13] (see Supplementary Material 1) and has been registered at PROSPERO (Identification number: CRD42024541073).

Eligibility criteria

The inclusion criteria of this study included all randomized controlled trials (RCTs) that evaluated the efficacy of PNF in the treatment of scapulohumeral periarthritis, and the included RCTs strictly followed the PICO(S) principle.

(1) Research object: patients who were diagnosed with scapulohumeral periarthritis. (2) Intervention measures: the PNF technique was implemented in the experimental group; the control group was treated with routine nursing or treatment, such as routine exercise, health education, routine examination, and so on. (3) Specific types of intervention: PNF technique includes dynamic reversal, stability reversal, rhythmic stability, hold-relaxation, contraction-relaxation, and other methods. (4) Study outcome indicators: pain intensity, shoulder joint function and activity, daily living ability, and psychological state were used as outcome indicators. (5) Study type: randomized controlled trial.

Exclusion criteria

The exclusion criteria of this study are as follows.

(1) Repetitively published literature. (2) The article data is incomplete or cannot be converted to normal use. (3) Cannot obtain full-text information. (4) Literature with

serious quality problems. (5) Summary or meeting summary. (6) Non-Chinese and English literature.

Search strategy

The relevant randomized controlled trials on the intervention of the PNF technique in patients with scapulo-humeral periarthritis were systematically searched in 9 databases such as PubMed, Embase, Web of Science, Cochrane Library, Clinical Trials, China National Knowledge Infrastructure (CNKI), China Biomedical Literature Database, VIP, Wanfang, and the platform of China Clinical Trial Registry. To reduce bias, key conferences and grey literature were also searched. The search was carried out in a combination of subject words and free words. The language was limited to Chinese and English, and the search time limit was from the establishment of the database to January 2024. Search terms in English were “PNF / proprioceptive neuromuscular facilitation/stretching / isometric contraction/spiral diagonal motion” and “Scapulohumeral Periarthritis /SP/ periarthritis humeroscapularis / frozen shoulder”. Taking PubMed as an example, the specific search strategy is shown in Table 1.

Selection and data collection process

The retrieved literature was imported into NoteExpress 3.2 literature management software. Two researchers screened and removed duplicate literature according to the inclusion and exclusion criteria. If there was a dispute, the dispute was debated and no agreement was reached, it was decided by the third researcher. The input information includes: (1) Author, year of publication, country; (2) Research object, sample size, and age; (3) Intervention measures and time; (4) Outcome indicators and evaluation tools.

Study risk of bias assessment

Cochrane Risk of Bias Tool 2.0 (ROB 2.0) was used to evaluate the quality of the included randomized

controlled trials [14]. Two researchers assessed the risk of bias in randomized trials. Any differences between their assessments were resolved by discussion or, if consensus could not be reached, consultation with a third researcher was sought. The methodological quality of the study was assessed in several areas, including the randomization process, adherence to the intended intervention, treatment of missing outcome data, measurement of outcomes, and selection of reported outcomes. According to the ROB 2.0 standard, each of these domains was classified as low risk, high risk, or some problem.

Statistical analysis

Meta-analysis was performed using Revman 5.3 software. The chi-square test and I² index were used for the heterogeneity test. I²>50% P<0.1 indicated significant heterogeneity among studies. A random effect model was used for meta-analysis. On the contrary, I²<50% P>0.1 suggested that heterogeneity was acceptable, and a fixed-effect model was used for meta-analysis. If the heterogeneity was high, sensitivity analysis and subgroup analysis were performed on the data to explore the source of heterogeneity. If the same measurement tool is used in the study, the weighted mean difference (WMD) is used to represent the measurement data. If different, it is expressed by standardized mean difference (SMD). SMD was classified as small (<0.40), medium (between 0.41 and 0.70) and large (>0.70). If the heterogeneity between groups is too high but the reasons cannot be judged, descriptive analysis is performed. P<0.05 was considered statistically significant.

Results

Study selection

Two researchers screened and removed duplicate literature according to the inclusion and exclusion criteria. If there was a dispute, the dispute was debated and no agreement was reached, it was decided by the third researcher. A total of 478 articles were retrieved. Through NoteExpress 3.2 duplicate checking, reading the title and abstract, and reading the full text, 12 randomized controlled trials were screened and finally included [15–26]. Among them, 8 Chinese articles [15–22] and 4 English articles [23–26], the screening process is shown in Fig. 1.

Study characteristics and quality evaluation

A total of 12 articles [15–26] were included, including 885 patients. The basic characteristics are shown in Table 2. All studies were assessed using the ROB 2.0. It was found that two studies were of low-risk bias [25–26], and ten studies were conducted as controlled clinical trials, raising concerns about potential bias in several criteria [15–24]. The risk of bias assessed by the study was shown in Table 3.

Table 1 Pubmed search strategy

Procedure	Search Strategy
#1	“proprioceptive neuromuscular facilitation”[MeSH Terms]
#2	“proprioceptive neuromuscular facilitation”[Title/Abstract] OR “PNF”[Title/Abstract] OR “stretching”[Title/Abstract] OR “isometric contraction”[Title/Abstract] OR “spiral diagonal motion”[Title/Abstract]
#3	#1OR#2
#4	“Scapulohumeral Periarthritis”[MeSH Terms]
#5	“Scapulohumeral Periarthritis”[Title/Abstract] OR “SP”[Title/Abstract] OR “periarthritis humeroscapularis”[Title/Abstract] OR “frozen shoulder”[Title/Abstract]
#6	[Title/Abstract]
#7	#4OR#5
	#3AND#6

PRISMA 2020 flow diagram for new systematic reviews which included searches of databases, registers and other sources

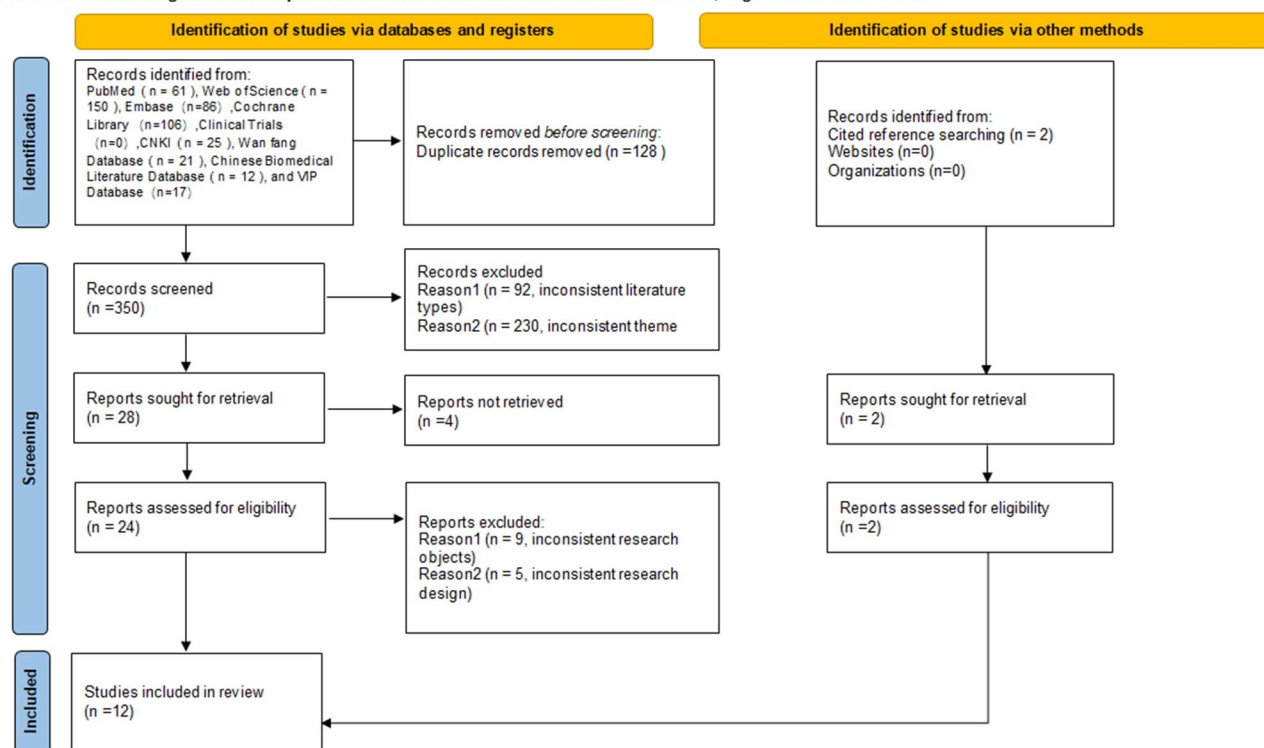


Fig. 1 Flow diagram of the study selection process

Results of syntheses

Effect of PNF technique on pain intensity of SP

Ten articles reported the changes in pain intensity. Due to the different measurement tools, SMD was selected for combined analysis. There was significant heterogeneity in the results of the study ($I^2=93\%$, $P<0.01$). The random effect model was used for subgroup analysis according to the measurement tool method. Among them, 5 pieces of literature were scored by VAS, and 5 of the literature were scored by JOA score (conscious pain score standard). In the subgroup analysis results, the difference was statistically significant in the VAS score group (SMD = -0.67, 95% CI [-1.18, -0.15], $P=0.03$, $I^2=67\%$), and in the JOA score (perceived pain score) group (SMD = 0.79, 95% CI [0.23, 1.35], $P<0.01$, $I^2=89\%$). Both groups showed that the implementation of the PNF technique could reduce the pain intensity of patients with scapulohumeral periarthritis. See Fig. 2.

Effect of PNF technique on shoulder function of SP

Nine articles reported changes in joint function. Due to the different measurement tools used, SMD was selected for merging analysis. There was significant heterogeneity in the results of the study ($I^2=76\%$, $P<0.01$), See Fig. 3. Sensitivity analysis is an analytical method used to determine the sensitivity of a study's results or how it changes the evaluation of the system. The purpose of

the sensitivity analysis is to evaluate the stability of the consolidated results. Exclusion-by-exclusion method is the most commonly used method in sensitivity analyses, which compares whether there is a significant difference between pre-and post-combined effects by re-performing Meta-analyses after excluding relatively poor-quality literature from the included studies [27–28]. The results of omitting a particular study on a case-by-case basis were shown in Table 4. The results showed that after excluding the studies of Liu [17] and Ibrahim [26], the heterogeneity was significantly reduced ($I^2=39\%$, $P<0.01$), which may be related to the low quality of literature or the use of different inclusion and exclusion criteria standards and efficacy evaluation criteria standards. After eliminating 2 articles, the fixed effect model was used for Meta-analysis of the remaining 7 studies, and the heterogeneity was reduced. The results showed that the improvement of joint function in the experimental group was higher than that in the control group, and the difference was statistically significant (SMD = 1.13, 95% CI [0.96, 1.31], $P<0.01$). PNF technique can effectively promote the recovery of joint function in patients with scapulohumeral periarthritis. See Fig. 4.

Effect of PNF technique on the daily living ability of SP

Five articles reported changes in daily living ability. Due to the different measurement tools used, SMD

Table 2 Basic characteristics of the included literature ($n = 12$)

Table 2 Basic characteristics of the included literature (n = 12)

Author Year (Ref.)	Published time (years)	Publish country	Sample size (T/C)	Age, years (T/C)	Duration of intervention and frequency
Wang [15]	2012	China	35/30	50.43 ± 13.96/53.56 ± 17.83	4 weeks, 1 time a day, 20–30 min each time
Xiao [16]	2017	China	43/43	49.2 ± 5.6/52.6 ± 4.8	2 weeks, 1 time a day, 25–30 min each time
Liu [17]	2018	China	62/63	52.09 ± 9.17/51.35 ± 8.73	4 weeks, 1 time a day, 30 min each time
Cheng [18]	2018	China	30/30	55.03 ± 8.34/55.80 ± 7.59	4 weeks, 3 times a day, 30 min each time
Kong [19]	2019	China	47/47	51.99 ± 2.28/51.24 ± 2.41	4 weeks, 1 time a day, 30 min each time
Guo [20]	2020	China	43/43	60.27 ± 4.01/60.28 ± 4.23	3 months, 1 time a day, 30 min each time
Wang [21]	2020	China	67/67	50.34 ± 5.17/49.68 ± 5.09	1 month, 1 time a day, 30 min each time
Meng [22]	2021	China	35/35	55.58 ± 4.20/55.72 ± 4.18	2 weeks, 1 time a day, 30 min each time
Lin [23]	2022	China	24/24	40–65	4 weeks, 1 time a day, 30 min each time
İğrek [24]	2022	Istanbul	14/15	45.9 ± 9.7/47.6 ± 12.4	4 weeks, 5 times a week, 30 min each time
Hwang [25]	2021	Korea	14/14	32.86 ± 6.49/32.01 ± 5.87	6 weeks, 5 times a week, 25 min each time
Ibrahim [26]	2014	USA	30/30	51.9 /51.2	4 weeks, 3 times a week, 30 min each time
Author Year (Ref.)	Intervention measures in the trial group		Intervention mea- sures in the control group	Outcome index	Assessment tool
Wang [15]	Upper limb PNF technique		Conventional therapy	②③	d, e
Xiao [16]	Upper limb PNF technique combined with scapular girdle PNF technique		Regular exercise	②③	b, d, e
Liu [17]	Scapular girdle PNF technique		Regular exercise	①②③	b, d, e
Cheng [18]	Scapular girdle PNF technique		Conventional therapy	②③	b, c
Kong [19]	Scapular girdle PNF technique		Regular exercise	②③	b, d, e
Guo [20]	Scapular girdle PNF technique combined with psychological counseling treatment		Regular exercise	②③④	d, e, g, h
Wang [21]	Upper limb PNF technique		Regular exercise	①②③	b, d, e
Meng [22]	Scapular girdle PNF technique		Regular exercise	①③	d, e
Lin [23]	Upper limb PNF technique combined with scapular girdle PNF technique		Conventional therapy	②③	b, e
İğrek [24]	Scapular girdle PNF technique		Conventional therapy	②③	b, c, e, f
Hwang [25]	Scapular girdle PNF technique		Regular exercise	②③	e, f
Ibrahim [26]	Scapular girdle PNF technique		Conventional therapy	②③	b, f

Note: T Trial group; C Control group. Outcome indicators ①activities of daily living; ②the degree of pain; ③ joint function; ④ mental state. Evaluation tool (a) shoulder daily life ability rating scale (ADL); (b) VAS pain Rating Scale; (c) CMS shoulder function score scale; (d) Japanese Orthopaedic Association Shoulder Dysfunction Index (JOA); (e) ROM joint activity scale; (f) upper limb dysfunction rating scale (DASH); (g) self-rating anxiety scale (SAS); (h) self-rating depression scale (SDS)

was selected for the combination of effect quantities. The results of the study were heterogeneous ($I^2 = 57\%$, $P = 0.05$). Using a random effect model, the difference between the experimental group and the control group was statistically significant (SMD = 1.06, 95% CI [0.77, 1.34], $P < 0.01$). PNF technique can improve the daily living ability of patients with scapulohumeral periarthritis. See Fig. 5.

Reporting biases

Funnel plot was drawn for the studies on shoulder function with more outcome indicators in the included studies. Most of the shoulder function studies were distributed within the 95% CI range of the inverted funnel plot. The results show that the distribution is vertically symmetrical, indicating that the publication bias is small. See Fig. 6.

Table 3 The risk of bias of RCTs included and evaluated through Rob 2.0 ($n = 12$)

Author Year	Randomization process	Deviation from intended interventions	Missing Outcome data	Measurement of the outcome	Selection of the reported result	Overall
Wang 2012	Low risk	Some concerns	Low risk	Some concerns	Low risk	Some concerns
Xiao 2017	Low risk	Some concerns	Low risk	Some concerns	Low risk	Some concerns
Liu 2018	Some concerns	Some concerns	Low risk	Some concerns	Low risk	Some concerns
Cheng 2018	Low risk	Some concerns	Low risk	Some concerns	Low risk	Some concerns
Kong 2019	Low risk	Some concerns	Some concerns	Some concerns	Low risk	Some concerns
Guo 2020	Low risk	Some concerns	Low risk	Some concerns	Low risk	Some concerns
Wang 2020	Some concerns	Some concerns	Low risk	Some concerns	Low risk	Some concerns
Meng 2021	Low risk	Low risk	Low risk	Some concerns	Low risk	Some concerns
Lin 2022	Low risk	Some concerns	Low risk	Some concerns	Low risk	Some concerns
İğrek 2022	Low risk	Some concerns	Low risk	Some concerns	Low risk	Some concerns
Hwang 2021	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk
Ibrahim 2014	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk

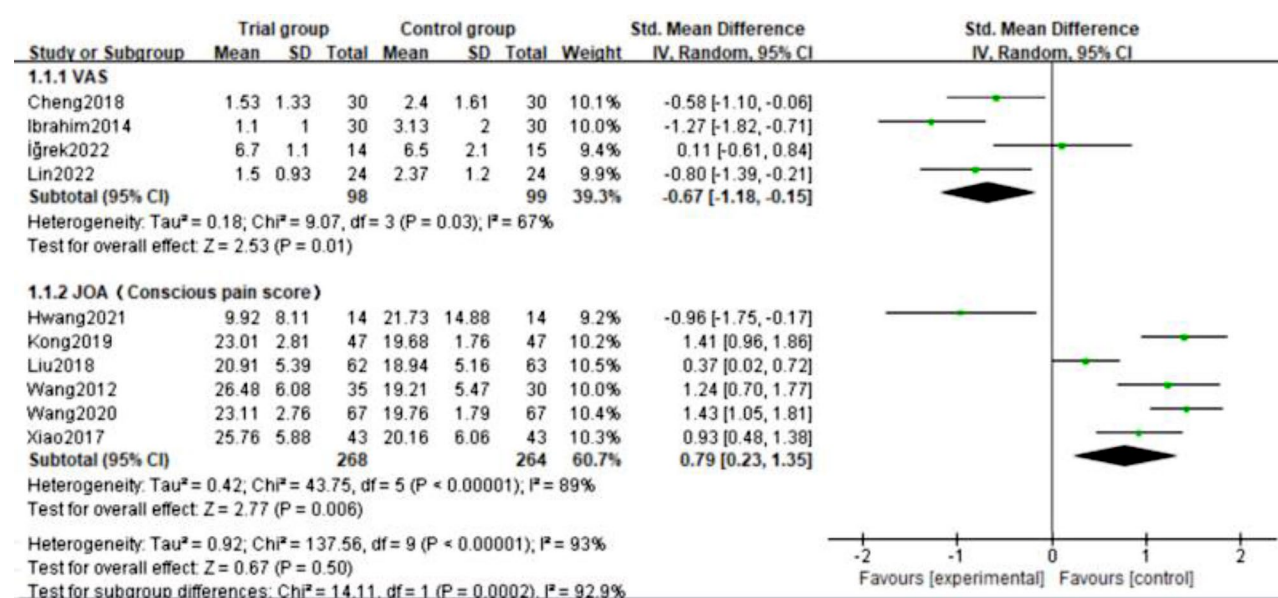
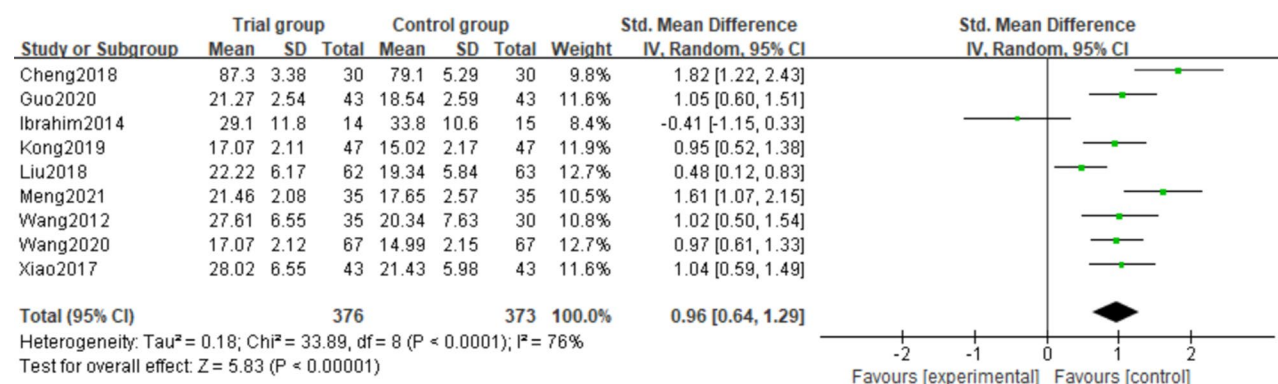
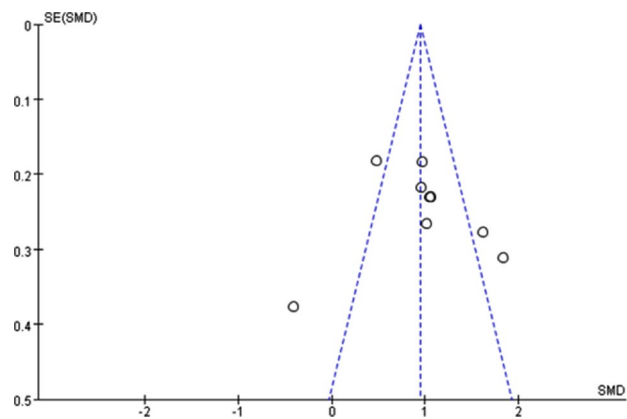
**Fig. 2** Forest plot of shoulder pain**Fig. 3** Forest plot of shoulder function

Table 4 Sensitivity analyses - omitting a particular study

Study	SMD, 95%CI	I ²	P
Omitting Cheng2018	0.87[0.56,1.18]	72	<0.01
Omitting Guo2020	0.85[0.58,1.32]	79	<0.01
Omitting Ibrahim2014	1.08[0.80,1.35]	66	<0.01
Omitting Kong2019	0.96[0.59,1.34]	79	<0.01
Omitting Liu2018	1.03[0.70,1.37]	73	<0.01
Omitting Meng2021	0.89[0.56,1.21]	75	<0.01
Omitting Wang2012	0.96[0.59,1.32]	79	<0.01
Omitting Wang2020	0.96[0.58,1.34]	79	<0.01
Omitting Xiao2017	0.95[0.58,1.32]	79	<0.01

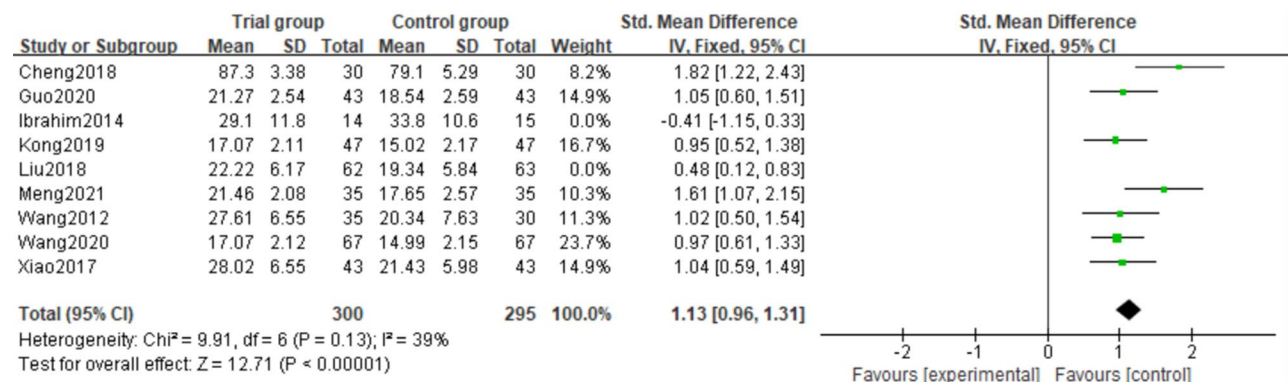
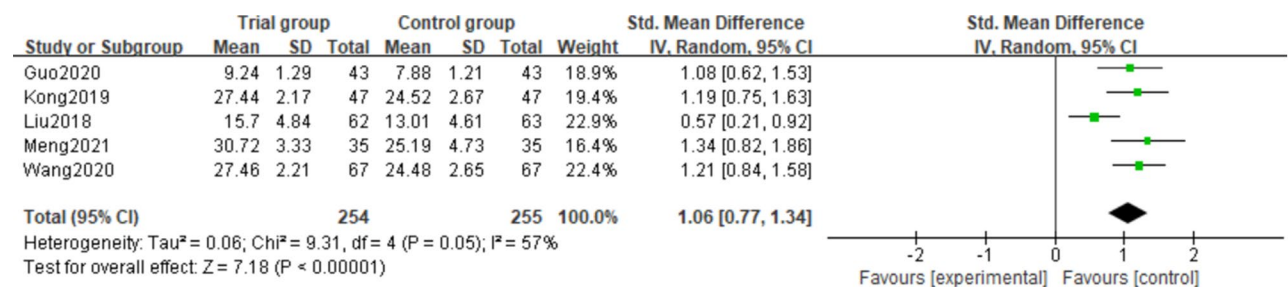
**Fig. 6** Funnel plot for comparison of shoulder function between the two groups

Discussion

The results of Meta-analysis showed that PNF technique could reduce the degree of pain ((Visual analog scale (VAS) score (SMD = -0.67, 95% CI [-1.18, -0.15], $P=0.03$), Japanese Orthopaedic Association (JOA) score (subjective pain score standard) (SMD = 0.79, 95% CI [0.23, 1.35], $P<0.01$)), improve the shoulder function (SMD = 1.13, 95% CI [0.96, 1.31], $P<0.01$), and improve the daily living ability (SMD = 1.06, 95% CI [0.77, 1.34], $P<0.01$). SMD was classified as small (<0.40), medium (between 0.41 and 0.70) and large (>0.70). Overall, the effect of the PNF technique on pain intensity, shoulder function, and daily living ability was large.

PNF technique is a rehabilitation method that uses a spiral diagonal motion mode to promote the recovery of limb motor function. It stimulates the body's proprioceptors, promotes neuromuscular-related responses, increases sensory input feedback, and promotes the contraction of the corresponding muscle groups. At the same time, it regulates the excitability of sensory nerves, improves abnormal muscle tension, and restores normal exercise patterns. It is safe and not require other special equipment, and is currently widely used in sports injury and rehabilitation [29].

PNF technique includes dynamic reversal, stability reversal, rhythmic stability, hold-relaxation, contraction-relaxation, and other methods. The rehabilitation training methods involve diagonal upper-limb movement,

**Fig. 4** Forest plot of shoulder function (After omitting Ibrahim2014 and Liu2018)**Fig. 5** Forest plot of daily living ability

extension and flexion of the upper limbs, and extension and contraction of the shoulder girdle. The upper limb flexion and extension exercises include flexion-abduction-external rotation, extension-adduction-internal rotation, flexion-adduction-external rotation, and extension-abduction-internal rotation [15, 21]. The scapular girdle patterns used during training include forward extension, retraction, forward retraction, and forward extension, which encourages patients to mobilize the shoulder joint in the opposite direction of the therapist's operation [17–20, 22, 24–26]. Some studies have combined the upper limb PNF technique with the scapular girdle PNF technique in the training of SP patients and achieved good training results [16, 23]. Once a day, each extension and flexion cycle lasts about 30 min.

The PNF technique is effective in the pain intensity of SP

As the symptoms of scapulohumeral periarthritis become more and more serious, adhesions will occur in the shoulder tissues of patients, which are manifested in adhesions between muscles and fascia or even within nerve tissues. These tissue adhesions interlaced hinder the normal activity of the joints, resulting in limited activity often accompanied by pain, and patients are afraid of secondary injury and fear of movement [30]. The PNF technique emphasizes the principle of painless stretching during the operation, which largely overcomes the patient's fear of pain and increases the patient's autonomy [12]. The physiological mechanism of pain relief by the PNF technique is related to the reflex inhibition of the spinal cord and brainstem release of pain-causing substances during stretching, to improve the pain domain and increase the stability of the joint [15].

In addition, the PNF technique and traditional Chinese medicine appropriate technique to intervene in SP patients at the same time often can get better results. The appropriate technique of traditional Chinese medicine is mainly to use the meridian theory of traditional Chinese medicine to relieve the pain of periarthritis of the shoulder. The traditional Chinese medicine techniques commonly used by medical staff in clinical practice include traditional Chinese medicine fumigation, acupuncture, cupping, massage, acupoint injection, moxibustion, and other methods. It has a long history and has the characteristics of strong operability and less harm [31]. Studies have shown that the effect of the appropriate technique of traditional Chinese medicine combined with the PNF technique on patients with scapulohumeral periarthritis is significantly better than that of a single treatment [32]. Therefore, the PNF technique can help patients gradually develop a reasonable understanding of pain and reduce their fear of pain based on providing patients with scientific exercise training guidance. Patients gradually increase muscle activity within a reasonable training

intensity to avoid adverse events such as increased pain after exercise.

The PNF technique works well for the shoulder function of SP

The results of the meta-analysis showed that the PNF technique could effectively improve the joint function of patients with scapulohumeral periarthritis, expand the range of motion of the shoulder joint, and reduce disability. The results showed that after excluding the studies of Liu [17] and Ibrahim [26], the heterogeneity was significantly reduced ($I^2 = 39\%$, $P < 0.01$), which may be related to the low quality of literature [17] or the use of different inclusion and exclusion criteria standards and efficacy evaluation criteria standards [26]. The incidence of scapulohumeral periarthritis is slow, when the patient with scapulohumeral periarthritis is in the adhesion period, the shoulder pain is persistent, and the night is aggravated obviously. The patient does not dare to suffer from the lateral position. The function of the shoulder joint is severely limited and in a 'frozen' state, accompanied by a certain degree of deltoid atrophy and osteoporosis [33]. Although scapulohumeral periarthritis has a certain degree of self-limitation, some patients will have dysfunction or even disability. However, the PNF technique can promote the recovery of joint function in patients with scapulohumeral periarthritis. PNF stretching technique promotes the proprioception of the shoulder joint within a limited range and stimulates the continuous contraction of the shoulder muscles through contraction-relaxation and other methods. This method can effectively prevent the occurrence of shoulder muscle atrophy, improve shoulder shape, improve shoulder muscle strength, and expand shoulder range of motion [34].

For patients with scapulohumeral periarthritis, the PNF technique not only provides simple and low-restrictive training methods, but also significantly reduces pain, improves joint mobility, shortens the course of treatment, and increases patient satisfaction. Moreover, studies have shown that the self-stretching technique of the shoulder in PNF technique can even be recommended as a treatment method to prevent shoulder diseases, which is helpful for patients in the early stage of scapulohumeral periarthritis to prevent other shoulder diseases, as not to delay the disease [35]. Therefore, medical staff should guide patients with scapulohumeral periarthritis to learn disease knowledge and provide corresponding PNF stretching training programs according to the patient's situation. By improving the patient's self-training ability, promote the recovery of joint function, and avoid disability in the later stage.

The PNF technique improves the daily living ability of SP

The results of the Meta-analysis showed that the PNF technique could effectively improve the daily living ability of patients with scapulohumeral periarthritis. The results showed that compared with conventional treatment, PNF stretching training was carried out by doctors according to the specific conditions of patients, selecting reasonable stretching methods, intensity, time, and frequency, and formulating targeted training programs to guide patients to carry out the correct and effective stretching actions required [29]. For example, sitting self-stretching rhomboid and trapezius middle (can improve shoulder joint forward), standing self-stretching infraspinatus and teres minor (can improve shoulder joint internal rotation), and other movements [36]. In this process, it is also very important to guide patients to consciously develop good living habits such as diet, exercise, and sleep. This helps patients to establish the confidence to actively respond to the disease, reduce their physical and mental, social, and emotional discomfort, improve self-care ability, and enhance self-efficacy [37]. In addition, in the later stage of PNF stretching training, mild patients can carry out home training under the remote supervision of doctors after they have mastered the action skillfully and standardly. During the stay at home, after the patient completes the established exercise plan every week, the medical staff can conduct guidance and inspection through telephone follow-up, platform uploading exercise videos, and calling cards [38]. Therefore, in the future, mobile devices and other channels can be used to increase patients' participation in rehabilitation training, improve patients' exercise compliance, and better play the effect of patients' independent training management. In the training management of patients with scapulohumeral periarthritis, timely adjustment of PNF stretching training intervention program and remote continuous intervention of scapulohumeral periarthritis are the future research trends.

Attention should be paid to the psychological state of patients with scapulohumeral periarthritis during the intervention of the PNF technique. At present, only one of the included studies included psychological status in the outcome indicators and used the self-rating anxiety scale (SAS) and self-rating depression scale (SDS). The results of descriptive analysis showed that the PNF technique could improve the psychological state of patients with scapulohumeral periarthritis to a certain extent. The study found that [20], patients with scapulohumeral periarthritis received the PNF technique combined with psychological counseling, which can not only effectively improve the clinical symptoms of scapulohumeral periarthritis, promote the recovery of shoulder joint function, but also reduce patients' anxiety, depression, and other negative emotions. Scapulohumeral periarthritis

is a chronic inflammatory disease with a long course of disease. Patients need long-term functional exercise to restore shoulder joint function. However, the effect of routine functional exercise in patients is generally not obvious, and factors such as physical labor, low temperature, cold, and dampness in daily life can lead to repeated attacks of the disease. Long-term pain and insomnia caused by these reasons can cause patients to have anxiety, depression, and other negative emotions, which interfere with the normal work and life of patients [4]. Therefore, we should pay attention to the psychological state of patients when using the PNF technique to intervene in patients with scapulohumeral periarthritis. In the process of stretching training, patients should be given positive psychological counseling, so that patients can gradually relax physically and mentally, and ensure compliance with training, to effectively enhance the training effect. In addition, medical staff can reasonably increase some relaxation training, such as deep breathing, meditation, listening to music, language hints, etc., in the process of using the PNF stretching technique intervention. By diverting the patient's attention to reduce negative emotions and pain. At the same time, giving patients positive and healthy psychological counseling can help patients pick up confidence in disease rehabilitation, and eliminate redundant psychological burdens, to promote the improvement of the disease and promote the recovery of shoulder joint function [39].

Limitations

There are still some limitations in this study. First of all, this study only retrieved Chinese and English literature, there may be publication bias, the sample size is small, and the vast majority of the research centers are in China, and the generality is low. Secondly, the study did not explain whether to implement a blind method for outcome evaluators, and there was a possibility of measurement bias. Finally, the outcome indicators of the included studies are mainly subjective evaluation indicators, with less description of safety and a lack of objective indicators and safety indicators. It is suggested that researchers can further improve the sample size, blind control, objective indicators, and safety indicators in future related experimental studies. And vigorously carry out multi-center three-blind clinical research, record the adverse reactions and compliance of PNF technique in the intervention process of patients with scapulohumeral periarthritis, to provide better evidence-based evidence for clinical practice.

Conclusion

In summary, the results of this study show that the PNF technique can have a positive impact on the prognosis of patients with SP, reduce pain intensity, improve the

function of the shoulder joint, expand the range of joint activity, improve daily living ability, and promote their healthy behavior. In addition, the psychological state of patients with scapulohumeral periarthritis should be paid attention to during the intervention. Future researchers should further improve the sample size, blind control, and safety indicators. Due to the limited quality and number of included trials, additional high-quality prospective clinical studies are needed to verify these conclusions.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12891-025-08303-w>.

Supplementary Material 1

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Author contributions

Chengyu Zhu and Xueyan Huang wrote the main manuscript text. Jiaying Yu and Ying Feng prepared Figs. 1, 2, 3, 4, 5 and 6; Tables 1, 2, 3 and 4. Haifang Zhou critically revised the important knowledge content. All authors reviewed the manuscript.

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Data availability

All data generated or analysed during this study are included in this published article [and its supplementary information files].

Declarations

Human ethics and consent to participate

Not applicable.

Consent to publish

Not applicable.

Registration statement

This study has been registered at PROSPERO (Identification number: CRD42024541073).

Competing interests

The authors declare no competing interests.

Author details

¹Hangzhou TCM Hospital of Zhejiang Chinese Medical University, No. 453 Tiayuchang Road, Xihu District, Hangzhou City, Zhejiang Province 310007, China

²Nursing School, Zhejiang Chinese Medical University, Hangzhou 310053, China

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