Journal of Orthopaedic Surgery and Research

RESEARCH

Open Access

Arthroscopic adhesiolysis in elderly patients with post-traumatic frozen shoulder

Zhusha Wang[1], Yulong Shi[2], Xu Yang[2], Qubo Ni[2] and Kai Tie[2*]

Abstract

Purpose The aim of the current study is to investigate the efficacy and risk factors associated with arthroscopic adhesiolysis in treating elderly traumatic frozen shoulder.

Methods One hundred and two elderly patients with post-traumatic frozen shoulder treated at our Hospital were selected. The patients were randomly divided into a study group and a control group, with 51 cases in each group. The study group was treated with arthroscopic adhesiolysis, and the control group received physical therapy combined with joint manipulation.

Results The operation time and intraoperative blood loss of the study group were (54.98 ± 5.94) min and (53.28 ± 4.93) ml, respectively. The Visual Analogue Scale (VAS) (0.87 ± 0.12, $P = 0.021$), Present Pain Intensity (PPI) (0.76 ± 0.07, $P = 0.016$), and Pain Rating Index (PRI) (5.32 ± 0.32, $P < 0.001$) scores were lower in the study group than the control group at 3 months post-treatment. Moreover, no significant differences were seen in terms of pain relief, daily living activities, shoulder joint function, and muscle strength between the two groups before the treatment; however, at 3 months post-treatment, the study group demonstrated better outcomes in these dimensions compared to the control group (all $P \leq 0.021$), with notably improved shoulder joint mobility (all $P < 0.001$).

Conclusion Arthroscopic adhesiolysis exerts beneficial outcomes for elderly patients with post-traumatic frozen shoulder. Age and fat infiltration are identified as risk factors influencing the efficacy of arthroscopic adhesiolysis in this patient population.

Keywords Arthroscopic, Frozen shoulder, Shoulder joint, Risk factors, Gerontics

Introduction

Traumatic frozen shoulder is a condition caused by external forces impacting the soft tissues surrounding the shoulder joint. It typically arises from acute shoulder or upper limb trauma, as well as prolonged immobilization, leading to circulatory disturbances, chronic inflammation, and degenerative changes in tendons, ligaments, and joint capsules [1, 2]. As a consequence, fibrosis develops in shoulder muscle fibers, leading to synovial adhesions with articular cartilage, as well as adhesions between shoulder tendons and ligaments [3]. This condition often results in secondary issues such as long head of the biceps tendinitis, supraspinatus tendinitis, and

*Correspondence:
Kai Tie
saintdiego2001@sina.com
[1]Department of Radiology, Zhongnan Hospital of Wuhan University, Wuhan, China
[2]Division of Joint Surgery and Sports Medicine, Department of Orthopedic Surgery, Zhongnan Hospital of Wuhan University, No. 169 Donghu Road, Wuchang District, Wuhan 430071, China

subacromial bursitis [4]. Following shoulder trauma, inflammatory exudation occurs, which gradually leads to fibrotic changes and the formation of adhesions between the synovium and articular cartilage, as well as tendons and ligaments in the shoulder region [5]. This, in turn, causes shoulder pain and restricted motion, ultimately affecting shoulder joint function and the patient's ability to carry out daily activities [6]. Elderly patients face additional challenges in recovery due to age-related physical decline and reduced joint mobility [7]. Therefore, it is of significant clinical importance to employ effective treatment methods to address post-traumatic frozen shoulder in elderly patients, aiming to restore shoulder joint function and enhance their daily life capabilities. Currently, clinical treatments for elderly patients with post-traumatic frozen shoulder mainly involve manual manipulation, intra-articular steroid injections, and non-steroidal anti-inflammatory drugs [8, 9]. Surgical interventions, such as arthroscopic capsular release and open surgical release of the shoulder joint, are considered for patients who do not respond well to conservative treatments [10]. However, most existing research in this field focuses on primary frozen shoulder, with limited investigation into the application of arthroscopic adhesiolysis in elderly patients with post-traumatic frozen shoulder[1]. Given this gap in knowledge, the present study aims to explore the effectiveness and risk factors associated with arthroscopic adhesiolysis in treating elderly patients with post-traumatic frozen shoulder.

Materials and methods

General characteristics of participants

This investigation constituted a prospective randomized controlled trial. According to the sample size calculation formula [11], $n = 2[(u_{1-\alpha+}u_{1-\beta)}s/\sigma]^2$, $\alpha = 0.05$, $\beta = 0.01$, $n = 109$, according to the regulations of the State Food and drug administration, taking 15% as the shedding release rate, it is determined that the grouping sample size of this study is $n = 109 \times 1/\ (1 \sim 0.15) = 102.3 \approx 102$. Then, a total of 102 elderly patients with post-traumatic frozen shoulder were recruited in Zhongnan Hospital of Wuhan University from February 2021 to March 2023. All patients after admission were randomly divided into 51 cases in each group by random number table method. The study group consisted of 18 males and 33 females, with an age range of 61 to 79 years and a mean age of 68.92 ± 8.35years. The duration of symptoms ranged from 0.3 to 4 months, with a mean duration of 1.56 ± 0.32 months. The control group comprised 16 males and 35 females, with an age range of 61 to 79 years and a mean age of 68.78 ± 8.83 years. The duration of symptoms ranged from 0.4 to 4 months, with a mean duration of 1.41 ± 0.29 months. There were no significant differences in general characteristics between the two groups ($P > 0.05$). The study protocol was approved by the Ethics Committee of Zhongnan Hospital of Wuhan University (No. 2022023 K).

Selection criteria

Inclusion criteria

In order to be included in the current study, the following inclusion criteria were met: Patients with a history of shoulder trauma, such as fractures or ligament tears; presence of ≥ 1 fixed tender points in the shoulder, continuous pain and the VAS score ≥ 4; age ranging from 60 to 80 years, with a symptom duration of 0.1 to 6 months, significant history of trauma, and concurrent history of local immobilization; patients presenting with limited range of motion (forward flexion < 120°, abduction < 90°, back extension < 15°, unable to complete internal rotation, external rotation < 45°) as the main clinical symptoms, possibly accompanied by muscle atrophy in the shoulder region; normal cognitive function assessed by Montreal Cognitive Assessment (MoCA) test and willingness to complete the treatment and sign the informed consent form.

Exclusion criteria

Patients with increased joint effusion in the shoulder joint, evidence of infectious inflammation in the joint, distinct fracture lines shown by imaging examinations, dislocation, or other abnormal signs; presence of bleeding tendencies, tumors, or tuberculosis in the shoulder; patients with severe cardiovascular or other internal diseases, as well as other malignancies; patients with poor compliance for rehabilitation training and inability to cooperate with treatment; patients with tuberculosis or shoulder tumors; patients with a history of previous shoulder joint surgery, rotator cuff injury, or joint trauma or dislocation.

Methods

In the control group, patients received combined treatment of physical therapy and joint manipulation [12]. The physical therapy included wall crawling with arm flexion and extension, reaching back with the hand to the waist, holding each position for 20 s with three sets of repetitions, and pendulum exercises, with forward and backward swinging as well as inward and outward swinging, ten times each with three sets of repetitions. Joint manipulation treatment included traction and longitudinal traction for the glenohumeral joint, with anterior-posterior sliding, flexion to the foot side, abduction to the foot side, and posterior to anterior sliding[12]. For the shoulder joint, manipulation involved flexion, extension, adduction, internal rotation, and external rotation swings. Each

treatment technique was applied for 20 s with three sets of repetitions, once daily, five days a week, for six weeks.

In the study group, patients underwent general anesthesia and were placed in a beach chair position. Gentle manipulation was first attempted to assess joint mobility. Before the surgery, 30 mL of 0.9% saline solution was injected into the joint cavity to ensure sufficient capsule expansion. Using an arthroscope (purchased from Advance Medicare Corpora, Indonesia, model: Karl-Storz), the glenohumeral joint was first explored to determine the presence of any concurrent diseases. Subsequently, joint cleaning and capsule release were performed. Through the standard posterior approach followed by the anterior upper approach through a planer and a radiofrequency (RF) scalpel, the arthroscope was inserted to observe the patient's shoulder cuff interval, subscapularis muscle surface, anterior joint capsule, and subscapular ligament release. Mild to moderate adhesions were loosened to the 5–7 o'clock positions (in arthroscopic view, the circular field is considered a clock, with 12 o'clock being the upper position, 6 o'clock being the lower position, 9 o'clock being the leftmost position, and 3 o'clock being the rightmost position, and so on). Severe adhesions were released 360°. During the inferior joint capsule release, the arthroscope was kept close to the patient's scapular glenoid surface to prevent damage to the axillary nerve. The posterior joint capsule was observed through the anterior approach, and the decision to release the posterior capsule was based on the degree of contracture. The subacromial space was entered, and a 0.9% saline solution was used for irrigation. Proliferative bursa and inflammatory tissue were removed, and subacromial decompression was performed based on the patient's degree of subacromial impingement. Hemostasis was performed promptly using the RF knife, and excess joint fluid was washed out. The extent and location of shoulder joint adhesions were determined through arthroscopic examination, and adhesions were released to restore the shoulder joint's range of motion to normal or near-normal levels. Specifically, the aim of the procedure was determined as abduction ≥ 90°, anteflexion and elevation ≥ 180°, adduction ≥ 40°, and backward extension ≥ 40°.

Postoperative management: After the surgery, hemostasis was performed on the patients. Postoperatively, the patients were managed in different phases [13]. In the first phase (postoperative week 0–1), starting from the second day after the surgery, the affected limb was engaged in pendulum exercises, and the surrounding muscles of the affected shoulder were subjected to isometric contractions. Gradually, shoulder flexion and abduction within 90° were allowed. The focus was on achieving externalrotation movement of the shoulder as close as possible to the level of the unaffected side. In the second phase (postoperative week 2–4), full range of motion for shoulder flexion, abduction, external rotation, and internal rotation was restored, with overhead movements gradually completed. In the third phase (postoperative week 4–6), muscle strength exercises were performed to consolidate shoulder flexion, abduction, external rotation, and internal rotation. By the end of the 6th week post-surgery, patients were expected to achieve basic recovery of normal daily activities and movement. Each exercise session was limited to 20–25 min, three times a day, with the number of repetitions adjusted according to the patient's recovery progress. Slow and controlled movements were emphasized during exercise.

Outcome measures

Efficacy

The clinical efficacy of the treatment was evaluated in accordance with the *Classification, Staging, Grading, and Treatment Guidelines for Frozen shoulder* [14]. The evaluation criteria were as follows: (1) Cured: Absence of shoulder joint pain, shoulder abduction > 150°-180°, shoulder external rotation > 90°-180°, and fingertip touching of the spine reaching the level of T12 or above.(2) Significantly effective: Reduction in shoulder joint pain, shoulder abduction > 135–150°, shoulder external rotation > 70°-90°, and fingertip touching of the spine reaching from above L3 to the level of T12.(3) Effective: Some relief in shoulder joint pain, shoulder abduction > 90°-135°, shoulder external rotation > 60°-70°, and fingertip touching of the spine reaching from above the iliac crest to the level of L3.(4) Ineffective: No relief in shoulder joint pain, shoulder abduction 0–90°, shoulder external rotation 0–60°, and fingertip touching of the spine only reaching below the iliac crest. The overall effective rate was calculated as (cure + significantly effective + effective)/total cases × 100%. All measurements of shoulder joint range of motion were conducted with patients in a standard standing position.

Pain intensity

The Pain intensity was assessed using the McGill Pain Questionnaire, specifically the Visual Analogue Scale (VAS) [15], Present Pain Intensity (PPI) [16], and Pain Rating Index (PRI) [17], before treatment and at 3 months post-treatment. The VAS score ranges from 0 to 10, the PPI score ranges from 0 to 5, and the PRI score ranges from 0 to 45. The pain intensity is positively correlated with the VAS, PPI, and PRI scores.

Shoulder joint function.

The Constant-Murley Shoulder Score was used to evaluate the patients' shoulder joint function before treatment and at 3 months post-treatment [18]. The scoring system consists of four dimensions: pain (0–15 points),

activities of daily living (ADL, 0–20 points), range of motion (ROM, 0–40 points), and manual muscle testing (MMT, 0–25 points). A higher VAS score indicates more significant pain, while higher scores in ADL, ROM, and MMT indicates better shoulder joint function.

Shoulder joint range of motion

Before treatment and at 3 months post-treatment, the range of motion of shoulder joint was measured, including flexion, abduction, internal and external rotation [19]. The flexion measurement standard was: the axis of the goniometer was placed on the acromion, one arm of the goniometer was parallel to the mid-axillary line, and the other arm was moved along the longitudinal axis of the upper arm to read the angle between the two arms. The measurement standard of abduction mobility is: the axis of the goniometer was placed at the back of the shoulder joint, one arm of the goniometer was parallel to the body's midline, and the other arm was moved with the upper arm to read the angle between the two arms. The measurement standard of external and internal rotation was: with the patient in a supine position, the arm was abducted to 90°, the elbow joint was flexed at 90°, the palm faced downward, the forearm was vertical to the ground, and the axis of the goniometer passed through the vertical axis of the humerus to read the angle between the two arms. The internal rotation range of motion was scored based on the patient's ability to touch the sacrum with the tip of the thumb (1 point), L5-1 (2–6 points), or T12-1 (7–18 points).

Statistical analysis

SPSS 21.0 software was used to analyze the data. Parametric data following a normal distribution were expressed as $\bar{x}\pm s$. One-way analysis of variance was used for overall comparison among groups, with the Least-Significant Difference (LSD) method employed for pair wise comparison between and within groups. Categorical data were expressed as rates (%), and the chi-square test was used for comparisons. Multiple-factor logistic regression analysis was used to identify the risk factors affecting the efficacy of arthroscopic adhesiolysis for treating elderly patients with post-traumatic frozen shoulder. A significance level of $P<0.05$ was considered statistically significant.

Results

There were no significant differences in age, sex, BMI, disease duration, affected side, and Gerber classification between the two groups ($P>0.05$), as shown in Table 1.

At 3 months post-treatment, the research group showed significantly higher treatment efficacy compared to the control group ($P<0.05$), as laid out in Table 2.

Table 1 Comparison of general data between the two groups

Index	Study group ($n=51$)	Control group ($n=51$)	t/χ^2	P
Age (years)	68.92 ± 8.35	68.78 ± 8.83	0.212	0.916
Sex (*n*)			0.279	0.783
Male	18	16		
Female	33	35		
BMI (kg/cm^2)	23.09 ± 2.87	23.17 ± 2.94	-0.313	0.079
Duration of illness (months)	1.56 ± 0.32	1.41 ± 0.29	0.439	0.663
Affected side (*n*)			0.005	0.943
Left	23	22		
Right	28	29		
Gerber classification (*n*)			0.157	0.692
Type II	23	25		
Type III	28	26		
Hypertension (*n*)	7	5	0.425	0.514
Diabetes (*n*)	8	6	0.331	0.565
Smoking history (n)	9	7	0.297	0.586
Alcohol consumption history (*n*)	7	5	0.378	0.539
Preoperative pain (*n*)			0.353	0.552
Moderate ($5 \geq VAS \geq 3$)	23	26		
Severe($VAS \geq 5$)	28	25		
Injury site (*n*)			0.744	0.863
Subscapularis tendon injury	32	35		
Infraspinatus tendon injury	10	9		
Supraspinatus tendon injury	9	7		
Fat infiltration (*n*)	21	17		

Table 2 Comparison of treatment efficacy between the two groups

Index	Study group ($n=51$)	Control group ($n=51$)	χ^2	*P*
Cured	34	26		
Significantly effective	9	10		
Effective	6	6		
Ineffective	2	9		
Total effective rate (%)	49(96.08)	42(82.35)	4.993	0.025

Table 3 Comparison of pain intensity between the two groups ($\bar{x}\pm s$, points)

Index	Time	Study group ($n=51$)	Control group ($n=51$)	t	*P*
VAS	Before treatment	6.98 ± 1.21	6.89 ± 1.17	0.003	0.909
	3 months after treatment	0.87 ± 0.12	1.23 ± 0.09	-8.971	0.021
PPI	Before treatment	2.98 ± 0.45	2.91 ± 0.41	0.617	0.726
	3 months after treatment	0.76 ± 0.07	1.23 ± 0.09	-9.761	0.016
PRI	Before treatment	28.32 ± 2.39	28.23 ± 2.41	0.213	0.721
	3 months after treatment	5.32 ± 0.32	7.83 ± 0.37	-12.761	<0.001

VAS: Visual Analogue Scale; PPI: Present Pain Intensity; PRI: Pain Rating Index

Table 4 Comparison of shoulder joint function between the two groups ($\bar{x}\pm s$, points)

Index	Time	Study group ($n=51$)	Control group ($n=51$)	t	*P*
Activities of daily living	Before treatment	12.01 ± 2.03	11.97 ± 2.07	0.183	0.863
	3 months after treatment	16.87 ± 2.09	14.92 ± 2.04	14.871	<0.001
Joint range of motion (°)	Before treatment	27.29 ± 3.21	27.12 ± 3.19	1.471	0.228
	3 months after treatment	32.76 ± 3.37	29.54 ± 3.21	16.293	<0.001
Muscle strength	Before treatment	17.23 ± 3.12	17.12 ± 3.09	0.495	0.781
	3 months after treatment	19.83 ± 3.09	18.67 ± 3.11	25.093	<0.001

Table 5 Comparison of shoulder joint range of motion between the two groups

Index	Time	Study group ($n=51$)	Control group ($n=51$)	t	*P*
Flexion (°)	Before treatment	71.39 ± 3.02	71.28 ± 3.11	0.038	0.761
	3 months after treatment	163.76 ± 4.93	156.89 ± 4.01	16.932	<0.001
Abduction (°)	Before treatment	72.95 ± 3.16	72.87 ± 3.09	0.383	0.095
	3 months after treatment	166.93 ± 4.23	158.81 ± 4.34	24.391	<0.001
External rotation (°)	Before treatment	9.57 ± 1.32	9.49 ± 1.29	0.308	0.091
	3 months after treatment	42.81 ± 2.43	38.76 ± 2.39	23.918	<0.001
Internal rotation	Before treatment	3.59 ± 0.47	3.51 ± 0.59	1.468	0.225
	3 months after treatment	10.21 ± 1.09	12.46 ± 1.26	-13.371	<0.001

Before treatment, there were no significant differences in VAS, PPI, and PRI scores between the two groups ($P>0.05$). However, at 3 months post-treatment, the VAS, PPI, and PRI scores in the study group were significantly lower than those in the control group ($P<0.05$), as shown in Table 3.

Before treatment, no significant differences were seen in pain, activities of daily living, range of motion, and muscle strength scores between the two groups ($P>0.05$). However, at 3 months post-treatment, the study group showed significantly superior outcomes in these dimensions compared to the control group ($P<0.05$), as shown in Table 4.

Before the treatment, there were no significant differences in flexion, abduction, external rotation, and internal rotation angles between the two groups ($P>0.05$). However, at 3 months post-treatment, the study group demonstrated significantly greater improvements in flexion, abduction, external rotation, and internal rotation compared to the control group ($P<0.05$), as shown in Table 5.

The incidence of adverse reactions was lower in the study group than in the control group, but the difference was not significant ($P>0.05$), as shown in Table 6.

Risk factors for the efficacy of arthroscopic adhesiolysis in elderly patients with post-traumatic frozen shoulder: single-factor analysis.

There were no significant differences in BMI, affected side, Gerber classification, hypertension, diabetes, smoking history, alcohol consumption history, and injury site between the two groups ($P>0.05$). However, there were significant differences in sex, age, disease duration,

Table 6 Comparison of adverse reactions between the two groups

Index	Study group ($n=51$)	Control group ($n=51$)	t	*P*
Joint infection	0	0		
Nerve injury	0	0		
Vascular injury	0	0		
Hemarthrosis	0	1		
Muscle weakness	0	2		
Shoulder joint instability	1	1		
Overall incidence of adverse reactions (%)	1(%)	4(%)	1.893	0.169

Table 7 Single-factor analysis of risk factors for the efficacy of arthroscopic adhesiolysis in elderly patients with post-traumatic frozen shoulder

Index	Effective ($n=49$)	Ineffective ($n=2$)	t/χ^2	*P*
Age (years)			19.151	<0.001
61–69	46	0		
> 70	3	2		
Sex (*n*)			3.816	0.051
Male	16	2		
Female	33	0		
BMI (kg/cm^2)	22.92 ± 3.21	23.12 ± 3.43	-0.482	0.414
Duration of disease (months)	1.46 ± 0.23	1.59 ± 0.21	-6.921	0.029
Affected side (*n*)			0.021	0.888
Left side	22	1		
Right side	27	1		
Gerber classification (*n*)			0.021	0.888
Type II	22	1		
Type III	27	1		
Hypertension (*n*)	6	1	2.313	0.128
Diabetes (*n*)	7	1	1.853	0.173
Smoking history (*n*)	8	1	1.499	0.221
Alcohol consumption history (*n*)	6	1	2.313	0.128
Preoperative pain (*n*)			0.020	0.888
Moderate	22	1		
Severe	27	1		
Injury location (*n*)			2.671	0.445
Infraspinatus tendon injury	31	1		
Supraspinatus tendon injury	9	1		
Subscapularis tendon injury	9	0		
Fat infiltration (*n*)	19	2	2.974	0.085
Length of hospital stay (d)	5.78 ± 0.71	6.37 ± 0.78	-9.032	0.007
VAS score (before treatment)	6.71 ± 1.29	7.56 ± 1.32	-8.382	0.019
PPI score (before treatment)	2.89 ± 0.51	3.17 ± 0.46	-7.931	0.023
PRI score (before treatment)	28.21 ± 0.22	28.46 ± 0.27	-6.291	0.032
Forward flexion (°)	71.01 ± 4.87	71.23 ± 4.28	-1.076	0.967
Abduction (°)	72.16 ± 4.75	72.65 ± 5.13	-1.092	0.942
External rotation (°)	9.32 ± 1.82	9.87 ± 1.76	-1.298	0.876
Internal rotation (°)	3.42 ± 0.56	3.56 ± 0.47	-0.303	0.327

VAS: Visual Analogue Scale; PPI: Present Pain Intensity; PRI: Pain Rating Index

preoperative pain, length of hospital stay, VAS, PPI, and PRI scores ($P<0.05$), as summarized in Table 7.

Risk factors for the efficacy of arthroscopic adhesiolysis in elderly patients with post-traumatic frozen shoulder: multiple-factor logistic regression analysis.

The independent variables were set as the factors with significant differences in the single-factor analysis, including sex, age, disease duration, preoperative pain, length of hospital stay, VAS, PPI, PRI, and fat infiltration. The dependent variable was the efficacy of arthroscopic adhesiolysis in elderly patients with post-traumatic

Table 8 Multiple-factor logistic regression analysis of risk factors for the efficacy of arthroscopic adhesiolysis in elderly patients with post-traumatic frozen shoulder

Index	β	SE	Wdlodχ^2 value	OR(95%CI)	*P* value
Age	1.122	0.325	12.757	3.176(1.668–5.887)	<0.001
Sex	2.037	1.119	3.213	3.283(0.857–7.761)	0.067
Duration of disease	0.946	0.668	2.262	2.568(0.742–5.275)	0.136
Fat infiltration	0.276	0.109	7.651	1.278(1.052–1.763)	0.003
Preoperative pain	0.603	0.319	1.837	1.672(1.002–3.187)	0.057
Length of hospital stay	0.467	0.265	1.732	1.609(0.981–2.861)	0.089
VAS score (before treatment)	0.639	0.348	1.842	1.893(0.921–2.871)	0.076
PPI score (before treatment)	0.548	0.307	1.772	1.729(0.937–3.091)	0.079
PRI score (before treatment)	0.707	0.472	1.478	2.021(0.893–4.391)	0.139
Fat infiltration	0.328	0.127	6.761	2.187(1.089–2.981)	0.009

VAS: Visual Analogue Scale; PPI: Present Pain Intensity; PRI: Pain Rating Index

frozen shoulder. Multiple-factor logistic regression analysis showed that age, fat infiltration, and surgical time were the risk factors affecting the efficacy of arthroscopic adhesiolysis (Table 8).

Discussion

In recent years, with the continuous development of arthroscopic techniques and equipment, arthroscopic adhesiolysis has become the preferred treatment for primary frozen shoulder [20]. However, there are limited reports in the relevant literature on whether arthroscopic adhesiolysis can be performed and its treatment effect for patients with post-traumatic frozen shoulder. Current conservative treatments for frozen shoulder, such as hydrodilatation, have shown transient improvements in shoulder disability and passive external rotation [21]. However, for elderly patients with post-traumatic frozen shoulder who fail to respond to non-surgical interventions, arthroscopic adhesiolysis offers a more definitive solution by directly addressing adhesions under direct visualization. Yan et al. [22] reported in their study that arthroscopic adhesiolysis combined with rotator cuff repair can effectively shorten the operation time and length of hospital stay for patients with rotator cuff injury and secondary frozen shoulder, as well as reduce intraoperative blood loss. Based on our study, the operation time, intraoperative blood loss, and hospitalization time were significantly shorter in the study group ($P<0.05$), suggesting that arthroscopic adhesiolysisis able to reduce intraoperative blood loss, operation time, and hospitalization time in elderly patients with post-traumatic frozen shoulder. Sundararajan et al. [23] found in their research that arthroscopic adhesiolysis effectively treats frozen shoulder. She et al. [24] also indicated that joint loosening surgery effectively treats patients with frozen shoulder, leading to improved shoulder joint function and pain relief. The results of this study depicted that at 3 months after treatment, the effectiveness in the study group was significantly higher than that in the control group ($P<0.05$), indicating that arthroscopic adhesiolysis effectively improves the clinical symptoms of elderly patients with post-traumatic frozen shoulder with significant effectiveness. This may be due to the fact that arthroscopic adhesiolysis can, with the help of arthroscopy, cut and release the adhesion area and contracture joint capsule under direct vision, remove the pathogenic factors, so as to solve the lesions, control the clinical symptoms, and play a therapeutic role. Pain is the main clinical manifestation of elderly patients with post-traumatic frozen shoulder and is also the primary purpose of their medical visit. Pain prevents patients from performing movements and exacerbates adhesions, making the condition more severe. Therefore, pain remains one of the main observed indicators in this study [23]. Kim et al. [25] used arthroscopic capsular release surgery to treat frozen shoulder patients and found that this method effectively reduces postoperative VAS scores, improves shoulder joint function assessed by ASES scores, and increases the range of shoulder joint motion. Our study showed that at 3 months after treatment, the VAS, PPI, and PRI scores in the study group were lower than those in the control group ($P<0.05$), indicating that arthroscopic adhesiolysis effectively reduces VAS, PPI, and PRI scores in elderly patients with post-traumatic frozen shoulder, thereby alleviating their pain. This may be due to the fact that 0.9% sodium chloride solution was used to wash and clean the proliferative bursa and inflammatory proliferative tissue during the operation, and the pain of the shoulder joint is closely related to the presence of pro-inflammatory factors, so arthroscopic adhesiolysis can effectively relieve the pain of patients.

Li et al. [26] suggested in their study that supraclavicular nerve block combined with arthroscopic adhesiolysis alleviates the degree of pain and improves shoulder joint function in patients with frozen shoulder. In our results, at 3 months after treatment, the study group had lower scores in pain, daily living activities, joint mobility, and muscle strength compared to the control group ($P<0.05$),

indicating that arthroscopic adhesiolysis evidently improves shoulder joint function in elderly patients with post-traumatic frozen shoulder. Bottoni et al. [27] found positive effects of arthroscopic surgery on shoulder joint function and shoulder joint mobility in patients with frozen shoulder. Huang et al. [17] asserted that arthroscopic adhesiolysis can relieve clinical symptoms, reduce pain, and increase shoulder joint mobility in patients with frozen shoulder. According to Wang et al. [28], arthroscopic adhesiolysisis able to increase shoulder joint mobility in patients with frozen shoulder. The results of this study demonstrated that at 3 months after treatment, the study group had lower angles in flexion, abduction, external rotation, and internal rotation compared to the control group ($P<0.05$). This suggests that arthroscopic adhesiolysis greatly increases shoulder joint mobility in elderly patients with post-traumatic frozen shoulder. This may be due to the arthroscopic detection of the location and extent of shoulder joint adhesion during arthroscopic adhesiolysis, and the release, so that the range of motion of the shoulder joint returns to normal or close to normal. At the same time, combined with postoperative rehabilitation training, the range of motion of the shoulder joint is restored. Bottoni et al. [29] pointed out in their research that arthroscopic adhesiolysis can reduce the occurrence of adverse reactions in patients with frozen shoulder and restore shoulder joint function. Consistently, we found that the incidence of adverse reactions in the study group was lower than that in the control group ($P>0.05$), suggesting that arthroscopic adhesiolysis does not increase the occurrence of adverse reactions in elderly patients with post-traumatic frozen shoulder.

Our previous study [30] proposed that risk factors for elderly patients with frozen shoulder include fat infiltration and VAS score. In the current study, there were significant differences between the two groups in terms of sex, age, course of disease, preoperative pain, hospitalization time, VAS, PPI, and PRI ($P<0.05$), indicating that the influencing factors for elderly patients with post-traumatic frozen shoulder treated with arthroscopic adhesiolysis are sex, age, course of disease, preoperative pain, surgical time, hospitalization time, VAS, PPI, and PRI. Through multiple-factor logistic regression analysis of the risk factors for the efficacy of arthroscopic adhesiolysis in the treatment of elderly patients with post-traumatic frozen shoulder, the results showed that age, fat infiltration, and surgical time were risk factors for the efficacy of arthroscopic adhesiolysis in elderly patients with post-traumatic frozen shoulder, which is consistent with the aforementioned research findings. The results may be attributed to the following factors: (1) Elderly patients have reduced physical function, slower blood circulation, and diminished tissue repair ability after surgery, which can have an impact on the efficacy of the treatment [31]. (2) Fat infiltration serves as one of the indicators for assessing muscle quality and predicting the prognosis of arthroscopic adhesiolysis, as well as the integrity of the repair. Other studies have also shown that as patients age, their tissues become less tolerant to trauma, affecting tissue perfusion and depleting growth factors necessary for tendon healing, thereby influencing the prognosis of patients with frozen shoulder. (3) Prolonged surgical time leads to increased intraoperative bleeding and higher risks associated with the procedure.

The main advantages of physical therapy combined with joint mobilization are that it is a conservative treatment without trauma, for which complications such as infection and bleeding caused by surgery could be avoid. It can improve the range of motion of the joint, enhance muscle strength, promote local blood circulation, reduce pain and inflammation, and has a certain effect on traumatic arthritis and traumatic scapulohumeral frozen shoulder. It brings less pain compared with surgery, for which it is more acceptable. In addition, it can be individually adjusted according to the specific conditions and recovery stages of patients, which is helpful for the rehabilitation of patients. However, it also has shortcomings. For patients with severe disease, joint adhesion or large degree of injury, the curative effect is limited. The treatment cycle is relatively long, and patients need to have enough patience and compliance. Depending on the patient's own physical condition and degree of cooperation, efficacy of treatment will be impaired if the patient can not adhere to or correctly implement. The advantages of arthroscopic adhesiolysis are as follows: It is a minimally invasive surgery with less trauma and it allows for rapid recovery. It can directly release the adhesion tissue in the joint, and quickly and effectively improve the range of motion of the joint, especially for patients with post-traumatic scapulohumeral frozen shoulder who fail to respond to conservative treatment. It can be operated under direct vision with high accuracy, which can better deal with the diseased tissue and reduce the damage to the surrounding normal tissue. It can significantly relieve pain and improve the quality of life of patients, and the recovery time is shorter than that of exercise therapy combined with joint mobilization. The main shortcomings are that it is a traumatic operation, and some patients are difficult to accept. There are strict indications and contraindications, and not all patients are suitable. Therefore, the specific choice of treatment method in clinical practice needs to be decided by doctors according to the patient's specific condition, physical condition, age, and occupational needs.

There are several limitations in this study worth noting. Firstly, the sample size is relatively small, and the follow-up duration is short. Future research should aim to expand the sample size and the follow-up period to verify

the long-term efficacy. Secondly, the identification of risk factors influencing postoperative outcomes remains preliminary. Further investigation is warranted to delve deeper into these factors, potentially establishing them as grouping criteria for comparative studies, and enabling more objective assessment of their impact on risk.

Conclusion

Taken together, arthroscopic adhesiolysis is proven to be effective in significantly improving clinical symptoms, alleviating pain, restoring shoulder joint function and mobility, and reducing the occurrence of adverse reactions in elderly patients with post-traumatic frozen shoulder. However, age and fat infiltration are considered risk factors that may influence the efficacy of this surgical treatment in this specific patient population.

Abbreviations

VAS	Visual analogue scale
PPI	Present pain intensity
PRI	Pain rating index
RF	Radiofrequency
ADL	Activities of daily living
ROM	Range of motion
MMT	Manual muscle testing

Acknowledgements

We are grateful to all staff professionals and participants.

Author contributions

ZS W contributed to the conception and design of the study; YS and XY performed the experiments, collected and analyzed data; QB N wrote the manuscript; KT revised the manuscript. All authors reviewed and approved the final version of the manuscript.

Funding

This study was funded by National Science Foundation of Hubei Province (No. 2023AFB696), and Discipline Cultivation Funding of Zhongnan Hospital of Wuhan University (No. ZNXKPY2022040).

Data availability

The datasets analyzed during the current study are not publicly available due to the personal privacy but are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The current study was conducted in accordance with the Helsinki Declaration of the World Medical Association and approved by the Ethics Committee of XX Hospital. Informed consent was obtained from all the study subjects before enrollment.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Received: 24 October 2024 / Accepted: 18 March 2025
Published online: 25 March 2025

References

1. Hwang JT. Arthroscopic capsular release versus manipulation under anesthesia for primary frozen shoulder. Clin Shoulder Elb. 2020;23:167–8.
2. Prasetia R, Handoko HK, Rosa WY, Ismiarto AF, Petrasama, Utoyo GA. Primary traumatic shoulder dislocation associated with rotator cuff tear in the elderly. Int J Surg Case Rep. 2022;95:107200.
3. Makki D, Al-Yaseen M, Almari F, Monga P, Funk L, Basu S, Walton M. Shoulder hydrodilatation for primary, post-traumatic and post-operative adhesive capsulitis. Shoulder Elb. 2021;13(6):649–55.
4. Arce G. Primary frozen shoulder syndrome: arthroscopic capsular release. Arthrosc Tech. 2015;4(6):e717–720.
5. Chan HBY, Pua PY, How CH. Physical therapy in the management of frozen shoulder. Singap Med J. 2017;58(12):685–9.
6. Chiu CH, Sheu H, Chen P, Berco D, Chan YS, Chen AC. Arthroscopic Pan-Capsular and transverse humeral ligament release with biceps tenodesis for patients with refractory frozen shoulder. Med (Kaunas Lithuania). 2022;58(12):1712.
7. Sivasubramanian H, Chua CXK, Lim SY, Manohara R, Ng ZWD, Poh VPK. Arthroscopic capsular release to treat idiopathic frozen shoulder: how much release is needed? Orthop Traumatol Surg Research: OTSR. 2021;107:102766.
8. Dimmick S, Hayter C, Linklater J. Acute calcific periarthritis-a commonly misdiagnosed pathology. Skeletal Radiol. 2022;51:1553–61.
9. Koob E, Haasters J, Schlegel KF. [Conservative treatment possibilities of post-traumatic shoulder stiffness]. Hefte Unfallheilkd. 1975;(126):190–3.
10. Zong LZ, Ma L, Liu YY. Arthroscopic capsular release for the treatment of post-stroke frozen shoulder: a protocol for systematic review. Medicine. 2020;99(39):e22025.
11. Lv Y, Feng G. Common sample size estimation methods in medical research. Chronic Pathematol J. 2016;(4):359–61.
12. Zhang G, Ouyang G, Guan C, Xu S, Bao H. Effects of Mulligan dynamic joint mobilization in the treatment of traumatic periarthritis of shoulder in the elderly. Practical Geriatr. 2022;36(03):292–4.
13. Wu Z, Sun Y, Luo P, Xia X. Arthroscopic adhesiolysis for the treatment of post-traumatic periarthritis of shoulder. J Clin Orthop. 2021;24(05):660–3.
14. Cheng S, Lu NZ, Zhang TW, Pu JS, Li W, Xu HL, Wang HF, Huang J. Classification, staging, grading and treatment of shoulder periarthritis. Pain Clin J. 2013;9:205–8.
15. Sung YT, Wu JS. The visual analogue scale for rating, ranking and Paired-Comparison (VAS-RRP): A new technique for psychological measurement. Behav Res Methods. 2018;50(4):1694–715.
16. Zainal-Abidin RA, Afiqah-Aleng N. Protein-Protein Interaction (PPI) Network of Zebrafish Oestrogen Receptors: A Bioinformatics Workflow. 2022;12.
17. Huang J, Zhu S, Zhao C, Huang W, Shui W, Hu N, Chen H. [Effectiveness of arthroscopic 360° capsular release for frozen shoulder]. Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi. 2021;35:1141–6.
18. Hollman F, de Raadt WM, Wolterbeek N, van Rhijn LW, Auw Yang KG. Interchangeability of diverse analog scales used within the Constant-Murley score. Arthrosc Sports Med Rehabil. 2021;3:e521–6.
19. de KaszyF WM, Wołłecka M, Lubiatowski P. Shoulder range of motion measurement using inertial measurement Unit-Concurrent validity and reliability. Sens (Basel). 2023;23(17):7499.
20. Yanlei GL, Keong MW, Tijauw Tjoen DL. Do diabetic patients have different outcomes after arthroscopic capsular release for frozen shoulder? J Orthop. 2019;16:211–5.
21. Poku D, Hassan R, Migliorini F, Maffulli N. Efficacy of hydrodilatation in frozen shoulder: a systematic review and meta-analysis. Br Med Bull. 2023;147(1):121–47.
22. Yan L. Effect of arthroscopic release combined with rotator cuff repair in the treatment of rotator cuff injury with secondary frozen shoulder. Guide China Med. 2022;20:25–8.
23. Sundararajan SR, Dsouza T. Arthroscopic capsular release versus manipulation under ana esthesia for treating frozen shoulder - a prospective randomised study. 2022;46(11):2593–601.
24. She G, Nie C, Liu Y, Peng X, Zhang Q, Li Y. [Bilateral ultrasound-guided supraclavicular brachial plexus block in shoulder joint release surgery for shoulder periarthritis]. Nan Fang Yi Ke Da Xue Xue bao = J South Med Univ. 2015;35:1193–6.
25. Kim YS, Lee HJ, Park IJ. Clinical outcomes do not support arthroscopic posterior capsular release in addition to anterior release for shoulder stiffness: a randomized controlled study. Am J Sports Med. 2014;42:1143–9.

26. Li Y, Meng F. Observation on the curative effect of superior scapular nerve block combined with shoulder joint release in the treatment of periarthritis of shoulder. J Front Med. 2015:179.
27. Bottoni CR, Zhou L, Cruz CR. Arthroscopic versus open anterior shoulder stabilization: response. Am J Sports Med. 2022;50:Np25–6.
28. Wang YD, Ming YX, Pang YH, Chen WN, Zong XH, Wu JY, Deng YK. Effectiveness of arthroscopic management of idiopathic shoulder stiffness: A meta-analysis. J Back Musculoskelet Rehabil. 2021;34:565–72.
29. Bottoni CR, Johnson JD, Zhou L, Raybin SG, Shaha JS, Cruz CA, Lindell KK, Thoma DC. Arthroscopic versus open anterior shoulder stabilization: A prospective randomized clinical trial with 15-Year Follow-up with an assessment of the glenoid being On-Track and Off-Track as a predictor of failure. Am J Sports Med. 2021;49:1999–2005.
30. Tie K, Wang H, Yang X, Ni Q, Chen L. Analysis of risk factors for advanced age in patients with frozen shoulder. Aging Clin Exp Res. 2023;35:615–20.
31. Kraal T, Hekman K, van den Bekerom MPJ. What is the right timing for arthroscopic capsular release of a frozen shoulder?? Letter to the editor. Orthop J Sports Med. 2020;8:2325967120903710.

Publisher's note