Article

Effects of Animated Video Instruction Combined With Practical Demonstration Video on Postoperative Functional Exercise Compliance and Rehabilitation Outcomes in Patients Undergoing Arthroscopic Shoulder Surgery

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AIM: Patients undergoing shoulder arthroscopy often exhibit poor rehabilitation compliance due to kinesiophobia and inadequate understanding of postoperative rehabilitation. This study aimed to investigate the impact of animated video instruction combined with practical demonstration videos on postoperative compliance with functional exercises, correct brace use, and recovery of shoulder function in patients undergoing arthroscopic shoulder surgery, thereby providing evidence to optimize rehabilitation protocols.
METHODS: This prospective randomized controlled trial enrolled 140 patients between January 2024 and January 2025, who were randomly assigned to an experimental group (n = 70, combined video-based intervention with weekly application (APP)-based remote rehabilitation guidance) or a control group (n = 70, conventional care). Outcome measures included exercise compliance (6 weeks, 3 months, and 6 months), brace usage accuracy (1 week, 6 weeks, and 3 months), Constant-Murley Score (CMS), complication rate, and nursing satisfaction.
RESULTS: The experimental group demonstrated significantly higher exercise compliance rates at 6 weeks, 3 months, and 6 months (90.00%, 78.57%, 71.43%, respectively) than the control group (71.43%, 57.14%, 41.43%, respectively; all $p < 0.05$). Correct brace usage rates at 1 week and 6 weeks were also significantly higher in the experimental group (75.71% and 88.57%, respectively) compared with the control group (41.43% and 58.57%, respectively; both $p < 0.001$). At 1 week, 6 weeks, and 3 months postoperatively, the experimental group achieved significantly higher total CMS scores and subscores, including pain, range of motion, muscle strength, and activities of daily living, than the control group (all $p < 0.05$). Additionally, the experimental group showed a lower overall complication rate (8.57% vs. 24.29%, $p = 0.012$) and a higher proportion of "very satisfied" nursing evaluations (85.71% vs. 54.29%, $p < 0.001$).
CONCLUSIONS: The combined video-based rehabilitation intervention significantly improves postoperative exercise compliance, correct brace use, and early recovery of shoulder function. This approach may serve as a standardized rehabilitation nursing strategy for broader clinical application.
CLINICAL TRIAL REGISTRATION: ISRCTN registry (ISRCTN13541497).

Keywords: arthroscopic shoulder surgery; postoperative rehabilitation; compliance; animated video; practical demonstration video

Introduction

The incidence of rotator cuff injury and acromial impingement syndrome has increased significantly in recent years. The incidence of rotator cuff injury varies across regions and populations but demonstrates an overall upward trend, particularly among middle-aged and elderly individuals aged 40 years and older. The incidence is slightly higher in females than in males, with high-risk populations including individuals engaged in long-term heavy physical labor, those with excessive shoulder use (e.g., construction workers and athletes), and patients with abnormal shoulder anatomical structures [1,2]. As one of the primary causes of shoulder pain, acromial impingement syndrome accounts for approximately 44%–65% of shoulder pain cases according to literature reports. Sedentary individuals, manual laborers, and sports enthusiasts who frequently perform overhead shoulder movements (e.g., chefs and fitness enthusiasts) are more susceptible due to factors such as scapular muscle imbalance and abnormal acromial morphology, including hooked acromion [3,4].

With the development of minimally invasive technology, arthroscopic shoulder surgery has become the preferred treatment for the abovementioned conditions, because of its advantages of minimal trauma, rapid recovery, and fewer complications. This procedure enables precise repair of damaged tissues and debridement of pathological lesions, thereby achieving favorable clinical outcomes [5,6]. The rotator cuff, a tendon complex surrounding the humeral head, plays a pivotal role in maintaining shoulder joint stability and mobility. Postoperative functional

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recovery largely depends on systematic rehabilitation exercises, including passive range-of-motion training and active muscle-strengthening exercises, to prevent muscle atrophy and restore joint mobility [7]. However, during the early postoperative stage, many patients develop kinesiophobia, characterized by excessive fear of pain, reinjury, or damage to the surgical site, resulting in avoidance of rehabilitation exercises and poor compliance. This psychological barrier has increasingly been recognized as an important factor influencing functional recovery in musculoskeletal disorders. Postoperatively, specialized braces, such as shoulder abduction braces or neck-wrist slings, are often required to facilitate rehabilitation. However, patients commonly experience errors in brace application, including inappropriate abduction angles and excessive or insufficient tightness [8]. Notably, orthopedic braces are a common cause of device-related pressure injuries (DRPI), accounting for approximately 30% of hospital-acquired pressure injuries. Bony prominences, including the acromion and greater tuberosity of the humerus, are particularly susceptible to skin breakdown and ulceration caused by prolonged compression, resulting in exacerbated pain and delayed rehabilitation [9]. Incorrect brace use may also directly impair recovery of joint mobility: excessive immobilization can cause joint stiffness, while angular deviations may generate abnormal stress on tendon repair sites, thereby affecting rehabilitation outcomes [10,11]. However, traditional nursing models that rely on verbal education and printed manuals have notable limitations. Their abstract content cannot intuitively demonstrate brace positioning or exercise techniques, making them insufficient to meet the needs of patients with different injury types and rehabilitation stages [12,13].

Therefore, this study aimed to investigate the application of a combined video intervention (animated instruction combined with practical demonstration) through a prospective, randomized controlled trial to evaluate its effects on exercise compliance, brace usage accuracy, and functional recovery, and to provide evidence to optimize rehabilitation protocols.

Methods

Study Subjects

This study was registered in ISRCTN (registration number: ISRCTN13541497) and is available at the ISRCTN registry (https://www.isrctn.com/ISRCTN13541497). This study followed the Consolidated Standards of Reporting Trials (CONSORT) 2025 reporting guidelines when writing the report and used corresponding checklists **(Supplementary Materials)** to ensure the completeness and transparency of the report.

Study Design

A prospective randomized controlled trial (RCT) with a parallel-group design was conducted. Patients who underwent arthroscopic shoulder surgery at Beijing Jishuitan Hospital between January 2024 and January 2025 were enrolled. Recruitment was completed, and all patients completed the 6-month follow-up. Eligible participants were randomly assigned to the experimental group (animated video instruction combined with practical demonstration video nursing) or the control group (conventional nursing) at a 1:1 ratio. The flow chart of this study is shown in Fig. 1. This study strictly adhered to the principles of the Declaration of Helsinki. The study protocol was approved by the Ethics Committee of Beijing Jishuitan Hospital (Approval No. K2023-330-00), and all participants provided written informed consent before enrollment.

The sample size was calculated based on the primary outcome, namely the “exercise compliance rate”. Referring to a previous study [14], a compliance rate of 50% was assumed for the control group and 75% for the experimental group, with α = 0.05 (two-tailed), power (1 - β) = 0.8, and effect size of 0.25. The sample size was estimated using the formula for comparison of two independent proportions:

$$n = \frac{\left(Z_{\alpha/2}\sqrt{2p(1-p)}+Z_{\beta}\sqrt{p_1(1-p_1)+p_2(1-p_2)}\right)^2}{(p_1-p_2)^2}.$$

The calculation indicated that 68 patients per group were required. Applying a 10% dropout adjustment (68 ÷ 0.90 = 75.6) yielded a recommended threshold of 76 participants per group; however, 70 patients were ultimately enrolled in each group. Given that no participants were lost to follow-up and post-hoc power analyses demonstrated >80% power for all primary outcomes, the final sample size was considered sufficient for statistical validity. Nevertheless, this discrepancy is acknowledged as a study limitation. Considering the anticipated dropout rate, the final sample size was set at 70 patients per group, for a total of 140 participants.

Study Participants

Inclusion Criteria

① Aged 18–75 years, diagnosed with rotator cuff injury or acromial impingement syndrome confirmed by MRI; ② undergoing first-time arthroscopic shoulder surgery (e.g., rotator cuff repair or acromioplasty); ③ postoperative requirement for specialized sports medicine braces, including a shoulder abduction brace or neck-wrist slings; ④ clear consciousness and ability to cooperate with rehabilitation training and data collection; and ⑤ voluntary participation with provision of informed consent.

Exclusion Criteria

① Presence of severe osteoarticular diseases (e.g., rheumatoid arthritis or fractures) or nerve injuries; ② cognitive impairment or a history of psychiatric illness; ③ previous shoulder surgery or severe shoulder deformity; and ④ cognitive impairment or visual deficits that could interfere with participation in video-based education, or anticipated inability to complete the 6-month follow-up schedule.

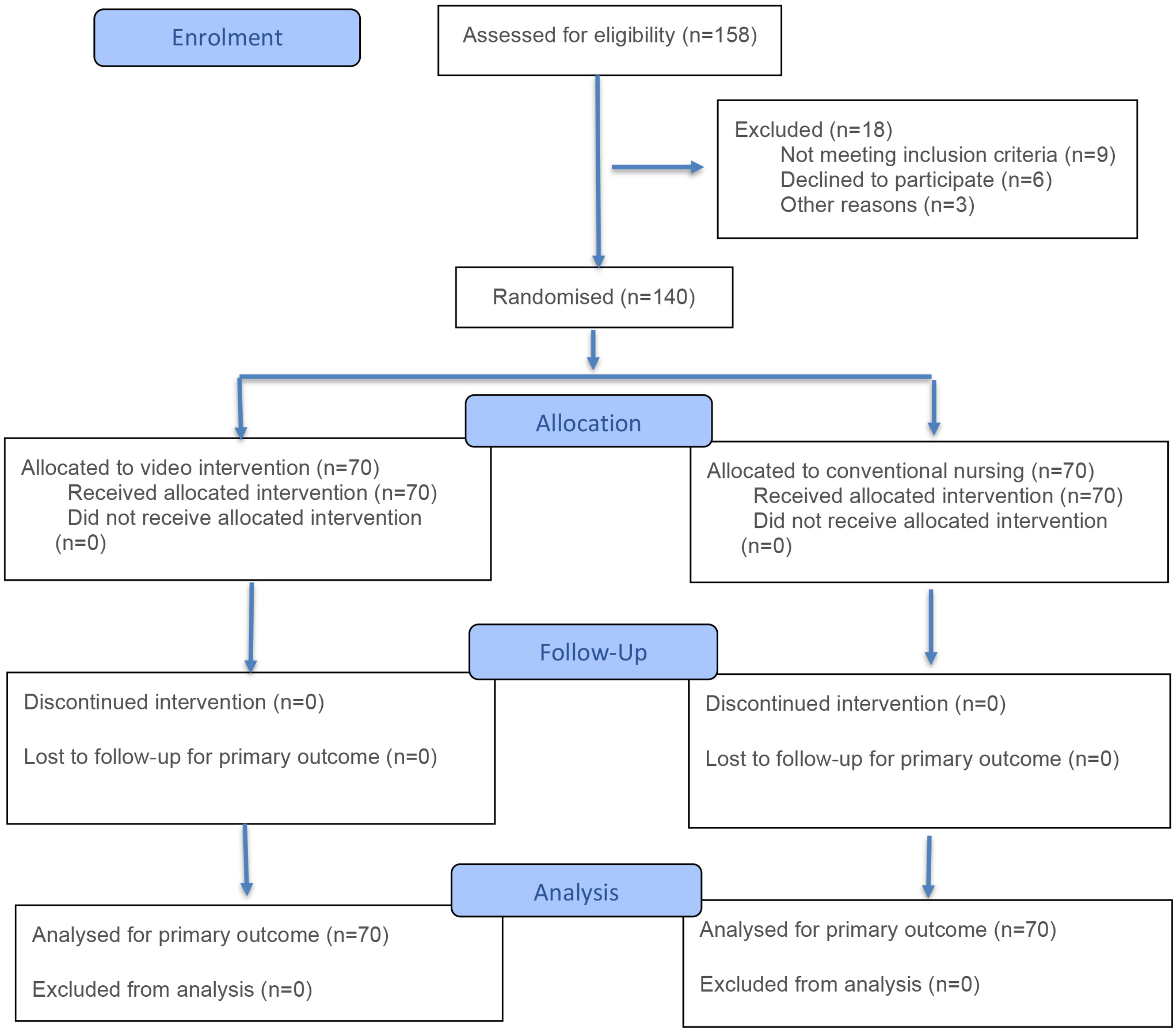

Fig. 1. Consolidated Standards of Reporting Trials (CONSORT) 2025 flow diagram.

Randomization and Blinding

Stratified block randomization was performed, stratified by injury type (rotator cuff injury/acromial impingement syndrome) and age (<60 years/≥60 years), and block size = 4. SPSS 26.0 (IBM Corp., Armonk, NY, USA) was used to generate random sequences by an independent statistician who had no involvement in patient recruitment, intervention delivery, or outcome assessment. Allocation concealment was ensured using sequentially numbered, opaque, sealed envelopes (SNOSE). The generated allocation sequence was placed by the statistician into consecutively numbered, opaque envelopes that were sealed and stored in a locked cabinet in a department separate from the recruitment site; the block size was not disclosed to the recruiting staff. After a patient had completed eligibility screening, provided written informed consent, and undergone surgery, the attending nurse opened the lowest-numbered unused envelope corresponding to the appropriate stratum in the presence of the patient, and the group assignment was recorded on the envelope and returned to the study file for audit. Envelopes were opened only at the moment of allocation, so that neither the recruiting clinician nor the patient could foresee the upcoming assignment. Due to the video-based intervention, blinding of patients and intervention providers was not feasible; therefore, outcome assessors and the data analyst were blinded to group allocation, and patients were instructed not to disclose their allocation to the assessors during follow-up evaluations, in order to reduce detection and performance bias.

Intervention Measures

Control Group: Conventional Nursing Intervention

Verbal education: Responsible nurses explained brace usage and key points of rehabilitation exercises (15–20 minutes per session).

Printed manual: Illustrated rehabilitation manuals were provided, including brace-fitting diagrams and exercise protocols.
Routine follow-up: Weekly telephone reminders were provided to reinforce rehabilitation training; no video resources or remote guidance were offered.

Experimental Group: Combined Video Nursing Intervention

Animated video instruction: Patients received 8–10-minute three-dimensional animated videos covering the following content:
Shoulder anatomical structures, including the rotator cuff muscles and subacromial space;
Principles of postoperative brace fitting, such as the biomechanical mechanism of shoulder abduction braces in maintaining a 30°–60° shoulder abduction-neutral position;
Identification of pressure-injury risk areas, particularly bony prominences such as the acromion and greater tuberosity.
Practical demonstration videos: Standardized videos demonstrated brace-fitting procedures, including adjustment of shoulder abduction brace tightness and neck-wrist sling length, as well as functional rehabilitation exercises such as pendulum exercises and wall-climbing training. Videos included synchronized voice guidance and subtitle prompts.
Implementation: Videos were viewed on a tablet device within 24 hours postoperatively, once daily for three consecutive days. QR codes were provided to enable repeated access to the videos. Rehabilitation therapists and nurses remotely verified brace fitting and rehabilitation training weekly through a mobile application (APP).

Outcome Indicators and Measurement Methods

Primary Outcome Indicators

Exercise compliance: Data were recorded at 6 weeks, 3 months, and 6 months postoperatively. Exercise compliance was calculated as follows:
Exercise compliance rate = (actual weekly training sessions/planned sessions) × 100%.
Based on daily rehabilitation logs and APP records; the prescribed training frequency was identical for both groups and followed a phase-based protocol: three sessions daily during the passive phase (0–6 weeks; 21 planned sessions per week), two sessions daily during the active-assisted phase (6 weeks–3 months; 14 planned sessions per week), and one session daily on five days per week during the strengthening phase (3–6 months; 5 planned sessions per week), with one session defined as completion of all prescribed movements for that phase. According to a previous study [15], a compliance rate ≥80% was defined as "good compliance".
Correct brace usage rate [16]: A researcher evaluated brace usage at 1 week, 6 weeks, and 3 months postoperatively using a 10-item assessment checklist, comprising: ① correct brace type and size selection; ② abduction angle deviation ≤5° from the prescribed position; ③ correct shoulder position in the neutral rotation plane; ④ appropriate strap tightness allowing insertion of one finger; ⑤ correct positioning of the waist belt; ⑥ correct elbow flexion angle and forearm support; ⑦ adequate padding at bony prominences (acromion, greater tuberosity); ⑧ intact skin without redness or indentation at pressure points; ⑨ maintenance of the brace during sleep and the prescribed daily wearing time; ⑩ correct removal and re-application procedure during daily activities. Achievement of ≥8 correct items was defined as "correct usage". This threshold was established by a clinical expert panel using the Delphi method to ensure adequate mastery of critical safety-related procedures. The correct brace usage rate was calculated as follows:
Correct brace usage = (Number of patients with correct brace usage / Total patients using sports medicine braces) × 100%.
Shoulder function: The Constant-Murley Score (CMS) was assessed at 1 week, 6 weeks, and 3 months postoperatively [17]. The scale includes pain (15 points), range of motion (40 points), muscle strength (25 points), and activities of daily living (20 points), with a total score of 100 points. Higher scores indicate better shoulder function.
Outcome assessments were scheduled based on the biological healing phases following rotator cuff repair. Brace usage and CMS scores were evaluated during the early immobilization and recovery phases (1 week, 6 weeks, and 3 months), while shoulder range of motion was assessed at key rehabilitation milestones (6 weeks, 3 months, and 6 months).

Secondary Outcome Indicators

Shoulder range of motion [18]: Active shoulder forward flexion, external rotation, and abduction angles were measured using a goniometer in a standardized position at 6 weeks, 3 months, and 6 months postoperatively. Each measurement was performed three times, and the mean value was used for analysis.
Complication rate: Adverse events occurring within 6 months postoperatively, including joint adhesions, rotator cuff re-tears, and pressure injuries, were recorded.
Nursing satisfaction: The Newcastle Satisfaction with Nursing Scales (NSNS) [19] was administered at 6 weeks postoperatively. The scale includes 19 items, such as "nurse's explanation style", evaluated using a 5-point Likert scale (1 = very dissatisfied, 5 = very satisfied), with total scores ranging from 19 to 95. For categorical analysis, total scores were classified as "very satisfied" (≥86), "satisfied" (67–85), or "neutral" (48–66).

Baseline Data Collection

Demographic characteristics, including age, gender, and body mass index (BMI), as well as injury characteristics (injury type and duration) and surgical information, were

Table 1. Comparison of baseline characteristics between the experimental and control groups.

Variable	Experimental group (n = 70)	Control group (n = 70)	Statistical test/value	*p*-value
Age (years)	50.77 ± 9.03	51.23 ± 9.28	0.295	0.768
Gender (male/female)	41/29 (58.57%/41.43%)	36/34 (51.40%/48.60%)	0.722	0.396
BMI (kg/m^2)	24.26 ± 2.71	24.38 ± 2.99	0.255	0.799
Injury type (rotator cuff injury/acromial impingement syndrome)	49/21 (70.00%/30.00%)	50/20 (71.43%/28.57%)	0.034	0.853
Surgical procedure (rotator cuff repair/acromioplasty)	53/17 (75.71%/24.29%)	51/19 (72.86%/27.14%)	0.150	0.699
Disease duration (months)	6.04 ± 2.58	6.67 ± 2.89	1.357	0.177
Smoking history (yes/no)	17/53 (24.29%/75.71%)	15/55 (21.43%/78.57%)	0.162	0.687
Alcohol consumption history (yes/no)	14/56 (20.00%/80.00%)	12/58 (17.14%/82.86%)	0.189	0.664
Hypertension (yes/no)	10/60 (14.29%/85.71%)	8/62 (11.43%/88.57%)	0.255	0.614
Diabetes mellitus (yes/no)	3/67 (4.29%/95.71%)	3/67 (4.29%/95.71%)	Fisher's	1.000

BMI, body mass index.

collected preoperatively through structured interviews and verified using medical records to ensure data accuracy.

Statistical Analysis

Data analysis was performed using SPSS (version 26.0, IBM Corporation). The normality of continuous variables was assessed using the Shapiro-Wilk test. Normally distributed quantitative data were expressed as mean ± standard deviation (SD), while non-normally distributed data were expressed as median and interquartile range (IQR). Intergroup comparisons of normally distributed variables were performed using independent-samples *t*-tests. For non-normally distributed continuous variables, the Mann-Whitney *U* test was applied, and results were presented as median (IQR). Repeated-measures analysis of variance was used to evaluate the interaction between group and time (Group × Time) across multiple time points. Categorical variables were expressed as frequencies and percentages (%) and compared using the chi-square test or Fisher's exact test, as appropriate. For within-group comparisons of binary outcomes across the three postoperative time points, Cochran's Q test was used, followed by pairwise McNemar tests with Bonferroni correction for multiple comparisons. For repeated-measures ANOVA, the sphericity assumption was assessed using Mauchly's test. When the assumption of sphericity was violated, the Greenhouse–Geisser correction was applied. Ranked data were analyzed using the Wilcoxon rank-sum test. A two-sided *p*-value < 0.05 was considered statistically significant.

Results

Comparison of Baseline Characteristics Between the Two Groups

No statistically significant differences were observed between the two groups in baseline characteristics, including age, gender, BMI, and comorbidities (all $p > 0.05$). Similarly, surgical procedures and injury types were comparable between the two groups (all $p > 0.05$). Details are presented in Table 1.

Comparison of Exercise Compliance and Correct Brace Usage Rate

At 6 weeks, 3 months, and 6 months postoperatively, the experimental group demonstrated significantly higher rates of good exercise compliance than the control group (all $p < 0.05$). Additionally, at 1 and 6 weeks postoperatively, the experimental group showed significantly higher rates of correct brace use compared with the control group (both $p < 0.05$). However, no statistically significant difference was observed between the groups at 3 months postoperatively ($p > 0.05$). Between 3 and 6 months, the good compliance rate declined significantly in the control group (McNemar $p < 0.05$) but not in the experimental group ($p = 0.063$), indicating better maintenance of adherence over time. Details are shown in Table 2.

Comparison of Shoulder Function Scores

Repeated-measures analysis of variance (ANOVA) for total CMS score revealed significant main effects for Group (F = 125.947, $p < 0.001$) and Time (F = 9910.818, $p < 0.001$), as well as a significant Group × Time interaction effect (F = 109.818, $p < 0.001$), indicating that the trajectory of CMS improvement differed significantly between the two groups over time. At 1 week, 6 weeks, and 3 months postoperatively, the experimental group achieved significantly higher total CMS scores and subscale scores (pain, range of motion, muscle strength, and activities of daily living) than the control group (all $p < 0.05$). Detailed findings are presented in Table 3.

Comparison of Shoulder Range of Motion

Repeated-measures ANOVA demonstrated significant group effects, time effects, and Group × Time interaction effects for shoulder range-of-motion parameters (all $p < 0.001$). At 6 weeks and 3 months postoperatively, the experimental group exhibited significantly greater shoulder forward flexion, external rotation, and abduction angles compared with the control group (all $p < 0.05$). At 6 months postoperatively, no statistically significant

Table 2. Comparison of exercise compliance and correct brace usage rates between the two groups.

Variable	Time point	Experimental group (n = 70)	Control group (n = 70)	Statistical test/value	*p*-value
Good rate of exercise compliance	6 weeks postoperatively	63 (90.00%)	50 (71.43%)	7.755	0.005
	3 months postoperatively	55 (78.57%)*	40 (57.14%)*	7.368	0.007
	6 months postoperatively	50 (71.43%)*	29 (41.43%)*#	12.812	<0.001
Correct brace usage rate	1 week postoperatively	53 (75.71%)	29 (41.43%)	16.955	<0.001
	6 weeks postoperatively	62 (88.57%)^	41 (58.57%)^	16.200	<0.001
	3 months postoperatively	70 (100.00%)^*	69 (98.57%)^*	Fisher's	1.000

Note: ^ indicates comparison with 1 week postoperatively within the same group (^$p < 0.05$); * indicates comparison with 6 weeks postoperatively within the same group (*$p < 0.05$). # represents compared with 3 months after surgery in the same group ($^{\#}p < 0.05$). Within-group comparisons across time points were performed using Cochran's Q test with post hoc pairwise McNemar tests (Bonferroni corrected); between-group comparisons are shown in the t/χ^2 and *p*-value columns.

Table 3. Comparison of postoperative shoulder function between the two groups according to constant-murley score (CMS) ($\bar{x} \pm$ SD, points).

Variable	Time point	Experimental group (n = 70)	Control group (n = 70)	*t*-value	*p*-value
Total CMS score	1 week postoperatively	39.01 ± 3.65	28.84 ± 3.00	18.000	<0.001
	6 weeks postoperatively	64.96 ± 5.07^	51.89 ± 5.27^	14.959	<0.001
	3 months postoperatively	87.67 ± 5.83^*	75.94 ± 6.63^*	11.122	<0.001
Pain	1 week postoperatively	6.19 ± 1.32	4.06 ± 1.46	9.030	<0.001
	6 weeks postoperatively	10.16 ± 1.96^	8.24 ± 2.00^	5.724	<0.001
	3 months postoperatively	13.86 ± 1.38^*	11.53 ± 2.30^*	7.281	<0.001
Range of motion	1 week postoperatively	12.24 ± 2.45	9.49 ± 2.33	6.833	<0.001
	6 weeks postoperatively	25.37 ± 3.44^	19.06 ± 3.89^	10.169	<0.001
	3 months postoperatively	33.53 ± 4.21^*	28.69 ± 4.72^*	6.411	<0.001
Muscle strength	1 week postoperatively	10.53 ± 1.82	6.99 ± 1.82	11.500	<0.001
	6 weeks postoperatively	15.46 ± 2.83^	12.33 ± 2.60^	6.812	<0.001
	3 months postoperatively	21.56 ± 3.18^*	18.26 ± 3.10^*	6.222	<0.001
Activities of daily living (ADL)	1 week postoperatively	10.06 ± 1.34	8.31 ± 1.38	7.587	<0.001
	6 weeks postoperatively	13.97 ± 2.06^	12.26 ± 1.65^	5.431	<0.001
	3 months postoperatively	18.73 ± 1.58^*	17.47 ± 1.91^*	4.247	<0.001

Note: ^ indicates comparison with 1 week postoperatively within the same group (^$p < 0.05$); * indicates comparison with 6 weeks postoperatively within the same group (*$p < 0.05$). CMS, Constant-Murley Score.

Repeated-measures ANOVA results:

Total CMS score: Group effect, F = 125.947, $p < 0.001$; Time effect, F = 9910.818, $p < 0.001$; Group × Time interaction, F = 109.818, $p < 0.001$. Pain dimension: Group effect, F = 62.782, $p < 0.001$; Time effect, F = 2125.432, $p < 0.001$; Group × Time interaction, F = 1.556, $p = 0.213$. Range of motion dimension: Group effect, F = 71.897, $p < 0.001$; Time effects, F = 3678.340, $p < 0.001$; Group × Time interaction, F = 28.583, $p < 0.001$. Muscle strength dimension: Group effect, F = 70.512, $p < 0.001$, Time effect, F = 2120.980, $p < 0.001$; Group × Time interaction, F = 0.722, $p = 0.486$. Activities of daily living (ADL) dimension: Group effect, F = 38.653, $p < 0.001$; Time effect, F = 3324.912, $p < 0.001$; Group × Time interaction, F = 3.083, $p = 0.047$.

differences were observed between the two groups in forward flexion or external rotation angles (both $p > 0.05$). However, the experimental group maintained a significantly greater abduction angle than the control group ($p < 0.05$). Detailed data are provided in Table 4.

Comparison of Postoperative Complication Rates

The total postoperative complication rate in the experimental group was 8.57% (6/70), which was significantly lower than the 24.29% (17/70) observed in the control group ($\chi^2 = 6.295$, $p = 0.012$). Specifically, the experimental group included 2 cases of joint adhesion (2.86%), 1 case of rotator cuff re-tear (1.43%), and 3 cases of pressure injury (4.29%). In comparison, the control group had 7 cases of joint adhesion (10.00%), 5 cases of rotator cuff re-tear (7.14%), and 5 cases of pressure injury (7.14%). Detailed results are presented in Table 5.

Comparison of Nursing Satisfaction at 6 Weeks Postoperatively

At 6 weeks postoperatively, the overall distribution of nursing satisfaction differed significantly between the two

Table 4. Comparison of postoperative shoulder range of motion between the two groups ($\bar{x} \pm SD$, °).

Variable	Time point	Experimental group (n = 70)	Control group (n = 70)	*t*-value	*p*-value
Forward flexion angle	6 weeks postoperatively	122.76 ± 12.50	100.07 ± 11.03	11.386	<0.001
	3 months postoperatively	141.19 ± 14.67*	130.39 ± 17.71*	3.929	<0.001
	6 months postoperatively	154.16 ± 17.06*#	150.51 ± 18.87*#	1.198	0.233
External rotation angle	6 weeks postoperatively	31.00 ± 8.90	19.87 ± 5.83	8.751	<0.001
	3 months postoperatively	40.69 ± 9.25*	36.67 ± 10.06*	2.458	0.015
	6 months postoperatively	45.94 ± 9.81*#	44.39 ± 10.86*#	0.890	0.375
Abduction angle	6 weeks postoperatively	119.81 ± 11.02	96.20 ± 8.58	14.150	<0.001
	3 months postoperatively	136.86 ± 11.61*	127.23 ± 11.20*	4.993	<0.001
	6 months postoperatively	150.64 ± 12.15*#	146.07 ± 12.44*#	2.199	0.030

Note: * indicates comparison with 6 weeks postoperatively within the same group ($^*p < 0.05$); # indicates comparison with 3 months postoperatively within the same group ($^\#p < 0.05$).

Repeated measures ANOVA results:

Forward flexion angle: Group effect, F = 27.672, $p < 0.001$; Time effect, F = 816.033, $p < 0.001$; Group × Time interaction, F = 44.537, $p < 0.001$. External rotation angle: Group effect, F = 15.821, $p < 0.001$; Time effect, F = 550.732, $p < 0.001$; Group × Time interaction, F = 33.681, $p < 0.001$. Abduction angle: Group effect, F = 55.033, $p < 0.001$; Time effect, F = 1522.610, $p < 0.001$; Group × Time interaction, F = 89.859, $p < 0.001$.

Table 5. Comparison of postoperative complication rates between the two groups (n, %).

Group	Joint adhesion	Rotator cuff re-tear	Pressure injury	Total complication rate
Experimental group (n = 70)	2 (2.86%)	1 (1.43%)	3 (4.29%)	6 (8.57%)
Control group (n = 70)	7 (10.00%)	5 (7.14%)	5 (7.14%)	17 (24.29%)
χ^2 value	-	-	-	6.295
p-value	-	-	-	0.012

Note: "-" indicates not applicable; individual complication types were not compared statistically because of the low event counts.

Table 6. Comparison of nursing satisfaction at discharge between the two groups (n, %).

Group	Very satisfied (5 points)	Satisfied (4 points)	Neutral (3 points)
Experimental group (n = 70)	60 (85.71%)	10 (14.29%)	0 (0.00%)
Control group (n = 70)	38 (54.29%)	30 (42.86%)	2 (2.86%)

Note:The overall distribution of nursing satisfaction was compared between groups using the Wilcoxon rank-sum test (Z = 4.084, $p < 0.001$).

groups (Z = 4.084, $p < 0.001$), with the experimental group reporting higher satisfaction levels than the control group. Detailed results are presented in Table 6.

Discussion

Arthroscopic shoulder surgery is currently the mainstream minimally invasive technique for the treatment of rotator cuff injuries and acromial impingement syndrome. However, its therapeutic efficacy is highly dependent on systematic functional rehabilitation within 6–12 weeks postoperatively [20]. In clinical practice, patients often exhibit inadequate rehabilitation compliance, with approximately 30%–40% failing to perform standardized training due to complex rehabilitation protocols, improper movement execution, or fear of pain. These factors may result in complications such as joint adhesions and reduced muscle strength, thereby compromising surgical outcomes [21]. Traditional verbal or written guidance is limited by its abstract nature and poor retention by patients, whereas animated video instruction combined with practical demonstration videos may improve patients' understanding of rehabilitation principles and enhance exercise accuracy through dynamic visual presentation and stepwise action breakdowns [22].

At present, prospective studies investigating the effects of this combined intervention model on rehabilitation compliance and functional recovery following arthroscopic shoulder surgery remain limited, underscoring the need for a scientifically rigorous evaluation of its clinical value. In the present study, the effect of animated video instruction combined with practical demonstration videos on postoperative rehabilitation in patients undergoing arthroscopic shoulder surgery was systematically evaluated through a prospective randomized controlled trial. The findings showed that the experimental group significantly outperformed the control group in exercise compliance, correct brace usage, shoulder function recovery, and complication prevention. This advantage was particularly evident during the early postoperative period (within 6 weeks), thereby confirming the clinical value of video-based interventions in orthopedic postoperative rehabilitation.

Impact of Combined Video Intervention on Rehabilitation Compliance and Brace Usage

The significant improvements in exercise compliance and correct brace usage rates observed in the experimental group may be explained from the perspectives of cognitive neuroscience and motor learning theory. At the cognitive level, animated video instruction may facilitate information transmission through mechanisms consistent with dual-coding theory. Three-dimensional anatomical demonstrations activate the visual representation system, while synchronized voice narration activates the verbal representation system. The synergistic interaction among these systems enhances information encoding, consistent with the "visual-verbal dual-channel memory enhancement effect" [23]. In contrast, traditional verbal education relies primarily on the verbal channel and is therefore more susceptible to limitations in working memory capacity, particularly because the adult phonological loop can retain only approximately four information units simultaneously. Consequently, patients may develop an incomplete understanding of abstract concepts such as brace positioning and joint angles [24].

From a motor learning perspective, practical demonstration videos promote skill acquisition through observational learning. According to Bandura's social learning theory, observing model actions may facilitate imitation and internalization of actions through mechanisms proposed by social learning theory [25]. The standardized action demonstration used in this study, such as scapular stability control during pendulum exercises, provided patients with accurate "motor templates", while multi-angle video recordings (frontal, lateral, and overhead views) helped correct common "action imagination biases" associated with conventional education, such as confusion between shoulder abduction and forward flexion movements. Furthermore, the repeatability of video-based learning allowed distributed practice, in which repeated viewing at intervals strengthened neural synaptic connections. This finding is consistent with previous evidence indicating that "repeated exposure improves motor memory consolidation efficiency" [26], which may explain why the experimental group maintained a significantly higher correct brace usage rate (88.57%) than the control group (58.57%) at 6 weeks postoperatively.

Compared with previous studies, the present study introduces an innovative hierarchical intervention design. Springer B et al. [27] reported that postoperative and rehabilitation-related videos on YouTube generally exhibit poor information quality, accuracy, and reliability for patients undergoing arthroscopic rotator cuff repair. While traditional educational videos mainly emphasize procedural steps, the current study additionally used animated instructions to explain "the relationship between brace angles and tendon stress distribution", thereby enabling patients to progress from "knowing how" to "knowing why". This approach is consistent with the theory proposed by Kintsch W et al. [28], which emphasizes that "meaningful learning is superior to rote memorization". This theoretical framework may partly explain the sustained long-term compliance advantage observed in the experimental group (71.43% at 6 months postoperatively).

Promotion of Shoulder Function Recovery by Combined Video Intervention

The early advantages observed in CMS outcomes and shoulder range of motion in the experimental group may be related to improved rehabilitation performance. The first 0–6 weeks following rotator cuff repair are characterized by inflammatory responses and granulation tissue formation, during which inappropriate movement may increase the risk of repaired tendon re-tear by 3.2-fold [29]. The video intervention optimized this rehabilitation process through several mechanisms.

First, animated demonstrations illustrating "the impact of different external rotation angles on tendon tension", such as the marked increase in shear force when external rotation exceeds 20°, enabled patients to actively avoid potentially harmful movements. This finding is consistent with previous evidence suggesting that "early postoperative restrictive exercise reduces re-tear rates" [30]. Second, practical demonstration videos showing "scapulohumeral rhythm synchronization during wall-climbing training" assisted patients in establishing correct scapulohumeral coupling patterns and avoiding "compensatory shoulder shrugging", a common phenomenon observed during traditional rehabilitation training.

The subsequent 3-month period represents a critical stage for tendon collagen fiber remodeling, during which the video intervention may have promoted early functional recovery by accelerating this biological process. However, considering the natural trajectory of postoperative recovery, rehabilitation outcomes tend to converge over time. Therefore, the observed advantages of the video intervention primarily reflect accelerated early-stage recovery rather than a sustained long-term divergence between groups. This temporal recovery pattern aligns with the time-window effect observed in shoulder rehabilitation and is consistent with the meta-analysis conducted by Chen et al. [31], which reported no clinically meaningful differences in long-term functional recovery between early and delayed rehabilitation after arthroscopic rotator cuff repair.

Impact of Combined Video Intervention on Complications and Nursing Satisfaction

The lower complication rate observed in the experimental group may be associated with improved rehabilitation adherence and brace use. In terms of device-related pressure injuries, the video module addressing "identification of pressure points at bony prominences", including anatomical localization of the acromion and greater tuberosity of the humerus, enabled patients to proactively adjust brace padding positions. This finding is consistent with previous evidence indicating that "patient education reduces medical device-related pressure injury rates by 30%" [32]. The underlying mechanism may involve visual demonstrations of the "pressure-time-tissue tolerance" relationship.

The reduced incidence of rotator cuff re-tear may be associated with enhanced patient awareness of postoperative biomechanics. Animated simulations demonstrating "shear force distribution on repaired tendons during improper external rotation", including stress concentration at the tendon insertion site when external rotation exceeds 30°, enabled patients to intuitively understand movement-related contraindications [33]. This observation corroborates the findings reported by Shimokobe H et al. [34], who demonstrated a negative correlation between patients' understanding of postoperative biomechanical principles and the risk of tendon re-tear.

The improvement in nursing satisfaction reflects the optimization of doctor-patient communication, consistent with the findings reported by Wasim AS et al. [35]. Standardized video instruction reduced "information attenuation" commonly associated with traditional verbal education, such as variations in exercise explanations among different nurses, thereby ensuring that patients received standardized information consistent with recommendations by the physicians. Additionally, the ability to repeatedly view videos at an individualized pace satisfied the "autonomy need" described in Self-Determination Theory (SDT), which may represent a potential psychological mechanism underlying the significantly higher proportion of "very satisfied" patients in the experimental group (85.7%) compared with the control group (54.3%) [36].

Compared with previous studies, the present research is among the first to demonstrate the potential of video intervention to promote shared decision-making (SDM). Through APP-based remote verification, patients could actively upload photographs of brace usage and receive real-time feedback. This "bidirectional interaction" model may better enhance patient engagement than traditional one-way educational approaches, which is consistent with previous findings [37].

Study Limitations and Future Directions

This study was a single-center RCT with a relatively small sample size (140 participants), which may have introduced selection bias. Additionally, the follow-up period was limited to 6 months, and therefore the long-term effects of the intervention require further investigation. Because the experimental intervention also included weekly APP-based remote verification and guidance, whereas the control group did not receive remote guidance, the independent effect of the video components could not be distinguished from that of the additional remote support. Future studies should include multi-center trials, enroll patients with varying injury severity and pathological conditions, such as massive rotator cuff tears, and further evaluate the applicability of video-based interventions in elderly populations or patients with lower educational levels. Additionally, integrating intelligent wearable devices, such as angle-monitoring sensors, for real-time assessment of brace use may further enhance the precision and effectiveness of postoperative rehabilitation management.

Clinical Significance

The core mechanism underlying this study is the improvement of the cognitive understanding and self-efficacy of patients through a video-based intervention. The novelty of the approach does not primarily lie in the intervention modality itself, but rather in the systemic application of cognitive-behavioral intervention strategies to the postoperative rehabilitation population following shoulder arthroscopy, thereby verifying its effectiveness during a specific stage of disease recovery and demonstrating its potential for clinical translation.

The combined video intervention effectively addresses limitations associated with traditional nursing education through a closed-loop management model that integrates "anatomical principle explanation-operational demonstration-remote verification". This approach may be particularly applicable in primary healthcare institutions and home-based rehabilitation settings. Therefore, incorporating this intervention into routine perioperative nursing protocols is recommended to establish a more standardized rehabilitation model for arthroscopic shoulder surgery, reduce postoperative complications, shorten rehabilitation duration, and provide a cost-effective strategy for orthopedic postoperative rehabilitation.

Conclusions

In summary, this study demonstrated that combined video-based intervention significantly improves postoperative rehabilitation outcomes following arthroscopic shoulder surgery by optimizing cognitive processing, enhancing motor learning, and strengthening patient self-efficacy. Elucidation of the underlying mechanisms and comparison with previous research provide new theoretical and practical support for the future development of "precision" and "visualization" strategies in orthopedic rehabilitation.

Availability of Data and Materials

The data analyzed are available from the corresponding author upon reasonable request.

Author Contributions

SZ designed and performed the study. SZ, YL, SY, XL and MZ supervised the data collection, analyzed the data, interpreted the data, participated in the writing of the manuscript, prepared the manuscript for publication and reviewed the manuscript. All authors have been involved in revising the manuscript critically for important intellectual content. All authors gave final approval of the version to be published. All authors have participated sufficiently in the work to take public responsibility for appropriate portions of the content and agreed to be accountable for all aspects of the work in ensuring that questions related to its accuracy or integrity.

Ethics Approval and Consent to Participate

Ethical approval was obtained from the Ethics Committee of Beijing Jishuitan Hospital (Approval No. K2023-330-00). Written informed consent was obtained from a legally authorized representative for anonymized patient information to be published in this article. This study strictly adhered to the principles of the Declaration of Helsinki.

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Conflict of Interest

The authors declare no conflict of interest.

Supplementary Material

Supplementary material associated with this article can be found, in the online version, at https://doi.org/10.62713/aic.4560.

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