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Comparison of the Effects of Infraspinatus-Teres Minor Fascial Plane Block versus Suprascapular Nerve Combined with Axillary Nerve Block on Postoperative Analgesia and Recovery after Rotator Cuff Repair

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Abstract: *Objective*: To compare the effects of ultrasoundguided infraspinatusteres minor (ITM) fascial plane block versus suprascapular nerve combined with axillary nerve block (SSAX) on postoperative analgesic efficacy and early recovery after rotator cuff repair. *Methods*: A total of 72 patients scheduled for elective arthroscopic rotator cuff repair at Donghai County People's Hospital from June 1, 2025 to March 31, 2026 were enrolled and randomly divided into three groups using a random number table: ITM group (infraspinatusteres minor fascial plane block, n = 24), SSAX group (suprascapular nerve combined with axillary nerve block, n = 24), and group I (traditional interscalene brachial plexus block, n=24). All three groups received ultrasoundguided nerve block 30 min before general anesthesia. The visual analog scale (VAS) scores at rest and during movement at various time points within 72 h postoperatively, incidence of diaphragmatic paralysis, recovery of sensory and motor function of the operative limb, opioid consumption, postoperative quality of recovery15 (QoR15) scores, ConstantMurley shoulder function scores (CMS), and incidence of adverse reactions were compared among the three groups. *Results*: No statistically significant differences were found in VAS scores at rest and during movement at 24, 48, and 72 h postoperatively among the three groups ($p > 0.05$). At 30 min after block and at 6 h postoperatively, the incidence of diaphragmatic paralysis in the ITM and SSAX groups was lower than that in group I ($p < 0.05$). The duration of sensory and motor blockade in the ITM group was shorter than that in group I ($p < 0.05$). Within 24 h postoperatively, sufentanil consumption in both the ITM and SSAX groups was lower than that in group I ($p < 0.05$). The QoR15 scores at 24 h postoperatively in the ITM group, and the CMS scores at 48 h postoperatively in both the ITM and SSAX groups, were higher than those in group I (all $p < 0.05$). There was no statistically significant difference in the incidence of adverse reactions among the three groups ($p > 0.05$). *Conclusion*: Both ultrasoundguided infraspinatusteres minor fascial plane block and suprascapular nerve combined with

axillary nerve block can provide analgesic effects comparable to those of interscalene brachial plexus block after rotator cuff repair, with a lower incidence of diaphragmatic paralysis, which is conducive to early patient recovery.

Keywords: Rotator cuff injury; Ultrasound guidance; Infraspinatusteres minor fascial plane block; Suprascapular nerve block; Axillary nerve block; Postoperative analgesia; Early recovery; Diaphragmatic paralysis

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1. Introduction

Arthroscopic rotator cuff repair is the primary treatment for rotator cuff injuries; however, moderatetosevere postoperative pain is common and significantly hampers early rehabilitation [1]. Although interscalene brachial plexus block is a frequently used technique for postoperative analgesia, it carries a high risk of phrenic nerve palsy and reduces distal limb muscle strength, limiting its clinical application [2]. Suprascapular nerve block combined with axillary nerve block (SSAX) can provide comparable analgesic effects with fewer complications, but requires a twopuncture technique that is relatively cumbersome. The infraspinatusteres minor (ITM) fascial plane block achieves simultaneous blockade of both the suprascapular and axillary nerves through a single puncture, and cadaveric dye injection studies have confirmed that its efficacy is not inferior to that of SSAX [3]. This study aimed to compare the effects of ultrasoundguided ITM block, SSAX block, and traditional interscalene brachial plexus block on early analgesia and recovery after rotator cuff repair, providing evidence for optimizing clinical analgesic strategies.

2. Methods

2.1. General data

A total of 72 patients scheduled for elective arthroscopic rotator cuff repair at Donghai County People's Hospital from June 1, 2025, to March 31, 2026, were enrolled.

Patients were randomly divided into three groups using a random number table: ITM group (infraspinatusteres minor fascial plane block, n = 24), SSAX group (suprascapular nerve combined with axillary nerve block, n = 24), and group I (traditional interscalene brachial plexus block, n = 24). In the ITM group, there were 14 males and 10 females; age ranged from 35 to 65 years, with a mean of (52.38 ± 8.76) years; body mass index (BMI) ranged from 19.6 to 30.1 kg/m², with a mean of (24.85 ± 2.63) kg/m²; ASA grade I in 10 cases and grade II in 14 cases. In the SSAX group, there were 13 males and 11 females; age ranged from 32 to 65 years, with a mean of (51.25 ± 9.42) years; BMI ranged from 18.5 to 29.7 kg/m², with a mean of (24.12 ± 2.81) kg/m²; ASA grade I in 9 cases and grade II in 15 cases. In group I, there were 15 males and 9 females; age ranged from 35 to 65 years, with a mean of (53.17 ± 8.93) years; BMI ranged from 19.1 to 30.0 kg/m², with a mean of (24.53 ± 2.74) kg/m²; ASA grade I in 11 cases and grade II in 13 cases. Baseline characteristics were balanced among the three groups ($p > 0.05$).

2.2. Inclusion and exclusion criteria

Inclusion criteria: age ≥ 18 years; ASA grade I–III; scheduled for elective rotator cuff repair. Exclusion criteria: contraindications to puncture; allergy to study drugs; communication difficulties or inability to

communicate; history of surgery on the ipsilateral neck or supraclavicular fossa; preoperative neurological deficits in the operative limb; massive rotator cuff tear.

2.3. Methods

2.3.1. Nerve block procedure

All patients received routine monitoring of blood pressure, heart rate, and pulse oximetry, and a peripheral intravenous line was established 30 min before entering the operating room. Ultrasoundguided nerve block was performed 30 min before anesthesia induction.

(1) ITM group

Patients were placed in the lateral decubitus position with the operative shoulder elevated. A 613 MHz highfrequency linear probe was used to scan below and posterior to the lateral acromial angle to identify the fascial plane between the infraspinatus and teres minor muscles. An inplane needle approach was used, and after the needle tip reached the fascial plane and aspiration was negative for blood, 20 mL of 0.4% liposomal bupivacaine was injected.

(2) SSAX group

Patients were placed in the supine position. Suprascapular nerve block: The probe was placed in an oblique coronal orientation on the shoulder, parallel to the lateral onethird of the scapular spine, and tilted anteriorly until the supraspinous fossa depression appeared at a depth of approximately 3–4 cm. An inplane technique was used to advance the needle until bony contact was made and the tip was positioned adjacent to the vessels; 20 mL of 0.4% liposomal bupivacaine was then injected deep to the supraspinatus muscle fascia. Axillary nerve block: The ultrasound probe was placed in a sagittal orientation on the posterior aspect of the upper arm, between the acromion and the axillary fold, and the angle was adjusted until the posterior humeral circumflex artery was visible among the teres minor, deltoid, and triceps muscles. Using an inplane technique, the needle was advanced, and after negative aspiration, 10 mL of 0.4% liposomal bupivacaine was injected at the quadrangular space.

(3) Group I

After identifying the anterior and middle scalene muscles and the C5 and C6 nerve roots, the needle tip was positioned between the C5 and C6 nerve roots within the brachial plexus sheath, and 30 mL of 0.4% liposomal bupivacaine was slowly injected.

2.3.2. Anesthesia protocol

At 30 min after nerve block, all patients received standardized general anesthesia. Anesthesia was induced with intravenous sufentanil 0.5–1 μg/kg, propofol 1.5–2.0 mg/kg, and cisatracurium 0.2 mg/kg. Tracheal intubation was performed under video laryngoscopy, and mechanical ventilation was delivered with a lungprotective ventilation strategy. Anesthesia was maintained with sevoflurane 1.0–1.5 MAC, with blood pressure maintained within ± 20% of baseline. Sufentanil 10.0 μg was administered 10 min before skin incision, and 5–10 μg was given 10 min before wound closure. At the end of surgery, patients were transferred to the postanesthesia care unit (PACU).

2.3.3. Postoperative analgesia

Standardized patientcontrolled intravenous analgesia (PCIA) was administered postoperatively. The analgesic pump was prepared with sufentanil 1 μg/kg per 24 h and ketorolac tromethamine 120 mg, diluted with normal saline to a total volume of 120 mL. The background infusion rate was 3–4 mL/h, with a patientcontrolled

bolus of 3 mL and a lockout interval of 10 min.

2.4. Observation indicators

(1) VAS scores at rest and during activity at each time point within 72 h postoperatively: assessed at 24, 48, and 72 h after surgery, using a 0–10 numeric rating scale.

(2) Incidence of diaphragmatic paralysis: diaphragmatic excursion was evaluated using Mmode ultrasound at 30 min after block and at 6, 12, and 24 h postoperatively, and the occurrence of diaphragmatic paralysis was recorded.

(3) Duration of sensory and motor block: the time from completion of the block to the return of normal sensory and motor function was recorded.

(4) Opioid consumption: the total dose of sufentanil used within 24 and 48 h postoperatively was recorded.

(5) ① The 15item Quality of Recovery (QoR15) questionnaire was used to assess early postoperative recovery quality at 24 and 48 h after surgery, with a Cronbach's α coefficient of 0.898. Each item was scored on a 0–10 numeric scale, with a total score ranging from 0 to 150; higher scores indicate better recovery quality [4]. ② The ConstantMurley Shoulder Score (CMS) was used to evaluate shoulder joint function at 24 and 48 h after surgery, with a Cronbach's α coefficient of 0.868 [5]. The scale comprises four domains: pain, activities of daily living, shoulder range of motion, and muscle strength, with a total score ranging from 0 to 100; higher scores indicate better shoulder joint function.

(6) Adverse reactions: nausea, vomiting, dizziness, pruritus, etc. were recorded.

2.5 Statistical methods

Data were analyzed using SPSS 26.0. Continuous variables are expressed as mean ± standard deviation ($\overline{x}$ ± s). Comparisons among multiple groups were performed using oneway analysis of variance (ANOVA), and pairwise comparisons were conducted using the LSD*t* test. Categorical variables are presented as n (%) and were compared using the chisquare test. A *p*value < 0.05 was considered statistically significant.

3. Results

3.1. Comparison of resting VAS and VAS during activity at each time point among the three groups

There were no statistically significant differences in resting VAS and VAS during activity at 24, 48, and 72 h postoperatively among the three groups (all $p > 0.05$), as shown in **Table 1**.

Table 1. Comparison of resting VAS and VAS during activity at each time point among the three groups ($\overline{x}$ ±s, points)

Group	Resting VAS			Activity VAS		
	24h	48h	72h	24h	48h	72h
ITM group (n = 24)	1.67 ± 0.64	1.25 ± 0.48	0.83 ± 0.35	2.85 ± 0.76	2.13 ± 0.62	1.46 ± 0.48
SSAX group (n = 24)	1.58 ± 0.59	1.18 ± 0.42	0.79 ± 0.31	2.71 ± 0.72	2.05 ± 0.58	1.38 ± 0.45
I group (n = 24)	1.52 ± 0.61	1.12 ± 0.45	0.75 ± 0.33	2.63 ± 0.68	1.98 ± 0.55	1.33 ± 0.42
F value	0.412	0.587	0.426	0.623	0.412	0.587
p value	0.663	0.558	0.654	0.538	0.663	0.558

3.2. Comparison of the incidence of diaphragmatic paralysis among the three groups

At 30 min after blockade and 6 h postoperatively, the incidence of diaphragmatic paralysis in the ITM group and the SSAX group was lower than that in group I ($P < 0.05$). See **Table 2**.

Table 2. Comparison of the incidence of diaphragmatic paralysis among the three groups [cases (%)]

Group	30 min after block	6 h postoperatively	12 h postoperatively	24 h postoperatively
ITM group (n = 24)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
SSAX group (n = 24)	3 (12.50)	3 (12.50)	0 (0.00)	0 (0.00)
I group (n = 24)	22 (91.67)[ab]	11 (45.83)[ab]	4 (16.67)	0 (0.00)
χ^2	52.330	19.746	9.270	—
p	< 0.001	< 0.001	0.010	—

Note: [a]$p < 0.05$ vs. ITM group; [b]$p < 0.05$ vs. SSAX group.

3.3. Comparison of sensory and motor block duration among the three groups

There was no statistically significant difference in the duration of sensory block or motor block between the ITM group and the SSAX group ($p > 0.05$), while both groups had significantly shorter durations than group I (all $p < 0.05$). See **Table 3**.

Table 3. Comparison of sensory and motor block duration among the three groups ($\overline{x} \pm$s, h)

Group	Duration of sensory block	Duration of motor block
ITM group (n = 24)	12.38 ± 2.15	8.25 ± 1.86
SSAX group (n = 24)	12.85 ± 2.42	8.63 ± 1.92
I group (n = 24)	16.72 ± 3.08[ab]	11.38 ± 2.54[ab]
F value	18.654	14.287
p value	< 0.001	< 0.001

Note: [a]$p < 0.05$ vs. ITM group; [b]$p < 0.05$ vs. SSAX group.

3.4. Comparison of opioid consumption among the three groups

Within 24 h postoperatively, sufentanil consumption in both the ITM group and the SSAX group was significantly lower than that in group I (all $p < 0.05$), while there was no statistically significant difference between the ITM group and the SSAX group ($p > 0.05$). Within 48 h postoperatively, there was no statistically significant difference among the three groups ($p > 0.05$), as shown in **Table 4**.

Table 4. Comparison of opioid consumption among the three groups (mean ± SD, μg)

Group	24 h postoperatively	48 h postoperatively
ITM group (n = 24)	28.75 ± 6.42	42.38 ± 8.15
SSAX group (n = 24)	30.42 ± 6.85	44.17 ± 8.62
I group (n = 24)	35.83 ± 7.18[ab]	51.25 ± 9.36
F value	5.874	2.156
p value	0.004	0.122

Note: [a]$p < 0.05$ vs. ITM group; [b]$p < 0.05$ vs. SSAX group.

3.5. Comparison of postoperative recovery quality and shoulder function scores among the three groups

At 24 h postoperatively, only the ITM group had significantly higher QoR15 scores than group I ($p < 0.05$); there were no statistically significant differences in CMS scores among the three groups ($p > 0.05$). At 48 h postoperatively, there were no statistically significant differences in QoR15 scores among the three groups ($p > 0.05$); both the ITM group and the SSAX group had significantly higher CMS scores than group I (both $p < 0.05$), while the difference between the two groups was not statistically significant ($p > 0.05$). See **Table 5**.

Table 5. Comparison of postoperative recovery quality and shoulder function scores among the three groups ($\overline{x} \pm s$, points)

Group	QoR15		CMS	
	24 h postoperatively	48 h postoperatively	24 h postoperatively	48 h postoperatively
ITM group (n = 24)	118.75 ± 8.42	128.42 ± 7.18	58.42 ± 6.75	68.42 ± 7.25
SSAX group (n = 24)	116.83 ± 8.76	126.58 ± 7.65	56.85 ± 7.12	66.38 ± 7.08
I group (n = 24)	112.38 ± 9.15[a]	123.75 ± 8.02	54.38 ± 6.58	62.15 ± 6.83[ab]
F value	3.587	2.145	2.856	4.215
p value	0.033	0.124	0.064	0.019

Note: [a]$p < 0.05$ vs. ITM group; [b]$p < 0.05$ vs. SSAX group.

3.6. Comparison of adverse reactions among the three groups

No serious adverse reactions, such as respiratory depression, Horner's syndrome, or local anesthetic toxicity, were observed in any of the three groups. There was no statistically significant difference in the overall incidence of adverse reactions among the three groups ($p > 0.05$), as shown in **Table 6**.

Table 6. Comparison of adverse reactions among the three groups [cases (%)]

Group	Nausea and vomiting	Dizziness	Pruritus
ITM group (n = 24)	2 (8.33)	1 (4.17)	0 (0.00)
SSAX group (n = 24)	3 (12.50)	2 (8.33)	1 (4.17)
I group (n = 24)	4 (16.67)	3 (12.50)	1 (4.17)
χ^2	0.824	0.987	1.043
p value	0.662	0.611	0.594

4. Discussion

Pain management after rotator cuff injury repair is a crucial component of the enhanced recovery after surgery (ERAS) concept. Postoperative pain not only prolongs hospital stays but can also lead to complications such as joint adhesions and muscle atrophy due to immobilization caused by pain, severely affecting postoperative functional recovery. Although the interscalene brachial plexus block is considered the primary analgesic method for arthroscopic shoulder surgery, its relatively high incidence of phrenic nerve blockade limits its application in patients with concomitant respiratory diseases. Therefore, exploring a nerve block approach that can provide effective analgesia while preserving diaphragmatic function is of great clinical significance.

The results of this study demonstrated that both the ITM block and the SSAX block provided analgesic effects comparable to those of interscalene brachial plexus block at rest and during activity at 24–72 h

postoperatively. This finding is consistent with previous studies showing that selective peripheral nerve blocks can cover the main sensory innervation areas of the shoulder joint, thereby achieving analgesic effects similar to those of brachial plexus block [6]. From an anatomical perspective, the suprascapular nerve and axillary nerve are the primary sensory nerves of the shoulder joint, and their combination can cover the vast majority of the shoulder's sensory territory. The ITM block involves injection of local anesthetic into the fascial plane between the infraspinatus and teres minor muscles, where the drug spreads along the fascial plane to the vicinity of the suprascapular and axillary nerves, achieving dual nerve blockade with a single puncture [7]. The durations of sensory and motor blockade in both the ITM and SSAX groups were shorter than those in group I, which is attributable to the dosage of local anesthetic and the extent of blockade. The interscalene brachial plexus block used 30 mL of local anesthetic, covering the entire brachial plexus with a large nerve–drug contact area and slower absorption; in contrast, the ITM and SSAX blocks used relatively smaller volumes of local anesthetic, with a more localized blockade and relatively faster drug absorption [8]. Nevertheless, postoperative analgesia was based on patientcontrolled intravenous analgesia (PCIA) with continuous background infusion combined with patientcontrolled rescue analgesia; the role of the nerve block was to lower the baseline pain level in the early postoperative period. In addition, the ITM group had lower opioid consumption within 24 h postoperatively than group I, suggesting that the ITM block has certain advantages in reducing opioid dependence [9]. In the present study, the incidence of diaphragmatic paralysis at 30 min after blockade was higher in group I, consistent with previous reports [10]. The incidence was 0% in the ITM group and 12.50% in the SSAX group, both lower than that in group I. The anatomical basis for this is as follows: during an interscalene brachial plexus block, local anesthetic can directly spread to the adjacent phrenic nerve; whereas the puncture site for the ITM block is located lateral to the scapula, away from the course of the phrenic nerve, and the spread of local anesthetic within the fascial plane is restricted by fascial barriers [11]. The three cases of diaphragmatic paralysis in the SSAX group may be related to cephalad spread of local anesthetic to the superior trunk of the brachial plexus during suprascapular nerve block. The QoR15 score at 24 h postoperatively in the ITM group and the CMS scores at 48 h postoperatively in both the ITM and SSAX groups were higher than those in group I, suggesting that the ITM block has advantages in promoting early recovery. The reasons are as follows: first, ITM block avoids diaphragmatic paralysis, so patients' respiratory function is not affected postoperatively, allowing earlier performance of deep breathing and coughing exercises; second, ITM block has a relatively minor impact on motor function of the affected limb, enabling patients to initiate shoulder mobilization earlier; third, ITM block requires only a single puncture, reducing the psychological trauma and risk of complications associated with multiple punctures [12]. There was no statistically significant difference in the incidence of adverse reactions among the three groups, and no serious adverse reactions occurred. ITM and SSAX blocks reduced diaphragmatic paralysis without increasing other adverse reactions, indicating that both nerve block approaches have favorable safety profiles.

5. Conclusion

In conclusion, both ultrasoundguided infraspinatusteres minor interfascial plane block and combined suprascapular and axillary nerve block can provide analgesic effects comparable to those of interscalene brachial plexus block after rotator cuff injury repair, with a significantly lower incidence of diaphragmatic paralysis, thereby facilitating early patient recovery. Among these, ITM block requires only a single puncture, is operationally simpler, and possesses unique advantages in preserving diaphragmatic function and promoting early rehabilitation.

Disclosure statement

The authors declare no conflict of interest.

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