

# Suprascapular Nerve Block Is an Effective Pain Control Method in Patients Undergoing Arthroscopic Rotator Cuff Repair

## A Randomized Controlled Trial

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**Background:** Effective pain control in patients who have undergone arthroscopic rotator cuff surgery improves functional recovery and early mobilization. Interscalene blocks (ISBs), a widely used approach, are safe and provide fast pain relief; however, they are associated with complications. Another pain management strategy is the use of a suprascapular nerve block (SSNB).

**Hypothesis:** We hypothesized that indwelling SSNB catheters are a more effective pain control method than single-shot ISBs. We also hypothesized that indwelling SSNB catheters will reduce the level of rebound pain and the demand for opioid analgesics.

**Study Design:** Randomized controlled trial; Level of evidence, 1.

**Methods:** Included in this study were 93 patients who underwent arthroscopic rotator cuff surgery between May 2012 and January 2019. These patients were assigned to either the indwelling SSNB catheter group, the single-shot ISB group, or the control (sham/placebo) group (31 patients per group). Level of pain was measured with a visual analog scale (VAS; 0 to 10 [worst pain]) on the day of the operation. The preoperative VAS score was recorded at 6 AM on the day of operation, and the postoperative scores were recorded at 1, 8, and 16 hours after surgery and then every 8 hours until postoperative day 3.

**Results:** The VAS pain scores were lower in the SSNB and ISB groups than in the control group up to postoperative hour (POH) 8, with the most significant difference at POH 8. At POH 1 and POH 8, the mean VAS scores for each group were 2.29 and 1.74 (SSNB), 2.59 and 2.50 (ISB), and 3.42 and 4.48 (control), respectively. VAS scores in the SSNB and ISB groups were consistently <3, compared with a mean VAS score of  $3.1 \pm 1.58$  in the control group ( $P < .001$ ). Compared with the ISB group, the SSNB group had significantly fewer side effects such as rebound pain duration as well as lower VAS scores ( $P < .001$ ).

**Conclusion:** VAS scores were the lowest in the indwelling SSNB catheter group, with the most pronounced between-group difference in VAS scores at POH 8. Severity and recurring frequency of pain were lower in the indwelling SSNB catheter group than in the single-shot ISB group.

**Keywords:** shoulder; rotator cuff; suprascapular nerve block; visual analog scale

Postoperative control of intensive pain in patients who have undergone arthroscopic rotator cuff surgery improves rehabilitation, functional recovery, and early mobilization. Postoperative pain can persist for 48 hours, even with the use of many different analgesic agents.<sup>30</sup> Numerous treatments have been introduced to manage pain; however, they can have several side effects and risks. Nonsteroidal anti-inflammatory drugs (NSAIDs) can cause reduced platelet function, prolonged bleeding

time, and gastric ulceration.<sup>21</sup> Opioids can be used instead of NSAIDs, but severe side effects such as nausea, vomiting, sedation, constipation, and intestinal ileus can occur. In addition, the United States is currently facing the challenge of limiting the use of opioids in the management of postoperative pain. Recent data show that chronic opioid use after any surgery increases postoperative and preoperative complications in patients.<sup>16</sup> Intra-articular (IA) injections have been proposed as an alternative pain control method; however, IA local anesthetic injections alone are ineffective in reducing intense pain, and the effectiveness of morphine or local IA anesthetics has been debated.<sup>21,25</sup>

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An excellent solution to these problems is to use peripheral nerve blocks. Interscalene blocks (ISBs) have commonly been used as an alternative pain control method; however, they can have severe side effects, including unintentional spinal anesthesia, spinal cord injury, brachial plexus injury, pneumothorax, and paralysis of the vagus nerve, laryngeal recurrent nerves, and cervical sympathetic nerve. In addition, the effectiveness of ISB is correlated with the anesthetist's skill level.<sup>37</sup> Recently, other peripheral nerve blocks such as suprascapular nerve block (SSNB) and axillary nerve block have been used for effective pain management after arthroscopic rotator cuff repair. However, the procedure for peripheral nerve block entails some difficulties, such as implementation of the nerve stimulation technique, and ultrasonography cannot offer a definitive benefit in preventing major complications such as extremity numbness.<sup>4,9</sup>

Successful ambulatory surgery depends on effective analgesics with minimal adverse effects.<sup>25</sup> To block nerves effectively, the local anesthetic should be injected as close to the nerve as possible. Complications have been reported with many different methods of SSNB and ISB.<sup>25,37,29</sup> In our procedure, a catheter is placed very close to the nerve based on the surgeon's visual field, thus effectively blocking the suprascapular nerve. The purpose of the current study was to determine the postoperative analgesic efficacy of the indwelling SSNB catheter in patients who underwent arthroscopic rotator cuff repair under general anesthesia. We hypothesized that indwelling SSNB catheters are a more effective pain control method than single-shot ISBs. We also hypothesized that indwelling SSNB catheters will reduce the level of rebound pain and the demand for opioid analgesics.

## METHODS

Patients who required surgical treatment at our institution due to a rotator cuff tear were recruited into this study, which was conducted between May 2012 and January 2019. The patients were assessed by magnetic resonance imaging (MRI) before surgical treatment and were asked whether they agreed to participate in the study after the procedures were explained.

In total, 181 patients were considered for inclusion. All patients had shoulder pain with a rotator cuff tear, the medial to lateral length of which was measured on a T2-weighted MRI scan. All patients had an American Society of Anesthesiologists (ASA) score of 1 or 2. The ASA scoring system is a 6-category scale and is widely used to assess patients' general preoperative health.<sup>31</sup> We excluded from

this study any patients with massive full-thickness supraspinatus tendon rupture or a supraspinatus tendon rupture with other associated injuries such as fracture and calcific tendinitis, patients who experienced rerupture and required reoperation, those who had inflammatory arthritis or previous neurological symptoms of the shoulder, and patients with other issues (eg, drug allergy, underlying disease that precluded use of general anesthesia in the outpatient department). A full list of exclusion criteria is shown in Figure 1. Patients with pathological injuries of the biceps were included because only a few patients had supraspinatus tendon rupture without pathological injuries to the biceps. Of the 181 initial patients, 88 were excluded, leaving 93 patients for the study (Figure 1).

Patients were randomly allocated to the SSNB group, ISB group, or control group ( $n = 31$  for each). The assignments were randomized sequentially based on a randomization table created by medical statisticians. The randomization method was used to assign an equal number of patients to the SSNB, ISB, and control groups. Each time a participant received a randomization number, it was verified before the operation.

All surgeries were performed by a single senior surgeon (K.C.N.), and all patients underwent arthroscopic shoulder surgery while in the lateral position under general anesthesia. An acromioplasty was performed for hooked or curved-type acromia. The subacromial bursa was debrided to allow a clear view of the rotator cuff. To classify tear size and severity, we used the Southern California Orthopedic Institute (SCOI) classification of full-thickness rotator cuff tears<sup>22</sup>: type I refers to a small but complete tear, such as a puncture wound; type II refers to a moderate tear (usually <2 cm) that still encompasses one of the rotator cuff tendons with no retraction of the torn ends; type III refers to a large, complete tear involving an entire tendon, with minimal retraction of the torn edge (usually 3-4 cm); and type IV refers to a massive rotator cuff tear involving 2 or more tendons, frequently with associated retraction and scarring of the remaining tendons ends, and often an L-shaped tear that is frequently irreparable. The average tear size of each group was also measured.

To minimize bias, only 2 suture techniques were used: the suture-bridge and the arthroscopic single-row techniques. The suture-bridge technique was used in patients in whom the torn cuff tendon could be reduced by >50% of the entire footprint. If this was not possible, the single-row repair was used. In the single-row technique, a suture anchor (JuggerKnot; Biomet) was placed along the lateral edge of the greater tuberosity within the rotator cuff footprint and as close as 5 to 10 mm. In the suture-bridge technique, a suture anchor (JuggerKnot) was used for medial

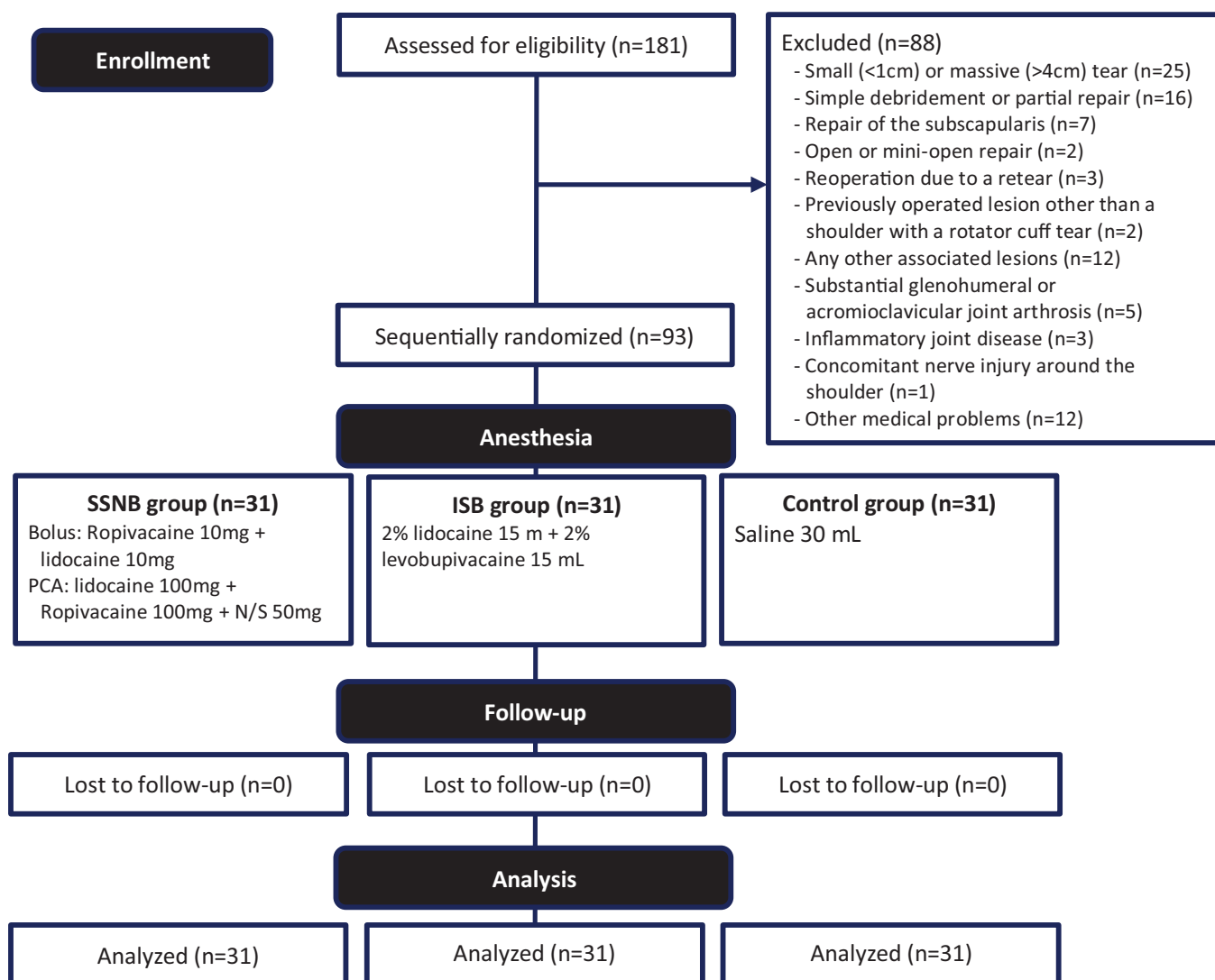
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Ethical approval for this study was obtained from Hallym University Kangnam Sacred Heart Hospital (ref No. 2019-07-013).



**Figure 1.** Patient flowchart. ISB, interscalene block; N/S, normal saline; PCA, patient-controlled analgesia; SSNB, suprascapular nerve block.

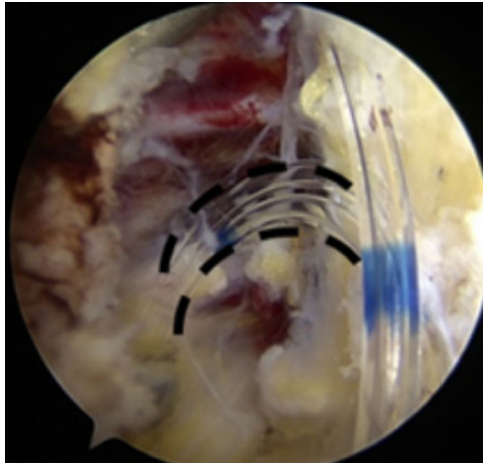
row repair, and a footprint anchor (Footprint Ultra PK anchor; Smith & Nephew) was used for lateral row repair.

In patients with suspected biceps tendon pathology, a biceps tenotomy or tenodesis was performed. Our protocol was used to perform tenodesis in patients younger than 55 years, highly active patients, or those who performed manual labor. Preoperative biceps pathology was suspected only in cases where the patient felt pain in the front of the shoulder and/or in the bicipital groove, or if the Speed test and Yergason test were positive.<sup>15</sup> After MRI, biceps tenotomy or tenodesis was considered when a large amount of edema was observed in the bicipital groove or there was evidence of biceps adhesion, tendinopathy, or absence of the biceps from the bicipital groove. When a proximal biceps injury was confirmed intraoperatively, we performed a biceps tenotomy or tenodesis. In tenodesis, an incision was used as an anterolateral viewing portal, and an anteroposterior portal was used as a working

portal. The pectoralis major muscles were retracted proximally, and the biceps tendon and bicipital groove were visually identified. The bicipital groove was then scraped with a curette to prepare for bone-tendon healing, and a 4.5-mm bioabsorbable suture anchor (Healicoil suture anchor; Smith & Nephew) was placed in the center of the bicipital groove. The suture was passed through the tendon and tied in place, and the tendon was then placed on the suture anchor. Finally, the biceps tendon was in its native position. For tenotomy, the proximal biceps were cut off at the biceps-labral complex insertion site, and the superior labrum was debrided.

#### SSNB Technique

SSNB was performed by the senior surgeon (K.C.N.) immediately after completion of the procedure using an arthroscopic. Using the previous viewing portal, the surgeon



**Figure 2.** Catheter insertion procedure after transverse ligament release. The dashed black lines indicate the catheter.

performed the scapular notch location process. The transverse scapular ligament and suprascapular nerve were directly visualized by following the coronoid process and scapular notch; the transverse scapular ligament was then incised. The catheter was placed just above the nerve, and the drug was administered with a 20-mL bolus (mixed solution with 10 mL of 0.75% ropivacaine and 10 mL of lidocaine HCL injection via a Stimuplex 22-gauge spinal needle [B. Braun]). Next, patient-controlled analgesia (PCA) containing lidocaine HCL injection (100 mL), 0.75% ropivacaine (100 mL), and normal saline (50 mL) (a total of 250 mL) was connected to the catheter line (basal infusion rate, 5 mL/h) (Figure 2). Daily monitoring of the remaining medicine was performed, and no severe complications were observed. The catheter was removed when all the medication had been injected.

### ISB Technique

A sonography-guided Stimuplex 22-gauge spinal needle (B. Braun) and Stimuplex-DIG peripheral nerve stimulator (B. Braun) were used to inject ISB using 15 mL of 2% lidocaine and 15 mL of 2% levobupivacaine. Approximately 30 minutes later, the success of the block was determined by checking for a change in sensation in the upper arm. In this study, the anesthetic catheter was removed after bolus injection for ISB. In the control (sham/placebo) group, 30 mL of normal saline was injected to achieve the same volume effect using an aseptic technique. An experienced anesthesiologist performed the sonography-guided ISB and normal saline injection using the same equipment. The anesthesiologist also monitored the patients for any complications 30 minutes before surgery.

### Pain Monitoring

A visual analog scale (VAS; 0 to 10 [worst pain]) was used to assess the pain level in each group on the day of operation

(preoperative VAS) at 6 AM, and postoperative VAS was checked 1, 8, 16, and 24 hours after the operation and then every 8 hours until 72 hours after the operation. Based on a previous study,<sup>27</sup> the primary outcome was effectively evaluated for 16 hours after the surgery.

Although the risk of developing peripheral nerve block complications is low (retrospective studies estimate an incidence rate of 0.5%-1.0%<sup>19</sup>), monitoring was performed every 8 hours to prevent and investigate possible complications. The patients were monitored for complications, motor weakness, sensory changes, and nausea every 8 hours as VAS scores were recorded. All patients were hospitalized for at least 3 days after the surgery and were discharged after 3 or 4 days.

During hospitalization, intravenous tramadol injection was administered if the patient was still unable to tolerate severe pain. Although medicines such as hydrocodone or acetaminophen are standard rescue analgesics after surgery in many countries, tramadol and acetaminophen are standard rescue analgesics used in our institution due to regulations controlling the use of narcotic analgesics. Preoperative medication was prescribed following these regulations for all our patients. Therefore, there was no difference in the preoperative medication between patients.

We also checked for the rebound phenomenon after nerve block use. The definition of rebound pain is the quantifiable difference in pain scores when a peripheral nerve block is working versus the acute pain encountered when the blocking effectiveness is reduced.<sup>34</sup> In a 2007 study of cruciate ligament reconstruction, Williams et al<sup>38</sup> defined rebound pain as a remarkable increase in acute pain in the first few hours after the peripheral nerve block wears off. DeMarco et al<sup>10</sup> also described possible rebound pain after arthroscopic shoulder procedures. In the current study, in terms of the pain score, we defined the start of the rebound period as the time point at which the VAS score began to increase again and the end point as the next decrease in the VAS score. Times and VAS scores were checked.

### Statistical Analysis

Drawing on a previous study,<sup>27</sup> we determined that the comparison of 3 independent groups with a sample size of 31 participants per group had sufficient power ( $\beta = 0.2$ ) to detect a difference in postoperative VAS scores. The type I error probability was set at .05. At least 29 cases per group were needed to achieve a result using the PASS 11 calculating system.<sup>17</sup> Within a relatively short period (3-4 days after surgery), the primary efficacy endpoint was calculated. This study assumed that a 5% dropout rate was reasonable. Therefore, we decided to include 31 participants per group. The chi-square test was used to analyze the difference factors of the 3 groups, and the generalized linear model was used to compare any 2 of the groups.

### RESULTS

The nerve block was performed successfully in all patients in the SSNB and ISB groups, and no patients dropped out of

TABLE 1  
Demographic and Operative Characteristics by Group<sup>a</sup>

Variable	SSNB (n = 31)	ISB (n = 31)	Control (n = 31)	P Value <sup>b</sup>
Age, y	62.39 ± 8.78	59.09 ± 7.5	62.74 ± 6.92	.1133
Sex				.7074
Male	14 (45.16)	17 (54.84)	15 (48.39)	
Female	17 (54.84)	14 (45.16)	16 (51.61)	
Tear size, mm	21.72 ± 4.57	21.79 ± 3.03	21.64 ± 2.82	.9371
SCOI classification				
Type I	1 (3.23)	0 (0)	1 (3.23)	
Type II	28 (90.32)	31 (100)	30 (96.77)	
Type III	2 (6.45)	0 (0)	0 (0)	
ASA score	1.69 ± 0.74	1.41 ± 0.50	1.65 ± 0.49	.0703
ASA score 1	12 (38.71)	18 (58.06)	11 (35.48)	
ASA score 2	19 (61.29)	13 (41.94)	20 (64.52)	
Biceps procedure				.7562
Simple	10 (32.26)	12 (38.71)	13 (41.94)	
debridement				
Tenotomy	10 (32.26)	9 (29.03)	7 (22.58)	
Tenodesis	11 (35.48)	10 (32.26)	11 (35.48)	
Suture				.9341
Single-row	5 (16.13)	3 (9.68)	6 (19.35)	
Suture-bridge	26 (83.87)	28 (90.32)	25 (80.65)	

<sup>a</sup>Data are reported as mean ± SD or n (%). ASA, American Society of Anesthesiologists; ISB, interscalene block; SCOI, Southern California Orthopedic Institute; SSNB, suprascapular nerve block.

<sup>b</sup>Fisher exact test or Kruskal-Wallis test.

the study (Figure 1). There were no significant differences among the 3 groups in variables such as sex, age, tear size, ASA score, biceps procedure, and suture technique (Table 1). Lidocaine and levobupivacaine were used in the ISB and SSNB groups, and no patient reported nausea or vomiting.

The mean VAS scores were much lower in the SSNB and ISB groups than in the control group at postoperative hour (POH) 1 and 8. The scores for these respective time points were 2.29 and 1.74 in the SSNB group, 2.59 and 2.50 in the ISB group, and 3.42 and 4.48 in the control group ( $P < .001$ ) (Table 2). The overall postoperative (POH 1-72) VAS scores were lower in the SSNB group than in the ISB group. The mean ± SD postoperative VAS score was 1.95 ± 0.85 in the SSNB group, 2.89 ± 1.63 in the ISB group, and 3.1 ± 1.58 in the control group ( $P < .001$ , chi-square test).

From POH 1 to 72, the SSNB group showed the lowest number of rescue tramadol administrations. At POH 1, no patient in the SSNB and ISB groups required an additional rescue with tramadol. A significant difference was found between the SSNB, ISB, and control groups at POH 8 ( $P < .001$ ) (Figure 3).

Regarding other peripheral nerve blocks, after the first episode of rebound pain, postoperative pain was suspected 8 to 64 hours after arthroscopic rotator cuff repair.<sup>30</sup> Rebound pain is a crucial complication associated with peripheral nerve blocks. We found a significant difference in rebound pain VAS score between the SSNB and ISB groups from POH 8 to 40 ( $P < .05$ ) (Figure 4). In the

TABLE 2  
Postoperative Pain Change During the Initial 72 Hours<sup>a</sup>

Variable	SSNB	ISB	Control	P Value
Preoperative	1.94 ± 0.25	1.94 ± 1.01	1.94 ± 0.77	.8834
Postoperative				
1 h	2.29 ± 1.77	2.59 ± 1.13	3.42 ± 1.82	<b>&lt;.001</b>
8 h	1.74 ± 0.63	2.50 ± 1.57	4.48 ± 2.42	<b>&lt;.001</b>
16 h	2.35 ± 1.70	4.22 ± 2.24	3.45 ± 1.98	<b>&lt;.001</b>
24 h	2.68 ± 1.70	3.72 ± 2.53	3.13 ± 1.75	<b>&lt;.001</b>
32 h	1.71 ± 0.53	3.22 ± 1.54	3.39 ± 1.52	<b>&lt;.001</b>
40 h	1.71 ± 0.53	2.59 ± 1.29	2.94 ± 1.71	<b>&lt;.001</b>
48 h	1.90 ± 0.60	2.78 ± 1.90	3.13 ± 1.52	<b>&lt;.001</b>
56 h	1.71 ± 0.53	3.16 ± 1.74	2.81 ± 1.19	<b>&lt;.001</b>
64 h	1.71 ± 0.53	2.53 ± 1.57	2.77 ± 1.63	<b>&lt;.001</b>
72 h	1.71 ± 0.53	2.53 ± 1.41	2.74 ± 1.06	<b>&lt;.001</b>

<sup>a</sup>Data are presented as mean ± SD. Bolded P values indicate statistically significant difference between the SSNB, ISB, and control groups ( $P < .05$ , chi-square test). ISB, interscalene block; SSNB, suprascapular nerve block.

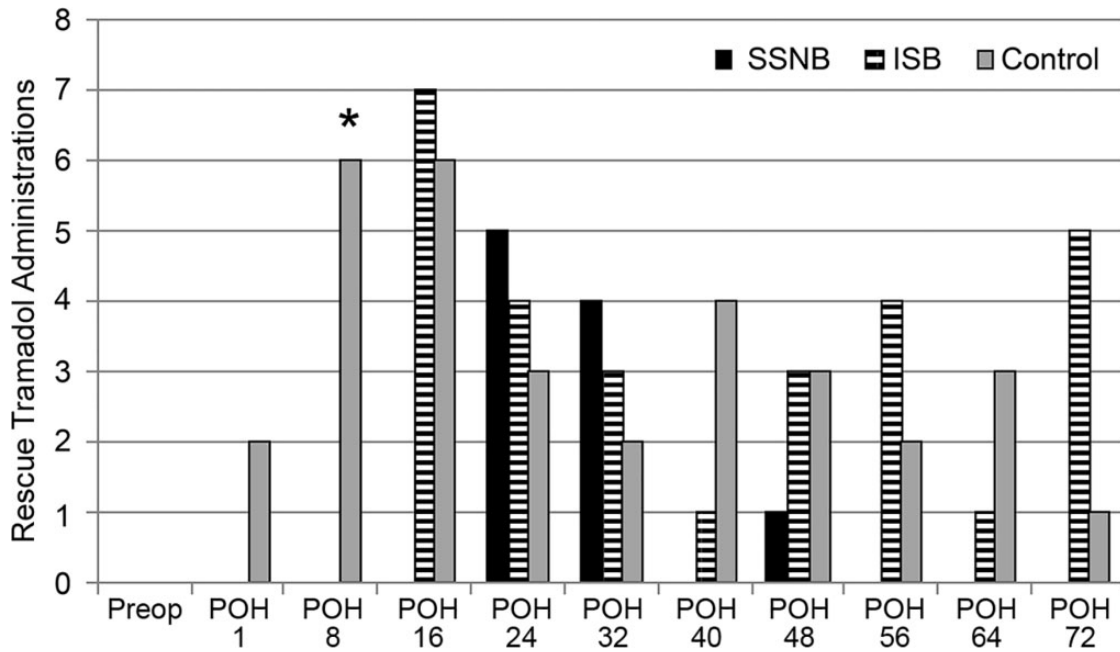
generalized linear model, the period of rebound pain was shorter in the SSNB group with an earlier starting and stopping time; in addition, the highest mean pain severity was lower in the SSNB group ( $P < .05$ ) (Table 3). There were only a few other complications in this study. Two patients each in the SSNB group and ISB group reported symptoms such as nausea and vomiting. However, the difference between the groups was not significant.

## DISCUSSION

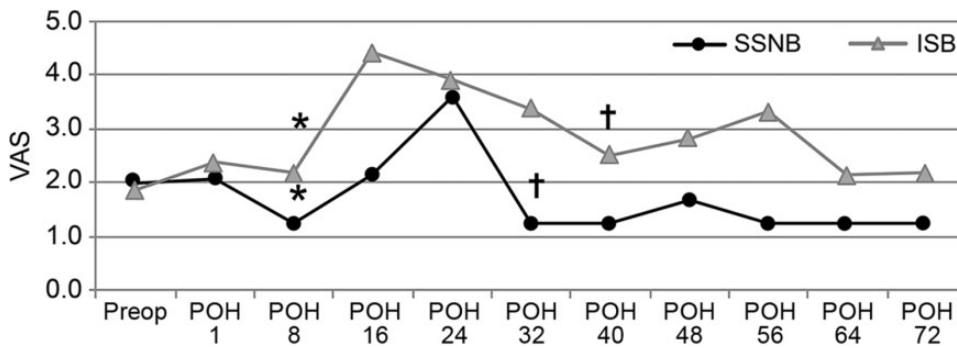
Postoperative pain management after shoulder rotator cuff surgery is essential to shorten the hospitalization stay and facilitate earlier initiation of rehabilitation exercises.<sup>9</sup> Basat et al<sup>2</sup> reported that within POH 48 after rotator cuff surgery, intensive postoperative pain can occur. To determine the most effective way to control pain after surgery, this study focused on the pain block and analyzed the associated VAS score, side effects, and the number of additional pain medicines administered.

As shown in previous studies, peripheral nerve blocks can reduce postoperative pain effectively in patients undergoing arthroscopic shoulder rotator cuff surgery, and minor complications such as vomiting, nausea, sedation, or nerve injuries are rare.<sup>6,26</sup> In our study, only 2 patients reported nausea and vomiting after SSNB and 2 patients after ISB; hence, we could not statistically analyze the complication rate.<sup>33</sup> Peripheral nerve block also has serious side effects, such as rebound pain, diaphragmatic paresis, phrenic nerve palsy, and pneumonia.<sup>11-18</sup> SSNB has been used effectively for anesthesia in shoulder arthroscopy, and this nerve block has a relatively low risk and is safe during the intraoperative and postoperative periods. However, SSNB alone is still associated with the rebound phenomenon, which is a complication of peripheral nerve blocks. Accordingly, a catheter was inserted directly after SSNB to reduce the rebound phenomenon





**Figure 3.** Administration of rescue tramadol by group per postoperative hour (POH). ISB, interscalene block; Preop, preoperative; SSNB, suprascapular nerve block. \*Statistically significant difference between all 3 groups ( $P < .05$ ).



**Figure 4.** Postoperative visual analog scale (VAS) pain scores in the peripheral nerve block groups. ISB, interscalene block; POH, postoperative hour; Preop, preoperative; SSNB, suprascapular nerve block. \*Rebound pain start point; †rebound pain stop point.

by continuously injecting the anesthetic until the phenomenon disappeared.

We found that VAS pain scores were significantly lower in both the SSNB and the ISB groups than in the control group during POH 1 to 8. However, average VAS score was lowest in the SSNB group on the day of the surgery.

ISB is an effective analgesia after arthroscopic rotator cuff surgery.<sup>12</sup> Fredrickson et al<sup>12</sup> showed that ISB resulted in lower VAS scores during the first 24 hours. However, ISB carries risks of severe complications: The rate of accidental catheter removal was almost 22% in 1 study, and nerve injuries such as phrenic nerve palsy, central neuraxial block, and Horner syndrome may occur, as well as infection.<sup>3,35</sup> The most important finding in our study was that pain was lower in the SSNB group than in the ISB group on the day of the surgery, and no major side effects were

observed. We suggest that further evaluation be conducted to confirm this finding.

SSNB is a new method for postoperative pain relief in arthroscopic shoulder surgery. Lee et al<sup>24</sup> reported that arthroscopic SSNB was highly effective in controlling postoperative pain after shoulder surgery. According to another study, SSNB performed with an arthroscopic guide was very effective in controlling postoperative shoulder pain in patients undergoing arthroscopic rotator cuff surgery.<sup>20</sup> Lehmann et al<sup>26</sup> found that rescue analgesics were used less in patients treated with ISB than in those treated with conventional pain control approaches at POH 24. In the current study, within 3 days of the surgery, we noted no major differences in the number of additional rescue tramadol requirements among the 3 groups. Notably, additional rescue tramadol

TABLE 3  
Postoperative Rebound Pain During the Initial 72 Hours  
(General Linear Model)<sup>a</sup>

Dependent Variable	Independent	Estimate (95% CI) <sup>b</sup>	P Value
Rebound pain period	ISB	7.54 (2.04 to 13.04)	<b>.031</b>
	SSNB	0	
Rebound VAS pain change value	ISB	1.01 (-0.27 to 2.3)	.12
	SSNB	0	
Highest rebound VAS pain score	ISB	1.56 (0.07 to 3.04)	<b>.021</b>
	SSNB	0	
Rebound pain start point	ISB	7.99 (0.3 to 15.68)	<b>.016</b>
	SSNB	0	
Rebound pain stop point	ISB	15.53 (4.31 to 26.75)	<b>.035</b>
	SSNB	0	
VAS pain score at rebound pain start	ISB	0.55 (0.04 to 1.05)	<b>.024</b>
	SSNB	0	
VAS pain score at rebound pain stop	ISB	1.08 (0.46 to 1.69)	<b>.047</b>
	SSNB	0	

<sup>a</sup>Bolded *P* values indicate statistically significant difference between the SSNB and ISB groups ( $P < .05$ , general linear model). ISB, interscalene block; SSNB, suprascapular nerve block; VAS, visual analog scale.

<sup>b</sup>General linear model to calculate ISB values with an SSNB value of zero.

requirements were lower during the first 8 hours postoperatively in both the SSNB and the ISB groups than in the control group.

As in other recent studies, the VAS pain scores in the ISB group rapidly increased and were greater than those of the control group after POH 8.<sup>1</sup> Oh et al<sup>30</sup> explained this phenomenon as “rebound pain,” which occurs because of the reduced effect of the peripheral nerve block and is a crucial problem in this block method. Therefore, we believe that the rapid increase in the amount of rescue tramadol required after POH 8 in the ISB group was due to rebound pain. Catheter insertion combined with SSNB in arthroscopic rotator cuff repair resulted in an improvement in VAS score in the first 72 hours after surgery compared with ISB alone. We also found that the combination of SSNB with catheter insertion tended to reduce rebound shoulder pain compared with ISB. In addition, although it was not covered as a topic in our article, we estimate that a patient who uses an indwelling catheter may be discharged within 3 days. This estimate is based on several factors: during the hospital stay, the only side effect of the drug was vomiting, which occurred in only 1 patient; only a few rescue drugs were used because of rebound pain (in the SSNB group, rescue drugs were used for 5 patients at POH 24 and 4 patients at POH 32); and it was possible to control the patients’ pain without using an opioid.

## Limitations

This study has some limitations. First, no study has determined the minimal clinically important difference (MCID) for VAS scores in the short period after arthroscopic rotator cuff repair. Tashjian et al<sup>36</sup> determined the MCID for VAS as 1.4 for patients who underwent 6 weeks of nonoperative treatment for rotator cuff disease, and Gallagher et al<sup>14</sup> determined the MCID for VAS as 1.3 for patients diagnosed with rotator cuff tear with acute pain. Another previous study<sup>23</sup> that estimated the effectiveness of ISB on postoperative pain after arthroscopic shoulder surgery determined the MCID for VAS as 1.2. These conflicting MCIDs for VAS scores may have led to sampling bias, thereby making interpretation of the treatment results difficult. Moreover, because of the presence of many factors, analyzing the VAS score alone may not be sufficient to analyze the various pain modalities. Second, the use of rescue tramadol could mask the level of pain after surgery. However, on the day of the surgery, the number of rescue tramadol administrations was significantly lower in both the SSNB and ISB groups than in the control group. This result demonstrates that a peripheral nerve block is a more effective method in relieving postoperative pain than conventional analgesics alone.

There are also limitations due to the surgical technique. First, the pain scores may differ depending on the suturing and biceps treatment methods, but the difference in pain scores due to these 2 factors was excluded because there was no difference between the 3 groups in this study. A previous study reported that even patients younger than 55 years who were highly active showed no difference in functional and subjective outcomes according to the biceps procedure.<sup>13</sup> In the current study, a long-term follow-up was not achieved for the included patients; therefore, the correlations between these 2 factors (the suturing and biceps treatment methods), pain scores, practice equations, and analysis of side effects between ISB and SSNB groups should be evaluated at longer term follow-up in the future. Second, transverse scapular ligament release was performed in the SSNB group but not in the other groups. This factor can mask an SSNB effect because the transverse scapular ligament release induces suprascapular nerve decompression and pain relief. Notably, patients in the SSNB group did not have a diagnosis of suprascapular nerve stenosis when arthroscopic rotator cuff repair was performed. The transverse scapular ligament release was performed to identify the node for direct injection after confirmation of the nerve. However, because patients with massive tears were excluded, the nerve decompression effect of nerve traction should be minimal. In addition, pain was assessed 3 days postoperatively, and the decompression effect of preventing nerve traction that may occur during ROM after release was insufficient because a shoulder immobilizing brace was worn in this period.

Another limitation is associated with the use of medication. There were differences in medication between the ISB and SSNB groups. This study was designed based on the fact that there are no differences between levobupivacaine and ropivacaine with respect to onset time of surgical

anesthesia, onset time of sensory block, onset time of motor block, duration of motor block, and overall patient satisfaction.<sup>8</sup> Levobupivacaine only provided more long-term anesthesia.<sup>7</sup> This study focused on the fact that catheter insertion can be more potent even with short-term anesthetics.

Last, there were differences in methods between the ISB and SSNB groups. Application times in the ISB, SSNB, and control groups were different. ISB was performed before the surgery, whereas the other methods were performed during the surgery. Because arthroscopic rotator cuff surgery duration is approximately 1 hour and ISB effect duration is up to 24 hours, difference in the application time should not have affected the study results.<sup>5</sup> However, for more accurate analysis, the application times between groups should be matched in future studies. The single bolus shot was the same in the 2 peripheral nerve block groups, but catheter insertion was done in the SSNB group. However, we were concerned about severe complications with continuous catheter block in the ISB group. This study aimed at analyzing the effect of SSNB and continuous anesthetic injection through a catheter; however, further studies are warranted to determine the effectiveness of a single-shot SSNB versus an indwelling ISB.<sup>28</sup>

## CONCLUSION

For postoperative pain control in patients who underwent arthroscopic rotator cuff repair, indwelling SSNB catheter relieved pain on the day of the surgery, without any major complications, and additional catheter insertion significantly reduced rebound pain at POH 8 to 56. This indicates that SSNB with catheter insertion could be more effective than single-shot ISB for pain control after arthroscopic rotator cuff repair surgery.

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