ORIGINAL ARTICLE

CiSE
Clinics in Shoulder and Elbow

Clinics in Shoulder and Elbow Vol. 20, No. 1, March, 2017
https://doi.org/10.5397/cise.2017.20.1.10

The Efficacy of Additional Intravenous Patient-controlled Analgesia to the Interscalene Block in Arthroscopic Shoulder Surgery: A Prospective Randomized Controlled Study

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Background: The purpose is to determine the efficacy of additional intravenous patient-controlled analgesia (IV-PCA) by comparing the analgesic effects between interscalene block (ISB) combined with IV-PCA and single ISB after arthroscopic shoulder surgery.
Methods: A total of 213 patients who underwent arthroscopic shoulder surgery were divided into two groups based on the type of perioperative anesthesia. The single ISB group included 100 patients, while the IV-PCA group included 113 patients. The visual analogue scale for pain (VAS pain) scores were assessed at 12, 24, and 48 hours postoperatively in accordance with shoulder pathology. Postoperative narcotics-related complications and consumption of additional non-steroidal anti-inflammatory drugs between the two groups were compared.
Results: VAS pain showed no significant difference between the two groups at most points of the postoperative timeline, regardless of shoulder pathology, except in patients with rotator cuff repair at postoperative 24 hours. Although the IV-PCA group showed a statistically lower VAS pain score than the ISB group at postoperative 24 hours (p=0.04), the difference in the VAS pain score was only 9.0 mm in patients with rotator cuff repair. Narcotics-related complications were observed more frequently in the IV-PCA group than in the ISB group for patients with rotator cuff repair.
Conclusions: Additional IV-PCA demonstrated no booster effect for immediate pain control in patients undergoing arthroscopic shoulder surgery with preoperative single ISB. Furthermore, patients with IV-PCA experienced greater narcotics-related complications.
(Clin Shoulder Elbow 2017;20(1):10-17)

Key Words: Anesthesia; Analgesia; Arthroscopy; Shoulder

Introduction

Approximately 30% to 70% of patients who undergo shoulder surgery experience severe pain, particularly in the first 48 hours postoperation.[1)] Although arthroscopic rotator cuff repair has many advantages, such as smaller scar, faster recovery, lower infection rate, and shorter hospital days as compared with open shoulder surgery, postoperative pain is an issue that remains unresolved.[2,3)] Appropriate pain control after arthroscopic shoulder surgery is crucial for enhanced postoperative rehabilitation and functional recovery of the shoulder, including range of motion and muscle power.[4)]

Various options are available to control postoperative pain following shoulder surgery, including intravenous patient-controlled analgesia (IV-PCA), subacromial or intraarticular injection, suprascapular nerve block (SSB), interscalene block (ISB), and continuous brachial plexus blockade.[5)] Although ISB is associated with several potential side effects, such as nerve block failure, phrenic nerve palsy, and rebound pain, it has been proven to be one of the most effective analgesic treatment modalities for arthroscopic shoulder surgery. Single ISB has a high success rate and lesser complications as compared with other modalities,

Received August 8, 2016. **Revised** September 21, 2016. **Accepted** September 21, 2016.

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IRB approval (No. EUMC 2015-01-047-002).

Financial support: None. **Conflict of interests:** None.

pISSN 2383-8337
eISSN 2288-8721

especially when administered with ultrasound (US) guidance.[6] However, single ISB is often combined with continuous analgesic infusion[7] or with additional IV-PCA due to its short analgesic effect.[8]

IV-PCA with opioids is a well-established technique for postoperative pain management after major surgeries. This technique helps patients to control the level of pain more effectively than intravenous bolus injection of analgesia, enhancing patient satisfaction.[9] However, IV-PCA is often associated with several side effects, including drowsiness, nausea, and vomiting, due to the opioids contained in IV-PCA. Furthermore, if used alone in large doses for a long period of time or even in moderated single doses at risky patients, opioids can lead to more serious adverse effects, such as acute tolerance to analgesia, as well as respiratory and hemodynamic depression.[10] The high cost of IV-PCA may also be a considerable burden for patients after surgery.[11]

This study aimed to determine the efficacy of additional IV-PCA by comparing the analgesic effects of ISB combined with IV-PCA and single ISB for postoperative pain management after arthroscopic shoulder surgeries and to analyze the narcotics-related complications based on various shoulder pathologies in the immediate postoperative period. We hypothesized that IV-PCA has no an additional benefit for immediate postoperative pain control after arthroscopic shoulder surgery when administered in combination with preoperative single ISB.

Methods

Patients

A total of 213 patients who underwent arthroscopic shoulder surgery from January 2011 to January 2012 were included prospectively. The institutional review board of the hospital approved this study, and written informed consent was obtained from each study participant. The inclusion criteria were as follows: patients who underwent arthroscopic full-thickness or partial-thickness rotator cuff repair or repair of intraarticular lesions, including Bankart lesion, superior labral tear from anterior to posterior (SLAP) lesion, and posterior labral tears under anesthesia with single ISB and general anesthesia. The exclusion criteria were as follows: patients with allergies to medications used in the study, history of renal diseases, coagulation abnormalities, existing hepatic disease, concomitant fractures, history of joint infection, history of previous shoulder surgery, and inability to understand the questionnaires. All arthroscopic shoulder surgeries were performed by a single, experienced orthopedic surgeon.

Randomization

The sample size was calculated based on the visual analogue scale for pain (VAS pain). From a pilot study with 30 patients, the mean difference of the estimated relief of pain intensity was calculated to be 10.0 mm, with a standard deviation of 22.1 mm, between the two groups (single ISB and single ISB combined with IV-PCA). Thus, it was assumed that at least 86 patients per group should be recruited to detect a difference of 10.0 in the VAS pain score (one-sided type I error rate 5%, $\beta=0.9$). Assuming a 15% dropout rate, the final sample size was set at 100 patients in each group. All enrolled patients were allocated to either the IV-PCA group (patients receiving IV-PCA in addition to single ISB) or the ISB group (patients receiving only single ISB), without stratification by demographic characteristics. The randomization sequence was created using a web-based service available on "www.sealedenvelope.com" with a 1:1 balanced allocation. Upon arrival to the operating room, an independent assistant oversaw the randomization using the web site results. After confirming the allocation of the patient, the independent assistant notified the anesthetist regarding the allocation. Within each group, patients were subdivided into two groups based on shoulder pathology: rotator cuff tear or intraarticular lesion.

Intervention

All patients received single ISB before the induction of general anesthesia. The IV-PCA device (Accufuser Plus®; Woo Young Medical, Seoul, Korea) was connected postoperatively for all patients. All procedures of ISB were performed irrespective of the allocated groups by two anesthetists with similar levels of experience. After skin preparation with povidone-iodine solution, the nerve location of the brachial plexus was assessed using an US with a 5.0–13.0 MHz linear probe (M-Turbo; SonoSite, Bothell, WA, USA) for ISB. After the identification of brachial plexus between the anterior and middle scalene muscles, a 50-mm needle with 22 gauge insulation (Stimuplex A; B-Braun, Melsungen, Germany) was used, and the tip was advanced towards the C5 and C6 roots or superior trunk within the sheath using the in-plane method. After localization and negative aspiration, we administered a loading dose of 10 ml of 0.5% ropivacaine. After 15 minutes of ISB, the anesthetists evaluated the sensory status of the upper arm using an alcohol swab. Decreased sensory sensitivity in the C5 and C6 dermatomes was considered as a successful ISB. If there was no change in the sensory status in the C5 and C6 dermatomes after 30 minutes, ISB was considered a failure.

In the recovery room, the IV-PCA pump, which contained a mixture of 1,500 μg fentanyl and 150 mg ketorolac diluted with saline solution to a total volume of 100 ml, was attached to patients in the IV-PCA group.[12] The IV-PCA device for the ISB group contained normal saline as a placebo. IV-PCA device was programmed to use 0.5 ml/hr for background infusion and 0.5-ml bolus on demand, with a 15-minute lockout time. The same amount of normal saline without narcotics was administered to patients in the ISB group. The bottles of IV-PCA devices in both groups were packed and sealed with a black sack. The running

status of IV-PCA device was checked by the nurses until patient discharge.

Clinical Evaluation

The preoperative VAS pain score, American Shoulder and Elbow Surgeons score, Constant score, and range of shoulder motion were assessed on admission. Shoulder stiffness was defined as less than 120° of passive forward elevation, less than 30° of passive external rotation, or lower than the 3rd lumbar level of passive internal rotation. Postoperatively, the type of shoulder pathology, operating time, amount of normal saline for intraoperative irrigation, mean pressure of irrigation fluid used intraoperatively, and number of suture anchors were all recorded. After transferring the patients to the recovery room, oxygen saturation was monitored and a chest plain radiograph was obtained to identify pneumothorax or phrenic nerve palsy. For all patients, the VAS pain score was assessed at postoperative 12, 24, and 48 hours. Before discharge (48 hours after surgery), the usage of additional oral non-steroidal anti-inflammatory drugs (NSAIDs) and occurrence of narcotic analgesics-related complications were also recorded. When patients complained of nausea and experienced vomiting, or asked for rescue antiemetic at postoperative 12, 24, and 48 hours or at any time, we assessed whether patients had narcotic analgesics-related complications. Postoperatively, additional oral NSAIDs were administered only at the request of the patients. The clinical outcomes were also analyzed in each group in accordance with shoulder pathology. All assessments were performed by a single physician assistant without any clinical involvement in this study.

Statistical Analysis

All statistical analyses were performed using IBM SPSS statistical software ver. 20 (IBM Co., Armonk, NY, USA) with a confidence level of 95%. Descriptive evaluation was performed based on the mean values and standard deviations. Paired t-test and repeated measures ANOVA were used to analyze the normally distributed preoperative and postoperative data in each group and to analyze the normally distributed data between the two groups, respectively. Chi-square test for nonparametric data and Fisher's exact test for nonparametric specific pair comparisons were used to identify significant differences. A $p<0.05$ was considered to be statistically significant.

Results

A CONSORT diagram is depicted in Fig. 1, which shows detailed information regarding the flow of patient selection. A total of 353 patients were screened for eligibility. Of these, 111 patients were excluded: 94 patients did not meet the inclulsion criteria, and 17 patients refused to participate. Overall, 242 eligible patients consented to be included in the study and were randomly allocated to either the ISB group or IV-PCA group. However, 21 patients in the ISB group and 8 patients in the IV-PCA group were later excluded due to reasons, such as patient

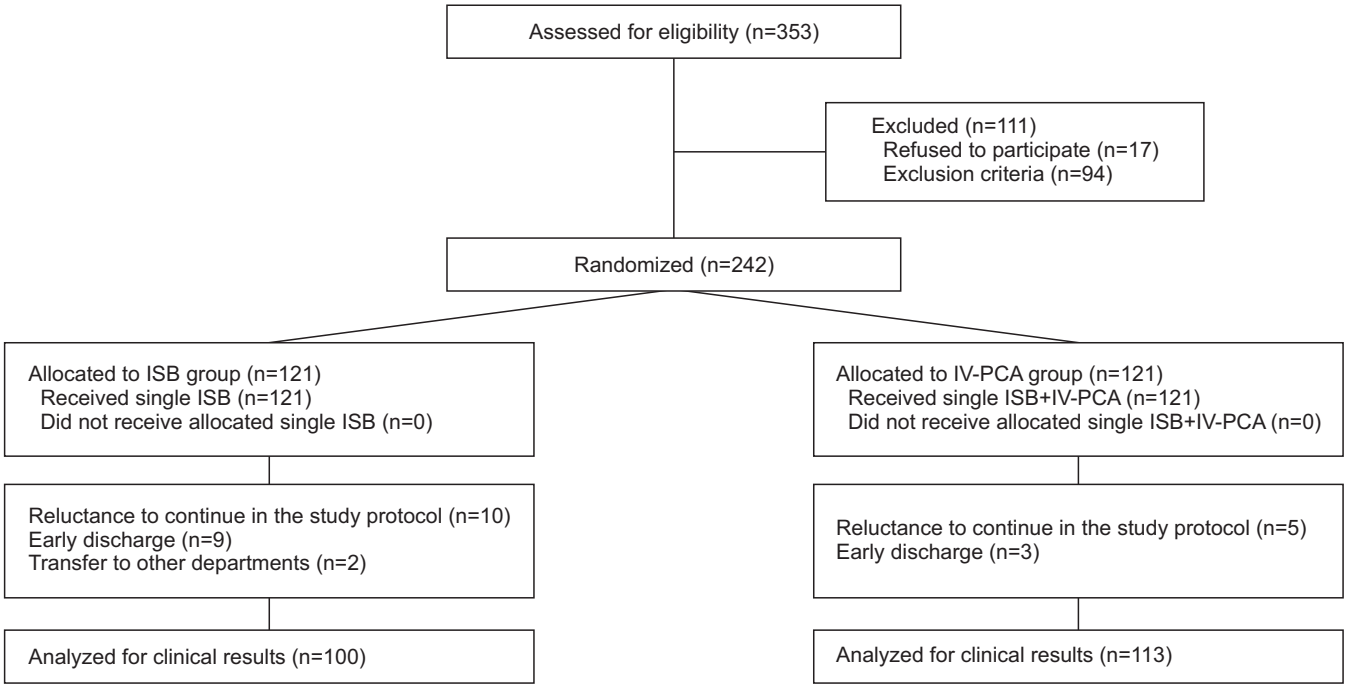

Fig. 1. Patient recruitment based on CONSORT (consolidated standards of reporting trials) statement.
ISB: interscalene block, IV-PCA: intravenous patient-controlled analgesia.

reluctance to continue in the study protocol, early discharge, or transfer to other departments. Finally, 213 patients completed the study, with 100 patients in the ISB group and 113 patients in the IV-PCA group without any loss of follow-up of up to 48 hours postoperatively.

There was no case suspected as block fail in all patiensts underwent operations.

There were no significant differences in the demographic characteristics of the two groups (Table 1). Overall, no intergroup differences regarding the intraoperative factors, including operating time, fluid amount and pressure, or number of anchors, were observed. The overall operation time was 66.7 ± 20.5 minutes in the ISB group and 70.1 ± 23.1 minutes in the IV-PCA group (p=0.26). The fluid amount was 21.2 ± 7.6 L in the ISB group and 21.7 ± 12.1 L in the IV-PCA group (p=0.74). The fluid pressure was 58.5 ± 9.3 mmHg in the ISB group and 62.1 ± 10.0 mmHg in the IV-PCA group (p=0.11). With respect to the anchor numbers, 3.3 ± 1.8 were used in the ISB group and 3.0 ± 1.7 in the IV-PCA group (p=0.27). No intergroup differences were noted between patients with rotator cuff tears and intraarticular lesions for intraoperative factors (Table 2).

Table 1. Demographic Data

Variable	ISB group (n=100)	IV-PCA group (n=113)	*p*-value
Average age (yr)	47.2 ± 19.8	44.8 ± 19.0	0.374
Gender (male:female)	59:41	74:39	0.395
Symptom duration (mo)	4.4 ± 3.4	4.5 ± 3.3	0.875
Preoperative ASES score	50.1 ± 20.5	51.2 ± 18.3	0.699
Preoperative Constant score	63.2 ± 27.9	54.2 ± 19.0	0.262
Stiffness*	10	14	0.667

Values are presented as mean ± standard deviation or number only.
ISB: interscalene block, IV-PCA: intravenous patient-controlled analgesia, ASES score: American Shoulder and Elbow Surgeons Evaluation score.
*Less than 120° of passive forward elevation or less than 30° of passive external rotation, or lower than L-3 of passive internal rotation.

Comparison of Clinical Outcomes between the Interscalene Block and Intravenous Patient-controlled Analgesia Groups

At each of the three time points, postoperative VAS pain score intensity showed no significant differences between the two groups. For the ISB and IV-PCA groups, the VAS pain score were 11.7 ± 10.2 mm and 13.0 ± 14.9 mm (p=0.45) at 12 hours, 18.2 ± 21.3 mm and 17.9 ± 26.9 mm (p=0.99) at 24 hours, and 5.0 ± 8.0 mm and 6.3 ± 11.1 mm (p=0.56) at 48 hours postoperatively, respectively.

Complications

None of the patients experienced any severe complications, such as phrenic nerve or brachial plexus palsy related to ISB. However, 3 patients complained of a tingling sensation on the ipsilateral hand or forearm of up to 48 hours after the operation (1 patient [1.0%] in the ISB group and 2 patients [1.8%] in the IV-PCA group). The symptoms of all patients had been resolved at the time of the follow-up visit to the outpatient clinic at postoperative 6 weeks.

Immediately after the operation (up to 48 hours), the occurrence of narcotics-related complications was higher in the IV-PCA group (Table 3). Among patients who were treated for intraarticular lesions, the differences in the frequency of narcotics-related complications were not significant between the two groups (p=0.22). However, among patients with rotator cuff tears, the IV-PCA group showed a significantly higher complication rate than the ISB group (p<0.001). In both groups, the following narcotics-related symptoms were recorded (ISB group and IV-PCA group, respectively): nausea (8% and 23.9%), dizziness (6% and 8.8%), headache (4% and 2.7%), ischuria (3% and 4.4%), and vomiting (2% and 13.3%).

Additional Non-steroidal Anti-inflammatory Drugs Administration

With respect to the dose of additional oral NSAIDs administration, the ISB group required significantly higher doses of NSAIDs as compared with the IV-PCA group among all patients (p=0.04) as well as among those with rotator cuff tears (p=0.02).

Table 2. Intraoperative Factors in Patients with Rotator Cuff Tear or Glenohumeral Lesion

Variable	Patients with rotator cuff tear			Patients with glenohumeral lesion		
	ISB group	IV-PCA group	*p*-value	ISB group	IV-PCA group	*p*-value
Operation time (min)	74.4 ± 22.8	80.4 ± 24.6	0.16	55.1 ± 6.8	54.6 ± 5.1	0.66
Fluid amount (L)	21.7 ± 8.1	20.9 ± 9.9	0.62	20.6 ± 6.8	23.0 ± 14.8	0.34
Fluid pressure (mmHg)	58.5 ± 9.4	62.8 ± 10.3	0.12	58.5 ± 9.2	61.1 ± 9.6	0.21
Anchor number	2.8 ± 1.5	2.5 ± 1.2	0.26	4.7 ± 1.7	4.6 ± 1.9	0.85

Values are presented as mean ± standard deviation.
ISB: interscalene block, IV-PCA: intravenous patient-controlled analgesia.

Table 3. Narcotics-related Complications and Additional NSAID Usage

Variable	ISB group (n=100)	IV-PCA group (n=113)	*p*-value
Narcotics-related complications			
Overall (n=213)	23.0 (23/100)	53.1 (60/113)	0.00
Rotator cuff tear (n=128)	11.7 (7/60)	52.9 (36/68)	0.00
Nausea	2	17	
Dizziness	2	6	
Headache	1	2	
Ischuria	1	3	
Vomiting	1	8	
Intraarticular lesion (n=85)	40.0 (16/40)	53.3 (24/45)	0.22
Nausea	6	10	
Dizziness	4	4	
Headache	3	1	
Ischuria	2	2	
Vomiting	1	7	
Additional NSAID usage			
Overall (n=213)	62.0 (62/100)	47.8 (54/113)	0.04
Rotator cuff tear (n=128)	70.0 (42/60)	50.0 (34/68)	0.02
Intraarticular lesion (n=85)	50.0 (20/40)	44.4 (20/45)	0.61

Values are presented as percent (number/subtotal) or number only.
NSAID: non-steroidal anti-inflammatory drug, ISB: interscalene block, IV-PCA: intravenous patient-controlled analgesia.

However, in patients with intraarticular lesion, no significant differences were found between the two groups (p=0.61) (Table 3).

Visual Analogue Scale for Pain Analysis in Subgroup (Rotator Cuff Tear and Intraarticular Lesion)

Although the current study was not powered to assess the results of the subgroups, we found some statistically significant elements.

1) Clinical comparison of patients with rotator cuff tears based on anesthesia type

A total of 128 patients underwent arthroscopic rotator cuff repair (average age, 62.4 years), with 60 patients in the ISB group and 68 patients in the IV-PCA group. Among these patients, the VAS pain score at postoperative 12 hours and 48 hours showed no significant differences between the two groups (p=0.08, p=0.17, respectively) (Fig. 2). However, the VAS pain score at postoperative 24 hours in the ISB group was higher than that in the IV-PCA group (p=0.04). The difference in the VAS pain score between the two groups that was evaluated at postoperative 24 hours was 9.0 mm. For the ISB and IV-PCA groups, the VAS pain scores were 10.0 ± 10.4 mm and 14.9 ± 17.2 mm (p=0.08) at 12 hours, 21.4 ± 26.2 mm and 12.4 ± 17.7 mm (p=0.04) at 24 hours, and 7.2 ± 7.9 mm and 10.2 ± 12.7 mm (p=0.17) at 48 hours postoperatively, respectively.

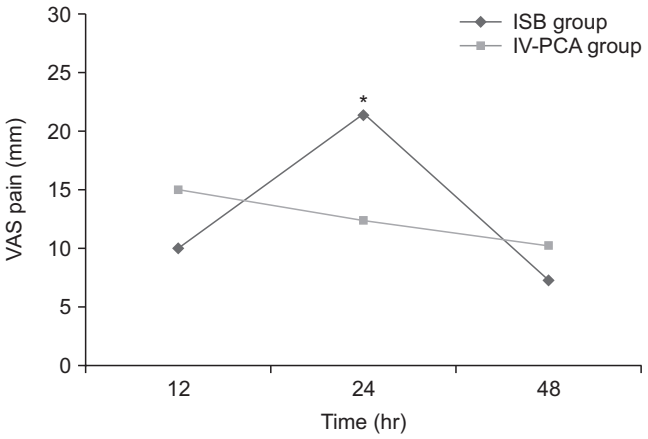

Fig. 2. Postoperative VAS pain score in patients operated for rotator cuff tear. VAS pain score at 24 hours in the ISB group showed a significantly higher VAS pain score than that in the IV-PCA group (p=0.04).
VAS pain: visual analogue scale for pain, ISB: interscalene block, IV-PCA: intravenous patient-controlled analgesia.
*p<0.05.

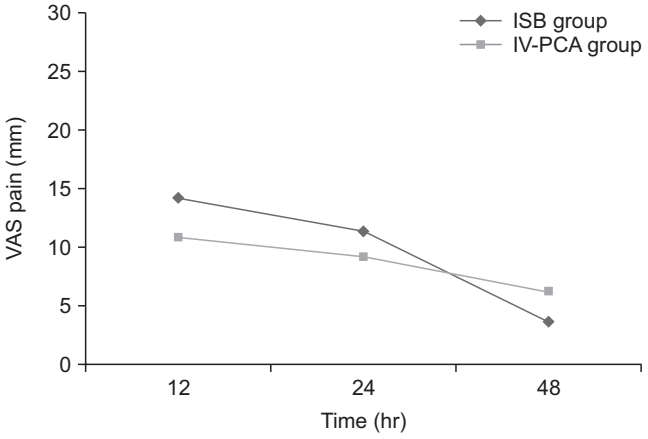

Fig. 3. Postoperative VAS pain score in patients with intraarticular lesion. No significant difference was observed in the VAS pain score between the two groups at any of the time-points.
VAS pain: visual analog scale for pain, ISB: interscalene block, IV-PCA: intravenous patient-controlled analgesia.

2) Clinical comparison of patients with intraarticular lesions based on anesthesia type

A total of 85 patients were treated for intraarticular lesions, including 42 Bankart lesions, 37 SLAP lesions, and 6 posterior labral tears (average age, 35.1 years). Of these, 40 patients were included in the ISB group and 45 patients in the IV-PCA group. No significant difference was noted in the VAS pain score between the two groups during the study period (Fig. 3). For the ISB and IV-PCA groups, the VAS pain scores were 14.0 ± 9.3. mm and 10.7 ± 8.2 mm (p=0.14) at 12 hours, 11.3 ± 6.1 mm

and 9.1 ± 11.4 mm (p=0.28) at 24 hours, and 3.4 ± 7.2 mm and 6.1 ± 4.9 mm (p=0.18) at 48 hours postoperatively, respectively.

Discussion

This study showed satisfactory pain control with single ISB at 12, 24, and 48 hours post arthroscopic shoulder surgery. Additional IV-PCA revealed significant benefits only in patients who had rotator cuff surgery at 24 hours after the operation. However, the overall benefit of IV-PCA was only a reduction of 9.0 mm in the VAS pain score. Moreover, the frequency of narcotics-related complications was significantly higher in the IV-PCA group than in the ISB group.

Singelyn et al.,[13] in a prospective randomized study, assessed the analgesic efficacy of ISB, SSB, and intraarticular local anesthesia during the first 24 hours after arthroscopic acromioplasty. Among the three methods evaluated, ISB showed better pain relief and patient satisfaction, with a significant reduction in morphine consumption. After arthroscopic surgery, ISB also showed better or comparable analgesic effects when compared with single subacromial block (SAB) or continuous SAB.[14-16] Interestingly, another study that compared pain relief after arthroscopic shoulder surgery for the combination of IV-PCA with ISB and IV-PCA alone showed a lower VAS pain score for a period of immediately following the surgery to 8 hours after surgery in the IV-PCA with ISB group than in the IV-PCA alone group.[17] A high pain score during the first 8 hours was observed in the IV-PCA group, demonstrating an inadequate efficacy of single IV-PCA for pain relief after arthroscopy surgery.[17] In the current study, all patients showed satisfactory outcomes for immediate postoperative pain after arthroscopic shoulder surgery, indicating that single ISB played a key role in controlling immediate postoperative pain.

Continuous interscalene brachial plexus block (CISB) has been shown to provide an analgesic effect that is superior to single ISB after shoulder surgery.[18] Hence, CISB is considered to be the gold standard among analgesic methods for post shoulder surgery. However, CISB is associated with higher risk of infection due to the use of indwelling catheter; and it is technically more challenging than ISB.[7] Therefore, CISB is not usually used by inexperienced anesthetists. In this study, single ISB showed satisfactory results in controlling immediate postoperative pain without requiring continuous pump equipment after arthroscopic shoulder surgery. Webb et al.[16] also found no difference between ISB and CISB in patients undergoing arthroscopic shoulder surgeries, although the majority of their patients required glenohumeral joint surgeries.

Although the short duration of analgesic effect after single ISB might be one of its drawbacks, ISB is thought to provide a sufficient duration of analgesia, especially for minor arthroscopic surgery.[7] The present study shows that among patients with intraarticular lesions, there is no significant difference in pain intensity between the ISB and IV-PCA groups at any postoperative time-point. These results indicate that additional IV-PCA confers no additional benefit, and single ISB may be sufficient in controlling immediate postoperative pain after arthroscopic shoulder surgery for intraarticular lesions.

The VAS pain scores of patients with rotator cuff tear were relatively higher than those of patients with intraarticular lesions. This might be attributed to various reasons. In patients with large or massive rotator cuff tears, longer operating time and high fluid pressure are required to repair the retracted rotator cuff as compared with the repair of intraarticular lesions; these factors cause soft tissue swelling around the shoulder, increasing postoperative pain.[19] However, postoperative pain in patients with partial-thickness or small full-thickness rotator cuff tears might originate from different causes. It is possible for overtension or tension mismatch within a tendon after the anatomical repair of a partially torn rotator cuff or small-sized full-thickness rotator cuff tear to increase postoperative pain.

Patients who received single ISB may experience higher pain subjectively, known as the rebound phenomenon, after the effect of the ISB was lessened postoperatively.[20] In patients with intraarticular lesions, no rebound phenomenon was observed for up to 48 hours postoperatively in our study. We observed a similar rebound phenomenon in the ISB group; however, this was confined only in patients who underwent rotator cuff repair. Furthermore, among patients with rotator cuff tears, the VAS pain score at postoperative 24 hours was higher than that at 12 hours; however, it decreased again by 48 hours.[1] Although the VAS pain score among patients with rotator cuff tears at postoperative 24 hours was higher with statistical significance in the ISB group than in the IV-PCA group, the actual difference in the VAS pain score between the two groups was 9.0 mm. Several studies have reported that a VAS pain score of less than 30 mm is associated with perceptibly lesser pain; moreover, a reduction of 14 mm is considered a clinically detectible change by most patients.[21] In the present study, all VAS pain scores across the entire timeline were less than 30 mm in both groups, regardless of shoulder pathology. Therefore, the difference in the VAS pain scores between the two interventions in this subset of patients might not be clinically significant. These results indicate that sufficient postoperative pain control was obtained for all patients, regardless of shoulder pathology, supporting the satisfactory analgesic efficacy of ISB without additional IV-PCA after arthroscopic shoulder surgery.

Various side effects related to ISB have been reported, including pneumothorax, cardiac complications, neurological deficits, seizures, and auditory disturbances.[22,23] In this study, no severe or complex side effects related to ISB were noted—except 3 patients (1.4%) of transient paresthesia in the ipsilateral upper arm—since the ISB procedure was conducted under US guid-

ance. The success rate of US guided ISB has been reported to be as high as 97.5% to 99.6%, with a prevalence of adverse events to be 2.88%.[24,25]

Postoperative nausea and vomiting after general anesthetic surgery are frequent adverse effects due to various causes.[26,27] Nausea and vomiting caused by opiates included in IV-PCA have been reported in 18% to 70% of patients, mostly during the first postoperative 12 hours.[27-29] In this study, the incidence was recorded as 53.1% in the IVP group, and it was significantly higher than that in the ISB group (23.0%), regardless of shoulder pathology.

Patients with rotator cuff tears in the ISB group used greater doses of additional NSAIDs than those in the IV-PCA group. It is possible that patients with rotator cuff tears in the ISB group used more NSAIDs to control postoperative pain, while the patients with rotator cuff tears in the IV-PCA group used IV-PCA to control postoperative pain. However, the differences in the pain levels between the two groups were less than 14 mm of the VAS pain score at all time-points; hence, this may be considered clinically insignificant. We used NSAIDs instead of opioids as a rescue pain medication because we wanted to assess the adverse effects of pure opioids in IV-PCA. Hence, we try to minimize other potential causes that might increase the events of postoperative complications, such as nausea and vomiting.

This study has several limitations. First, single ISB procedure in the present study was performed by two anesthetists. Therefore, there may be performance bias between the two anesthesiologists influencing the results. Second, postoperative nausea and vomiting can be caused not only by opiate drugs in IV-PCA but also by inhaled anesthetics, such as thiopental and fentanyl, used during induction and maintenance of general anesthesia. Third, a wide age range of patients with a variety of shoulder pathologies and treatments methods were included in this study. Fourth, the disproportionate withdrawal of patients (21 patients in the ISB group vs. 8 patients in the IV-PCA group) might have affected the outcomes in the two groups. Fourth, the additional information regarding IV-PCA usage, which could provide valuable secondary outcome information on treatment effectiveness, was not collected. The total amount of consumption of drugs or placebos in PCA infusion, number of buttons pressed, number of broken down cases into successful bolus and denied doses due to lockout should have been obtained from both groups.

Conclusion

Satisfactory immediate pain control was obtained using single ISB after arthroscopic shoulder surgery regardless of shoulder pathology. Clinically, additional IV-PCA did not have any booster effect for immediate postoperative pain control in patients who underwent arthroscopic shoulder surgery with preoperative single ISB. Furthermore, patients with IV-PCA showed a higher frequency of narcotics-related complications.

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