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Ultrasound-guided interscalene block anesthesia performed by an orthopedic surgeon: a study of 1322 cases of shoulder surgery

Kazumasa Takayama, MD*, Hayao Shiode, MD, Hiromu Ito, MD, PhD

Department of Orthopaedics, Kurashiki Central Hospital, Okayama, Japan

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Background: Interscalene blocks are becoming increasingly common for shoulder surgeries. This study primarily aimed to demonstrate the efficacy and complications and the secondarily to investigate the anesthesia-related time and patient satisfaction of an ultrasound-guided interscalene block performed by an orthopedic surgeon.

Methods: We retrospectively reviewed the medical records of 1322 consecutive patients (arthroscopic, 1225 cases; open, 97 cases) with a mean age of 64.2 years, who underwent shoulder surgery (arthroscopic or opensurgery) under an ultrasound-guided interscalene block performed by an orthopedic surgeon at a single institution between December 2012 and December 2019. We investigated patient satisfaction, block success rates, and complications and also compared the anesthesia-related time of an interscalene block with that of general anesthesia (428 cases, arthroscopic, 257 cases; open, 171 cases) for shoulder surgery with patients in the beach chair position during the same period. Difference between total anesthesia time and surgical time was defined as anesthesia-related time.

Results: Approximately 98.3% of patients were satisfied with an interscalene block, and the block success rate on the first attempt was 99.9%. Total complication incidence was 2.3%, with no recorded life-threatening complications. Anesthesia-related times were significantly shorter in the interscalene block group than those in the general anesthesia group (45 ± 14 min vs. 100 ± 26 min, $P < .001$).

Conclusion: An ultrasound-guided interscalene block performed by an orthopedic surgeon for shoulder surgery is effective and safe, requires less time, and has a high patient acceptance rate, making it a feasible and alternative to the block performed by anesthesiologists.

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An interscalene block (ISB) was first conceptualized in 1970 and is performed alone or in combination with general anesthesia.[32] With advances in surgical equipment and techniques, ISBs are becoming increasingly common in shoulder surgery, as they can relieve intraoperative and postoperative pain and relax muscles.[8,10] ISB has many advantages over general anesthesia, including the lack of need for airway manipulation, avoidance of postoperative nausea and vomiting, low risk of postoperative delirium,[25] reduction of perioperative opioid consumption,[21] and reduced medical expenses.[14]

The ISB for shoulder surgery has been performed by anesthesiologists owing to the potential need for general anesthesia due to block failure and associated complications even though ISBs have a high success rate and low complication rate.[8,11,15,30] Recently, there is a new trend where the surgeons perform the nerve block (ultrasound-guided or blinded);[19,29] moreover, exploring or treating the injuries under ultrasound guidance is becoming popular.[5,18]

Because of the retirement of a number of anesthesiologists in our hospital, it has become difficult to perform shoulder surgeries under general anesthesia. Since April 2012, an orthopedic surgeon at our institution has been performing ultrasound-guided ISB for shoulder joint surgery. Between April 2012 and November 2012, we performed 78 shoulder surgeries under ISB with no complications and high patient acceptance. This led us to investigate the satisfaction of patients who underwent shoulder surgery under ISB administered by an orthopedic surgeon. Therefore, this study primarily aimed to demonstrate the efficacy and complications and secondarily to investigate the anesthesia-related time and patient satisfaction of an ultrasound-guided ISB. We hypothesized that ISB performed by an orthopedic surgeon is safe and effective (primary hypothesis), contributes to high patient satisfaction, and reduces anesthesia-related times (secondary hypothesis).

This study was approved by the ethical committee of our institution (approval number 3608). Patients provided written informed consent before enrolling into this study.

*Corresponding author: Kazumasa Takayama, MD, 1-1-1 Miwa, Kurashiki, Okayama, 7108602 Japan.

E-mail address: kt13551@kchnet.or.jp (K. Takayama).

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Materials and methods

The study was approved by the institutional review board of our hospital. Written informed consent was obtained from all patients for performing ISB and participating in this study. We retrospectively reviewed 1322 consecutive patients (arthroscopic: 1225 cases, open: 97 cases) with a mean age of 64.2 (range, 16-89) years who underwent shoulder surgery, that is, arthroscopic surgery or open surgery, under ultrasound-guided ISB performed by a single orthopedic surgeon at a single institution between December 2012 and December 2019. Patients with neurological disorders of their branchial plexus were excluded from receiving ISB to avoid double crush syndrome (2 cases). In addition, as multiple sclerosis is considered a risk factor for brachial plexopathy, we excluded these patients from ISB (2 cases).[16] Preoperatively, all patients underwent routine blood and pulmonary function tests and electrocardiography. Patients with active infections at the block site, coagulopathy (international normalized ratio >2.0 as per the criteria of our institution), severe chronic obstructive pulmonary disease (percent predicted forced expiratory volume in one second < 50%), and contralateral phrenic nerve palsy as diagnosed with preoperative plain radiographs were excluded. If the international normalized ratio was ≤2, anticoagulant drugs were continued. When obtaining consent for surgery, the planned surgical procedure and expected surgical time were explained, and patients who refused shoulder surgery under ISB were excluded. Block failure was defined as when the sensory blockade was insufficient to perform shoulder surgery. The criterion for discharging the patient from the operation room postoperatively was an Aldrete score[4] ≥9.

The primary outcome of this study was patient satisfaction. Forty-eight hours postoperatively, all patients were queried about their satisfaction related to the anesthesia, which was classified into the following five grades: very satisfied, indicating that they would choose ISB again if another shoulder surgery was needed, satisfied, not satisfied, dissatisfied, and very dissatisfied, indicating that they do not want to undergo surgery under ISB again. Patients who were dissatisfied or very dissatisfied were asked for the corresponding reason.

The secondary outcome of this study was that of anesthesia-related times. Total anesthesia time was defined as the total duration from the patient's arrival to departure from the operation room. Surgical time was defined as the total duration from the skin incision to closure. The difference between total anesthesia and surgical times was calculated and defined as the anesthesia-related time. We compared the anesthesia-related times of ISB with those of general anesthesia (428 cases), which was performed by anesthesiologists for shoulder surgery with the patient in the beach chair position during the same period. Furthermore, we evaluated the isolated block time, which was defined as the total length from sterile dressing to needle extraction. These were obtained from anesthesia records (PHILIPS Operation Room System). The ISB efficacy time was defined as the number of sensory blockade hours that was reported by patients. In addition, we performed logistic regression analysis to examine the factors contributing to the patients selecting general anesthesia.

Acute complications during ISB, including blood aspiration, dyspnea (including pneumothorax), local anesthetic intoxication, and hematoma and perioperative anesthesia-related complications, including nausea, vomiting, brachial plexus disorder, hoarseness, Horner syndrome, complex regional pain syndrome, arrhythmia, seizure, and infection, were evaluated.

General anesthesia

General anesthesia procedures were performed by multiple anesthesiologists. General anesthesia was intravenously induced with fentanyl (100 μg), propofol (4 mg/kg), and rocuronium (0.6 mg/kg). There was no additional regional or local anesthesia administered. The trachea was intubated, and general anesthesia was maintained with sevoflurane and remifentanil. Intraoperatively, fentanyl was administered as needed in boluses. The trachea was extubated after completing radiography.

Ultrasound-guided ISB

After placing electrocardiography, noninvasive blood pressure, and pulse oximetry measurers, patients were placed in the supine position with their head turned to the nonaffected side. Routine skin preparation and sterile draping were performed, and ultrasonic scanning using a 15-6 Hz linear probe (SonoSite S-Nerve, Fujifilm SonoSite Inc., Bothell, WA, USA) was begun at the supraclavicular fossa to confirm the subclavian artery and branchial plexus positions; subsequently, we moved the linear probe toward the cranial direction and confirmed the C5-6 roots. For patients undergoing ISB, we did not use sedative drugs, and local anesthesia was not administered at the puncture site. Using a lateral-to-medial approach, the 25-gauge needle was inserted into the middle scalene muscle, advanced, and placed immediately lateral to the nerve roots. We routinely visualized the needle using an ultrasound beam to avoid intraneural and intravascular injections. After confirming negative blood aspiration, we injected 20 mL of 0.75% ropivacaine around the nerve roots. If blood aspiration or radiating pain occurred with injection, the needle was repositioned under ultrasound guidance.

When dermatome C4-6 areas were anesthetized and elbow flexion weakness was demonstrated, we considered that the block was successfully performed and sufficient for shoulder surgery.

During shoulder arthroplasty, it was necessary to add local anesthesia before the skin incision and at wound closure. ISB alone may not anesthetize the most distal part of the skin incision made using the standard deltopectoral approach. Skin sensation in the medial part of the upper arm is innervated by the intercostal brachial nerve and the medial brachial cutaneous nerve; therefore, a brachial plexus block (ISB or supraclavicular block) cannot sufficiently block this area.

During shoulder arthroscopy, we routinely supplied additional local anesthesia using 3 mL of 1% lidocaine at the site of the standard posterior portal before starting the operation. The skin in this area is usually innervated by the axillary or supraclavicular nerve; however, in our experience, it is sometimes not blocked by an ISB.

All surgeries were performed with patients in the beach chair position. There were operating room nurses instead of the anesthesiologist to monitor vitals and provide medication. Hypotension (systolic blood pressure <100 mmHg) and hypertension (systolic blood pressure >140 mmHg) were treated with ephedrine and nicardipine as appropriate. To preserve cerebral perfusion pressure, we maintained a systolic blood pressure of ≥100 mmHg.[12,20,31] Bradycardia (heart rate <45 beats/min) and tachycardia (heart rate >130 beats/min) were treated by administering a bolus of atropine and landiolol hydrochloride. Intraoperatively, we administered a bolus of midazolam for sedation after the request of patients. Antibiotics were administered intravenously preoperatively and three hours after the initial administration.

Statistical analysis

Descriptive statistics (medians with standard deviation for continuous variables and frequencies with proportions for categorical data) were used to summarize recorded variables. We used the Mann-Whitney U test to compare continuous variables (eg, age and anesthesia-related time between the ISB and general

Table I
Patient characteristics and surgical procedures.

	Regional anesthesia (n = 1322)	General anesthesia (n = 428)	*P* value
Age, yr	64.2 ± 14.1	61.4 ± 21.6	.57
Sex, male/female	756/566	216/212	.019[†]
Arthroscopy			
Rotator cuff repair	1013 cases (76.6%)	64 cases (15.0%)	<.001[*]
Labrum repair	101 cases (7.6%)	78 cases (18.2%)	
Acromio-clavicular joint reconstruction	14 cases (1.1%)	3 cases (0.7%)	
Manipulation	42 cases (3.2%)	11 cases (2.6%)	
Supra-scapular nerve decompression	4 cases (0.3%)	2 cases (0.5%)	
Others	51 cases (including SCR: 3 cases) (3.9%)	99 cases (including SCR: 66 cases) (23.1%)	
Open surgery			
Arthroplasty	RTSA: 9 cases (0.7%) TSA: 5 cases (0.3%) HHA: 1 case (0.1%)	RTSA: 90 cases (21.0%) TSA: 23 cases (5.4%) HHA: 28 cases (6.5%)	<.001[*]
Humeral fracture	Intramedullary nail or plate fixation: 49 cases (3.7%)	Intramedullary nail or plate fixation: 17 cases (4.0%)	
Clavicle fracture	20 cases (1.5%)	6 cases (1.4%)	
Others	13 cases (1.0%)	7 cases (1.6%)	

RTSA, reverse total shoulder arthroplasty; *TSA*, total shoulder arthroplasty; *HHA*, humeral head arthroplasty; *SCR*, superior capsular reconstruction.
Continuous variables are presented as mean ± SD (standard deviation).
[*]$P < .01$.
[†]$P < .05$.

Table II
The block success rate and satisfaction level of interscalene block.

Block success rate	99.9%, (1322/1323 cases)
Level of satisfaction	Very satisfied: 1300 cases (98.3%) Satisfied: 0 cases Not satisfied: 0 cases Dissatisfied: 9 cases (0.7%) Very dissatisfied: 13 cases (1%)
Reason for dissatisfied or very dissatisfied	Urge to urine during surgery (17 cases) Lumbago during surgery (4 cases) Noise (1 case)

anesthesia groups) and Fisher's exact test to compare categorical data (eg, sex ratio and surgical procedures). Logistic regression analysis was performed to investigate the factors (eg, sex, surgical time, open surgery, etc.) that correlated with the selection of the general anesthesia. Statistical analysis was conducted using SPSS software (version 22.0; IBM, Armonk, NY, USA). A *P* value of <0.05 was considered statistically significant.

Results

One patient who was considered too obese (body mass index: 41.4) to delineate the nerve using ultrasound was operated under general anesthesia. In total, 1322 and 428 patients underwent shoulder surgery with ISB and general anesthesia, respectively. A total of 1244 of 1322 patients who underwent shoulder surgery with ISB received an average of 2.1 mg of midazolam for intraoperative sedation.

Patient characteristics and surgical procedures in each group are shown in Table I. Patients undergoing shoulder arthroplasty tended to refuse ISB and opted for general anesthesia (141/156 cases, 90.4%). Patients who underwent labral repair were younger than those who underwent rotator cuff repair and tended to opt for general anesthesia. Conversely, patients who underwent rotator cuff repair, which is often performed for elderly individuals, tended to select ISB. General anesthesia tended to be selected for superior capsular reconstruction, which required the tensor fascia lata to be harvested. Three patients who underwent superior capsular reconstruction with ISB required additional lumbar anesthesia.

Table II presents the block success rate and the patient satisfaction level of the ISB and the reasons for dissatisfaction with it. The success rate was 99.9%, and all ISBs were successfully performed on the first attempt. Approximately 98.3% of patients were satisfied with the ISB. The main reason for dissatisfaction was the urge to urinate during surgery.

Anesthesia-related and isolated block times are shown in Table III. Approximately 94.5% (1250 cases) of ISBs were performed within 5 minutes. The duration of pain relief was 10 to 14 hours. Anesthesia-related and surgical times were significantly shorter in the ISB than those in the general anesthesia groups ($P < .001$).

Acute and perioperative complications related to ISB are shown in Table IV. The complication rate was 2.3% (30 cases), and no life-threatening complications were observed. Hoarseness and Horner syndrome improved with conservative treatment.

The results of logistic regression analysis, investigating the factors correlated with the selection of the general anesthesia, are shown in Table V. Long surgical time, sex (female), age (young), labrum repair, and shoulder arthroplasty significantly correlated with the selection of the general anesthesia. As the variance inflation factors were <2.0, we concluded that there was no concern about multicollinearity.

Discussion

Regardless of the block method, which is ultrasound-guided or nerve stimulation, recent studies have reported high success rates and satisfaction and low complication rates of ISB performed by experienced anesthesiologists.[8,9,15,30] However, in this study, an orthopedic surgeon performed ultrasound-guided ISB with a high success rate, patient satisfaction, and fewer complications. To the best of our knowledge, this is the largest study examining ISB performed by an orthopedic surgeon.

The results of this study demonstrated a high acceptance of ISB performed by an orthopedic surgeon, with more than 98% of patients being very satisfied or satisfied.

Previous studies on ISB performed with nerve stimulation or those on temporary paresthesia-guided ISB described severe adverse effects, such as pneumothorax, local anesthetic intoxication, arrhythmia, seizure, and neurological disorders[22]; this caused hesitation among orthopedic surgeons to recommend shoulder surgery with an ISB to patients. Previous studies demonstrated that the success rate of ISB with nerve stimulation was 84%-96%,[8,10]

Table III
Anesthesia-related and isolated block times.

Isolated block time	1-2 min: 0 cases 2-3 min: 0 cases 3-4 min: 99 cases (7.5%) 4-5 min: 1151 cases (87%) 5-6 min: 44 cases (3.4%) ≥6 min: 28 cases (2.1%)		
	Interscalene block (n = 1322)	General anesthesia (n = 428)	*P* value
Anesthesia-related time	45 ± 14 min (range, 29-108 min)	100 ± 26 min (range, 60-140 min)	<.001*
Surgical time	89 ± 43 min (range, 20-228 min)	122 ± 71 min (range, 20-247 min)	<.001*

Continuous variables are presented as mean ± SD (standard deviation).
*$P < .01$.

Table IV
Acute and perioperative complication related to interscalene block.

Acute complications	Blood aspiration: 3 cases (0.2%) Dyspnea (including pneumothorax): 0 cases Local anesthetic intoxication: 0 cases Hematoma: 0 cases
Perioperative complications	Nausea: 6 cases (0.5%) Vomiting: 4 cases (0.3%) Brachial plexus disorder: 0 cases Complex regional pain syndrome: 0 cases Hoarseness: 8 cases (0.6%) Horner syndrome: 9 cases (0.7%) Arrhythmia: 0 cases Seizure: 0 cases Infection at the puncture site: 0 cases

Table V
Results of logistic regression analysis between the selection of general anesthesia and surgical time, sex, age, open surgery, labrum repair, and shoulder arthroplasty.

	Odds ratio	*P* value	95% confidence interval
Constant	0.23	<.001*	0.13-0.42
Surgical time	1.02	<.001*	1.02-1.02
Sex	1.43	.025†	1.05-1.95
Age	0.95	<.001*	0.94-0.96
Open surgery	1.05	.82	0.66-1.68
Labrum repair	1.89	.004*	1.22-2.93
Shoulder arthroplasty	41.5	<.001*	21.2-81.3

*$P < .01$.
†$P < .05$.

whereas the success rate of ultrasound-guided ISB was 97%-99%.[8,21,30]

In this study, our ISB success rate was 99.9%, and all ISBs were successfully performed on the first attempt; these results are comparable with those of previous studies and may have directly contributed to the high level of patient satisfaction. The main reason for patient dissatisfaction with ISB was the intraoperative urge to urinate. Elderly male individuals, possibly with benign prostatic hyperplasia, were at a high risk of having the intraoperative urge to urinate. It is difficult for patients to urinate while in the beach chair position. Because of this urge to urinate, the blood pressure of patients may rise, causing patients to be unable to maintain the resting position; this leads to difficulty in performing surgery and reduced patient satisfaction. For patients who frequently urinate, it may be necessary to place a urinary catheter in advance or recommend general anesthesia. In this study, general anesthesia was selected for patients with long surgical times, and this may be reasonable considering the risk of intraoperative lumbago and the urge to urinate.

With advancements in ultrasound medical equipment, nerve blocking has become easier to perform, and the success rate of nerve blocking has increased.[21] Recent studies have reported that needle localization is more precisely performed by ultrasound guidance than by nerve stimulation and the paresthesia method.[6,24] It is possible to visualize the tip of the 25G needle and nerve roots under ultrasound guidance; thus, even if an orthopedic surgeon performs ISB, there is a low risk of the accidental puncture of blood vessels, lungs, and intraneural injection. In this study, there were no major complications such as seizures, pneumothorax, or neurological disorders. The complication rate in this study was 2.3%, which was comparable with that reported in recent studies.[7,8,23,30] Sixteen patients had postoperative paresthesia on their ulnar side. We considered that these complications were due to the inadequate use of abduction sling because the ulnar nerve was only 40% blocked after ISB.[8] All complications improved with conservative treatment by avoiding compression on the cubital tunnel area. This study had a Horner syndrome incidence of 0.7%, which is lower than that reported in previous studies,[21] and the reason for this is unknown; however, we suspect the low dose of ISB (20 mL of 0.75% ropivacaine) possibly caused this low incidence.[26]

We performed shoulder surgery in patients in the beach chair position. Shoulder surgery under ISB with the patient in the lateral decubitus position, especially for shoulder arthroscopy, may not achieve a high level of patient satisfaction because it may be uncomfortable.[8] When patients are conscious during shoulder surgery, it may be important to consider the surgical position to achieve a high level of patient satisfaction. However, shoulder surgery in the beach chair position is an independent risk factor for cerebral desaturation events (CDEs).[2,28] Moreover, the combination of a beach chair position and hypotensive general anesthesia, which has been performed to reduce intraoperative bleeding, may increase CDE risk.[12,20,31] CDE frequency related to shoulder surgery in patients under general anesthesia was 0-100% (mean, 41.1%).[13,27] Previous studies that compared general anesthesia with regional anesthesia for shoulder surgery in the beach chair position have reported a lower CDE incidence in the regional anesthesia than in the general anesthesia groups (0-2.2% vs. 56.7%-71.1%).[1,17] These studies also demonstrated that regional anesthesia had greater hemodynamic stability than general anesthesia. Furthermore, CDE is correlated with coronary artery disease.[3] Regional anesthesia is safe in terms of maintaining blood perfusion, which may have contributed to the avoidance of life-threatening complications.

Anesthesia-related ISB times were significantly shorter than those of general anesthesia. ISB did not require tracheal intubation, extubation, and recovery times, which contributed to reducing anesthesia-related times. Moreover, regarding our block time, 1250 of 1322 patients were administered the block within 5 minutes, which also led to reduced anesthesia-related times and may have resulted in the increased patient satisfaction. The required time to

complete ISB tended to decrease with experience. In our study, 72 cases of ISB, all early cases, took more than 5 minutes. These results suggested that ultrasound-guided ISB could be completed in less than 5 minutes after experience with approximately 150 cases. With advancements in the ultrasound apparatus, the learning curve of ISB has been remarkably reduced. We believe that reducing the length of stay in the operation room is important for smooth operation room management, and accordingly, ISB may be an effective solution.

Compared with general anesthesia, ISB can reduce drug and supply costs.[14] Moreover, if an orthopedic surgeon performs ISB, the cost of an anesthesiologist can be reduced. Shoulder surgery with ISB effectively reduces costs and helps in operation room management.[8,24]

Limitations

This study has some limitations. First, this was not a randomized controlled study; therefore, potential selection bias should be considered because the patients decided their anesthesia method to choose after we explained the planned surgical procedure and expected surgical time. Second, we did not evaluate patient satisfaction for general anesthesia, as it was performed by the anesthesiologist. Nevertheless, this study clarified that ISB performed by an orthopedic surgeon was safe and effective, reduced the time spent in the operation room, and provided high patient satisfaction for most types of shoulder surgery.

Conclusions

Ultrasound-guided ISB performed by an orthopedic surgeon for shoulder surgery is effective, is safe, requires less time, and has high patient acceptance; consequently, ISB performed by orthopedic surgeons could be a feasible alternative to general anesthesia or ISB performed by anesthesiologists.

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