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Original Article

Interscalene Block and Reduced Urinary Retention after Shoulder Arthroscopy under General Anesthesia

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SUMMARY

Background: Preoperative interscalene brachial plexus block (ISB) has been shown to reduce postoperative nausea and vomiting after shoulder arthroscopy performed under general anesthesia (GA), possibly via reduced consumption of opioids. Postoperative urinary retention (POUR) is another adverse effect after GA with higher incidence among the elderly patients. The aim of this study is to investigate the effect of preoperative ISB on POUR.

Methods: A historical cohort analysis of patients receiving shoulder arthroscopy under GA was conducted. Included patients were allocated to ISB + GA or GA only group. The difference in incidence of POUR between groups were explored as well as intraoperative requirement of inhaled anesthetics and fentanyl. Potential risk factors of POUR were also assessed with multivariate logistic regression analysis.

Results: There are 229 patients in ISB + GA group and 169 patients in GA only group. Patient characteristics shows no difference between groups. ISB + GA group required lower concentration of inhaled anesthetics (fraction of minimum alveolar concentration (fMAC) 0.71 (0.16) vs. 0.93 (0.15), $p < 0.001$) and less total fentanyl dose (mcg kg^{-1} , 1.9 (0.7) vs. 2.7 (1.1), $p < 0.001$). The incidence of POUR is lower in ISB + GA group than GA only group (3.9% vs. 10%, $p = 0.02$) as well as the incidence of postoperative nausea (28.4% vs. 39%, $p = 0.03$), and postoperative vomiting (16.2% vs. 25%, $p = 0.03$). Multivariate analysis reveals increased age and intraoperative fentanyl dose are associated with increased POUR.

Conclusion: Preoperative ISB is associated with decreased consumption of intraoperative opioids, which may contribute to a reduced incidence of POUR.

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1. Introduction

Shoulder arthroscopy is one of the most commonly performed orthopedic procedures.¹ With a rapidly ageing population, the number of elderly patients receiving this operation is expected to increase. Although these operations can be performed under regional anesthesia alone or in combination with sedation, general anesthesia is still a common practice to cover failed regional anesthesia and provide a safe control of respiration during the operation.^{2–4} Given the majority of shoulder arthroscopies are carried out on an outpatient basis,⁵ it is of paramount importance to provide adequate postoperative pain control and minimize postoperative side-effects of general anesthesia to facilitate patient recovery.

Without appropriate treatment, postoperative pain after shoulder surgeries can be significant⁶ and hinder patient discharge. Interscalene block (ISB) of the brachial plexus is one of the most effective approaches to manage postoperative pain after shoulder surgeries.^{6–9} When performed preoperatively, in addition to its analgesic benefits, ISB is also associated with reduced side-effects of general

anesthesia, such as postoperative nausea and vomiting (PONV).^{6,9} These beneficial effects of preoperative ISB could be attributed to decreased intraoperative requirement of inhaled anesthetics and opioids.

Postoperative urinary retention (POUR) is another potential undesirable effect of general anesthesia and is more common among the elderly. For an ambulatory procedure, it is imperative to minimize the occurrence of POUR, because POUR may result in prolonged hospital stay, bladder catheterization, urinary tract infection, and unplanned return to emergency department.^{10,11} As both inhaled anesthetic agents and opioids have been reported to impair bladder function, it is intriguing to know if preoperative ISB could also reduce the occurrence of POUR through reducing consumption of intraoperative inhaled anesthetics or opioids. Currently, there is scarce literature regarding the impact of preoperative ISB on the occurrence of POUR after shoulder arthroscopy performed under general anesthesia. The aim of this study is to investigate if preoperative ISB is associated with reduced POUR after shoulder arthroscopy under general anesthesia.

2. Patients and methods

After approved (22MMHIS085e, 2022-03-30) by the institu-

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tional review board of MacKay Memorial Hospital, a historical cohort analysis of patients undergoing shoulder arthroscopic surgeries in a single tertiary center between January 1st, 2020 and December 8th, 2021 was conducted. Informed consents were waived by the ethics committee. Only patients receiving shoulder arthroscopy under general anesthesia with inhaled anesthetics were included. Those who received total intravenous anesthesia or regional anesthesia with sedation were excluded from the study. Patients who received ISB postoperatively or with missing data were also excluded.

2.1. Interscalene brachial plexus block

For those patients who opted for ISB as postoperative pain management, a single-shot ISB was carried out before operation. Before the initiation of ISB, standard American Society of Anesthesiologists monitors (electrocardiography, non-invasive arterial blood pressure, and pulse oximetry) were applied and oxygen was provided via a facemask. Then patients were sedated with intravenous midazolam 1–2 mg and fentanyl 25–50 mcg. After the neck was sterilized with 2% chlorhexidine, ISB was performed as previously mentioned.¹² In brief, a linear array ultrasound probe (6 to 13 MHz, Sonosite M-Turbo, FUJIFILM Sonosite, Bothell, WA, USA) was placed on the lateral neck to obtain transverse view of the brachial plexus between anterior and middle scalene muscles. A 23-gauge needle was inserted in line with the probe in a lateral-to-medial direction. After negative aspiration, 10–20 mL 0.5% ropivacaine with or without 1:200,000 epinephrine was injected between the C5 and C6 nerve roots or between the superior and middle trunks at the discretion of the anesthesiologists.

2.2. General anesthesia

General anesthesia was induced with intravenous fentanyl (2–3 mcg kg⁻¹), propofol (2–3 mg kg⁻¹), and rocuronium (0.6–0.9 mg kg⁻¹) or *cis*-atracurium (0.2–0.3 mg kg⁻¹). After orotracheal intubation, the lungs were mechanically ventilated. General anesthesia was maintained by inhaled anesthetics (sevoflurane or desflurane) with intermittent intravenous bolus of fentanyl as needed. Inhaled anesthetics were discontinued at the completion of surgery, and neuromuscular blockade was reversed by neostigmine 40–60 mcg kg⁻¹ with glycopyrrolate 5 mcg kg⁻¹. The administration of dexamethasone 5 mg during induction of anesthesia and/or ondansetron 4–8 mg at the end of operation was determined by the anesthesiologists.

2.3. Postoperative assessment of side-effects of general anesthesia

On postoperative day 1, all patients were visited by anesthetic nurses to assess potential side-effects of general anesthesia, including postoperative nausea (PON), postoperative vomiting (POV), and POUR. POUR was defined as a new-onset sensation of difficulty in emptying bladder or bladder catheterization due to inability to void with a sense of full bladder. The presence or absence of these side-effects was recorded in the electronic anesthesia record system.

2.4. Data collection

Both patient characteristics and clinical data were extracted from the institutional electronic anesthesia record system. The characteristics data included age, sex, body weight (BW), height, and body mass index (BMI). The extracted clinical data included presence or absence of preoperative ISB, American Society of Anesthesiolo-

gists (ASA) Physical Status classification, surgical procedure type, total fentanyl dosage administered from the beginning of anesthesia to the completion of operation, end-tidal concentration of inhaled anesthetics recorded every 5 minutes, anesthesia duration (defined as from the initiation of preparation of anesthesia to sending the patient to post-anesthesia care unit), the last measurement of body temperature in the operating room, and presence or absence of PON, POV, and POUR.

2.5. Calculation of averaged fraction of minimum alveolar concentration

To analyze the intraoperative requirement of inhaled anesthetics, the fraction of minimum alveolar concentration (fMAC) was used as a surrogate marker. During the operation, end-tidal concentrations (C_{ET}) of inhaled anesthetics were automatically recorded every 5 minutes in the electronic anesthesia record system. The fMAC was obtained by dividing the C_{ET} by the age-adjusted minimum alveolar concentration (aaMAC).¹³ The aaMAC was calculated using the formula proposed by Eger¹⁴ with the percentage of MAC of sevoflurane and desflurane at the age of 40 years being 2.03 and 6.44, respectively.¹⁵ For each patient, the calculated fMACs were averaged to serve as a proxy of intraoperative requirement of inhaled anesthetics.

2.6. Statistical analyses

Enrolled patients are allocated into the ISB + GA group if they had received preoperative ISB, or into GA only group if they had not received preoperative ISB. Continuous data are expressed in means with standard deviations and analyzed by two-tailed independent samples *t* test. Categorical data are expressed in percentage and analyzed by chi-square test, or Fisher's exact test when more than 20% of cells has expected frequencies < 5. Univariate logistic regression is used to analyze the association between the occurrence of POUR and potential candidate factors. Candidate factors with a *p* value less than 0.1 are subsequently included in the multivariate logistic regression analysis to identify independent factors. A *p* value of less than 0.05 is considered statistically significant. All analyses are performed using SPSS version 28 (IBM Corp., Armonk, NY, USA), except calculation of 95% confidence interval of absolute risk difference in POUR, PON, and POV, which were performed using Statology (<https://www.statology.org>).

3. Results

The initial search yielded 7969 cases of orthopedic procedures during the study period, of which, 7573 were excluded based on exclusion criteria (Figure 1), leaving 229 patients in the ISB + GA group and 167 in the GA only group. There is no significant difference between the two groups in age, body weight, height, BMI, sex, ASA physical status classification, anesthesia duration, surgical procedure types, the last measurement of body temperature in the operating room, and use of dexamethasone or ondansetron. The occurrences of POUR (3.9% vs. 9.6%; 95% confidence interval [CI], -10.8% to -0.6%; *p* = 0.022), PON (28.4% vs. 38.9%; 95% CI, -19.99% to -1.21%; *p* = 0.027), and POV (16.2% vs. 25.1%, 95% CI, -16.89% to -0.71%; *p* = 0.027) are all significantly less in the ISB + GA group than in the GA only group. Both the averaged fMAC (mean (SD) 0.71 (0.16) vs. 0.93 (0.15), *p* < 0.001) and the total fentanyl dose per kilogram BW (mcg kg⁻¹, 1.9 (0.7) vs. 2.7 (1.1), *p* < 0.001) are significantly lower in ISB + GA group (Table 1).

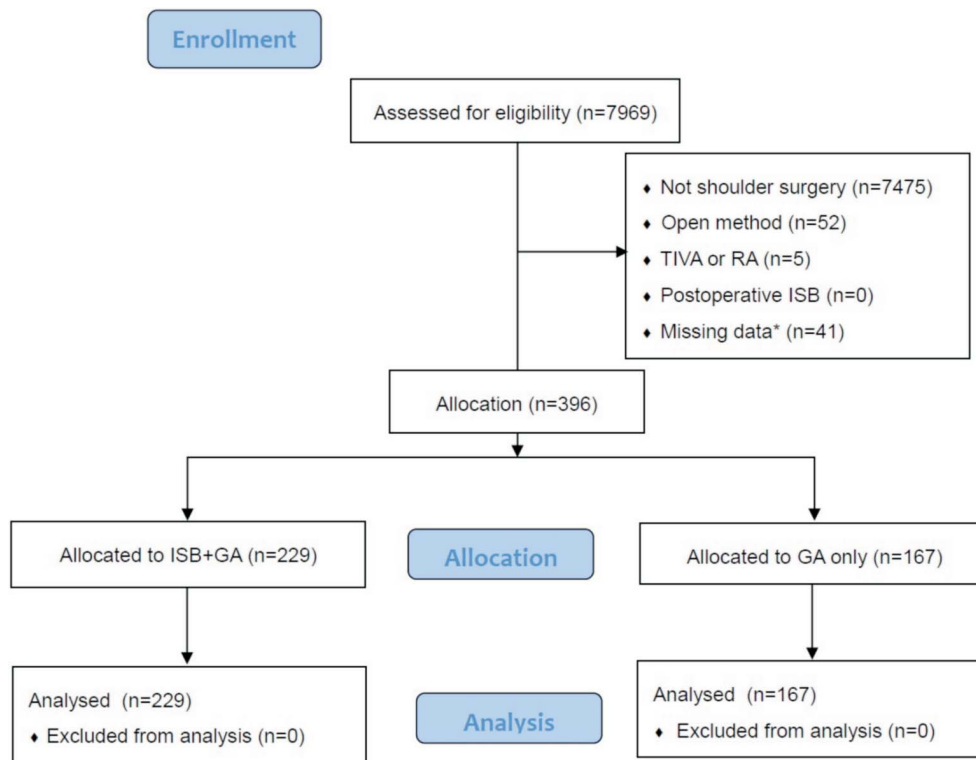


Figure 1. Enrolment flow diagram. GA: general anesthesia, ISB: interscalene block of the brachial plexus, RA: regional anesthesia, TIVA: total intravenous anesthesia. * All missing data were due to early discharge that postoperative visit was not made.

Table 1
Comparison of patient characteristics and clinical data between ISB + GA and GA only groups.

	ISB + GA (N = 229)	GA only (N = 167)	p value
Age (yr), mean (SD)	57.7 (13.7)	58.2 (12.5)	0.734
Female	129/229 (56.3%)	107/167 (64%)	0.121
Height (cm)	162 (8.8)	160 (8.9)	0.052
Body weight (kg)	65.5 (12.9)	65.2 (14.8)	0.941
BMI (kg m ⁻²)	24.8 (3.6)	25.3 (4.2)	0.169
ASA physical status			0.913
I	16/229 (6.9%)	13/167 (8%)	
II	183/229 (79.9%)	134/167 (80%)	
III	30/229 (13.1%)	20/167 (12%)	
Operation procedure			0.516
Rotator cuff repair	186/229 (81.2%)	130/167 (78%)	
SLAP lesion repair	27/229 (11.8%)	20/167 (12%)	
Others [‡]	16/229 (6.9%)	17/167 (10%)	
Inhaled anesthetic agent			0.025*
Sevoflurane	198/229 (86.5%)	130/167 (78%)	
Desflurane	31/229 (13.5%)	37/167 (22%)	
Anesthesia duration (hour)	2.5 (0.6)	2.6 (0.6)	0.686
fMAC	0.71 (0.16)	0.93 (0.15)	< 0.001*
Total Fentanyl dose (mcg BW ⁻¹)	1.9 (0.7)	2.7 (1.1)	< 0.001*
Dexamethasone	76/229 (33.3%)	58/167 (35%)	0.772
Ondansetron	5/229 (2.2%)	2/167 (1%)	0.704
Last temperature (°C) in OR	35.8 (0.5)	35.9 (0.5)	0.05
PON	65/229 (28.4%)	65/167 (39%)	0.027*
POV	37/229 (16.2%)	42/167 (25%)	0.027*
POUR	9/229 (3.9%)	16/167 (10%)	0.022*

All numbers are n/group N (%) unless otherwise specified.

[‡]: Others including repair of biceps tendon, shaving, release, and removal of loose body.

BMI: body mass index; BW: body weight; CI: confidence interval; fMAC: fraction of minimum alveolar concentration; GA: general anesthesia; ISB: interscalene block of the brachial plexus; PON: postoperative nausea; POUR: postoperative urinary retention; POV: postoperative vomiting; SD: standard deviation; SLAP: superior labrum tear from anterior to posterior.

* p < 0.05.

In the analysis of potential predicting factors of POUR, in addition to the absence of preoperative ISB, increased age and total fentanyl dose per kilogram BW are associated with the occurrence of POUR

(Table 2). Subsequent multivariate logistic regression analysis reveals that only age and the total fentanyl dose per kilogram BW, but not the absence of ISB, are associated with increased odds of POUR (Table 3).

Table 2
Univariate analysis of potential risk factors of POUR.

	Odds ratio	95% CI	p value
Age (yr)	1.04	1.01 to 1.08	0.046*
BMI (kg m ⁻²)	1.08	0.98 to 1.18	0.112
Sex			
Female	1		
Male	1.96	0.87 to 4.44	0.106
Anesthesia time	0.90	0.46 to 1.75	0.756
Inhaled agents			0.374
Sevoflurane	1		
Desflurane	0.39	0.05 to 3.07	
fMAC	3.60	0.41 to 31.3	0.246
Fentanyl dose BW ⁻¹ (mcg kg ⁻¹)	1.65	1.22 to 2.23	0.001*
Preoperative ISB	0.39	0.17 to 0.90	0.027*

BMI: body mass index; BW: body weight; CI: confidence interval; fMAC: fraction of minimum alveolar concentration; ISB: interscalene block for brachial plexus; POUR: postoperative urinary retention.

* $p < 0.05$.

4. Discussion

This historical cohort study demonstrates that, for patients receiving shoulder arthroscopic surgery under general anesthesia by inhaled anesthetics with intermittent intravenous fentanyl, preoperatively placed single-shot ISB is associated with a reduced incidence of POUR. In addition, congruent with previous reports,^{3,9,16,17} preoperative ISB is also associated with decreased consumption of intraoperative opioids and inhaled anesthetics, and reduced odds of PONV.

The importance of preventing POUR cannot be overemphasized, especially in the elderly population, as the incidence increases with ageing. It has been reported that up to 25% of patients were unable to void after shoulder surgery under general anesthesia by inhaled anesthetics with intermittent administration of fentanyl.¹⁸ POUR has manifested to delay hospital discharge or prolonged hospital stay^{10,19,20} with resultant increase in hospital cost.²¹ This is a relevant interest for shoulder arthroscopy, as most of these procedures are performed on an outpatient basis. Furthermore, patients with POUR had increased odds of urinary tract infection, sepsis, and non-infectious catheter-related complications.^{19,22} Both indwelling and intermittent catheterization increased the risk of infection,^{10,21,23} with the reported incidence of bacteremia after single catheterization up to 8%.¹⁰ Another potential concern of POUR is its impact on urodynamics. Previous studies have reported that prolonged bladder overdistention may impair bladder contractile response²⁴ or produce irreversible detrusor damage leading to incontinence and recurrent urinary infections.²⁵

The etiology and underlying mechanisms of POUR after general anesthesia are not completely understood. A number of risk factors of POUR have been identified.^{10,19–21,23,26–28} In current study, absence of preoperative ISB, increased intraoperative fentanyl dosage, and age are associated with the occurrence of POUR in the univariate analyses. However, in subsequent multivariate logistic regression analysis, only intraoperative fentanyl dosage and age, but not preoperative ISB, remained as significant predictors for POUR. It is highly likely that the excellent analgesic effect from preoperative ISB prevented POUR indirectly via reducing intraoperative fentanyl use. This is consistent with previous reports that POUR was associated with increased systemic opioids administration,²⁶ and avoidance of opioids reduced the odds of POUR.²⁹

The mechanisms underlying opioid-induced POUR are still unclear. Intrathecal opioids caused dose-dependent suppression of detrusor contractility and decreased sensation to urge.³⁰ Malinovsky

Table 3
Multivariate logistic regression analysis of potential risk factors of POUR.

	Odds ratio	95% CI	p value
Age (year)	1.04	1.01 to 1.09	0.047*
Fentanyl dose BW ⁻¹ (mcg kg ⁻¹)	1.52	1.10 to 2.11	0.011*
Preoperative ISB	0.53	0.23 to 1.29	0.16

BW: body weight, CI: confidence interval; ISB: interscalene block for brachial plexus, POUR: postoperative urinary retention.

* $p < 0.05$.

and colleagues had compared the urodynamic effects of intravenous morphine, fentanyl, buprenorphine, and nalbuphine.³¹ It appeared that all of these opioids delayed full bladder sensation, but only fentanyl and buprenorphine decreased detrusor contraction. What is more, urinary retention occurred after all these opioids except nalbuphine. Although it has been suggested that systemic opioids caused urinary retention via action on spinal opioids receptors,²¹ urinary retention induced by intravenous remifentanyl can be reversed by not only naloxone but also methylnaltrexone, a peripheral opioid antagonist, suggesting that peripheral opioid receptor also plays a role in the opioid-induced urinary retention.³²

The effect of preoperative ISB on intraoperative requirement of inhaled anesthetic agents and opioids had been examined before. Accordant with previous findings, our results display that preoperative ISB was associated with decreased requirement of inhaled anesthetic agents^{3,33} and opioids,^{4,16} and a reduced incidence of PONV.⁹ This preventive effect of preoperative ISB on PONV can be, at least partially, attributed to the decreased usage of intraoperative inhaled anesthetic agents and opioids. The opioid-sparing effect of preoperative ISB may be particularly beneficial for the elderly patients, as they are more likely to experience POUR and opioid-induced respiratory depression.³⁴

The present study has several limitations. First, as all historical cohort studies, the analyses are limited by post-hoc selection of study variables, a lack of predetermined sample size, expectation bias, and missing data. Second, postoperative pain assessment and the use of postoperative opioids were not included in the analysis. It is possible that the decreased occurrence of POUR and PONV may be partially attributed to decreased postoperative opioids administration, which could be attributed to the effective analgesia by the ISB. Indeed, single-shot ISB was found to reduced opioid demand in the first 12 hours and the incidence of PONV, another opioid-related side-effect, in the first 24 hours after shoulder surgery.⁹ Third, since a significant number of patients failed to feel discomfort or an urge to void with an overdistended bladder after general anesthesia,^{10,35} the actual incidence of POUR could be higher if ultrasound had been utilized for diagnosis. Fourth, some potential risk factors of POUR, such as intraoperative fluid status, benign prostate hypertrophy, and diabetes mellitus (DM), were not included in the analysis. Nonetheless, the predicting value of these factors are controversial.^{10,20,22,36,37} Furthermore, an accurate assessment of intraoperative fluid status during shoulder arthroscopy is difficult. Because estimation of blood loss is often inaccurate while a large amount of fluid being flushed into surgical site, and employing invasive monitoring device to evaluate volume status is usually not required during elective shoulder arthroscopy. Fifth, both intraoperative administration of fentanyl and titration of inhaled anesthetics were not standardized or guided by nociception monitoring or electroencephalography-based monitoring. Despite of this, the result of current study is consistent with previous studies^{3,16} employing bispectral index (BIS), in terms of the effect of ISB on anesthetics requirement and occurrence of PONV.

5. Conclusion

For shoulder arthroscopy performed under general anesthesia with inhaled anesthetics and intermittent supplementation of intravenous fentanyl, preoperative ISB may indirectly reduce the incidence of POUR through decreased requirement of intraoperative opioids. This beneficial effect of preoperative ISB might be particularly important for the elderly patients because they are at higher risk of POUR. Further prospective randomized controlled trials are required to exam this hypothesis.

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Conflicts of interest

The authors declare no competing interests.

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