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For Outpatient Rotator Cuff Surgery, Nerve Block Anesthesia Provides Superior Same-day Recovery over General Anesthesia

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Background: **Both general and nerve block anesthesia are effective for shoulder surgery. For outpatient surgery, it is important to determine which technique provides more efficient recovery. The authors' goal was to compare nerve block with general anesthesia with respect to recovery profile and patient satisfaction after rotator cuff surgery.**

Methods: **In this clinical trial, 50 consenting outpatients (aged 18–70 yr) were randomly assigned to receive either fast-track general anesthesia followed by bupivacaine (0.25%) wound infiltration or interscalene brachial plexus block (0.75% ropivacaine), each under standardized protocols. Blinded recovery room nurses assessed the need for pain treatment and rated patient eligibility for bypass of the phase 1 postanesthesia care unit and for discharge home. Patients were followed up for 2 weeks postoperatively. The primary outcome measures were postanesthesia care unit bypass and same-day discharge. Other same-day recovery outcomes included severity of and treatment for pain and time to ambulation. Postoperative outcomes at home included satisfaction with the anesthesia technique and absence of complications (at 2 weeks).**

Results: **Patients who received nerve block (*vs.* general anesthesia) bypassed the postanesthesia care unit more frequently (76 *vs.* 16%; $P < 0.001$), reported less pain, ambulated earlier, were ready for home discharge sooner (123 *vs.* 286 min; $P < 0.001$), had no unplanned hospital admissions (*vs.* 4 of 25 patients who underwent general anesthesia; $P = 0.05$), and were more satisfied with their care. No complications were reported in either treatment group.**

Conclusions: **Nerve block anesthesia for outpatient rotator cuff surgery provides several same-day recovery advantages over general anesthesia.**

SHOULDER pain is a common complaint, third only to headache and backache as the most frequent cause for a visit to a physician.[1] In one study, gross pathologic changes in the shoulder, such as thinning or tear of the rotator cuff, were observed in 60% of cadavers examined.[2] Shoulder pain may result in significant job-related disability, particularly for individuals who lift heavy items or perform activities at shoulder level. Surgery is often advised for patients who do not improve after 6 months of conservative treatment.

Both general anesthesia (GA) and nerve block anesthesia have been used for shoulder surgery. An interscalene brachial plexus block (ISB) can provide complete regional anesthesia for shoulder surgery and has been used as the sole anesthetic by some.[3–6] ISB for shoulder surgery is commonly administered in conjunction with GA, with the block performed primarily for postoperative analgesia.[7–10] However, there are compelling reasons to avoid GA in outpatients and older patients because of short-term cognitive impairment, postoperative nausea and vomiting (PONV), and delayed recovery. Furthermore, postoperative pain can interfere with initial rehabilitation.[11]

Opioid analgesics are commonly used for analgesia when nerve blocks are not used. Opioids are effective in relieving postoperative pain at rest but may increase PONV, somnolence, constipation, urinary retention, respiratory depression, and sleep disturbances.[5]

There have previously been no prospective, randomized studies comparing the use of ISB *versus* GA for outpatient shoulder surgery. Our hypothesis was that use of nerve block anesthesia would result in improved same-day recovery over GA.

Materials and Methods

The study was approved by the Institutional Review Board of St. Luke's-Roosevelt Hospital Center, New York, New York. Patients were eligible for participation if they were aged 18–70 yr, had an American Society of Anesthesiologists physical status of I–III, and were scheduled to undergo outpatient open repair of the rotator cuff. Patients were recruited on the day of surgery by a coinvestigator and a research assistant. After obtaining written informed consent, patients were randomized to receive either ISB or fast-track GA (specifically designed for rapid wake up and same-day discharge), using standard protocols.

Data were recorded with respect to anesthesia drugs given and several physiologic parameters during anesthesia (heart rate, blood pressure, and oxygen saturation). Patients were monitored during surgery and recov-

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ery according to standard guidelines published by the American Society of Anesthesiologists.††

Interscalene Brachial Plexus Block

Patients assigned to receive ISB were given midazolam (1–2 mg intravenous) and alfentanil (250–500 μg) in the operating room (OR) before block placement. These premedications were used to decrease anxiety and discomfort during block injection while maintaining meaningful patient contact. Blocks were performed by a senior trainee or fellow under the direction of an attending anesthesiologist with extensive experience in ISB.

Supplemental oxygen (5 l/min) was administered by facemask throughout. The ISB was performed using a 22-gauge, 50-mm Stimuplex® block needle (B. Braun Medical Inc., Bethlehem, PA) and a nerve stimulator (Tracer II®; LifeTech Inc., Stafford, TX). The block was performed using a standard technique with the patient supine.[12] After the brachial plexus was localized with a current of 0.2–0.4 mA (0.1 ms), 35–40 ml ropivacaine (0.75%) was injected in divided doses.

After injection, surgeons proceeded with surgical preparation without waiting for complete onset of surgical anesthesia. During surgery, ISB patients received an intravenous infusion of propofol (Diprivan®; AstraZeneca Pharmaceuticals LP, Wilmington, DE), titrated to light sleep with easy arousability. No other intraoperative sedatives or opioids were allowed. After surgery, propofol was stopped, and the patient was taken to the phase 1 postanesthesia care unit (PACU).

Interscalene block patients with inadequate surgical anesthesia, or those requiring intraoperative intravenous opioids, were given GA. The research team predetermined that all patients with failed blocks would be analyzed in the ISB treatment group to follow principles of intent to treat.

General Anesthesia

General anesthesia patients were given preoperative dolasetron (12.5 mg intravenous) for prophylaxis against PONV, midazolam (1–2 mg), and fentanyl (50–100 μg). GA was induced with propofol (1.5–2.0 mg/kg); one dose of rocuronium (1 mg/kg) was given to facilitate intubation. Anesthesia was maintained with desflurane in a 1:1 mixture of nitrous oxide and oxygen. The end-tidal concentration of desflurane was maintained at 3–6%, based on mass spectrometry (Capnomac Ultima ULT1; Datex-Ohmeda, Helsinki, Finland). Fentanyl boluses (25–50 μg intravenous) were administered as deemed necessary by the attending anesthesiologist.

Surgeons prepared the limb as soon as correct placement of the endotracheal tube was confirmed. At the end of surgery, the incision was infiltrated with 5–10 ml bupivacaine (0.25%) followed by an intraarticular injection of 10–15 ml bupivacaine (0.25%). Patients were awakened after a wound dressing and an arm sling had been applied.

Recovery

After surgery, patients were taken to the phase 1 PACU. Phase 1 PACU nurses were blinded to the anesthetic technique used and had no access to the (automated) anesthesia record. Patients were evaluated using a modified Aldrete score[13] by the PACU nurse who made a decision regarding the patient's eligibility to bypass phase 1 PACU going directly to the phase 2 PACU. Patients could bypass phase 1 PACU only with the following criteria: modified Aldrete score of 9 or greater, no treatment for pain (visual analog scale [VAS] score < 3), and no PONV. If a patient was admitted to phase 1 PACU, his or her vital signs were determined according to PACU policy, and the presence of symptoms (*e.g.*, PONV) was recorded.

In phase 2 PACU, patients were assessed at 15-min intervals by the nurses. They determined when patients met discharge-to-home criteria (a score of ≥ 9 on the postanesthesia discharge scoring system).[14] There was no minimum time required for patients to remain in phase 2 PACU. Voiding was not required for discharge from the hospital.[15]

Daily pain scores and overall satisfaction with anesthesia were assessed as single VAS scores (1–10); these scores were then arbitrarily trichotomized as 0–2 (unacceptable), 3–7 (marginal), and 8–10 (acceptable).

The severity of postoperative pain was repeatedly assessed using the VAS at 15-min intervals. If patients reported pain in phase 1 PACU, morphine (1–2 mg intravenous) was administered every 5–10 min until the patient was comfortable (VAS score ≤ 2). The pain management protocol in phase 2 PACU and at home consisted of acetaminophen (325 mg) with codeine (30 mg) every 4 h as needed.

Hospital time intervals (*e.g.*, induction time, OR time, PACU time) were recorded using data from the automated record-keeping system. Data on discharge time were collected from the nursing documentation and verified by research assistants.

The research assistant, who was blinded to the type of anesthetic used, collected patient data by phone at 24 h, 48 h, 72 h, and 2 weeks after surgery. During the first 3 postoperative days, data included highest VAS pain score, daily pill counts, and other parameters of anesthesia recovery (*e.g.*, appetite, self-care, ambulation, interest in daily activities, anxiety). At 2 weeks after surgery, patients were asked about the occurrence of potential complications (*e.g.*, prolonged numbness, radiating pain in the distribution of the brachial plexus, motor weakness), overall satisfaction with anesthesia care, and will-

†† Standards for Basic Anesthetic Monitoring. Available at: http://www.asahq.org/publicationsAndServices/standards/02.pdf. Accessed January 4, 2005.

Table 1. Demographic Characteristics of the Study Sample

	ISB (n = 25)	GA (n = 25)	*P* Value
Sex, % male	17 (68)	13 (52)	NS
Age, yr	49 ± 13	49 ± 12	NS
Height, cm	173 ± 10	172 ± 10	NS
Weight, kg	85 ± 20	86 ± 21	NS
ASA physical status			NS
I or II	24 (96)	24 (96)	
III	1 (4)	1 (4)	

Data are presented as n (%) for discrete variables and mean ± SD for continuous variables.

ASA = American Society of Anesthesiologists; GA = General anesthesia; ISB = interscalene block.

ingness to have the same anesthetic for a subsequent surgery (if needed).

Statistics

Sample size estimates were based on time to home readiness and discharge (in minutes) because this variable was of primary interest to the study. It was estimated that a sample size of 18 patients/group would provide 80% power to detect a clinically meaningful difference of 90 min (within-group SD, 60 min) at $\alpha = 0.001$. The probability of a type I error was set low to accommodate the multiple comparisons that were planned, particularly for the targeted time measures (*e.g.*, time to ambulation, time to intake of fluids and solids). The final sample size was increased to 25 patients/group as an additional assurance that α would not be inflated when demographic and postoperative data were analyzed.

Discrete categoric data are presented as n (%); continuous data are given as mean ± SD. Confidence intervals are reported for the specific aims (PACU bypass and discharge times), and number-needed-to-treat analysis is reported for PACU bypass ineligibility and unplanned hospital admission. Differences in demographic, surgical, anesthetic, and postoperative data were tested by independent Student *t* test (continuous data) or by chi-square (categoric data) and Fisher exact tests (where appropriate). For descriptive purposes, *P* value differences less than 0.05 are noted in the tables. All analyses were conducted using the Statistical Package for the Social Sciences (SPSS for Windows, version 11.0.1; Chicago, IL).

Results

Recruitment began in April 2000, and study follow-ups were completed by March 2002. Fifty-four patients were enrolled in the study, with the only refusals to participate occurring after randomization for 4 patients (3 ISB, 1 GA). No patient refused to participate before signing the study consent form. Fifty patients (25 in each group) completed the study on the day of surgery. There were no failed blocks, so intent-to-treat analysis was not applicable. There were no significant differences between groups with respect to sex, age, height, weight, and American Society of Anesthesiologists physical status (table 1), nor were there any differences in surgical process times (table 2).

Table 2. Surgical, Anesthesia, and Postoperative Time Intervals

	ISB (n = 25)	GA (n = 25)	*P* Value
OR*	127 ± 35	147 ± 49	NS
Induction†	12 ± 6	8 ± 7	NS
Surgery‡	82 ± 23	98 ± 34	NS
Postoperative§	7 ± 2	6 ± 2	NS

Data are presented as mean minutes ± SD.

* Time from patient entry into operating room (OR) to patient exit from OR. Note that blocks were placed in the OR and not preoperatively (*e.g.*, in an induction room). † Time from patient entry into OR to completion of anesthesia induction. ‡ Duration of surgical procedure (from incision to closure). § Time from patient exit from OR to transfer of care to phase 1 postanesthesia care unit (PACU) nursing.

GA = general anesthesia; ISB = interscalene block.

Main outcome measures were eligibility to bypass phase 1 PACU to phase 2 PACU and eligibility and timing for same-day discharge. More patients who received ISB (76%) were able to bypass phase 1 PACU than those who received GA (16%) (table 3). Four patients (all in the GA group) were unable to be discharged because of refractory pain and were admitted to the hospital, whereas no patients in the ISB group were ($P = 0.05$). Among patients who were discharged, time to home readiness and time to discharge were more than 2.5 h sooner for patients who had received ISB *versus* those who had received GA (table 3). Number-needed-to-treat analysis for the specific aims is shown in table 4.

Table 3. Day-of-surgery Postoperative Outcomes

	ISB (n = 25)	GA (n = 25)	*P* Value
Bypass PACU*	19 (76) (59–93)	4 (16) (2–30)	< 0.001
Hospital admission*	0 (0)	4 (16)	0.05
Moderate/severe pain (VAS >3)	0	16 (64)	< 0.001
Treatment for pain	0	20 (80)	< 0.001
Nausea	3 (12)	11 (44)	0.02
Vomiting	0	4 (16)	0.05
Sore throat	4 (16)	12 (48)	0.03
Ambulation, min†	84 ± 47	234 ± 174	< 0.001
Intake of fluids, min†	54 ± 47	198 ± 182	0.001
Intake of solids, min†	64 ± 59	201 ± 194	0.005
Home readiness, min†	113 ± 55 (91–135)	270 ± 101 (230–310)	< 0.001
Discharge time, min*†	123 ± 57 (101–145)	286 ± 100 (247–325)	< 0.001

Data are presented as n (%) for discrete variables and mean ± SD for continuous variables.

* These variables are the primary outcome measures for this study, and data presented include 95% confidence intervals (lower bound–upper bound). † From end of procedure.

GA = general anesthesia; ISB = interscalene block; PACU = postanesthesia care unit; VAS = visual analog score on a scale of 1–10.

Table 4. NNTT Analysis for Forced PACU Admission (PACU Bypass Ineligibility) and Unplanned Hospital Admission, Based on Patients Receiving GA *versus* ISB for Outpatient Rotator Cuff Surgery

Parameter	GA	ISB	*P* Value	ARR	NNTT, n
Forced PACU admission	21/25 (84%)	6/25 (24%)	< 0.001	0.6 (60%)	1.67
Unplanned hospital admission	4/25 (16%)*	0/25 (0%)	0.05	0.16 (16%)	6.25 (3.33–50)†

Forced postanesthesia care unit (PACU) admission (%) was calculated as 1 minus PACU bypass proportion.

* The 95% confidence interval (CI) of the unplanned admission rate was (2–30). † Because the admission rate for interscalene block (ISB) was zero, the 95% confidence interval was used from the general anesthesia (GA) admission rate to calculate the 95% confidence interval for number needed to treat (NNTT).

ARR = absolute risk reduction.

For the secondary aims, moderate/severe pain (VAS > 3) was not reported by any ISB patients, whereas 80% of all GA patients requested treatment with analgesics ($P < 0.001$; table 3). PONV and sore throat were significantly less frequent in the ISB group ($P < 0.05$), whereas times to ambulation and oral intake were significantly less in the ISB group ($P < 0.005$; table 3)

For patients reached by phone at 24, 48, and 72 h, there was no significant difference between groups in pain scores and pill counts (table 5). The ISB and GA groups did not differ with regard to difficulties with sleep or appetite, self-care, or ambulation within the first 72 h after surgery. However, these findings are statistically underpowered.

Two weeks after surgery, 1 GA patient and 3 ISB patients reported backache (P = not significant); similar results were reported for headache. There were no reports of prolonged numbness, radiating pain in the distribution of the brachial plexus, or motor weakness. However, these findings are statistically underpowered. Global patient satisfaction with anesthesia care was higher in the ISB than in the GA group, and significantly more patients in the ISB group reported that they would choose the same anesthetic technique again ($P = 0.014$ for each; table 6).

Table 5. Postoperative Course through the 72-h Follow-up

	ISB (n = 25)	GA (n = 25)	*P* Value
Assessments at 24 h, 48 h, and 72 h			
24–h valid sample	25 (100)	23 (92)	
48–h valid sample	24 (96)	23 (92)	
72–h valid sample	24 (96)	20 (80)	
Pain score 24 h			NS
Low (1–2)	2 (8)	3 (13)	
Moderate (3–7)	19 (76)	17 (74)	
High (8–10)	4 (16)	3 (13)	
Pain medication 24 h*			NS
None	0	1 (4)	
1–3 pills	5 (20)	7 (32)	
4–7 pills	15 (60)	7 (32)	
8–10 pills	5 (20)	7 (32)	
Pain score 48 h†			NS
Low (1–2)	6 (25)	5 (22)	
Moderate (3–7)	17 (71)	18 (78)	
High (8–10)	0	0	
Pain medication 48 h			NS
None	5 (21)	3 (13)	
1–3 pills	5 (21)	4 (17)	
4–7 pills	10 (42)	11 (48)	
8–10 pills	4 (17)	5 (22)	
Pain score 72 h			NS
Low (1–2)	7 (29)	6 (30)	
Moderate (3–7)	17 (71)	14 (70)	
High (8–10)	0	0	
Pain medication 72 h			NS
None	7 (29)	2 (10)	
1–3 pills	11 (46)	6 (30)	
4–7 pills	5 (21)	11 (55)	
8–10 pills	1 (4)	1 (5)	

* One patient in the general anesthesia (GA) group could not quantify response. † One patient in the interscalene block (ISB) group could not quantify response.

GAA = general anesthesia; ISB = interscalene block; NS = not significant.

Discussion

The change from inpatient to ambulatory surgical care represents a significant advance.[16] Rapid recovery, adequate analgesia, prevention of PONV, and timely discharge are essential to a successful ambulatory anesthesia practice.[17–19] Our data suggest that from both the hospital's and the patient's perspective, there are advantages to using nerve block anesthesia *versus* GA for outpatient rotator cuff surgery. Nerve block anesthesia was associated with a greater number of patients being able to bypass phase 1 PACU, fewer unplanned hospital admissions, and faster time to discharge.

Fast tracking/PACU bypass (being able to bypass the more costly and labor-intensive phase 1 PACU to go directly to phase 2 PACU) is frequently used as a bench-

Table 6. Postoperative Course through the 2-Week Follow-up

	ISB (n = 25)	GA (n = 25)	*P* Value
Valid sample	24 (96)	14 (56)	
Satisfaction scores (VAS 1–10)			
1–2	0	0	0.014
3–7	5 (21)	9 (64)	
8–10	19 (79)	5 (36)	
Anesthesia choice			0.014
Yes	19 (79)	5 (36)	
No/not sure	5 (21)	9 (64)	

Data are presented as n (%) for discrete variables and mean ± SD for continuous variables.

GA = general anesthesia; ISB = interscalene block; VAS = visual analog score on a scale of 1–10.

mark test for success in ambulatory surgery (as is same-day discharge).[20,21] In our study, we ensured that all patients were free from pain, nausea, and vomiting before being transferred from phase 1 PACU to phase 2 PACU recovery, regardless of the Aldrete score.[22] This is important to prevent shifting of workload from phase 1 to phase 2 nurses.

In other studies, bypass of acute phase 1 PACU recovery has been associated with a $400 cost savings per patient,[20] and successful same-day discharge decreases hospital costs by an estimated $400–1,000.[20,23] Our findings of more successful PACU bypass and same-day discharge after ISB could be due, in part, to the fact that patients who had received ISB were more alert at the time of arrival to the PACU and had significantly less pain than did patients in the GA group.

None of the patients in the ISB group required treatment for pain before discharge home, whereas 80% of patients in the GA group required pain management despite wound infiltration and intraarticular instillation of local anesthetic by the surgeon. This finding is similar to another study in which continuous interscalene analgesia was superior to continuous wound infiltration with surgically placed incisional/intracapsular catheters.[24]

Some perceived disadvantages of ISB *versus* GA include the additional time required to perform the block, the possibility of block failure, and the potential that patients undergoing blocks ultimately may have more pain when the blocks wear off. None of these disadvantages were apparent in our study, although our sample size was underpowered to determine these specific outcomes. It is possible that OR times could have been even shorter for the ISB group if blocks had been placed in the preoperative area while the OR was being prepared.[25] Anesthesia-controlled time for emergence (time from end of the application of surgical dressing until OR exit) has been reported to be shorter after regional anesthesia *versus* GA.[25,26] Applying these findings would help to offset any additional time needed to place the block in the OR before the procedure begins.

Our results of nerve block success differ from those reported in a retrospective study by Weber and Jain.[27] In that study, the authors reported that 13% of ISB failed and that 92% of patients receiving ISB required additional opioid analgesics. In addition, potentially severe complications were reported, including seizures, cardiovascular collapse, respiratory distress, and neurologic injuries.[27] The difference between our study and that of Weber and Jain could be explained by the fact that the latter used retrospective methodology, whereas our study was blinded and randomized. Second, nerve block performance in our study was limited to a team of university-based anesthesiology trainees medically directed by anesthesiologists with substantial experience with ISB and nerve block anesthesia in general. It has been reported that training in nerve block anesthesia is inadequate in many residency programs.[28] Nonetheless, ISB nerve block is successfully used as a sole anesthetic, with a low risk of complications, in institutions where the staff is experienced.[4]

Postoperative pain is a common reason for unexpected hospital admission or delay in discharge.[29] It is possible that a multimodal approach to postoperative pain management (including the addition of antiinflammatory drugs) could have resulted in better analgesia for patients in the GA group.[30,31] Unfortunately, multimodal analgesia using newer nonopioid analgesics (specifically, cyclooxygenase-2 inhibitors) is not a universal practice.

Several studies have suggested that use of nerve block anesthesia or local anesthetics may produce a preemptive effect in reducing sensitization of nerve endings after surgical incision, potentially reducing postoperative pain.[32,33] A single-injection ISB using a long-acting local anesthetic such as ropivacaine (as in the current study) has been described as providing 12–14 h of analgesia after shoulder surgery.[12] More recently, ISB with a continuous infusion of local anesthetic during the postoperative period has resulted in excellent analgesia with minimal opioid requirement as long as the infusion is maintained.[5,10,34–38]

Postoperative nausea and vomiting remains a common problem after anesthesia; these symptoms commonly result in discharge delays after ambulatory surgery.[17,29,39,40] In the current study, patients receiving ISB had a significantly lower incidence of PONV, despite the fact that they did not receive prophylactic dolasetron, an antiemetic, as did patients receiving GA. The odds ratio of experiencing PONV after GA with volatile agents (*e.g.*, desflurane, when compared with propofol sedation/anesthesia) has been reported to be 2.7–10.6.[41,42] It is probable that the use of volatile anesthetics as the primary maintenance technique, when superimposed on the significant postoperative pain and opioid requirements after shoulder surgery,[20] may have predisposed patients to PONV. Using antiemetics with different sites of action may have reduced the risk of PONV in the GA group.[42,43] However, in our study, all patients receiving GA who were admitted had a primary reason of refractory pain, not nausea or vomiting.

It may be argued that the advantages of nerve block anesthesia in this study would be less pronounced if another GA technique had been used. However, the GA protocol in this study is commonly accepted as a conventional model for fast-track GA in patients undergoing outpatient shoulder surgery. A systematic analysis of the literature comparing postoperative recovery after propofol-, isoflurane-, desflurane-, and sevoflurane-based anesthesia in adults demonstrated that early recovery was faster in the desflurane and sevoflurane groups. However, PONV was less frequent with propofol.[44] In addition, our data may not be reproducible in institutions

without extensive expertise in performing peripheral nerve blocks. The training and practice of peripheral nerve blocks varies significantly from institution to institution, and in-depth training is a prerequisite for the success and safety of peripheral nerve blocks.[28,45]

We assessed our patients' perception of their recovery using questions about their sleep, appetite, self-care, ambulation, interest in activities, and anxiety after surgery. The functions assessed by our questioning addressed most aspects covered in two validated surveys.[46,47] Unfortunately, these validated survey instruments were not available at the time of our study design. Nonetheless, there were no differences between the two anesthetic regimens in these daily functions, although our sample size was underpowered to definitively show no differences between treatment groups.

In summary, under the conditions of our clinical practice, interscalene block with long-acting local anesthetic in outpatients undergoing rotator cuff surgery provided efficient and reliable surgical conditions. Compared with GA with wound infiltration, nerve block anesthesia with a long-acting local anesthetic also resulted in increased eligibility for PACU bypass and same-day discharge, faster same-day recovery, fewer adverse events on the day of surgery, better analgesia immediately after surgery, and greater patient acceptance.

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