Single-shot liposomal bupivacaine interscalene block versus continuous interscalene catheter in total shoulder arthroplasty: Opioid administration, pain scores, and complications

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ABSTRACT

Introduction: We sought to evaluate the efficacy and safety of the liposomal bupivacaine interscalene block (LBB) compared with continuous interscalene catheter block (CISB) in primary shoulder arthroplasty patients.

Methods: A prospective database was retrospectively queried over a 4-year period.

Results: LBB (n = 34) patients had lower opioid consumption and pain scores than CISB (n = 70), especially in opioid naïve patients. LBB patients were discharged with less opioids and had fewer revisits to the emergency department.

Conclusion: Compared with CISB, LBB patients consume fewer opioids, have less pain, are discharged with less opioids, and have fewer revisits to the emergency department.

Level of evidence

Level III; Retrospective cohort study; Treatment study.

1. Introduction

As the rate of total shoulder arthroplasty increases amid an environment emphasizing patient satisfaction and reducing opioid use and abuse, effective analgesic protocols are essential.¹ Adequate pain control in the postoperative setting has also been shown to affect clinical outcomes.^{2,3} Interscalene nerve blocks have been shown to improve postoperative pain and reduce opioid use in the early postoperative period in patients undergoing shoulder arthroplasty, but early rebound pain has led researchers to seek alternative analgesia protocols.⁴ Continuous interscalene nerve blocks were introduced to address rebound pain and to prolong analgesia.⁵ Catheters have multiple drawbacks, however, including inconvenience to the patient, block failure due to technical issues, malfunction of the infusion pump, catheter displacement, persistent neuropraxia, and respiratory problems.^{5,6} Recent efforts have attempted to provide longer pain control while minimizing the disadvantages of traditional interscalene blocks.

Liposomal bupivacaine (LB; Exparel; Pacira Pharmaceuticals, Inc., Parsippany, NJ, USA) is a local anesthetic with a lipid-based delivery

system encapsulating the drug to allow release over 72 h.⁷ Local infiltration of LB aims to provide extended analgesia without the potential complications of interscalene blocks in shoulder arthroplasty, but studies of efficacy show conflicting results.^{6–13}

The U.S. Food and Drug Administration (FDA) approved LB for use in interscalene nerve blocks in April 2018, opening further avenues to establish the optimal pain protocol in patients undergoing shoulder arthroplasty. Prior to FDA approval, Vandepitte et al. performed the first study investigating LB in interscalene blocks, but only included 10 shoulder arthroplasty patients in their cohort of 50 patients.¹⁴ The study did show modest improvements in pain scores, but no differences in opioid consumption. Therefore, further studies are needed to determine the efficacy and safety of LB in interscalene blocks for patients undergoing shoulder arthroplasty.

The purpose of this study was to retrospectively evaluate the efficacy and safety of the LB interscalene block (LBB) compared with the standard continuous interscalene catheter block (CISB) in patients undergoing primary shoulder arthroplasty. We hypothesized that patients receiving the single-shot LBB will have lower postoperative opioid administration, pain scores, discharge opioids, and complications compared with patients who received the continuous interscalene catheter block.

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2. Materials and methods

After obtaining institutional review board approval, a prospective orthopaedic database was queried for patients undergoing primary anatomic (TSA) or reverse (RTSA) total shoulder arthroplasty between June 2015 to February 2019 by one of two fellowship-trained shoulder surgeons at a single institution.¹⁵ Patients were included in the study if they underwent a primary TSA or RTSA, completed baseline demographic and shoulder-specific patient-reported outcome questionnaires, and had a preoperative CISB or single-shot LBB. One-hundred and seventeen patients were identified from the prospective database. Patients were excluded if they underwent a revision arthroplasty procedure ($n = 5$), did not receive a preoperative CISB or LBB ($n = 2$), had a history of infection ($n = 1$), or had a same-day discharge ($n = 5$), leaving 104 patients available for analysis. A retrospective review was performed following the STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) guidelines to enhance the study quality and minimize bias.¹⁶

2.1. Continuous interscalene catheter protocol

Seventy patients underwent a preoperative CISB by an attending anesthesiologist. In the preoperative holding area, 3 mL of 1% lidocaine was injected subcutaneously for local analgesia. Using ultrasound guidance, a perineural interscalene catheter was placed and, after negative aspiration, 20 mL of 0.5% ropivacaine was injected as a single bolus. Patients then received 6 mL per hour of 0.2% ropivacaine for up to of 66 h using an ambit Infusion Pump (Summit Medical Products, Inc., Sandy, UT, USA). Patients were given instructions for removal of the catheter and were asked to mail the infusion pump back to the hospital once removed.

2.2. Single-shot liposomal bupivacaine block protocol

Thirty-four patients underwent a single-shot LBB by an attending anesthesiologist. Local analgesia was provided with 3 mL of 1% lidocaine. Using ultrasound guidance, a single-shot perineural interscalene block was administered with 15 mL of 0.5% standard bupivacaine followed by 10 mL of LB (133 mg), similar to the protocol described by Vandepitte et al.¹⁴

2.3. Data collection

All English-speaking patients undergoing a TSA or RTSA were approached in the preoperative holding area on the day of surgery for prospective enrollment in the Maryland Orthopaedic Registry (MOR). This prospective Web-based registry utilizes the Research Electronic Data Capture (REDCap) data collection system. Baseline demographic information included age, sex, race, body mass index (BMI), smoking status. Patients also completed baseline patient-reported outcomes, including the numeric rating scale (NRS) for pain in the operative shoulder (0–10), the American Shoulder and Elbow Surgeons (ASES) Standardized Shoulder Assessment Form, and six domains of the Patient-Reported Outcomes Measurement Information System (PROMIS; Physical Function, Pain Interference, Fatigue, Social Satisfaction, Anxiety, and Depression domains). The modified Charlson Comorbidity Index (CCI) was calculated from comorbid conditions according to the method by Johnston et al.¹⁷

A retrospective chart review was performed to record the type of interscalene block administered (LBB versus CISB), surgical variables, length of stay, postoperative NRS pain scores recorded by the nursing staff, opioid pain medications administered during the hospital stay, and complications, emergency department revisits, and readmissions within 90 days of surgery. All opioid pain medications were converted to milligram morphine equivalents (MMEs) according to the Consortium to Study Opioid Risks and Therapeutics.¹⁸ Pain scores and

opioids were averaged in 4-h intervals during the first 24 h, and 12-h intervals after 24 h until the time of discharge. The rate of opioid administration (MME per hour) was calculated by dividing the total MME by the total hospital stay in hours.

Hospital records and a regional prescription drug monitoring program database were utilized to determine if patients received narcotics within 3 months preoperatively.¹⁹ If patients received opioids in this timeframe they were considered “opioid tolerant,” while patients who did not receive opioids in this timeframe were considered “opioid naïve.” The quantity of opioids filled within 30 days prior to surgery were recorded as “preoperative MME,” while opioids filled at discharge (“discharge MME”) and refills within 8 weeks postoperatively (“refill MME”) contributed to the “total postoperative MME.” Discharge and refill opioids were only gathered for patients after July 2017, and were considered secondary outcomes of the study. No changes were made to the prescribing practices during the study period.

Complications were further subdivided into major and minor complications as described by Weller et al.¹⁹ Major complications were defined as those that required further surgical or medical intervention, while minor complications required minimal intervention or observation. Complications were assessed during the first eight weeks postoperatively.

2.4. Statistical analysis

After assessing for normality, continuous variables were compared with independent samples t-tests for normally distributed variables and the Mann-Whitney *U* test for variables that were not normally distributed. Categorical variables were compared with Fisher exact tests or Chi squared tests. A multivariable stepwise linear regression analysis was performed for total MME use in the 24-h postoperative timeframe, controlling for preoperative opioid use, CCI, and the procedure performed. Differences with $P < 0.05$ were considered statistically significant. All statistical analyses were performed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA).

3. Results

3.1. Baseline patient characteristics

A total of 104 patients were included in the analysis (LBB, $n = 34$; CISB, $n = 70$) and baseline demographic and surgical data are provided in Table 1. The CCI was significantly lower in patients who received the LBB (1.9 ± 1.4) than those who received the CISB (2.7 ± 1.5 ; $P = 0.011$). There were no other significant differences in baseline demographics, surgical variables, preoperative opioid use, or length of hospital stay. There were no significant differences in baseline NRS pain, PROMIS, or ASES scores between groups (Appendix A).

3.2. Total cohort postoperative opioid administration and pain

Table 2 shows the postoperative MME administration between groups. The LBB group required significantly lower opioid administration in the first 24 h postoperatively (32.3 ± 38.2 versus 45.7 ± 43.5 MME; $P = 0.039$), during the total hospital stay (40.1 ± 50.6 versus 54.1 ± 51.0 MME; $P = 0.028$), during the first 4 h postoperative timeframe (2.2 ± 5.1 versus 6.0 ± 12.7 MME; $P = 0.014$), and during the 9–12 h postoperative timeframe (7.9 ± 11.6 versus 10.4 ± 12.4 MME; $P = 0.026$). The LBB group also had a lower rate of opioid administration compared with the CISB group ($P = 0.035$). A multivariable linear regression analysis controlling for preoperative opioid use, CCI, and procedure revealed patients undergoing LBB utilized 17.3 MME less than the CISB group 24 h postoperatively (95% confidence interval [CI], -32.5 to -2.1 MME; $P = 0.026$).

Table 3 shows the postoperative NRS pain scores between groups. There was no significant difference in the mean 24 h or total hospital

Table 1
Patient demographics and surgical characteristics.

	Total (n = 104)	CISB (n = 70)	LBB (n = 34)	P value
Age, yr	64.6 ± 9.7	64.3 ± 9.3	65.5 ± 10.6	0.55
Sex				
Female	65 (62.5)	45 (64.3)	20 (58.8)	0.67
Male	39 (37.5)	25 (35.7)	14 (41.2)	
Race				
White	81 (77.9)	53 (75.7)	28 (82.4)	0.75
Black	19 (18.3)	14 (20.0)	5 (14.7)	
Other	4 (3.8)	3 (4.3)	1 (2.9)	
BMI, kg/m ²	31.7 ± 7.2	31.7 ± 7.2	31.6 ± 7.4	0.94
ASA score				
1	1 (1.0)	1 (1.4)	0 (0)	0.08
2	69 (66.3)	51 (72.9)	18 (52.9)	
3	34 (32.7)	18 (25.7)	16 (47.1)	
CCI	2.5 ± 1.5	2.7 ± 1.5	1.9 ± 1.4	0.011*
Smoking				
Never	60 (57.7)	43 (61.4)	17 (50.0)	0.44
Former	34 (32.7)	20 (28.6)	14 (41.2)	
Current	10 (9.6)	7 (10.0)	3 (8.8)	
Preoperative opioid use	32 (30.8)	20 (28.6)	12 (35.3)	0.50
Arthroplasty				
Anatomic	36 (34.6)	23 (32.9)	13 (38.2)	0.66
Reverse	68 (65.4)	47 (67.1)	21 (61.8)	
Surgical side				
Left	45 (43.3)	31 (44.3)	14 (41.2)	0.84
Right	59 (56.7)	39 (55.7)	20 (58.8)	
Diagnosis				
Osteoarthritis	47 (45.2)	32 (45.7)	15 (44.1)	0.82
Rotator cuff arthropathy	43 (41.3)	27 (38.6)	16 (47.1)	
Acute fracture	5 (4.8)	4 (5.7)	1 (2.9)	
Avascular necrosis	3 (2.9)	2 (2.9)	1 (2.9)	
Malunion/nonunion	3 (2.9)	2 (2.9)	1 (2.9)	
Post-traumatic arthritis	3 (2.9)	3 (4.3)	0 (0)	
Length of stay, hours	29.3 ± 16.7	28.0 ± 12.1	31.8 ± 23.6	0.39

Values are given as the mean plus or minus the standard deviation or as the number with the percentage in parentheses.

CISB, continuous interscalene nerve block; LBB, liposomal bupivacaine interscalene block; BMI, body mass index; ASA, American Society of Anesthesiologists; CCI, Charlson Comorbidity Index.

*Indicates statistically significant values ($P < 0.05$).

stay NRS pain scores. The LBB group had significantly lower pain scores in the first 4 h postoperatively compared with the CISB group (0.6 ± 1.1 versus 1.5 ± 2.0 ; $P = 0.034$), but no significant difference existed at other timeframes.

Table 2
Postoperative opioid (MME) administration.

	All Patients			Opioid Naïve			Opioid Tolerant		
	CISB (n = 70)	LBB (n = 34)	P value	CISB (n = 50)	LBB (n = 22)	P value	CISB (n = 20)	LBB (n = 12)	P value
0–4 h	6.0 ± 12.7	2.2 ± 5.1	0.014*	3.3 ± 5.3	1.3 ± 3.8	0.055	12.8 ± 21.0	3.8 ± 6.8	0.60
5–8 h	5.6 ± 8.9	5.3 ± 8.2	0.73	3.5 ± 5.6	3.1 ± 5.5	0.57	10.7 ± 13.0	9.5 ± 10.8	0.94
9–12 h	8.3 ± 8.7	4.9 ± 7.4	0.026*	7.3 ± 7.3	4.1 ± 6.8	0.039*	10.7 ± 11.1	6.4 ± 8.5	0.27
13–16 h	10.4 ± 12.4	7.9 ± 11.6	0.25	7.6 ± 8.7	4.3 ± 5.9	0.12	17.6 ± 17.0	14.6 ± 16.1	0.71
17–20 h	8.5 ± 10.1	7.3 ± 9.4	0.43	6.5 ± 8.0	5.0 ± 6.8	0.41	13.3 ± 12.9	11.6 ± 12.3	0.77
21–24 h	9.1 ± 9.7	6.7 ± 10.1	0.12	6.8 ± 6.2	4.3 ± 9.2	0.03*	14.7 ± 13.9	12.2 ± 10.6	0.78
24–36 h	11.9 ± 17.7	9.5 ± 12.8	0.70	14.4 ± 20.8	8.2 ± 12.3	0.48	6.8 ± 6.6	13.1 ± 15.5	0.55
Total in 24 h	45.7 ± 43.5	32.3 ± 38.2	0.039*	33.2 ± 23.7	21.1 ± 27.3	0.014*	76.8 ± 63.3	52.9 ± 47.4	0.38
Total hospital	54.1 ± 51.0	40.1 ± 50.6	0.028*	42.9 ± 41.3	30.6 ± 46.1	0.016*	82.1 ± 62.4	57.3 ± 55.9	0.25
MME per hour	2.0 ± 2.0	1.5 ± 1.8	0.035*	1.5 ± 1.1	0.9 ± 1.2	0.008*	3.3 ± 3.0	2.5 ± 2.3	0.57

Values are given as the mean plus or minus the standard deviation.

CISB, continuous interscalene nerve block; LBB, liposomal bupivacaine interscalene block; MME, milligram morphine equivalent.

*Indicates statistically significant values ($P < 0.05$).

Patients who received an LBB were discharged with significantly less opioids compared with the CISB group (293 ± 62 versus 487 ± 379 MME; $P = 0.009$). There were no significant differences in the refill MME, number of refills, or total postoperative MME dispensed after discharge from the hospital (Appendix B).

3.3. Opioid naïve opioid administration and pain

Fifty patients in the CISB group and 22 patients in the LBB group did not receive preoperative opioid prescriptions in the 3 months before surgery. Table 2 shows opioid naïve patients in the LBB group utilized significantly less opioids in the first 24 h postoperatively ($P = 0.014$), during the total hospital stay ($P = 0.016$), during the 9–12 h postoperative timeframe ($P = 0.039$), and during the 21–24 h timeframe ($P = 0.03$) compared with the CISB group. The opioid naïve LB group also had a lower rate of opioid administration compared with the CISB group ($P = 0.008$).

Opioid naïve patients in the LBB group had significantly lower 24-h ($P = 0.024$), total hospital stay ($P = 0.019$), and 13–16 h timeframe ($P = 0.046$) NRS pain scores compared with the CISB group (Table 3). The LBB group received significantly less opioids at discharge ($P = 0.005$) and received fewer total opioids 8 weeks postoperatively ($P = 0.021$), despite similar numbers and MME of refills (Appendix B).

3.4. Opioid tolerant opioid administration and pain

Twenty patients in the CISB group and 12 patients in the LBB group received preoperative opioid prescriptions in the 3 months before surgery. There were no significant differences in opioid administration or NRS pain scores at any timeframe in opioid tolerant patients regardless of the type of interscalene block (Tables 2 and 3). There were no significant differences in preoperative MMEs 30 days before surgery, discharge MME, postoperative refills, or total opioids dispensed within 8 weeks postoperatively (Appendix B).

3.5. Complications

Table 4 shows there were no significant differences in major or minor complications between groups. The LBB group, however, had significantly fewer documented revisits to the emergency department compared with CISB patients (0% versus 11.4%; $P = 0.04$). Reasons for revisits to the emergency department included poor pain control ($n = 1$), neuropraxia ($n = 1$), hematoma ($n = 1$), shoulder instability ($n = 1$), nausea and vomiting ($n = 1$), dizziness ($n = 1$), upper extremity swelling ($n = 1$), and skin rash ($n = 1$).

Table 3
Postoperative numeric rating scale pain scores.

	All Patients			Opioid Naïve			Opioid Tolerant		
	CISB (n = 70)	LBB (n = 34)	P value	CISB (n = 50)	LBB (n = 22)	P value	CISB (n = 20)	LBB (n = 12)	P value
0–4 h	1.5 ± 2.0	0.6 ± 1.1	0.034*	1.2 ± 1.9	0.4 ± 0.8	0.11	2.3 ± 2.0	1.1 ± 1.6	0.10
5–8 h	2.6 ± 2.6	2.4 ± 2.6	0.70	1.9 ± 2.4	1.9 ± 2.5	0.70	4.0 ± 2.7	3.4 ± 2.7	0.59
9–12 h	3.4 ± 2.7	2.5 ± 3.0	0.09	3.1 ± 2.7	1.9 ± 2.5	0.056	4.1 ± 2.6	4.0 ± 3.7	0.96
13–16 h	2.5 ± 3.0	3.8 ± 2.8	0.06	3.6 ± 3.0	1.8 ± 2.0	0.046*	4.5 ± 2.2	3.7 ± 2.9	0.43
17–20 h	3.9 ± 2.4	3.6 ± 3.2	0.48	3.7 ± 2.5	2.7 ± 2.5	0.21	4.5 ± 2.1	5.4 ± 3.9	0.38
21–24 h	4.0 ± 2.4	4.0 ± 3.4	0.88	3.9 ± 2.5	2.7 ± 3.1	0.15	4.2 ± 1.9	6.1 ± 3.0	0.12
24–36 h	4.5 ± 2.5	3.7 ± 3.3	0.40	4.1 ± 2.6	3.4 ± 3.5	0.43	5.3 ± 2.4	5.0 ± 2.8	0.81
Total in 24 h	3.1 ± 2.0	2.4 ± 2.2	0.063	2.8 ± 1.9	1.8 ± 1.8	0.024*	3.9 ± 1.8	3.6 ± 2.5	0.73
Total hospital	3.2 ± 1.9	2.4 ± 2.2	0.054	2.9 ± 1.9	1.8 ± 1.8	0.019*	4.0 ± 2.5	3.6 ± 2.5	0.70

Values are given as the mean plus or minus the standard deviation.

CISB, continuous interscalene nerve block; LBB, liposomal bupivacaine interscalene block.

*Indicates statistically significant values ($P < 0.05$).

Table 4
Postoperative major and minor complications.

	Total (n = 104)	CISB (n = 70)	LBB (n = 34)	P value
Major complications	12	9 (12.9)	3 (8.8)	0.75
Respiratory distress	1 (1.0)	1 (1.4)	0 (0)	–
SSI, deep	1 (1.0)	1 (1.4)	0 (0)	–
SSI, superficial	2 (1.9)	2 (2.9)	0 (0)	–
Urinary tract infection	1 (1.0)	0 (0)	1 (2.9)	–
Pneumonia	1 (1.0)	1 (1.4)	0 (0)	–
Dislocation	2 (1.9)	1 (1.4)	1 (2.9)	–
Readmission	3 (2.9)	2 (2.9)	1 (2.9)	–
Death	1 (1.0)	1 (1.4)	0 (0)	–
Minor complications	37 (35.6)	28 (40.0)	9 (26.5)	0.20
Nausea/vomiting	13 (12.5)	10 (14.3)	3 (8.8)	–
Persistent hand numbness	6 (5.8)	5 (7.1)	1 (2.9)	–
Urinary retention	3 (2.9)	1 (1.4)	2 (5.9)	–
Hematoma	3 (2.9)	1 (1.4)	2 (5.9)	–
Hypotension	2 (1.9)	2 (2.9)	0 (0)	–
Dysphagia	2 (1.9)	2 (2.9)	0 (0)	–
Hoarseness	2 (1.9)	2 (2.9)	0 (0)	–
Fall	2 (1.9)	2 (2.9)	0 (0)	–
Dizziness	2 (1.9)	1 (1.4)	1 (2.9)	–
Rash	1 (1.0)	1 (1.4)	0 (0)	–
Catheter malfunction	1 (1.0)	1 (1.4)	–	–
Revisit to ED	8 (7.7)	8 (11.4)	0 (0)	0.04*

Values are given as the number with the percentage in parentheses.

CISB, continuous interscalene nerve block; LBB, liposomal bupivacaine interscalene block; SSI, surgical site infection; ED, emergency department.

*Indicates statistically significant values ($P < 0.05$).

4. Discussion

This is among the first studies to utilize LB as a single-shot interscalene nerve block in patients undergoing primary shoulder arthroplasty. While CISBs have historically provided increased analgesia postoperatively, patient inconvenience and complications related to the catheter have led researchers to devise alternative analgesia regimens. The results of this study indicate that patients receiving LBB consume significantly fewer opioids at multiple time intervals, including the first 24 h postoperatively, and during the total hospital stay. This was especially true in opioid naïve patients. Furthermore, we showed the LBB is also associated with more substantial decreases in discharge opioid prescriptions for the total cohort and opioid naïve patients. Finally, there were no differences in major or minor complication rates, but LBB patients had significantly fewer revisits to the emergency department within 8 weeks of surgery.

The use of LB in interscalene nerve blocks for shoulder surgery has only been described in two other studies in the anesthesia literature, but these studies combine shoulder arthroscopy and arthroplasty results. Vandepitte

et al.¹⁴ performed the first double-blinded, randomized controlled trial evaluating the efficacy of single-shot bupivacaine HCl interscalene block with or without LBB in patients undergoing elective total shoulder arthroplasty (n = 10) and rotator cuff repair (n = 40). While patients receiving the LBB had significantly lower pain scores (3.6 ± 0.3 versus 5.3 ± 0.4), there were no differences in opioid consumption or adverse events in the perioperative period. A multicenter, randomized, double-blinded controlled trial by Patel et al. compared the LBB to placebo (saline) in patients undergoing primary total shoulder arthroplasty (n = 34) or rotator cuff repair (n = 105).²⁰ While patients with the LBB had significant reductions in pain scores and opioid consumption, the noninferiority design limits the clinical significance of the study. Both studies combine total shoulder arthroplasty and rotator cuff repair patients into the final analysis, creating significant heterogeneity despite the randomized controlled study design. The present study is the first to examine the efficacy of LBB specifically in shoulder arthroplasty patients. Despite the retrospective design and lack of randomization, this study provides a more comparable cohort given all patients underwent open surgery with similar bone and soft tissue handling. This contrasts with the Vandepitte and Patel studies, where the higher proportion of arthroscopic rotator cuff repairs may have diluted potential differences in shoulder arthroplasty patients.

Our results show modest improvements in opioid consumption and pain scores for the total cohort and opioid naïve patients. The reductions in postoperative opioids and pain scores should be interpreted with caution, however, as statistical significance may not equate with clinical significance. To place our findings in context, the 17.3 MME reduction in opioid consumption for LBB patients equates with consuming 2.3 fewer 5 mg tablets of oxycodone in the first 24 h postoperatively. Additionally, the NRS pain score improvements in our study are modest given the minimal clinically important difference is 1.4 points.²¹ Despite these modest improvements in efficacy, the LBB is potentially advantageous over the CISB as it is a single-shot interscalene block, obviating the need for patients to remove a catheter and return an infusion pump. The LBB also avoids potential catheter-related complications and displacement. Further research should examine patient satisfaction between various interscalene blocks, as this could further drive clinical outcomes and reimbursement.²²

Prior to the introduction of the LBB, multiple studies showed variable results with the use of local LB infiltration around the surgical site. When comparing local LB to a single-shot interscalene block, patients receiving local LB showed higher pain and opioid requirements in the early postoperative period.^{7,9} This early latency period of efficacy with local LB led researchers to compare interscalene blocks with and without local LB, which surprisingly showed significantly higher opioid consumption in the LB patients and no significant difference in pain scores.¹² The authors attribute this finding to a “double rebound” phenomenon where patients experience more pain when both the interscalene block and LB effects subside. The CISB is the gold standard to

provide longer analgesia with less rebound pain in shoulder arthroplasty, but technical problems often lead to inadequate pain control. Sabesan et al. performed a randomized controlled trial comparing local LB infiltration with a single-shot interscalene block versus CISB.¹⁰ The authors showed similar opioid consumption, pain scores, and time to first narcotic rescue, concluding that local LB has similar analgesic qualities at a lower cost and fewer complications. Given the variable findings from prior studies involving local infiltration of LB, adding LB to the interscalene nerve block cocktail (LBB) seeks to combine the ease of a single-shot interscalene block with the prolonged analgesia of a CISB, while eliminating potential catheter-related complications.

In the setting of the “opioid crisis,” postoperative pain regimens should strive to reduce long-term opioid consumption in addition to in-hospital consumption. Weller et al. performed a retrospective review comparing CISB versus local infiltration of LB mixed with morphine, ketorolac, and 0.5% bupivacaine with epinephrine.¹¹ The authors reported no significant difference in outpatient narcotic use at 12 weeks postoperatively. While 46% of their patients required preoperative narcotics, the authors did not assess whether differences existed in post-discharge narcotic use for opioid naïve versus tolerant patients. In the present study, the total cohort and opioid naïve patients in the LBB group received significantly less opioids at discharge than CISB patients. Additionally, we showed opioid naïve LBB patients received significantly less total postoperative opioids at 8 weeks. This difference seems to be driven by the lower discharge opioid prescriptions written for LBB patients, as the groups had similar refill prescriptions. There were no significant differences in opioids prescribed at discharge or within 8 weeks of surgery, however, for opioid tolerant patients. This is likely due to multifactorial chronic pain that is managed by a pain specialist, and not influenced by postsurgical analgesia regimens.

Patients receiving the LBB had similar major and minor complication profiles, but LBB patients had fewer revisits to the emergency department within 8 weeks postoperatively. In their comparison of LBB versus placebo (saline) for shoulder arthroplasty and rotator cuff repair patients, Patel et al. showed a similar complication profile between groups.²⁰ Most complications in the present study were minor and nausea was the most common. Surprisingly, we were only able to detect one catheter malfunction despite rates being reported as high as 22% in the literature.²³ As our results showed lower opioid consumption and modest improvements in pain scores in LBB patients, we suspect there were more CISB catheter failures than we report in our results. This discrepancy is likely due to the retrospective nature of the study and unreliable documentation of catheter displacement in patient charts. While significantly more CISB patients returned to the emergency department postoperatively, it is unclear if this was directly related to the interscalene nerve block or other factors. With similar major and minor complication profiles, the use of LB in interscalene nerve blocks appears to be a safe alternative compared with the CISB.

While it was beyond the scope of this study, prior studies have cited reduced costs as a potential benefit of using local LB in shoulder arthroplasty.¹¹ The cost of LB was reported to be \$285, while that of a third-party pain pump for the CISB was \$237. The remainder of the costs for an interscalene block would presumably be comparable regardless of whether a LBB or CISB was performed. Despite little difference in cost, the LBB could potentially reduce costs through fewer revisits to the emergency department.

There were multiple limitations of the present study. First, this is a retrospective study and is subject to variable practice habits during the study period. While the patient characteristics and baseline outcomes were closely matched, variations in pain management during the study period could have influenced our results. We believe such changes are minimal, as we performed an analysis of in-hospital opioid consumption and pain scores for CISB patients before and after July 2017, showing no significant differences. Second, most patients were discharged within two days of surgery, and we were unable to establish the extent of efficacy after discharge from the hospital. Instead, we were

able to establish the number of opioid refills patients required after discharge. Patients with less pain would presumably require fewer refills. Given the FDA has approved LB analgesia for up to 72 h postoperatively, further studies are needed to determine the efficacy of LBB beyond the hospital course in shoulder arthroplasty patients. Third, despite showing a difference in opioid prescribing at discharge and 8 weeks postoperatively, this does not establish whether patients consumed the medication prescribed. In the context of the “opioid crisis,” however, dispensing fewer opioids to the community is still a significant finding. Fourth, our study does not provide postoperative outcome data, which could be used to establish if improved pain management correlates with improved function. Finally, despite showing a significant difference in revisits to the emergency department in favor of the LBB, the retrospective nature of the study limits our ability to establish the extent of influence of the block on complications.

5. Conclusion

Compared with CISB, utilizing a LBB in patients undergoing primary shoulder arthroplasty significantly decreases postoperative opioid consumption and improves pain scores at multiple time intervals, especially in opioid naïve patients. Fewer opioids prescribed at discharge seems to drive lower post-hospital opioid prescriptions for opioid naïve patients who receive a LBB. There were no significant differences in pain scores or opioid consumption for opioid tolerant patients. The use of a LBB may also reduce revisits to the emergency department within 8 weeks of surgery, but no differences exist between groups for major or minor complications. Further prospective, randomized controlled trials are needed to further establish the role of LBB in patients undergoing primary shoulder arthroplasty.

Author contributions

Tristan B. Weir, MD: conceptualization and design of the study; data collection; data curation and statistical analysis; formal analysis; writing, original draft; writing, review and editing.

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IRB approval

Approval was obtained from the University of Maryland, Baltimore Institutional Review Board (HP-00076479).

Appendix A. Baseline Patient-Reported Outcome Measures. Values are given as the mean plus or minus the standard deviation. CISB, continuous interscalene nerve block; LBB, liposomal bupivacaine interscalene block; NRS, numeric rating scale; PROMIS, Patient-Reported Outcomes Measurement Information System; ASES, American Shoulder and Elbow Surgeons. *Indicates statistically significant values ($P < 0.05$)

Baseline Patient-Reported Outcome Measures				
	Total (n = 104)	CISB (n = 70)	LBB (n = 34)	P value
NRS, shoulder pain (0-10)	6.3 ± 2.7	6.3 ± 2.9	6.2 ± 2.3	0.91
PROMIS				
Physical Function	39.6 ± 7.8	38.9 ± 8.4	41.3 ± 6.5	0.15
Pain Interference	63.1 ± 7.2	63.4 ± 7.5	62.5 ± 6.6	0.57
Fatigue	57.6 ± 9.3	58.4 ± 8.9	56.0 ± 10.1	0.23
Social Satisfaction	39.5 ± 7.2	38.8 ± 7.1	40.7 ± 7.4	0.23
Anxiety	56.9 ± 8.8	57.3 ± 8.9	56.2 ± 8.8	0.59
Depression	50.9 ± 9.5	51.8 ± 9.8	49.0 ± 8.6	0.17
ASES	32.0 ± 18.0	31.0 ± 17.6	34.0 ± 19.0	0.45

Values are given as the mean plus or minus the standard deviation.

CISB, continuous interscalene nerve block; LBB, liposomal bupivacaine interscalene block; NRS, numeric rating scale; PROMIS, Patient-Reported Outcomes Measurement Information System; ASES, American Shoulder and Elbow Surgeons.

*Indicates statistically significant values ($P < 0.05$).

Appendix B. Discharge and Refill Opioid Prescription MME within 8 Weeks†. Values are given as the mean plus or minus the standard deviation. CISB, continuous interscalene nerve block; LBB, liposomal bupivacaine interscalene block; MME, milligram morphine equivalents. *Indicates statistically significant values ($P < 0.05$). †Cohort includes patients after July 2017

Discharge and Refill Opioid Prescription MME within 8 Weeks†									
	All Patients			Opioid Naïve			Opioid Tolerant		
	CISB (n = 31)	LBB (n = 34)	P value	CISB (n = 25)	LBB (n = 22)	P value	CISB (n = 6)	LBB (n = 12)	P value
Preoperative MME	316 ± 1247	410 ± 711	0.72	–	–	–	1633 ± 2598	1059 ± 793	0.62
Discharge MME	487 ± 379	293 ± 62	0.009*	425 ± 206	293 ± 66	0.005*	745 ± 748	294 ± 56	0.20
Number of refills	0.6 ± 0.8	0.8 ± 1.0	0.22	0.4 ± 0.6	0.5 ± 0.6	0.77	1.2 ± 1.2	1.5 ± 1.2	0.58
Refill MME	270 ± 567	417 ± 680	0.35	157 ± 252	109 ± 164	0.44	738 ± 1141	980 ± 896	0.63
Total postop MME	757 ± 892	710 ± 675	0.81	582 ± 325	402 ± 173	0.021*	1483 ± 1866	1274 ± 878	0.75

Values are given as the mean plus or minus the standard deviation.

CISB, continuous interscalene nerve block; LBB, liposomal bupivacaine interscalene block; MME, milligram morphine equivalents.

*Indicates statistically significant values ($P < 0.05$).

†Cohort includes patients after July 2017.

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