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Research Article

Efficacy of Liposomal Bupivacaine in Orthopedic Procedures in an Academic Trauma Hospital

Abstract

Background: Alternatives to opioids have been sought to control postoperative pain given the opioid epidemic. Liposomal bupivacaine has been suggested to decrease postoperative opioid use and pain scores. The purpose of this study was to discover the effect of liposomal bupivacaine on postoperative pain scores and narcotic usage in orthopedic patients.

Methods: A retrospective cohort study of adult orthopedic patients was performed comparing those who received liposomal bupivacaine intraoperatively to those that received standard of care between January 2014 and December 2014. A least-squares regression model, was used to adjust for the influence of significant variables on primary outcomes; opioid use and pain scores.

Findings: The study enrolled 460 patients with an average age of 58 years and median Charlson Comorbidity Index of 3. Least squares regression analysis found a decrease in cumulative morphine equivalents used in postoperative patients that received liposomal bupivacaine at all pre-defined time points up to 48 hours postoperatively. At 48 hours the standard of care patients received 19mg of morphine equivalents more than the liposomal bupivacaine group. Pain scores were comparable between those who received standard of care and those that received liposomal bupivacaine, however a statistically significant decrease in pain scores was noted in those that received liposomal bupivacaine at 1 hours, 6 hours, and 12 hours.

Conclusion: A statistically significant decrease in opioid consumption was found up to 48 hours postoperatively with use of liposomal bupivacaine. Given the small decrease in morphine equivalents, this may not be clinically significant.

Introduction

Traditionally, opioids have been the mainstay of controlling post-surgical pain. Alternatives to opioids have been sought to control post-operative pain given the opioid epidemic [1]. Problematic side effects of opioids include constipation, nausea, sedation, dependence, and addiction. For these reasons, a multimodal approach has been recommended as a method to decrease overall narcotic use [2]. Medications that are often incorporated into the multimodal approach include nonsteroidal anti-inflammatory drugs, anticonvulsants like pregabalin or gabapentin, and local anesthetics including bupivacaine or ropivacaine. Typically, local anesthetics are limited by their short acting nature. Liposomal bupivacaine is a long acting formulation of bupivacaine that attempts to overcome this limitation. Like other local anesthetics, liposomal bupivacaine promotes analgesia by blocking the generation and conduction of nerve impulses [3]. Its long-acting mechanism is derived from a phospholipid bilayer that encompasses an aqueous core of bupivacaine micro-vesicles which is destabilized by body heat. This allows for the disruption of the internal micro-vesicle membranes and a slow, controlled release of bupivacaine [4,5]. Liposomal bupivacaine is generally considered safe except for mild side effects including nausea, vomiting, hypotension, and insomnia have been reported.

Liposomal bupivacaine has been suggested to decrease post-operative opioid use, pain scores, and length of stay, given its prolonged duration of action of up to 96 hours [6,7]. However, more recent literature has had mixed results regarding the effectiveness of liposomal bupivacaine in both decreasing post-operative pain and opioid usage [8-12]. Liposomal bupivacaine in patients undergoing hemorrhoidectomy showed reduced opioid dose, extended median time to first opioid dose, and higher patient satisfaction rates for post-operative analgesia [3,8]. Patients treated with liposomal

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bupivacaine for bunionectomy showed decreased opioid rescue medication and longer median time to first postoperative opioid [9]. Studies of liposomal bupivacaine in orthopedic procedures have shown a less favorable response. *Bagsby et al.*, compared patients undergoing total knee arthroplasty receiving liposomal bupivacaine vs. periarticular injection found that liposomal bupivacaine provided poorer pain control than traditional periarticular injection [11]. Similarly, other studies in orthopedic surgeries showed no difference in terms of analgesic consumption and pain scores [10,12]. Given the high cost of liposomal bupivacaine, we sought to discover the effect of liposomal bupivacaine on post-operative pain scores and narcotic usage in orthopedic patients.

Methods

A retrospective cohort study of adult orthopedic patients was performed comparing those who received liposomal bupivacaine intraoperatively to those that received standard of care between January 1, 2014 and December 31, 2014. Liposomal bupivacaine was used at the discretion of the attending surgeon. This study was performed at Erie County Medical Center which is a 600-bed academic medical center and a level 1-trauma center. The University at Buffalo Institutional Review Board approved this study.

All orthopedic surgery patients within the study window who were 18 years and older and received liposomal bupivacaine were included in this study. Orthopedic procedures were chosen based on CPT (Current Procedural Terminology) code (see supplement 1). Patients were excluded if they had moderate to severe renal impairment (creatinine clearance of ≤ 30ml/min as calculated by the Cockcroft-Gault equation), moderate or severe hepatic impairment (Child-Pugh score B or C), or an allergy to any opioid. Pregnant patients and prisoner were also excluded. Standard of care arm was matched using orthopedic CPT codes during the same time period in terms of type of procedure, age and BMI.

Baseline characteristics were compared between those that received intraoperative liposomal bupivacaine vs. standard of care, including Charlson Comorbidity Index, and level of care (general medical/surgical floor vs. critical care). The Charlson Comorbity Index categorizes various comorbities of patients which can equate to 10 year mortality. Additionally, surgery type and duration were compared between the two groups. The primary outcomes measure included cumulative post-operative opioid use as well as pain scores based on a visual and analog scale at the following time intervals 1, 2, 4, 6, 12, 18, 24, 48, 72 and 96 hours. Categorical data were analyzed using the Chi square test and continuous data was analyzed using the Student t test or one-way analysis of variance (ANOVA). Factors that differed significantly between the standard of care arm and the Liposomal Bupivacaine arm were built into a least squares regression model, which was used to adjust for the influence of these variables on primary outcomes, including opioid use and pain scores. Non-significant factors were eliminated in a backwards elimination fashion. All tests for significance were two sided and based on a significance level of 0.05. Statistical analyses were performed using JMP version 13 (SAS Institute Inc, Cary, NC).

Results

Of the 948 patients screened, 460 patients were enrolled in this study, (n=225 and n=235 in the standard of care and Liposomal Bupivacaine groups, respectively). Of the 235 patients that received liposomal bupicacaine six patients received less than 100mg, 14 patients received between 100mg and 200mg, 11 received between 200mg and 250mg, the majority (197 patients) received 266mg, and 7 received greater than 266mg. The average age between the standard of care group and the Liposomal Bupivacaine group was 57.8 vs 58 years (Table 1). About 50% of each group was male with an average BMI of

Table 1: Patient Characteristics.

	Standard of Care (n=225) Mean (sd)	Liposomal bupivacaine (n=235) Mean (sd)	p=value
Age	57.8 +/- 12.8	58.1 +/- 13.1	0.84
Male	100 (49.5%)	102 (50.5%)	0.82
BMI	32 +/- 7.2	32.2 +/- 7.2	0.42
Baseline Pain Score	0.54 +/- 1.2	0.54 +/- 1.1	0.97
Baseline Morphine equivalent	7.2 +/- 25.3	7.5 +/- 28.1	0.93
Serum Creatinine	0.88 +/- 0.2	0.87 +/- 0.2	0.80
Charlson Comorbidity Index	3 (2-4)	3(2-4)	0.72
Hospital location before surgery Ambulatory Floor ICU	 51 (22.7%) 174 (77.3%) 0	 62 (26.4%) 171 (72.8%) 2 (0.9%)	0.24
Pre-op PACU duration (minutes)	135.7 +/- 55.6	144.1 +/- 53.5	0.10
Surgery duration (minutes)	96.2 +/- 37.1	101.5 +/- 47.6	0.18
ASA Classification	2.2 +/- 0.5	2.1 +/- 0.5	0.48
Propofol	188.9 (46.4%)	190 (46.2%)	0.80
Anesthesia type Desflurane Sevoflurane	 39 (18.2%) 175 (81.8%)	 46 (20.4%) 180 (79.7%)	0.57
Anesthesia duration (min)	129 +/- 40.3	129.0 +/- 57.1	0.99
Time to Extubation (min)	144.4 +/- 6.4	158 +/- 79.7	0.06
Post-op Hospital location Ambulatory Floor ICU	 51 (22.8%) 173 (77.2%) 0	 60 (25.5%) 173 (73.6%) 2 (0.85%)	0.3
Adjuvant IR Pre-op	198 (88%)	220 (93.62%)	0.04
Adjuvant IR Intra-Op	162 (72%)	131 (55.7%)	0.0003
Ketorolac Pre-Op	1 (0.4%)	1 (0.4%)	0.98
Ketorolac Intra-op	31 (13.78%)	36 (15.3%)	0.64
Ketorolac Post-Op <1hr	5 (2.2%)	2 (0.8%)	0.23
Ketorolac 1-2hr	3(1.3%)	3(1.3%)	0.96
Ketorolac 2-4hr	1(0.4%)	0	0.31
Ketorolac 4-6hr	0	0	1
Ketorolac 6-12hr	2(1%)	0	0.15
Ketorolac 12-18	1(0.4%)	0	0.31
Ketorolac 18-24	2(0.9%)	0	0.15
Ketorolac 24-48	1(0.4%)	0	0.31
Pre-Op Opioid Consumption	9.2(3.2%)	9.3(2.5%)	0.88

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32kg/m². The Charlson Comorbidity Index was equivalent between the two groups- median 3 (interquartile range 2-4). The majority of patients were admitted to an inpatient ward prior to surgery with an average surgery duration in the standard of care group of 96.2 minutes vs 101.5 minutes in the liposomal bupivacaine group (p=0.18). Propofol use and anesthesia class, type, and duration were similar between each group (Table 1). Additional adjuvant local anesthetic was used pre-operatively and intra-operatively in both the standard of care group and the liposomal bupivacaine group. During the pre-operative time period, liposomal bupivacaine patients received more adjuvant local anesthetics than the standard of care group (94% vs. 88% p=0.04). During the intra-operative period the standard of care group received more adjuvant local anesthetics than the liposomal bupivacaine group (72% vs. 56% p=0.0003). The use of ketorolac and pre-operative narcotics was equivalent between both groups.

Least squares regression model initially included liposomal bupivacaine, pre-operative, and intra-operative adjuvant local anesthetic. Intra-operative adjuvant local anesthetic was found to not be significant and was removed leaving the final model containing liposomal bupivacaine and pre-operative adjuvant local anesthetic (Tables 2,3). There was a statistically significant decrease in cumulative morphine equivalents (ME) used in postoperative patients that received liposomal bupivacaine at all pre-defined time points up to 48 hours post-operatively. At 12 hours post operatively, patients who received liposomal bupivacaine received 6.9mg less of ME (liposomal bupivacaine 23.6mg ME vs. standard of care 30.5mg ME, p=0.0005). At 24 hours patients who received standard of care treatment received 13.4mg of additional morphine equivalents (liposomal bupivacaine 38.9mg ME vs. standard of care 52.3mg ME, p<0.0001). Finally, at 48 hours the standard of care patients received 19mg of morphine equivalents more than the liposomal bupivacaine group (liposomal bupivacaine 72.6mg ME vs. standard of care 91.6mg ME, p<0.0001). This statistically significant difference was no longer seen at 72 or 96 hours. A statistically significant decrease in opioid requirements was also seen when comparing those who received preoperative adjuvant local anesthetics versus those who did not at 1 hour, 2 hours, and 12 hours post operatively.

Pain scores were comparable between those who received standard of care and those that received liposomal bupivacaine, however a statistically significant decrease in pain scores was noted in those that received liposomal bupivacaine at 1 hours, 6 hours, and 12 hours. There was no difference in pain scores

Table 2: Least Squares Regression Cumulative ME.

Cumulative morphine equivalents	Standard of Care mean (SE) of ME	Liposomal Bupivacaine mean (SE) of ME	p value	No Pre-operative Adjunctive local anesthetic (SE)	Pre-operative Adjunctive local anesthetic (SE)	P value
1hr	5.1 +/-0.4	5.6 +/-0.5	0.0009	4.5 +/-0.7	4.2 +/-0.2	0.7
2hr	9.6 +/-0.7	8.0 +/-0.7	0.017	10.6 +/-1.3	7.1 +/-0.3	0.008
4hr	13.3 +/-1.0	10.1 +/-1.0	0.0006	13.3 +/-1.8	10.1 +/-0.5	0.09
6hr	17.8 +/-1.3	13.2 +/-1.3	0.0002	17.2 +/-2.3	13.7 +/-0.6	0.1
12hr	30.5 +/-2.1	23.6 +/-2.2	0.0005	30.3 +/-3.7	23.8 +/-1	0.09
18hr	39.2 +/-2.7	29.8 +/-2.7	0.0001	37.4 +/-4.7	31.6 +/-1.2	0.2
24hr	52.3 +/-3.4	38.9 +/-3.5	<0.0001	49 +/-5.9	42.3 +/-1.6	0.3
48hr	91.6 +/-7.2	72.6 +/-8	0.004	89.5 +/-13.3	74.7 +/-3.4	0.3
72hr	132.9 +/-13.2	136.3 +/-15.6	0.8	160.1 +/-24.1	109.2 +/-7.1	0.04
96hr	170.0 +/-25.4	172.4 +/-24.3	0.9	228.0 +/-42	114.3 +/-12.1	0.01

SE – Standard Error
ME – Morphine Equivalents

Table 3: Least Squares Regression Pain Scores.

Pain score	Standard of care (SE)	Liposomal Bupivacaine (SE)	p value	No operative Adjunctive local anesthetic (SE)	Pre-operative Adjunctive local anesthetic (SE)	p value
1hr	3.4 +/-0.3	2.8 +/- 0.3	0.02	3.0 +/-0.4	3.2 +/-0.1	0.7
2hr	3.3 +/-0.3	3.4 +/-0.3	0.5	3.7 +/-0.5	3.0 +/-0.1	0.1
4hr	4.6 +/-0.4	4.1 +/-0.5	0.2	3.7 +/-0.8	5 +/-0.2	0.1
6hr	5.2 +/-0.5	4.1 +/-0.5	0.01	4.4 +/-0.8	4.8 +/-0.2	0.7
12hr	6.9 +/-0.5	5.5 +/-0.6	0.03	6.5 +/-0.9	5.9 +/-0.3	0.5
18hr	6.0 +/-0.5	5.7 +/-0.5	0.4	6.4 +/-0.9	5.4 +/-0.2	0.3
24hr	5.6 +/-0.5	4.9 +/-0.5	0.09	4.8 +/-0.8	5.8 +/-0.2	0.2
48hr	4.7 +/-0.2	4.7 +/-0.7	1	4.5 +/-1	5 +/-0.3	0.06
72hr	5.8 +/-0.9	5.9 +/-1.1	1	6.3 +/-1.6	5.3 +/-0.5	0.5
96hr	5 +/-1	3.7 +/-1.7	0.5	4.3 +/-1	4.3 +/-1	1

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between patients that received preoperative adjuvant local anesthetics and those who did not.

Discussion

The American Pain Society has set forth guidelines for the management of postoperative pain. The use of local long acting anesthetic infiltration has a weak recommendation with moderate-quality evidence for efficacy and liposomal bupivacaine is one such agent [2]. We attempted to determine the effectiveness of liposomal bupivacaines ability to improve pain scores and decrease opioid consumption for 96-hour post-operatively to justify the use of liposomal bupivacaine.

During the first 48 hours a statistically significant decrease in opioid consumption was seen. The maximum reduction in opioid consumption that could be attributed to liposomal bupivacaine was 19mg of morphine equivalents and this was reached at hour 48. This reduction in opioid consumption was lost by hour 72. Pain score differed at 1, 6, and 12 hours; at these times pain scores were improved by an average of 1 in the liposomal bupivacaine group. Though a statistical difference was observed in terms of opioid reduction up to 48 hours, the question remains whether this is clinically significant.

The opioid epidemic is a priority in the USA. Prescription sales for opioids increased fourfold from 1999-2010 [13]. Prescription drug abuse has been identified by the Centers for Disease Control as one of the most important health threats facing the United States [14]. The benefit of a 19 mg mean reduction in opioid consumption over 48 hours may not make a substantial difference in combating the use of opioids. A population based study in Canada found that risk factors for prolonged opioid use after surgery included surgery type (open intrathoracic procedures and minimally invasive intrathoracic procedures), younger age, lower socioeconomic status, diabetes, heart failure, pulmonary disease and use of specific drugs [15]. Major elective surgery resulted in 3.1% of the patients in this cohort of 39,140 patients continuing to receive opioid prescriptions past 3 months after surgery [15]. Another trial utilizing claims data from Truven Health, a major US health insurer, found the most common risk factors for chronic opioid use following surgery included male gender, age greater than 50, preoperative benzodiazepine usage, antidepressant use, antipsychotic use, depression, psychosis, alcohol abuse, and drug pervious to drug abuse [16].

A recent Cochrane Database Systematic review of 9 studies found that liposomal bupivacaine reduced pain when compared to placebo however, there was no benefit compared to bupivacaine [17]. This review was limited due to the low quality and volume of evidence due to the small sample sizes in the majority of studies [17]. Other studies have questioned the utility of liposomal bupivacaine in orthopedic surgeries. A prospective randomized trial of 111 total knee arthroplasties (TKA) found no difference in pain scores or opioid usage [18]. Similarly a study of TKA patients receiving liposomal bupivacaine vs. femoral never block showed no difference in opioid usage [10].

Another important concern regarding the use of liposomal bupivacaine is cost of the agent. The average wholesale price of liposomal bupivacaine is $377.99 per 266 mg vial as of March 2017 [19]. In comparison, the cost a dose of oxycodone 5mg tablet is 15 cents [19]. Though we found a statistically significant decrease in narcotic usage at 48 hours, this is not a clinically significant reduction. Similarly, the reduction in pain scores by an average of 1 for three time periods is also inconsequential. The Centers for Medicare and Medicaid Services value based purchasing program is partially based on patient satisfaction scores including pain scores however, the pain scores in our study were not clinically decreased by using liposomal bupivacaine [20].

Limitations to our study included the retrospective nature, variability in a surgeon's experience with the product, and different types of orthopedic surgeries. Although our study was only a single center study, it is one of the largest cohorts of orthopedic patients studied. Other limitations include pain scores only being documented when the patient had pain as opposed to a standardized approach.

Conclusion

Liposomal bupivacaine statistically decreases the opioid consumption through 48 hours post-surgery with intermittent decreases in pain scores. Unfortunately, this decrease in opioid consumption is not clinically significant. The maximum decrease is no more than the equivalent of 2-3 tablets of Oxycodone 5 mg over 48 hours post-operative with no difference by 72 hours. Pain scores are only improved at three time points and are sporadic. Therefore the cost of liposomal bupivacaine cannot be justified for the marginal benefit provided.

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References

1. Crowley R, Kirschner N, Dunn AS, Bornstein SS, Health Public Policy Committee of the American College of Physicians (2017) Health and public policy to facilitate effective prevention and treatment of substance use disorders involving illicit and prescription drugs: An american college of physicians position paper. Ann Intern Med 166: 733-736. Link: https://goo.gl/gokJKH

2. Chou R, Gordon DB, de, Leon-Casasola OA, Rosenberg JM, Bickler S, et al. (2016) Management of postoperative pain: A clinical practice guideline from the american pain society, the american society of regional anesthesia and pain medicine, and the american society of anesthesiologists' committee on regional anesthesia, executive committee and administrative council. J Pain 17: 131-157. Link: https://goo.gl/XUuVH1

3. Exparel [Package Insert]. Parsippany NPPO.

4. Chahar P, Cummings KC 3rd (2012) Liposomal bupivacaine: A review of a new bupivacaine formulation. J Pain Res 5: 257-264. Link: https://goo.gl/fFWuTc

5. Lonner J (2014) Role of liposomal bupivacaine in pain management after total joint arthroplasty. J Surg Orthop Adv 23: 37-41. Link: https://goo.gl/7jqQAu

6. Singh PM, Borle A, Trikha A, Michos L, Sinha A, et al. (2017) Role of periarticular liposomal bupivacaine infiltration in patients undergoing total knee arthroplasty-a meta-analysis of comparative trials. J Arthroplasty 32: 675-688. Link: https://goo.gl/Pi9NMi

Citation: Ott MC, Powers J, Bernhardi C, Patzke C, Przespolewski E, et al. (2017) Efficacy of Liposomal Bupivacaine in Orthopedic Procedures in an Academic Trauma Hospital. Ann Musculoskelet Med 1(2): 027-031.

7. Hamilton TW, Athanassoglou V, Trivella M, Strickland LH, Mellon S, et al. (2016) Liposomal bupivacaine peripheral nerve block for the management of postoperative pain. Cochrane Database Syst Rev 8: CD011476. Link: https://goo.gl/YFnLTB

8. Gorfine SR, Onel E, Patou G, Krivokapic ZV (2011) Bupivacaine extended-release liposome injection for prolonged postsurgical analgesia in patients undergoing hemorrhoidectomy: A multicenter, randomized, double-blind, placebo-controlled trial. Dis Colon Rectum 54: 1552-1559. Link: https://goo.gl/5PKYsn

9. Golf M, Daniels SE, Onel E (2011) A phase 3, randomized, placebo-controlled trial of depofoam(r) bupivacaine (extended-release bupivacaine local analgesic) in bunionectomy. Adv Ther 28: 776-788. Link: https://goo.gl/GAoeHu

10. Surdam JW, Licini DJ, Baynes NT, Arce BR (2015) The use of exparel (liposomal bupivacaine) to manage postoperative pain in unilateral total knee arthroplasty patients. J Arthroplasty 30: 325-329. Link: https://goo.gl/Y1EfGt

11. Bagsby DT, Ireland PH, Meneghini RM (2014) Liposomal bupivacaine versus traditional periarticular injection for pain control after total knee arthroplasty. J Arthroplasty 29: 1687-1690. Link: https://goo.gl/uy2uzf

12. Jain RK, Porat MD, Klingenstein GG, Reid JJ, Post RE, et al. (2016) The aahks clinical research award: Liposomal bupivacaine and periarticular injection are not superior to single-shot intra-articular injection for pain control in total knee arthroplasty. J Arthroplasty 31: 22-25. Link: https://goo.gl/93ceK9

13. Cobaugh DJ, Gainor C, Gaston CL, Kwong TC, Magnani B, et al. (2014) The opioid abuse and misuse epidemic: Implications for pharmacists in hospitals and health systems. Am J Health Syst Pharm 71: 1539-1554. Link: https://goo.gl/4xYTMF

14. Centers for disease and prevention. Opioid painkiller prescribing: Where you live makes a difference. Link: https://goo.gl/E9K9tQ

15. Clarke H, Soneji N, Ko DT, Yun L, Wijeysundera DN (2014) Rates and risk factors for prolonged opioid use after major surgery: Population based cohort study. BMJ 348: g1251. Link: https://goo.gl/fqDdVK

16. Sun EC, Darnall BD, Baker LC, Mackey S (2016) Incidence of and risk factors for chronic opioid use among opioid-naive patients in the postoperative period. JAMA Intern Med 176: 1286-1293. Link: https://goo.gl/fP7xRG

17. Hamilton TW, Athanassoglou V, Mellon S, Strickland LH, Trivella M, et al. (2017) Liposomal bupivacaine infiltration at the surgical site for the management of postoperative pain. Cochrane Database Syst Rev 2: CD011419. Link: https://goo.gl/SFcrzE

18. Schroer WC, Diesfeld PG, LeMarr AR, Morton DJ, Reedy ME (2015) Does extended-release liposomal bupivacaine better control pain than bupivacaine after total knee arthroplasty (tka)? A prospective, randomized clinical trial. J Arthroplasty 30: 64-67. Link: https://goo.gl/DFUst4

19. Analytics TH (2017) Red book. Truven Health Analytics an IBM Company. Link: https://goo.gl/PTKaB5

20. Hospital value-based purchasing (2017). Link: https://goo.gl/QzHvij

Citation: Ott MC, Powers J, Bernhardi C, Patzke C, Przespolewski E, et al. (2017) Efficacy of Liposomal Bupivacaine in Orthopedic Procedures in an Academic Trauma Hospital. Ann Musculoskelet Med 1(2): 027-031.