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Comparative Analysis of Intraoperative use of Liposomal Bupivacaine (Exparel) and ON-Q Pump for Postoperative Analgesia in Abdominal Body Contouring Surgery in Massive Weight Loss Patients

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Abstract

Background: Pain management is particularly important in massive weight loss patients undergoing abdominoplasty. In the setting of abdominoplasty, patients usually require multi-modal analgesia to achieve adequate pain control. Liposomal bupivacaine, marketed as Exparel, and the continuous local anesthetic infusion pump, or On-Q pump, are two pain control modalities often used after body contouring procedures.

Objective: The purpose of this study was to compare the effectiveness of Exparel with the On-Q pump following abdominal body contouring procedures in massive weight loss patients.

Methods: A retrospective chart review was performed on all massive weight loss patients who underwent a variety of body contouring procedures, including fleur-de-Lis abdominoplasty, belt lipectomy, abdominoplasty, and combined belt lipectomy at a single institution between 2009-2014. Demographics, preoperative laboratory studies, procedure report, and 0-48 hour post-procedure assessment logs were reviewed for the study.

Results: Fifty-seven patients were included in the study. Forty-five patients received Exparel for postoperative pain control and twelve received the On-Q pump. The results demonstrate that opioid requirements for the Exparel group were significantly less than the On-Q group from 0-12 hours and from 12-24 hours.

Conclusions: Our study demonstrates that patients who received Exparel had lower requirements for postoperative opiates than those who received the On-Q pump. The data showed that a single-dose local infiltrative injection of Exparel is superior to the continuous bupivacaine pump infusion for pain control. Based on patient reported pain scores, Exparel was superior to bupivacaine pump at improving patient comfort within the first 12 hours postop.

Keywords: Liposomal bupivacaine; Massive weight loss; Abdominoplasty; Body contouring

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Introduction

Poorly controlled postoperative pain in massive weight loss patients undergoing abdominoplasty has been shown to increase the incidence of deep venous thrombosis, pulmonary embolus and delayed wound healing [1-3]. In the setting of an abdominoplasty, patients usually require multimodal analgesia to achieve adequate pain control, including patient-controlled narcotic analgesic pumps intravenously, and/or oral opioids on an as-needed basis [4]. There has been an increased effort to utilize non-narcotic multimodal analgesia to reduce opioid load and minimize opioid-related adverse side effects, while achieving sufficient pain control. Over the years, several opioid sparing strategies utilizing bupivacaine have had varying degrees of success at reducing postoperative pain [5]. These therapies include continuous local anesthetic infusion pump, marketed as On-Q Pump (Halyard) and/or direct local anesthetic infiltration with bupivacaine hydrochloride. Liposomal bupivacaine (LB), marketed as Exparel (Pacira) is a new multivesicular formulation of bupivacaine designed to be extended release [5]. Multiple studies have shown that perioperative use of LB can maintain analgesia for up to 72 hours after surgery, a time when the prevalence of postoperative pain is often most severe [4,5].

Table 1: Patient demographics.

Characteristics	Liposome bupivacaine n = 45	Bupivacaine infusion pump n = 12	Total n = 57
Age, years			
Mean (±SD)	48.67 (±13.29)	50.92 (±10.81)	48.93 (±12)
Range	25-73	35 - 70	
Age category			
< 50	24	7	31
≥ 50	21	5	26
Gender			
Female	42	11	53
Males	3	1	4
Preoperative BMI (±SD)			
Mean	30.10 (±4.20)	33.34 (±4.60)	31.06 (±4.47)
Range	22.39 - 40.60	27.04 – 41.67	
BMI category			
< 30	22	3	25
≥ 30	23	9	32

Abbreviations: BMI=Body Mass Index; FDL=Fleur De Lis Abdominoplasty; SD=Standard Deviation

Table 2: Study measurements between LB and On-Q for morphine equivalents for the first 48 hours and pain measurements for the first 48 hours.

	Liposome Bupivacaine			On-Q infusion pump			t-test
	Average (mg)	Range (mg)	Count	Average (mg)	Range (mg)	Count	
Morphine							
First 12 hours (0-12)	8.49	0 – 26	45	17.03	3.33 – 47	12	0.01
Second 12 hours (12-24)	8.17	2 – 24.33	26	14.60	3.33 – 31.67	10	0.03
Third 12 hours (24-36)	5.50	3-21	10	13.44	5.33-25	3	0.11
Fourth 12 hours (36-48)	8	4 – 16.67	3	5.11	3.33 – 8.33	3	0.57
Total 48 hours	14.96	0 – 60.34	45	33.83	6.66 – 107	12	0.003
Pain scores							
First 12 hours (0-12)	1.20	0-10	45	3.08	0-10	12	0.04*
Second 12 hours (12-24)	3.40	0-10	26	4.83	0-10	10	0.06
Third 12 hours (24-36)	3.77	0-10	10	4.88	0-10	3	0.41
Fourth 12 hours (36-48)	4.8	0-10	3	6	0-10	3	0.71

The aim of this study was to compare the effectiveness of LB with On-Q infusion pump following abdominal body contouring procedures in massive weight loss patients.

Materials and Methods

Study design

After Institutional Review Board approval was obtained, a retrospective chart review was performed on all patients who underwent body contouring procedures, specifically, Fleur de Lis abdominoplasty, belt lipectomy, abdominoplasty, and combined Fleur de Lis abdominoplasty with belt lipectomy with abdominal plication at the University of Texas Medical Branch Galveston Hospital between 2009-2014. The timeframe was methodically selected and depicts the institution's progression of multimodal analgesic strategies. The institution implemented the use of the bupivacaine pump in 2009 and subsequently transitioned to LB in 2012. Inclusion criteria included patients that had undergone massive weight loss (MWL) with subsequent body contouring procedures, as listed above. Patients with history of chronic pain, and/or those patients who underwent concomitant procedures under another surgical service were excluded from the review. Demographics, medical history, surgical history, medication administration record, and pain scores were obtained from patients 0-48 hours post-procedure.

Method of bupivacaine administration

Liposomal bupivacaine: a total of one vial of 20 mL of LB was administered per patient. The 20 mL LB vial was diluted with 0.9% sterile normal saline. The solution was injected along skin incision lines and directly into the fascia prior to closure. The distribution of injections included the anterior abdominal fascia, costal margins, bilateral flank fascia, and along the rectus plication line.

Bupivacaine infusion pump: Includes an elastomeric pump filled with 0.25% bupivacaine solution (total volume of 400 mL) with two catheters, which deliver anesthesia at a rate of 2 mL/hr each with consistent pressure (10 psi). Catheters were placed using an introducer by inserting 20-gauge guiding needles into the subcutaneous tissue, overlying the fascial plication lines, and exiting just above and below the length of the incisions. Each catheter typically covered approximately 20 cm of the incision line. The On-Q Painbuster

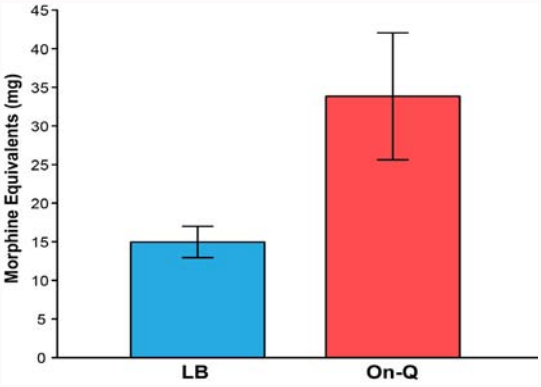

Figure 1: Average total morphine equivalents used postoperatively for LB versus on-Q*. *LB = liposomal bupivacaine; On-Q = On-Q Painbuster Infiltration 0.25% bupivacaine infusion; Error bars represent standard error of mean.

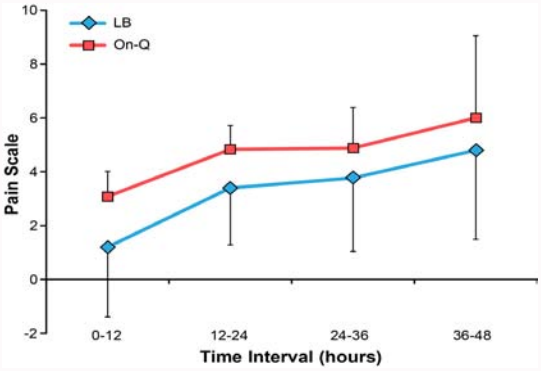

Figure 2: Average postoperative pain scores for LB versus On-Q. *LB = liposomal bupivacaine; On-Q = On-Q Painbuster Infiltration 0.25% bupivacaine infusion; Error bars represent standard error of mean.

Infiltration System continually infused anesthesia (bupivacaine) at a rate of 2mL/h (120 mg per day) to the incision site for 48 hours and was subsequently removed. This is well below the recommended maximum dose of 400 mg in 24 hours [6,7]. Products were utilized in the manner stated by the respective manufactures product insert and guidelines of administration.

Outcome measures

Postoperative opioid requirements during 48 hours postop were converted to morphine equivalents for standardized comparison. Pain scores were obtained during 48 hours postop using the Numerical Rating Scale (NRS) assigning a value n = 1-10. The numerical rating scale has been well validated in the literature and is commonly utilized as a pain assessment tool [8].

Statistical analysis

Data was collected and analyzed in an Excel database (Microsoft Corp., Redmond, Wash.). The two-tailed independent t-test was used to assess opioid requirements and pain scores. The two-way ANOVA was also utilized to assess interactions between age and BMI in response to opioid usage within the LB group. A p-value of < 0.05 was considered statistically significant. Statistical analysis was reviewed and completed by the university's biostatistics.

Results

Fifty-seven patient charts were ultimately included and reviewed (Table 1). Twenty-two underwent Fleur de Lis abdominoplasty, twenty-five underwent abdominoplasty, and ten underwent combined abdominoplasty with belt lipectomy (Table 2). There were 4 males and 53 females who with an average age of 49 years and an average BMI of 31.06 (+/- 4.47). LB was used in 45 patients, and the remaining 12 patients received the bupivacaine infusion pump for postoperative pain control.

The average equianalgesic morphine usage over the 48-hour period (Figure 1) was 14.96 mg (range 0.00 – 60.34) for the LB group and 33.83 mg (range 6.66 – 107) for the On-Q group (p = 0.003).

Additionally, this 48-hour period was broken down into 12-hour intervals to assess for differences in LB versus On-Q at various time points in the 48 hours Table 3). The total number of patients in the first 12-hour period (time 0-12 hours) was 57.

The average pain score (Table 3, Figure 2) over the first 12-hour period (time 0-12 hours) was 1.20 (range 0 – 10) for the LB group and 3.08 (range0 – 10) for the On-Q group (p = 0.04). The average equianalgesic morphine usage (Table 3, Figure 3) over the first 12-hour period (time 0-12 hours) was 8.49 mg (range 0 – 26) for the LB group and 17.03 mg (range 3.33 – 47) for the On-Q group (p = 0.01).

The total number of patients in the second 12-hour period (time 12-24 hours) was 36. The average pain score (Table 3, Figure 2) over the second 12-hour period (time 12-24 hours) was 3.40 (range 0 – 10) for the LB group and 4.83 (range 0 – 10) for the On-Q group (p = 0.06). The average equianalgesic morphine usage (Table 3, Figure 3) over the second 12-hour period (time 12-24 hours) was 8.17 mg (range 2.00– 24.33) for the LB group and 14.60 mg (range 3.33 – 31.67) for the On-Q group (p = 0.03).

The total number of patients in the third 12-hour period (time 24-36 hours) was 13. The average pain score (Table 3, Figure 2) over the third 12-hour period (time 12-24 hours) was 3.77 (range0 – 10) for the LB group and 4.88 (range 0 – 10) for the On-Q group (p = 0.41). The average equianalgesic morphine usage (Table 3, Figure 3) over the third 12-hour period (time 24-36 hours) was 5.50 mg (range 3 – 21) for the LB group and 13.44 mg (range 5.33 – 25) for the On-Q group (p = 0.11).

The total number of patients in the fourth 12-hour period (time 36-48 hours) was six. The average pain score (Table 3, Figure 2) over the fourth 12-hour period (time 36-48 hours) was 4.8 (range 0 – 9) for the LB group and six (range 0 – 10) for the On-Q group (p = 0.71). The average equianalgesic morphine usage (Table 3, Figure 3) over the fourth 12-hour period (time 36-48 hours) was 8 mg (range 4 – 16.67) for the LB group and 5.11 mg (range 3.33 – 8.33) for the On-Q group (p = 0.57).

Table 3: Average opioid usage in morphine equivalents based on proceduretype.

	Exparel (n)	Total Opioid Usage in mg (±SEM)	On-Q Pump (n)	Total Opioid Usage in mg (±SEM)	T-Test	Total Count
Fleur de Lis abdominoplasty	16	18.10 (±4.35)	6	36.36 (±14.82)	0.1211	22
Abdominoplasty	22	10.98 (±1.89)	3	27.16 (±18.62)	0.0505	25
Combined abdominoplasty and belt lipectomy	7	20.43 (±5.75)	3	35.44 (±3.05)	0.1438	10

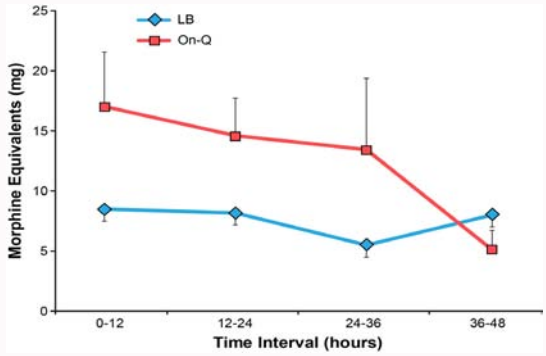

Figure 3: Postoperative average morphine equivalents used for LB versus On-Q*. *LB = liposomal bupivacaine; On-Q = On-Q Painbuster Infiltration 0.25% bupivacaine infusion; Error bars represent standard error of mean.

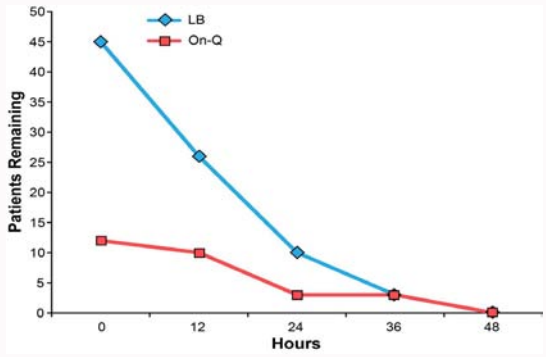

Figure 4: Number of patients present at 12-hour intervals postoperatively for LB versus On-Q*. *LB = liposomal bupivacaine; On-Q = On-Q Painbuster Infiltration 0.25% bupivacaine infusion.

A total of 21 patients were discharged (Figure 4) in the over the first 12-hour period (time 0-12 hours) (19 LB, 2 On-Q). A total of 23 patients were discharged in the over the second 12-hour period (time 12-24 hours) (16 LB, 7 On-Q). A total of seven patients were discharged in the over the third 12-hour period (time 24-36 hours) (7 LB, 0 On-Q). A total of six patients were discharged in the over the fourth 12-hour period (time 36-48 hours) (3 LB, 3 On-Q). The average time to discharge for LB was 17.67 hours and on-Q was 24.65 hours ($p = 0.11$).

Impact of LB on Age and BMI

An additional analysis was performed within the LB group to see its impact on age and BMI. The patients were stratified by 2 ages groups (less than 50 years old, and equal to or greater than 50), and 2 BMI groups (less than 30, and equal to or greater than 30). Total opioid requirements over the same 48-hour postoperative window were analyzed within each of the four subgroup. Of the total 45 patients treated with LB, 24 patients were younger than 50 years of age and required 18.95 mg of morphine equivalents on average, and 21 patients were 50 or older and required 10.44 mg of morphine equivalents on average. The average equianalgesic morphine requirements were significantly higher in the younger patients less than 50 years of age ($p = 0.04$) via independent t-test.

Out of the same 45 patients, a total of 22 patients had a BMI of less than 30 and required 15.61 mg of morphine equivalents on average. The remaining 23 patients had a BMI of 30 or greater and required an average of 14.37 mg of morphine equivalents. The BMI level had no significant impact on opioid usage in LB patients ($p = 0.77$) via independent t-test. The categories were also crossed with each other (BMI < 30 x Age < 50, BMI < 30 x Age > 50, BMI >30 x Age < 50, and BMI > 30 x Age >50) and analyzed via two-way ANOVA to check for interactions. There are no significant interactions that exist between age and BMI in response to opioid usage in LB-treated patients ($p = 0.53$).

Discussion

Multimodal analgesia with liposomal bupivacaine following abdominoplasty has the potential to improve pain management in the massive weight loss patient. Current methods for pain control vary from surgeon to surgeon. The bupivacaine pump has been considered as part of many surgeons' multimodal analgesia regimen, however, its' efficacy remains equivocal in the literature [9,10]. The results from our review showed that patients who received LB consistently required less opioids during the first 48 postop hours compared to patients with the On-Q pump. The data showed that a single-dose local infiltrative injection of LB is superior to the continuous bupivacaine pump infusion for pain control. Based on patient reported pain scores, LB was superior to bupivacaine pump at improving patient comfort within the first 12 hours postop. The opioid usage data may have not continued to reach statistical significance after 12 hours due to varying times of discharge, which severely decreased the sample size.

Since our LB group was matched upon stratification by age and BMI, we were curious to see the impact of LB on these two independent variables. Patients greater than the age of 50 required significantly less pain medication than those less than 50 years of age. Age-related decline in the perception of noxious stimuli have been studied within the context of postoperative pain. This results of this study correlate with the current hypothesis that there is an increase in pain tolerance with increasing age, which would subsequently reduce the patient's analgesic demand [11]. Obese versus non-obese individuals did not have a differing response to opioid demand. The results showed that LB is equally effective in either BMI category. Although some studies have shown that patients with BMI > 30 are at risk for increased complications, LB is still an effective analgesic at controlling postoperative pain, and curbing opioid-related complications through a reduction in opioid requirements [12].

Our results mirrored those observed by Morales et al. [13] in a similarly designed retrospective review. That study looked at an all-female population (average BMI 27) following abdominoplasty and abdominoplasty with combined procedures, and reported that the use of LB decreased pain pill use and pain scores. However, this study was limited due to lack of a comparison group. To our knowledge, this study is the first to comparatively analyze the effectiveness of LB to the On-Q pump following abdominoplasty.

In recent years, there has been an upward trend in body contouring surgery after massive weight-loss, and it is anticipated that this relationship will continue to grow [14]. It is imperative that practices are well prepared to treat this patient population since MWL patients are inherently difficult surgical candidates. Uncontrolled postsurgical pain and opioid use can affect recovery time and lead to unwanted outcomes and opioid-related complications. The results of this study have shown that multimodal analgesia with LB is comparatively effective in MWL patients. In comparison with On-Q pump, LB promotes a more pleasant postoperative experience for the patient through a reduction in opioid requirements, and should be considered as a viable modality for plastic surgeons.

Limitations of this study included a small sample size and the retrospective nature of the data analyzed. The lack of a large sample size limited propensity matching, thus reducing the power of the study. Despite these limitations, the authors felt that this study gave an accurate and objective assessment of the comparative effectiveness of LB by focusing on quantifiable and objective data. The opioid requirements were converted to morphine equivalents and the pain scores were recorded consistently per PACU assessment, which minimizes any errors in patient self-reporting.

Cost and Hazard

LB is an expensive product that may not be available to all patients. Needless to say, the authors have shown that the use of this product is superior to the more expensive alternative, the bupivacaine pump. The OnQ pump is at risk for malfunction, accidental disruption, and disrupts patient comfort.

The liver metabolizes bupivacaine, thus LB must be used with caution with patients with hepatic disease [1,15]. In addition, other bupivacaine products should not be administered within 96 hours of injecting liposomal bupivacaine due to risk of toxicity. Multiple studies have shown detectable plasma levels of Exparel 72-96 hours postop [16,17]. Our study did not look at any long-term complications with the use of LB. This is an area of potential further research.

In the setting of abdominal body contouring in MWL patients, LB use could potentially decrease the need for elastomeric pumps and continuous catheters and their associated limitations with higher costs and inconvenience. A potential future direction for this study includes a formal cost-effective analysis of LB versus the On-Q system to further justify the use of one local anesthetic modality over the other. Although length of stay is commonly used as a factor in gauging health economic outcomes, the length in this study did not differ significantly between the two groups.

Conclusion

The results of our study indicated that Exparel could be utilized as an adjunct in postoperative analgesic care. LB appears to decrease opioid requirements in the first 48 hours postop more than the bupivacaine pump. LB was additionally shown to be non-inferior to bupivacaine pump at improving patient comfort based on pain score ratings in the postoperative period in MWL patients following abdominoplasty.

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