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Does liposomal bupivacaine reduce hospital length of stay for multilevel lumbar decompressions? A retrospective matched cohort study

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ABSTRACT

Objectives: Adequate post-operative pain control improves patient outcomes, leading to fewer analgesia-related complications and shorter length of hospital stay (LOS). Liposomal bupivacaine (LB) is a long-acting injectable anesthetic. This study evaluates the impact of local LB use on pain control outcomes (LOS, visual analog scale [VAS], narcotic usage, readmission, and complications) after multilevel spinal decompression surgery compared to matched cohorts without local LB.

Methods: A single-center retrospective cohort study matched by age, gender, body mass index (BMI), medical comorbidities, and previous use of opioids was done at our institute. Subjects were divided into two groups; one who had LB at the end of spine surgery and one without LB. Patients' demographics, number of operating levels, and outcomes parameters (LOS and VAS), number of pain medications used preoperatively, through the hospitalization and at discharge, complication rate, and readmission rate were collected.

Results: Eighty-six patients with spinal stenosis were included; 45 (52.3%) in the LB group and 41 (47.7%) in the non-LB group. The average age was 67.8 ± 10.5. Both groups were comparable in terms of BMI and medical comorbidities. There was no diffidence in pain killers consumption between the two groups, throughout hospitalization and at the discharge. Strong statistically significant difference with VAS score favoring LB use ($P < 0.001$). LOS was 15 h less in the LB group (32.4 ± 36.6 vs. 47.5 ± 39.1) ($P = 0.069$). The complication rate was 10.6%, with no difference between both groups ($P = 0.49$). Both groups had no readmissions or the emergency department visits for pain complaints. After excluding patients with complications, LOS was significantly shorter in the LB group ($P = 0.029$). In subgroup analysis for the LB group to look for the impact of the learning curve, the VAS score was less, and LOS was shorter in the second half of the included patients. However, the difference did not reach statistical significance.

Conclusion: LB, as local infiltration at the end of a multilevel lumbar decompression, is an effective tool to decrease post-operative pain and shorten hospital stay, especially in patient with no post-operative complications.

Keywords: Complications rate, Length of hospital stay, Liposomal bupivacaine, Multilevel lumbar decompressions, Post-operative pain

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INTRODUCTION

Post-operative pain control is an essential aspect of any surgical procedure, especially spine surgery. Adequate pain control improves patient outcomes through a smooth post-operative course, fewer inpatient complications, and shorter hospital stay, directly impacting patient satisfaction and hospitalization cost.[1,2] Post-operative pain management starts with the pre-operative protocol through patient education, set expectations, and some medications such as acetaminophen and gabapentin, intraoperative through local anesthetic injection and nerve blocks, and post-operative through opioids and non-opioids medications.[3] Liposome bupivacaine (LB) is an injectable suspension, long-acting local anesthetic, non-opiate pain killer used widely as an adjuvant, and less invasive tool to decrease post-operative pain.[4] It may also shorten hospital stay, narcotic usage, pain management-related complications, and readmissions.[1,2] There have been no studies on the use of LB as a method of post-operative pain control following multilevel spine surgery.

This study aimed to evaluate the impact of locally injected LB on the pain control outcomes; length of hospital stay (LOS), visual analog scale (VAS), narcotic usage, readmission, and complications following 2–4 levels of spinal decompression compared to matched cohorts without locally injected LB.

MATERIALS AND METHODS

A single-center retrospective cohort study matched by age, gender, body mass index (BMI), medical comorbidities, and previous use of opioids was done at Kaiser Permanente Oakland Medical Center after appropriate ethical approval. The subjects were divided into two groups: Group 1 was those who took LB as local infiltration at the end of spine surgery and Group 2 was those who did not have LB. All surgeries and the infiltration were performed by the same surgeon.

Data for patients demographics (age, gender, BMI, and medical comorbidities), number of operating levels, and outcomes parameters (LOS and VAS) before discharge. while in case of an outpatient procedure in which the patient is discharged directly from the post-anesthesia care unit without hospital admission, or on last day of admission in case of inpatient procedure, the number of pain medication used preoperatively, was collected throughout hospitalization and at discharge, as well as complications rate and readmission rate.

Our focus was multilevel spinal decompression surgery (2–4 levels), which was done using McCullough techniques.[5,6] McCullough decompression is a unilateral laminectomy and bilateral decompression, using unilateral exposure (around 2 cm for each level) and muscle retraction to minimize the iatrogenic injury to the muscle envelope and posterior tension band. Our technique was to use local infiltration of LB at the end of the procedure, 2/3 deep to the fascia, and 1/3 above the fascia and subcutaneously. Patients with the previous spine surgery, trauma, or tumors and patients who underwent fixation or fusion were excluded from the study.

All data were coded and analyzed using the Statistical Package for the Social Sciences program (version 19). Descriptive statistics such as mean, median, range, and standard deviation were used, and frequencies (%) with their corresponding 95% confidence intervals were calculated. Both qualitative and quantitative analyses are applied to investigate associations and differences. Student's *t*-test was used to compare numerical data, and a Chi-square test was applied for categorical data. Logistic regression analysis was applied to identify the significance between the groups – significance considered at $P \leq 0.05$.

RESULTS

There were 86 patients with spinal stenosis were included: Forty-five (52.3%) in the LB and 41 (47.7%) in the non-LB group. The average age was 67.8 ±10.5, and the LB group was slightly older, 65 (75.6%) were male and 21 (24.4%) were female. Both groups were comparable in terms of BMI and medical comorbidities [Table 1].

The average number of operated levels was 2.6 ± 0.6, and there were 41 (47.7%) in two levels decompressions, 37 (43%) in the three levels group, and only 8 (9.3%) in the four levels group. There was no statistically significant difference between the two groups in regard to the number of operated levels.

The LB group was taking less pain medication preoperatively compared to the non-LB group (0.6 ± 0.9 vs. 1.1 ± 0.9) with $P = 0.014$. There was no diffidence in pain medication consumption between the two groups, throughout hospitalization and at the discharge. with P=0.63 and 0.96, respectively [Table 2].

Strong statistically significant difference was found in the VAS pain score in favor of using LB $P < 0.001$. The average VAS in both groups was 1.6 ± 1.6 in the LB group compared to 3.1 ± 1.9 in the non-LB group. The hospital stay was 15 h shorter in the LB group (32.4 ± 36.6 vs. 47.5 ± 39.1 h) with a comparable value of a statistically non-significant, $P = 0.069$.

The complication rate was 10.6%, with no difference between the two groups, $P = 0.49$. The complications were reported in nine patients (six dural tears, one superficial wound infection, one UTI, and one brachial plexopathy).

Both groups had no readmissions or emergency department (ED) visits for pain complaints. However, after excluding the

Table 1: Patients demographic and comorbidities.

	Overall	LB group	Non-LB group	*P*-value
Number	86	45 (52.3%)	41 (47.7%)	
Age (mean+SD)	67.8±10.5	69.2±11.4	66.3±9.4	0.203
BMI	29.6±5.2	28.8±4.8	30.5±5.5	0.119
Gender				
Male	65 (75.6%)	33 (73.3%)	32 (78%)	0.62
Female	21 (24.4%)	12 (26.7%)	9 (22%)	
Average number of levels (mean+SD)	2.6±0.6	2.5±0.6	2.6±0.6	0.57
Number of operated levels				
Two	41 (47.7%)	23 (51.1%)	18 (43.9%)	0.79
Three	37 (43%)	18 (40%)	19 (46.3)	
Four	8 (9.3%)	4 (8.9%)	4 (9.8%)	
Comorbidities				
Diabetes mellitus	22 (25.6%)	13 (28.9%)	9 (22%)	0.62
COPD	3 (3.5%)	3 (6.7%)	0	0.24
Chronic kidney disease	8 (9.3%)	6 (13.3%)	2 (4.9%)	0.27
Coronary artery disease	29 (33.7%)	14 (31.1%)	15 (36.6%)	0.65
Antiplatelet usage	31 (27.9%)	18 (40%)	13 (31.7%)	0.50
Anticoagulation usage	11 (12.8%)	3 (6.7%)	8 (19.5%)	0.1
Atrial fibrillation	4 (4.7%)	3 (6.6%)	1 (2.5%)	0.61
Peripheral artery disease	7 (8.1%)	4 (8.9%)	3 (7.3%)	1
Cognitive dysfunction	1 (1.2%)	1 (2.2%)	0	1
Depression	18 (20.9%)	13 (28.9%)	5 (12.2%)	0.06
DVT/PE	1 (1.2%)	0	1 (2.4%)	0.47
Sleep apnea	11 (12.8%)	6 (13.3%)	5 (12.2%)	1
Stroke	4 (4.7%)	3 (6.7%)	1 (2.4%)	0.61
HOCM	1 (1.2%)	0	1 (2.4%)	0.47
Smoking	11 (12.8%)	5 (11.1%)	6 (14.6%)	0.75
Asthma	16 (18.6%)	6 (13.3%)	6 (14.6%)	1

*LB: Liposomal bupivacaine, Non-LB: Non-liposomal bupivacaine, BMI: Body mass index, COPD: Chronic obstructive pulmonary disease, DVT/PE: Deep venous thrombosis/pulmonary embolism, HOCM: Hypertrophic cardiomyopathy

Table 2: Outcomes: VAS, LOS, complications rate, and readmission rate.

	Overall	LB group	Non-LB group	*P*-value
VAS	2.3±1.9	1.6±1.6	3.1±1.9	**<0.001**
LOS	39.6±38.3	32.4±36.6	47.5±39.1	0.069
Number of pain medications				
Pre-operative	0.9±0.9	0.6±0.9	1.1±0.9	0.014
During hospital stay	2.1±1.5	2±1.7	2.2±1.1	0.63
Discharge	1.3±0.5	1.3±0.6	1.3±0.5	0.96
Complications rate	9 (10.6%)	6 (13.3%)	3 (7.5%)	0.49
Readmission	0	0	0	

LB: Liposomal bupivacaine, Non-LB: Non-liposomal bupivacaine, LOS: Length of stay, VAS: Visualized analog score, *P* value of <0.05 was statistically significant value

patients with complications that required more extended hospitalization for non-pain-related reasons, the hospital stay was significantly shorter in the LB group (26.7 ± 32.5 vs. 41.1 ± 23 h) with $P = 0.029$.

In subgroup analysis for the LB group to look for the impact of the learning curve, there was no difference in VAS pain score between the first half of the cases and the second half (1.7 ± 1.7 vs. 1.4 ± 1.5), $P = 0.67$. Similarly, there was no difference in the hospital stay between the early and late included patients (35.2 ± 38 vs. 29.7 ±35.8), $P = 0.62$.

DISCUSSION

Post-operative chronic back pain in patients undergoing spine surgery is challenging to control. In the early 1980s, Woolf hypothesized a mechanism by which a tissue injury

will lead to post-injury pain hypersensitivity. He concluded that a preemptive of this mechanism could limit this pain.[7]

Although pain is an expected part of the post-operative course following any surgery, inadequate pain control is associated with adverse outcomes such as lower patient satisfaction; slower functional recovery, and more extended hospital stay with higher readmission rates, as well as postoperative pain might reduce post-operative mobility, leading to increased morbidities and mortalities.[8-10] Conversely, when adequate post-operative pain control is obtained in the early course, it allows faster mobilization, earlier transition to oral pain medications, decreased hospitalization length, and lower overall hospital cost.[11]

In our study, we found that with the local injection of LB, patients had an enormously significantly lower VAS score even though patients with LB injection had significantly less pain medication in the pre-operative period, which might be contributed to the severity of the disease in different patients. Still, postoperatively, there was no difference in the overall pain medication consumption between the two groups, and none of the groups had readmissions or visited the ED due to pain. Some authors have reported similar results regarding the improvement in the VAS and pain score.[3,12] On the other hand, some studies have shown no significant difference in the VAS score when comparing the control group to patients receiving local Exparel (bupivacaine liposome) infiltration.[11,13,14]

Kim *et al.* demonstrated that pain score and total narcotic consumption were significantly lower in the first post-operative 24 h, while there was no significant difference following the 1st day.[12] Furthermore, Brusko *et al.* have demonstrated significantly lower pain scores following surgery in patients who received LB infiltration and a significant reduction in the post-operative total narcotic consumption.[15] When this was studied in the pediatrics population, Cloyd *et al.* could not find any significant difference between them, which was attributed to the effective post-operative pain control by the treating physician.[13]

When we compared the total LOS between the two groups, there was a shorter hospitalization for patients who received LB, which may affect the overall hospital cost. Similar results were shown in other studies.[11,12,15,16] Wang and Grossman, in their ERAS study, showed reductions in the LOS from 3.9 days to 1.29 days in 44 patients with an average savings of $3444, and this contributed to 22% of the cost saving for the hospital. Furthermore, Kim *et al.* reported a mean savings of $590 per procedure using LB, and in their cohort of 74 patients, and the hospital saved $32,182.[16,17] On the other hand, other studies did not show any significant difference between the two groups regarding the LOS.[14,18] In spine surgery literature, Grieff *et al.* did not recommend LB as a pain management tool in mixed cervical and lumbar decompression cases. Puffer *et al.* reported the same finding for a single lumbar decompression. However, they advise using it in more complex cases and larger incisions.[11,18]

Not only LB is used in spine surgery but it has also shown good results with a significant reduction of post-operative pain and the need for higher doses of post-operative analgesia in other orthopedic specialties and other surgical fields. Reuben *et al.* studied the LB analgesia's effect in arthroscopic knee surgery. He found that patients who received pre-operative administration of intra-articular morphine with bupivacaine showed significantly better post-operative pain control when compared with patients who received the drug at the end of the surgery.[19] Mahfouz and Nabawi and Kristin *et al.* have studied the effect of pre-operative local anesthesia infiltration when conducting eye surgery. Both reported superior results in post-operative pain reduction and the need for analgesia when compared with patients not receiving local infiltration.[20,21] Pasqualucci *et al.* studied the LB analgesia effect with a patient undergoing laparoscopic cholecystectomy and reported superior results compared to the control group.[22] Vyas *et al.* proved its efficacy in plastic and reconstructive surgery. They suggested that it may work as an alternative to more invasive post-operative pain control, such as epidurals and blocks.[23] Conversely, Kuang *et al.*'s meta-analysis found that the LB is insufficient and costly compared to other pain control modalities in total knee replacement patients.[24]

The limitations of this study include the retrospective nature of the study, small sample size, and involvement of a single center.

CONCLUSION

LB, as local infiltration at the end of multilevel lumbar decompression, is an effective tool to decrease post-operative pain and shorten hospital stay, especially in patients with no post-operative complications.

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AUTHORS' CONTRIBUTIONS

AA: Investigation, data collection, and writing – original draft and editing. HB: Investigation, data collection, and writing – original draft. AO: Investigation and writing – original draft, and editing, CK: Investigation, project administration, and writing and editing. RSB: Investigation, supervision, project administration, writing – original draft, and editing. All authors have critically reviewed and approved the final draft and are responsible for the manuscript's content and similarity index.

ETHICAL APPROVAL

Approval from the Institutional Review Board at Kaiser Permanente Oakland Medical Center was obtained on the March 3, 2021, with approval number 1674191-1.

DECLARATION OF PATIENT CONSENT

The authors certify that they have obtained all appropriate patients consent forms. In the form, the patients have given their consent for their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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CONFLICTS OF INTEREST

There are no conflicting relationships or activities.

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