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Dexamethasone as an Adjuvant to Bupivacaine in Ultrasound-Guided Caudal Epidural Block in Lumbar Spine Decompression and Fusion Surgery

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Abstract

Background: **Postoperative pain control is a challenging issue that greatly affects the patient outcome and satisfaction. Adding dexamethasone to bupivacaine for nerve block has been shown to improve nerve block and achieve better analgesia. *Aim* The current study is designed aiming to evaluate and compare the preemptive analgesic effect and duration of postoperative analgesia of caudal bupivacaine versus dexamethasone as an adjuvant in single-level lumbar decompression and instrumented posterolateral intertransverse spinal fusion. *Patients and Methods:* The study included 60 patients undergoing elective lumbar spine decompression and fusion, randomly assigned to receive either bupivacaine alone or bupivacaine with dexamethasone via ultrasound-guided caudal epidural block under general anesthesia. Outcomes assessed included intraoperative hemodynamics, fentanyl use, timing of first analgesia request, postoperative pain (VAS at rest and movement), patient satisfaction, and complications. The primary endpoint was total postoperative morphine consumption. *Results:* Both groups were matched regarding age and sex. Patients of caudal dexamethasone showed lower mean postoperative VAS starting from 6 hours postoperative till 24 hours postoperative. By the end of follow up mean VAS was 4.57 among group I patients and 3.67 among group II patients with movement and 4.07 and 3.23 at rest among both groups respectively. Group II patients also have lower postoperative total dose of morphine among group II patients (mean total dose of 1 mg) compared to group II patients who reported mean total dose of 4.13 mg of morphine with p-value < 0.001. Patient satisfaction and adverse effects were insignificantly different among both groups. *Conclusion:* Preemptive caudal administration of bupivacaine with dexamethasone during lumbar decompression and fusion surgery prolongs postoperative pain relief, reduces intra- and postoperative analgesic needs, and promotes earlier ambulation, without causing hemodynamic instability or additional adverse effects compared to bupivacaine alone.**

Keywords: pain control, protective anaglesia, caudal epidural, nerve block, corticosteroids.

Introduction

Up till now, post-operative pain is still a challenging issue for anesthesiologists and surgeons despite all advancement in pain control approaches [(1)]. One of pain control approaches is to start analgesia before the onset of pain-inducing procedure which is known as "preemptive analgesia". In Preemptive analgesia, analgesics are initiated before the start of the surgery, so and due to this protective approach, the immediate

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postoperative pain is more likely to be reduced and controlled [2].

Caudal epidural block is a common technique used for anesthesia in children and chronic pain management in adults and when combined with general anesthesia it has been found to reduce intraoperative anesthetic or opioid consumption. Ultrasound (US)-guided blocks reduce the dependency on anatomic references, help in the precise placement of drugs around the nerves and follow the real-time spread. The blocks are more effective, require fewer anaesthetic drugs and are safer [3].

Bupivacaine, a potent local anesthetic belongs to the amid group that is used in regional, epidural, spinal and local infiltration anesthesia. Bupivacaine as well as other local anesthetics are being used in nerve block. However, bupivacaine is characterized by longer block time with higher quality which made bupivacaine the most widely used local anesthetics [4, 5]. Since its introduction, various adjuvants have been linked to bupivacaine for various objectives as longer anesthetic time, better anesthetic intensity, and prolonged analgesic effect [6].

Various studies have shown the benefits of adding corticosteroids to local anesthetics in terms of longer nerve block and better analgesic effects. Dexamethasone is a synthetic corticosteroid with anti-inflammatory, analgesic, immunosuppressive, and antiemetic properties. It was one of the adjuvants that have been added to bupivacaine and was found to significantly prolong motor block and was associated with better postoperative pain control with avoiding the undesired effects of epidural opioid. The analgesic effect of dexamethasone is thought to be due to blocking nerve fibers of group C, a feature is enhanced by its anti-inflammatory effect [7, 8].

In this study, we aimed to evaluate and compare the preemptive analgesic effect and duration of postoperative analgesia of caudal bupivacaine versus dexamethasone as an adjuvant in single-level lumbar decompression and instrumented posterolateral intertransverse spinal fusion.

Patients and Methods:

The study has been declared ethically approved by the ethics committee of Suez Canal University-Faculty of Medicine. We designed the current study as randomized clinical trial at the elective surgery theater of Suez Canal University Hospital and Ismailia Medical Complex Hospital among a total of 60 patients scheduled for elective lumbar single-level decompression and fusion surgery in 2023. We have included patients aged 30 – 60 years of either sex, with American Society of Anesthesiology (ASA) physical status score of I and II. Any patient requiring emergency procedure, have infection or skin lesion at puncture site, have bleeding disorders, allergic to local anesthetics or were receiving oral opioids in the preoperative period were excluded from the study.

The recruited patients were randomly allocated to one of two study groups. Group I (the Bupivacaine group) included 30 patients who received caudal epidural block with Bupivacaine alone and group II (Adjuvant Dexamethasone group) that included 30 patients who

received caudal epidural block with Bupivacaine and adjuvant dexamethasone.

Methods of the study:

Preoperative preparation and assessment:

An informed written consent was obtained from all patients with full explanation of the technique. Routine preoperative evaluation was done for all the studied patients according to the standardized institutional protocols including complete medical history, thorough clinical examination and detailed assessment of airway and examination of puncture site for any lesion or skin infection. Patients were asked to fast 2 hours after last fluid intake and 8 hours after the last food intake before the time of surgery.

Anesthesia:

General anesthesia was performed for all patients in both groups using standardized institutional protocols with standard electrocardiogram (ECG), oxygen saturation, neuromuscular and capnography monitoring. Basal hemodynamic readings were recorded (heart rate, blood pressure including mean arterial pressure). Patients were pre-oxygenated with 100% oxygen for 3 minutes. Then, anesthesia was induced by 1 ug/kg fentanyl, 2-3 mg/kg propofol, and cisatracurium (0.15 mg/kg). After confirming intubation by viewing three successive waves on capnography, the patients were ventilated with a mixture of 40% oxygen in air and 0.5 – 1.5% isoflurane and cisatracurium were given at a dose 0.03 mg/kg for maintenance. Patients were placed in the prone position on a Relton Hall frame or padded bolsters. Heart rate, blood pressure (systolic and diastolic), and mean arterial blood pressure were monitored intraoperatively and recorded every 15 minutes.

Caudal epidural block

We used an ultrasound machine, SonoSite M-turbo® with a high-frequency linear array probe (6–13 MHz). The probe was placed transversely over the coccyx and moved cranially to identify sacral cornu which appeared as a"frog eye sign" and hyperechoic sacrococcygeal ligament as "the hump". After that, the probe was rotated 90 degrees to get a longitudinal view of the caudal space, then placed between the two cornu. A 5-cm short-beveled 22 G needle was inserted at a 45-degree angle cephalad in the longitudinal plane. After locating the caudal space, aspiration for blood and CSF was performed, and if negative, 20 ml of 0.25% bupivacaine alone (group I) or 18ml of 0.25% bupivacaine in combination with 8 mg dexamethasone (group II) was injected under real live visualization. During injection, the distension of the sacral canal in transverse and longitudinal views further confirm the accurate placement of the needle [9].

Intraoperative monitoring and management:

According to clinical and hemodynamic monitoring, if any signs of inadequate analgesia – which were defined as an increase in heart rate (HR) and mean arterial blood pressure (MABP) > 20% from the baseline – a dose of 1ug /kg of fentanyl was administered as a top-up dose. Any drop of MABP more than 20% of MABP from baseline, the patients were treated with

intravenous infusion of 500 ml normal saline and 5 mg ephedrine was added if there was no response. Atropine 0.5mg was given if heart rate dropped to 45 beat/min. Intraoperative blood loss and duration of surgery (skin incision to skin closure) was recorded as well.

Any residual muscle paralysis at the end of the surgery was recorded and was reversed by a mixture of 0.01 mg/kg atropine and 0.05 mg/kg neostigmine. All patients received 1 gm paracetamol and 75 mg diclofenac as part of a multimodal analgesic approach.

Postoperative assessment and management:

Full recovery was reported at scores of 9 – 10 of Modified Aldrete score. Directly after full recovery, immediate postoperative pain was recorded then at 1, 2, 4, 6, 12, and 24 postoperative hours using numeric visual analogue scale (VAS) from 0 to 10 with 0 indicated no pain and 10 indicated severe pain. Secondary outcome measures included time to the first post-operative analgesic request that was defined as the time when the VAS is perceived by the patient to be 4 or more and at that time the patient was administered morphine according to body weight with a dose of 0.05 mg/kg. The total dose of morphine consumption was recorded over the 1st 24 hours. Postoperative patient satisfaction score graded as excellent, good, fair, or poor) and timing of first mobilization of each group was recorded too. Postoperative side effects as nausea, vomiting and itching were recorded and treated. Nausea was treated with 10 mg metoclopramide i.v, vomiting was treated by 4 mg Ondansatron intravenously while itching was treated with pheniramine maleate (45.5 mg/2 ml).

statistical analysis,

Data were processed and evaluated using the SPSS statistical software Version 20. Quantitative data were presented as mean ± SD, while qualitative data were represented as numbers and percentages. Unpaired t-tests were applied to compare different groups while paired one-way analysis of variance (ANOVA) test with Repeated Measures was used to analyze the continuous variables among the follow-up points within the same group. Statistically significant differences among the different readings were assessed usding Fisher's least significant differences (LSD) post hoc analysis. Chi-square and Fisher's exact tests were employed for qualitative variables. A p-value of <0.05 was deemed statistically significant.

Results:

Both groups were matched as regard age, sex and ASA class. Mean age was 50.7 years among group I patients and 47.3 years among group II. Majority of the patients studied were ASA class I (93.3%). Slightly more than half of group I patients were females (66.7%) while about half of group II patients were males (53.3%) without statistically significant difference **(Table 1)**.

As presented in **Figure 1**, there was no clinical or statistically significant change in systolic BP (Figure 1a), diastolic BP (Figure 1b), heart rate (Figure 1c) and mean arterial pressure (Figure 1d). Comparing both groups showed no statistically significant difference across different follow up time points**.**

Table 1: Baseline characteristics among both groups:				
Characteristics		Group I (n=30)	Group II (n=30)	p-value
Age	Mean ± SD	50.7 ±7.7	47.3 ± 9.5	0.1 (NS) [a]
Sex	Male	10 (33.3%)	16 (53.3%)	0.2 (NS) [b]
	Female	20 (66.7%)	14 (46.7%)	
ASA class	ASA I	28 (93.3%)	28 (93.3%)	1 (NS) [c]
	ASA II	2(6.7%)	2(6.7%)	
ASA: American Society of Anesthesiology *NS: not statistically significant* *[a]: Unpaired t-test, [b]: Chi square test, [c]: Fisher's exact test*				

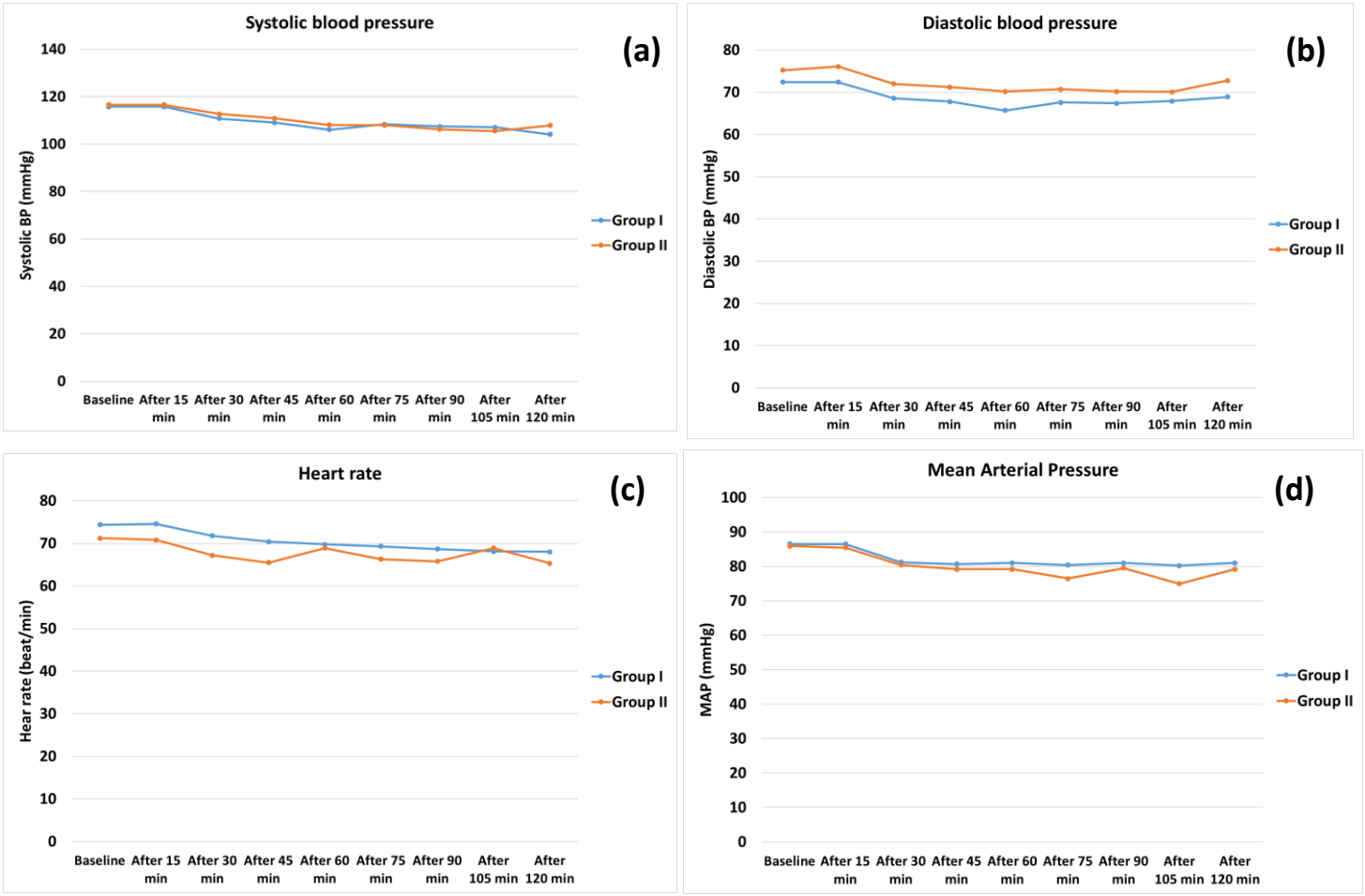

Figure 1: Serial measures of intraoperative hemodynamic parameters changes among both groups
BP: blood pressure, MAP: mean arterial pressure, min: minutes

Pain as evaluated by visual analogue score was significantly lower among group II patients whether at rest or with movement starting from 6 hours postoperative till 24 hours postoperative, while before that point pain was insignificantly different among both groups. By the end of follow up mean VAS was 4.57 among group I patients and 3.67

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among group II patients with movement and 4.07 and 3.23 at rest among both groups respectively with statistically significant difference between both groups at both conditions **(Table 2)**.

Table 2: postoperative pain (by visual analogue score) among both groups:

	Timing	Group I (n=30)	Group II (n=30)	P-value
VAS At Rest	2 hours post-op	1.1±0.31	1.1±0.31	1.00 (NS)[a]
	4 hours post-op	1.2±0.41	1.2±0.41	1.00(NS)[a]
	6 hours post-op	1.63 ±0.49	1.2±0.41	<0.001*[a]
	12 hours post-op	2.1±0.4	1.13±0.35	<0.001*[a]
	24 hours post-op	4.07±0.37	3.23±0.5	<0.001*[a]
	P-value	<0.001*[b]	0.009*[b]	
VAS At Movement	2 hours post-op	1.1±0.31	1.1±0.31	1.00(NS)[a]
	4 hours post-op	1.2±0.41	1.2±0.41	1.00(NS)[a]
	6 hours post-op	1.63 ±0.49	1.2±0.41	<0.001*[a]
	12 hours post-op	2.37±0.56	1.47±0.51	<0.001*[a]
	24 hours post-op	4.57±0.94	3.67±0.88	<0.001*[a]
	P-value	<0.001*[b]	0.007*[b]	

Postop: Postoperative, VAS: visual analogue score
[a]: unpaired test, [b]: One-way analysis of variance
**Statistically significant difference between both groups*
***Statically significant difference between serial measures*

It was found that mean time to the first request of postoperative analgesia was significantly delayed among group II patients (346 minutes ± 23.7 versus 702 minutes ± 28; p-value < 0.001). This delayed request of analgesia was associated with lower postoperative total dose of morphine among group II patients (mean total dose of 1 mg) compared to group II patients who reported mean total dose of 4.13 mg of morphine with p-value < 0.001. Also, patients of group II have shown earlier ambulation compared to group I patients with statistically significant difference.

Adding dexamethasone to bupivacaine among for group II patients have resulted in lower intraoperative fentanyl consumption (123.3 mcg versus 136 mcg; p-value = 0.03) meanwhile the duration of surgery was insignificantly different among both groups.

Most of the patients studied in both groups (70% in group I and 83.3% if group II) have reported excellent satisfaction (p-value = 0.22). Only one patient of group II has reported minor side effects (postoperative nausea) without statistically significant difference **(Table 3)**.

Table 3: Outcome measures among patients of both groups:				
		Group I (n=30)	Group II (n=30)	P-value
Time to 1st rescue analgesic (minutes)		346 ± 23.7	702 ± 28	<0.001*[a]
Total Post-operative Analgesic Requirement of Morphine (mg)		4.13 ± 2.5	1 ± 2.03	<0.001*[a]
Time to ambulate (hours)		7.7 ± 0.46	6.07 ± 0.52	<0.001*[a]
Total intraoperative fentanyl consumption (mcg)		136.7 ± 22.5	123.3 ± 25.4	0.03*[a]
Duration of surgery		136.2 ± 10.4	133.3 ± 9.2	0.3 (NS)[a]
Patient satisfaction	Good	9(30%)	5(16.7%)	0.22 (NS)[b]
	Excellent	21(70%)	25(83.3%)	
Any complications		0 (0%)	1 (3.3%)	1 (NS)[c]

NS: not statistically significant
[a]: Unpaired t-test, [b]: Chi square test, [c]: Fisher's exact test
Statistically significant difference

Discussion:

Management of postoperative pain in lumbar spine surgery often requires multimodal approach due to the multifactorial nature of pain and the great impact on surgery outcome and patient recovery, early ambulation and satisfaction. Preemptive analgesia offers a great change to start control pain before its onset and even before the initiation of pain-inducing procedure. Although US-guided caudal epidural block is a well-established technique that offers an approach for preemptive analgesia, the choice of adjuvant to improve pain control and potentiate the analgesic effect of caudal epidural block is still controversial [(10)].

The current study was designed aiming to explore the difference between the analgesic effect of the preemptive analgesic using plain bupivacaine or adjuvant dexamethasone when administered through an ultrasound-guided caudal epidural block in patients undergoing elective lumbar spine decompression and fusion surgery.

Both bupivacaine and dexamethasone have potential role in postoperative analgesia as bupivacaine causes regional sensory blockade through inhibition of nerve conduction while dexamethasone causes pain control via its anti-inflammatory properties. Comparing these agents can help us to explore potential differences in their ability to achieve preemptive analgesia thus provide further evidence to select optimal approach and agent to enhance postoperative pain control.

The current study has shown that US-guided caudal epidural block using bupivacaine with adjuvant dexamethasone is superior to bupivacaine alone in terms of postoperative pain at rest and movement, time to first request of postoperative analgesia, total postoperative morphine consumption and total intraoperative fentanyl consumption. This superiority in pain control was

associated without significant adverse events.

Various previous studies have consistently reported delayed first request of postoperative analgesia with caudal dexamethasone [11 – 14]. In our study, pain perception as measured by VAS started to be significantly lower among caudal dexamethasone group starting at 6 hours postoperative till the end of follow up period (24 hours postoperatively). This is consistent with Srinivasan et al, [15] who also have similarly reported lower postoperative analgesic consumption in caudal dexamethasone. However, the later study has combined caudal dexamethasone with intravenous dexamethasone and was compared to ropivacaine [15] which is nearly identical to bupivacaine used in our study.

Similar findings were also reported in different types of surgery. Elyazed et al., [16] and Jo et al., [17] have also reported the superior analgesic effect of caudal and epidural dexamethasone in hip replacement surgery [16] and radical subtotal gastrectomy [17] respectively.

The current study has shown faster ambulation among patients who received caudal dexamethasone that is consistent with Mohamed et al., [18]. They have found that caudal 0.1mg/kg of dexamethasone can significantly prolong postoperative analgesic effect leading to faster recovery [18].

The main limitation of the current study is the small sample size and the short duration of postoperative follow up. However, the current study has succeeded in adding evidence supporting the use of caudal epidural block as an effective route for preemptive analgesia for lumbosacral spine surgeries. Addition of dexamethasone enhance the analgesic effect of this approach and is associated with better pain control, and less intra and postoperative analgesic consumption which has subsequently resulted in earlier patient recovery and ambulation.

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