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A comparison of bupivacaine alone vs bupivacaine with dexamethasone for post-operative analgesia from an erector spinae plane block following thoracotomy

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ABSTRACT

Objective: is to assess the relative effectiveness of bupivacaine alone and bupivacaine with dexamethasone in Ultrasound-Guided Erector Spinae Plane (USG ESP) block for post-thoracotomy pain relief.

Methods: Randomized Control Trial (RCT) was conducted at department of Anesthesiology & Intensive Care, Sheikh Zayed Medical College/Hospital Rahim Yar Khan, from 04-03-2022 to 04-08-2022. A total of thirty participants were recruited and divided equally into two groups, Group "A" and Group "B". At the conclusion of the surgery, ESP Block was administered under general anesthesia. In group "A" an injection of Bupivacaine was used while in group "B", dexamethasone was added to bupivacaine. The pain was recorded as Visual Analogue Scale (VAS) at the 1, 6, 12, 24 & 36th Hours.

Results: In our study, we discovered that the combination of dexamethasone and bupivacaine in USG ESP Block not only improves the quality of analgesia, but also extends its duration.

Conclusion: Addition of dexamethasone to bupivacaine in USG ESP Block not only improves the quality of analgesia, but also increases the length of analgesia following thoracotomy.

Keywords: Analgesia, Bupivacaine, Dexamethasone, Erector Spinae Plane Block, Post-thoracotomy pain.

1. INTRODUCTION

Post-thoracotomy pain is a serious concern both for the anesthetist and surgeon as well as for the patients, and if not effectively relieved may cause serious complications; atelectasis, pneumonia, and prolonged mechanical ventilation, leading to an extended hospital stay, increased morbidity, and even death.^{1,2,3,4} Overall post-thoracotomy complications incidence varies between 15%-37.5%.³ Different regional techniques are being used to provide effective analgesia; including intercostal nerve block, paravertebral block, thoracic epidural, and USG ESP block.^{1,2,5,6}

In 2016, a novel regional anesthetic technique called the erector spinae plane block was used for the first time to provide relief from thoracic neuropathic pain associated with metastasis in the ribs, and it was conducted using ultrasound guidance.^{1,6,7,8} Multiple reasons make ESP block superior to other regional techniques. It is easier to perform when compared with thoracic epidural and paravertebral blocks. Moreover, ultrasound-guided erector spinae plane (ESP) block is associated with much lower risks of spinal cord damage, nerve damage, and pneumothorax compared to other techniques,^{9,10} because the injection is given under ultrasound guidance directly visualizing the needle movement and injection spread, moreover site of injection is away from pleura, spinal cord, nerves, and major blood vessels.⁹ Erector spinae plane extends from the nuchal fascia in the neck above to the sacrum below.^{7,10} Local anesthetic injected into the erector spinae plane creates an analgesic effect across the anterior, posterior, and lateral thoracic walls at multiple dermatomal levels.^{5,9,10} This is achieved by the diffusion of the local anesthetic into the paravertebral spaces, blocking the ventral and dorsal rami of thoracic spinal nerves as well as the rami

communicants that supply the sympathetic chain.^{1,5,8,9}

A literature review revealed that the use of a single dose of a local anesthetic in a peripheral nerve block can provide short-term analgesia, with bupivacaine typically lasting between 4 to 12 hours.^{11,12,14} Although, catheter placement provides continuous analgesia in the peri-operative period it is also associated with certain hazards like catheter blockage, catheter dislodgement, infection, neurological complications, and risk of local anesthetic systemic toxicity (LAST).^{12,13} In peripheral nerve blocks, various adjuvants have been used with local anaesthetic to enhance the duration of analgesia. These include opioids, clonidine, epinephrine, ketamine, dexmedetomidine, magnesium, midazolam, and dexamethasone.^{12,14,15,16} Review of different Studies showed that dexamethasone has been successfully used with local anesthetic in upper and lower extremity peripheral nerve block,^{12,14,15,16} but its use in erector spinae plane block to assess the enhancement of quality as well as the duration of analgesia for post-thoracotomy pain has not been researched so far.

Hence, in our study, we used dexamethasone with bupivacaine in an ultrasound-guided ESP block to prolong the duration of analgesia after thoracotomy.

2. METHODOLOGY

The Sheikh Zayed Medical College/Hospital institutional review board approved our Randomized Control Trial (RCT), with a reference number of 407/IRB/SZMC/SZH; dated:10-02-2022. After receiving informed consent from 30 patients aged between 18-60 years, with American Society of Anesthesiologist (ASA) physical status I-III, who were scheduled for unilateral elective thoracotomy were enrolled in our study. The study was conducted from 04-03-2022 to 04-08-2022. The trial was also

registered on clinical trial.Gov and was assigned an NCT number NCT05277974. Patients with infection at the site of injection; diabetes mellitus; peptic ulcer disease; hypersensitivity to local anesthetic or dexamethasone; coagulation disorders; pregnant females; patients with psychiatric illness; morbid obesity ($BMI \geq 40kg$) and patients with clinically significant cardiovascular, hepatic or renal diseases were excluded from the study. Both the anesthetist and surgeon were having more than 10 years of experience.

Patients were randomized into two groups, each containing 15 participants, using a lottery system. Group A participants were administered a combination of 29ml 0.25% bupivacaine and 1ml of normal saline, while Group B members were administered a combination of 29ml 0.25% bupivacaine and 1ml of 4mg dexamethasone at the conclusion of the procedure under general anaesthesia.

From the previous study results, Qiang Wang et al mean \pm SD of pain score (3.2 ± 1.4 ; 4.8 ± 1.5) were taken for two groups. Keeping the confidence interval 95% and power 80%, a sample size of 26 was calculated. We rounded off the sample size to 30 patients with 15 patients in each group.

The quality of analgesia was evaluated using Visual Analogue Scale (VAS) pain score both at rest and during coughing. The score was determined by measuring the distance on a 10cm line with "0" indicating no pain and "10" indicating the worst pain. VAS pain scores were assessed at 1, 6, 12, 24, and 36th hours. Injection ketorolac 30mg was given as a first-line rescue analgesia when VAS pain score ≥ 4 . And if after the injection of Ketorolac 30mg, the patient was still having a VAS pain score ≥ 4 , then an injection of Nalbuphine 0.1mg/kg was given as second-line rescue analgesia.

The period of analgesia was determined based on time when the initial rescue analgesia was administered. Patients

were also assessed for any episode of nausea and vomiting, total opioid consumption, and hemodynamic instability in the post-op period.

On the day of surgery, the patient received in the operation theatre room standard ASA monitoring attached i.e. NIBP, ECG, SPO₂, and EtCO₂. Induction of anesthesia was done with an injection of nalbuphine, propofol, and atracurium (at standard doses). Maintenance of anesthesia was achieved using controlled mechanical ventilation with oxygen and nitrous oxide (50:50) and isoflurane 1.2MAC. EtCO₂ was maintained at 35-40 mmHg. Injection Ketorolac 30mg was also given intra-operatively. As the procedure finished, the patient pruned to perform the ESP Block. GE logiq 200md pro series ultrasound machine with 3.5-7.5 MHZ probes were used to perform the block. A linear probe with 7.5 MHZ frequency was used to perform ESP Block. T5 spinous process was identified by palpating caudally from the prominent C7 spinous process. In a longitudinal orientation, the linear probe was positioned 3.0cm laterally to the T5 spinous process. The transverse process was recognized as a hyperechoic shadow beneath the three muscle layers of Erector spinae, Rhomboids major, and Trapezius. In a caudal-to-cephalad direction, a 22-gauge block needle was inserted until its tip touched the transverse process. The needle was then slightly withdrawn and correct needle placement was confirmed by injecting 2-3ml of saline and visualizing the spread under the Erector spinae muscle layer. After confirmation, Group "A" received 29ml of 0.25% bupivacaine with 1ml of normal saline, while group "B" received 29ml of 0.25% bupivacaine with 1ml of 4mg dexamethasone. After performing the block patient was placed in the supine position and extubated. Subsequently, the patient was transferred to the Post Anesthesia Care Unit

(PACU), and then, after an hour, to the general ward. VAS pain score was noted at five different time intervals (1st, 6th, 12th, 24th, and 36th hours) at rest and during coughing. Any episode of nausea and vomiting and hemodynamic instability was also noted in addition to the VAS pain score.

Data from 30 patients were entered in SPSS version 21. Mean ± SD was taken for age, VAS, and VASC. Using an Independent "T" test, the difference in age, VAS, and VASC between two groups (A and B) was determined.

Percentage and frequencies were taken for qualitative variables. The Chi-square was employed to compare how significantly two groups varied from one another (A&B) regarding gender, the severity of pain, and time for rescue analgesia.

3. RESULTS

As per analysis, out of 30 patients' mean ± SD age was 32±12 years, 43.3% (13) were females and 56.7% (17) were males. In group "A" there were 60% (9) males and 40% (6) females, while in group "B" 53.3% (8) were males and 46.7% (7) were female patients. This difference was statistically insignificant (P=0.713).

As per table No. 1, the pain was found to be moderate in 86.7% (13) patients in group "A", while in group "B" only 6.7% (1) patients has moderate pain at the 12th hour. This was a statistically significant difference (P≤0.01). While at the 24th hour, pain severity was almost equal in patients in the group "A" versus group "B" (11% v/s 10%) with P=0.884, which is statistically insignificant.

As per table No.2, in group "A" mean ± SD VAS was 0.133±0.516 versus "0" VAS in group "B" at the 6th hour, which shows an early onset of pain in the group "A", though it was statistically insignificant (P=0.334).

Table No.2 shows that at the 12th hour, in group "B" out of 15 patients, two patients felt pain, one mild and the other moderate pain with mean ± SD VAS 0.4±1.12 v/s 3.4±1.4 VAS in the group "A" (with P≤0.01), which indicates more severity of pain in the group "A".

The rescue analgesia requirement was more in group "A" (Table No.1) due to the early onset of pain with a higher VAS, as compared to group "B".

The foregoing data not only demonstrates that group "B" experienced greater quality analgesia, but also that it experienced longer duration analgesia compared to group "A". No complications were noted in both groups (nausea, vomiting, and any hemodynamic instability).

Table No. 1: Severity of Pain & Rescue Analgesia

Time	Group	Severity of Pain		P-Value	Rescue Analgesia n (%)	P-Value
		Mild n (%)	Moderate n (%)			
6 th Hour	A	1 (6.7%)	0	0.309	0	0.001
	B	0	0		0	
12 th Hour	A	0	13 (86.7%)	0.001	13 (86.7%)	0.001
	B	1 (6.7%)	1 (6.7%)		1 (6.7%)	
24 th Hour	A	2 (13.3%)	11 (73.3%)	0.884	2 (13.3%)	0.884
	B	2 (13.3%)	10 (66.7%)		10 (66.7%)	
36 th Hour	A	1 (6.7%)	14 (93.3%)	0.368	0	0.368
	B	0	14 (93.3%)		4 (26.7%)	

Table No. 2: Visual Analog Score (VAS) at rest and During Cough(VASC)

VAS	Drug Groups	Mean	Std. Deviation	95% Confidence Interval of the Difference		P-Value
				Lower	Upper	
				VAS 6	A	
B	.0000	.00000	-.15264	.41930		
VAS 12	A	3.4667	1.40746	2.11493	4.01840	0.000
B	.4000	1.12122	2.11279	4.02055		

VAS 24	A	3.2000	1.47358	-.91034	1.44367	0.646
	B	2.9333	1.66762	-.91114	1.44447	
VAS 36	A	4.0000	.75593	-.61107	.87774	0.717
	B	3.8667	1.18723	-.61712	.88378	
VASC 6	A	.1333	.51640	-.13979	.40654	0.334
	B	.0000	.00000	-.15264	.41930	
VASC 12	A	3.4667	1.40746	2.11493	4.01840	0.000
	B	.4000	1.12122	2.11279	4.02055	
VASC 24	A	3.3333	1.23443	-	1.00616	1.000
	B	3.3333	1.44749	-	1.00729	
VASC 36	A	4.1333	1.18723	-.79292	.79292	1.000
	B	4.1333	.91548	-.79524	.79524	

4. DISCUSSION

ESP is a novel regional technique recently launched in 2016.^{1,3,6} In ESP Block, research has demonstrated that an injection of local anaesthetic at the T5 level spreads in both craniocaudal directions between T3-L2.^{1,5} Therefore, we use USG ESP Block to provide post-op analgesia after thoracotomy, and we added dexamethasone to achieve superior quality and prolong the duration of analgesia and our study results confirmed that. The mechanism through which corticosteroids extend the duration of analgesia remains obscure. One theory is that the steroid-induced local vasoconstricting effect decreases Local anesthetic absorption. But a more appealing theory says that dexamethasone acts on nociceptive c-fibers and enhances the activity of inhibitory K⁺ channels.¹⁶

Kirksey MA et al in a systemic qualitative review demonstrated that long-acting local anaesthetic used alone in Peripheral Nerve Blocks gives analgesia of limited duration, often lasting no more than 12 hours.¹² Similarly, Hill SE et al in their study described that bupivacaine provides analgesia of short duration lasting from 4 to 12 hours when utilized in peripheral nerve blocks.¹¹ Our results are also compatible with the above-mentioned studies, showing that bupivacaine alone provides analgesia of 6 to

12 hours. Therefore we used dexamethasone with bupivacaine in ESP Block, and its addition prolongs the duration of analgesia by up to 24 hours.

Parrington SJ et al in their study showed that the duration of analgesia from a Supraclavicular Brachial Plexus block is much increased when dexamethasone is administered together with mepivacaine.¹⁴ Similarly, Vieira PA et al and Cummings KC III et al in their study showed that the use of dexamethasone combined with bupivacaine and ropivacaine increases the duration of analgesia in interscalene brachial plexus blocks.^{15,16} Similarly, Mohammed El-Sadawy et al use dexamethasone with bupivacaine in ESP Block for post-op analgesia in patients undergoing lumbar spine surgeries, showing dexamethasone prolongs the duration of analgesia.¹⁷ Our results are also consistent with the above-mentioned studies, but we evaluated the combination of bupivacaine and dexamethasone in ESP block for Post-thoracotomy analgesia.

The safety profile of dexamethasone as an adjuvant in Peripheral Nerve Block may raise some concerns. Different animal studies showed that repeated intrathecal high doses of betamethasone cause histopathological changes in the spinal cord.¹⁵ However, different studies showed that steroid-mediated neurotoxicity is related to the use of preservative benzyl alcohol in preparations as well as the presence of insoluble particulate matter.^{14,18,19} Moreover, Sugita K et al in their study reported that the use of an intrathecal injection of 8 mg dexamethasone to treat post-traumatic visual impairment in 200 individuals did not exhibit any neurotoxicity,^{15,20} showing safety profile of dexamethasone. We used soluble and preservative-free dexamethasone in our study, to avoid any neurotoxicity and we did

not find any neurological complications in our study.

5. CONCLUSION

In conclusion, we found in our study that the addition of dexamethasone to bupivacaine in USG ESP Block not only improves the quality of analgesia, but also increases the length of analgesia following thoracotomy.

Limitations: The sample size of our study was limited; more research can be conducted with a larger sample size. Moreover, while our investigation was conducted at a single institution, multicenter trials are possible.

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