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EFFICACY OF BILATERAL ERECTOR SPINAE PLANE BLOCK IN PATIENTS UNDER GOING OFF PUMP CORONARY ARTERY BYPASS GRAFTING: A RANDOMIZED STUDY

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Abstract

Background

Postoperative pain management in cardiac surgeries is challenging due to the limitations of opioid-based analgesia and the risks associated with neuraxial techniques. The Erector Spinae Plane Block (ESPB) is a novel regional analgesia technique offering effective pain relief with a safer profile. This study aims to evaluate the efficacy of bilateral ESPB in reducing postoperative pain and opioid consumption in patients undergoing off-pump coronary artery bypass (OPCAB) surgery.

Materials and Methods

This randomized prospective comparative study was conducted at the Dharma Vira Heart Centre, Sir Gangaram Hospital, New Delhi, from June 2021 to November 2022. Forty-two patients undergoing elective OPCAB surgeries were randomized into two groups:

- Group E (ESPB): Received intermittent boluses of 0.2% ropivacaine hydrochloride (0.2 mL/kg) via an ESP catheter every 6 hours for 48 hours post-extubation.
- Group W (Control): Received standard multimodal analgesia without ESPB.

Pain was assessed using the Visual Analog Scale (VAS) every 6 hours for 48 hours post-extubation. Total opioid consumption (fentanyl citrate and tramadol hydrochloride) was recorded. Statistical analysis was performed using SPSS version 17.0, with p-values <0.05 considered significant.

Results

Group E demonstrated significantly lower VAS scores compared to Group W at all time points. The mean VAS score in Group E ranged from 3.52 ± 0.98 (0 hours) to 0.38 ± 0.50 (48 hours), while in Group W, it ranged from 5.05 ± 0.67 (0 hours) to 1.29 ± 1.06 (48 hours) ($p < 0.05$).
Opioid consumption was markedly reduced in Group E. The mean fentanyl citrate consumption was 83.33 ± 32.57 mcg in Group E versus 321.43 ± 128.04 mcg in Group W ($p = 0.001$). Similarly, the mean tramadol hydrochloride consumption was 75.00 ± 50.00 mg in Group E compared to 188.10 ± 77.31 mg in Group W ($p = 0.012$). No complications related to ESPB were observed.

Conclusion

Bilateral ESPB significantly reduces postoperative pain and opioid consumption in OPCAB surgeries, offering a safer and more effective analgesic option. These findings support the inclusion of ESPB in enhanced recovery protocols for cardiac surgeries.

Keywords

Erector Spinae Plane Block, Postoperative Pain, OPCAB Surgery, Regional Analgesia, Opioid Consumption, Visual Analog Scale

Introduction

Since the evolution of surgery, one constant factor has been the challenge of pain management. The International Association for the Study of Pain redefined pain in July 2020 as “an unpleasant sensory and emotional experience associated with, or resembling that associated with, actual or potential tissue damage” (1). Pain processing involves six steps: transduction, inflammation, conduction, transmission, modulation, and perception (2). Effective pain management during and after surgery plays a crucial role in patient recovery and rehabilitation.

Historically, pain management has undergone significant evolution. In the 1600s, opium was the primary modality for pain relief (3). By the 1800s, ether and chloroform were introduced as anesthetic agents, marking a significant advancement in surgical anesthesia, albeit with concerns over their use in unconscious patients (3). In the early 1900s, morphine and heroin emerged as pain medications, but their chronic use was questioned due to addiction concerns (3). Over time, various modalities, including nonsteroidal anti-inflammatory drugs (NSAIDs), opioids, ultrasound-guided nerve blocks, and multimodal analgesia techniques, have been developed and implemented.

Postoperative pain management in cardiac surgeries remains a significant challenge. Ineffective control of postoperative pain can lead to patient dissatisfaction, increased opioid utilization, chronic opioid dependence, and long-term functional disability. Various methods of analgesia, including local anesthetic infiltration, nerve blocks, NSAIDs, epidural analgesia, and multimodal approaches, have been employed to address these issues (4,5).

The concept of Enhanced Recovery After Surgery (ERAS), introduced by Kehlet in the 1990s, emphasizes multimodal opioid-sparing strategies to optimize recovery and minimize opioid-related complications (6,7). While techniques like epidural and paravertebral nerve blocks (PVB) are widely used, they are associated with risks, such as hypotension, vascular puncture, pleural puncture, and nerve injury (8).

The erector spinae plane block (ESPB), first reported by Forero et al. in 2016, has emerged as a promising alternative for perioperative analgesia (9). ESPB involves the administration of local anesthetic (LA) deep to the erector spinae muscle (ESM), using ultrasound guidance to ensure precision and minimize complications. The technique is advantageous because it avoids critical structures like the spinal cord, major vessels, and pleura, significantly reducing complication rates (9). LA injected into the erector spinae plane spreads cephalocaudally, providing analgesia across multiple dermatomes (10).

ESPB has been successfully utilized for cervical, thoracic, abdominal, and pelvic analgesia in various surgical settings, although its application in cardiac surgeries, particularly for maintaining

postoperative analgesia after off-pump coronary artery bypass (OPCAB) surgeries, has been less extensively studied. Bilateral ESPB performed at the T5 spinous process provides analgesia from T2 to T9, encompassing both somatic and visceral components, making it particularly suitable for surgeries like median sternotomy (11).

Given its simplicity, efficacy, and safety profile, ESPB presents a viable alternative for postoperative pain management in cardiac surgeries. This study aims to evaluate the efficacy of ESPB in reducing postoperative pain and opioid consumption in patients undergoing OPCAB surgeries.

Materials and Methods

Study Area
This study was conducted at the Dharma Vira Heart Centre, Department of Cardiac Anaesthesia, Sir Gangaram Hospital (SGRH), New Delhi.

Study Design
A randomized prospective comparative study.

Study Duration
From June 8, 2021, following approval by the institutional scientific and ethics committee, to November 2022.

Study Population
Patients undergoing off-pump coronary artery bypass (OPCAB) surgeries.

Inclusion Criteria

- Patients aged >18 years.
- Patients providing informed consent for the procedure.

Exclusion Criteria

- Emergency surgeries.
- On-pump CABG surgeries.
- History of arrhythmias with significant hemodynamic instability.
- History of bleeding disorders.
- Local site infection.
- History of allergy to ropivacaine hydrochloride (confirmed via prior test dose).
- Spine deformities or fractures.

Randomization
Patients were randomized using a computerized randomization technique. The random number-generating function (RANDBETWEEN) assigned patients to Group E (ESPB group) or Group W (non-ESPB group). The study was single-blinded; neither the patients nor the investigators were aware of group allocation.

Outcome Measures

1. Primary Outcome

- Pain assessment using the Visual Analog Scale (VAS) every 6 hours for 48 hours post-extubation.

2. **Secondary Outcome**
    - Total opioid consumption (Injection Fentanyl citrate and Injection Tramadol hydrochloride) within 48 hours post-extubation.

Demographic Data
Baseline demographic data, including age, sex, height, and weight, were collected. Written informed consent was obtained from all participants.

Clinical Data
A pre-anaesthetic evaluation was performed for all patients, including:

- General physical examination with airway assessment.
- Systemic examination.
- Routine investigations: complete blood count, coagulation profile, electrocardiography, and chest radiograph.

Study Groups

- Group E (ESPB Group): Received intermittent boluses of 0.2% ropivacaine hydrochloride (0.2 mL/kg) via an ESP catheter every 6 hours for 48 hours post-extubation.
- Group W (Control Group): Did not receive ESPB and were managed with the hospital's standard analgesic protocol.

Both groups received paracetamol 1g intravenously every 8 hours. Rescue analgesia with fentanyl citrate or tramadol hydrochloride was administered when VAS scores were ≥4.

Procedure: Ultrasound-Guided Erector Spinae Plane Block (ESPB)
The procedure was performed under aseptic conditions. The ESPB technique involved:

1. Patient positioned sitting.
2. A linear ultrasound probe (6–13 MHz) placed 2–3 cm lateral to the T5 spinous process.
3. Identification of the transverse process and overlying muscles (trapezius, rhomboid major, and erector spinae).
4. A 19G needle was used to deliver local anesthetic (2% lignocaine) for skin infiltration and subsequent placement of a catheter into the erector spinae plane.
5. Catheter placement was confirmed by ultrasound imaging of LA spread in the interfascial plane.

Anesthesia Protocol
General anesthesia was induced with etomidate (0.2–0.6 mg/kg), fentanyl (1–2 μg/kg), and rocuronium (0.4–0.6 mg/kg). Postoperative pain was assessed every 6 hours for 48 hours using the VAS. Rescue analgesia was administered as needed.

Data Collection
Pain scores (VAS) and total opioid consumption were recorded. Patients with VAS ≥4 were administered rescue analgesia.

Sample Size Calculation
Based on a previous study by Jin et al., the sample size was calculated to detect significant differences in VAS scores between groups, resulting in 21 patients per group with 90% power and α=0.05.

Statistical Analysis
Data were analyzed using SPSS version 17.0.

- Continuous variables were expressed as mean ± SD and compared using unpaired t-tests or Mann-Whitney U tests.
- Categorical variables were analyzed using the chi-square test or Fisher's exact test.
- A p-value <0.05 was considered statistically significant.

Results

Table 1: Comparison of VAS Scores Between Group E (With ESPB) and Group W (Without ESPB)

Time Post Extubation (hours)	Mean VAS Score ± SD (Group E)	Mean VAS Score ± SD (Group W)	p-value
0	3.52 ± 0.98	5.05 ± 0.67	0.001
6	2.81 ± 1.03	4.43 ± 0.68	0.001
12	2.33 ± 0.73	4.10 ± 0.63	0.001
18	1.86 ± 0.85	3.71 ± 0.85	0.001
24	1.76 ± 0.83	3.52 ± 0.81	0.001
30	1.48 ± 1.03	2.86 ± 1.11	0.001
36	0.95 ± 0.74	2.19 ± 1.21	0.001
42	0.48 ± 0.51	1.57 ± 1.08	0.001
48	0.38 ± 0.50	1.29 ± 1.06	0.002

Description:

- Group E demonstrated significantly lower VAS scores at all time points post-extubation compared to Group W ($p < 0.05$).
- At 0 hours post-extubation, Group E had a mean VAS score of 3.52 compared to 5.05 in Group W. This trend persisted throughout the 48-hour observation period, with Group E showing substantially lower pain levels.

Table 2: Opioid Consumption in Group E (With ESPB) and Group W (Without ESPB)

Group	Mean Fentanyl Citrate Consumption (mcg) ± SD	Mean Tramadol Hydrochloride Consumption (mg) ± SD	p-value
Group E	83.33 ± 32.57	75.00 ± 50.00	0.001
Group W	321.43 ± 128.04	188.10 ± 77.31	0.012

Description:

- Fentanyl citrate consumption was significantly lower in Group E compared to Group W (mean: 83.33 mcg vs. 321.43 mcg, p = 0.001).
- Similarly, tramadol hydrochloride consumption was significantly reduced in Group E (mean: 75.00 mg vs. 188.10 mg, p = 0.012).
- In Group E, 9 out of 21 patients required no fentanyl citrate, and 17 patients required no tramadol hydrochloride during the 48-hour observation period, while all patients in Group W required both drugs.

These results demonstrate that ESPB significantly reduces both postoperative pain (as evidenced by lower VAS scores) and opioid consumption in patients undergoing OPCAB surgeries.

Discussion

This randomized, prospective study evaluated the analgesic efficacy of bilateral Erector Spinae Plane Block (ESPB) compared to multimodal analgesia in patients undergoing off-pump coronary artery bypass (OPCAB) surgery. To our knowledge, this is the first study conducted in an Indian cohort to evaluate ESPB in the context of OPCAB surgeries.

Postoperative pain management after cardiac surgery is challenging. Intravenous opioid-based analgesia, although effective, is associated with side effects such as reduced gastrointestinal motility, nausea, urinary retention, and prolonged hospital stay. Non-opioid options like ketamine and α-2 agonists reduce opioid consumption but pose risks of adverse effects, limiting their routine application (1,2). Neuraxial techniques such as thoracic epidural and paravertebral blocks offer potential benefits but are limited by complications, including epidural hematoma, pneumothorax, and high failure rates, which can reach 32% (3). These limitations emphasize the need for safer and more effective regional analgesic techniques.

The ESPB, first described by Forero et al., provides an alternative regional block with a safer profile and extensive cranio-caudal analgesic coverage. It delivers local anesthetic into the fascial plane beneath the erector spinae muscle, effectively blocking somatic and visceral pain without risks like pleural puncture or major vascular injuries. The sonographic target is easily visualized, allowing the block to be performed with greater precision and safety, even in anticoagulated patients (4,5).

In our study, patients receiving ESPB (Group E) experienced significantly lower VAS scores at all time points during the 48-hour observation period compared to those managed with multimodal analgesia (Group W). The mean VAS scores in Group E ranged from 3.52 (at 0 hours) to 0.38 (at 48 hours), compared to 5.05 and 1.29, respectively, in Group W. These findings align with previous studies, such as those by Chin et al., where ESPB was associated with significant reductions in postoperative pain scores (6).

Similarly, opioid consumption was markedly lower in Group E. Patients in the ESPB group required an average of 83.33 mcg of fentanyl citrate and 75 mg of tramadol hydrochloride, compared to 321.43 mcg and 188.10 mg in Group W. These results are consistent with Macaire et al., who reported significantly reduced morphine consumption in patients receiving ESPB after surgery (7).

Our study further supports the findings of Nagaraja et al., who demonstrated that ESPB performed on the day of surgery under ultrasound guidance is safe and effective. Unlike their approach of inserting the catheter a day prior, our protocol of catheter placement immediately before surgery resulted in no complications, such as hematoma or infection, underscoring the procedure's safety (8).

When comparing our study with the work of Jin et al., the VAS scores in our control and ESPB groups followed a similar trend, with the ESPB group showing a delayed peak pain score and overall lower values, indicating enhanced patient satisfaction and effective pain management (9).

Interestingly, we used a lower concentration of ropivacaine (0.2%) than other studies, such as those by Krishna et al. and Song et al., which used higher concentrations or alternative agents like liposomal bupivacaine. Despite the lower concentration, our results demonstrated comparable efficacy and safety, reinforcing the cost-effectiveness and feasibility of this approach in the Indian population (10,11).

The anti-inflammatory effects of ESPB have also been highlighted in previous studies. Liu et al. reported significant reductions in inflammatory markers such as TNF-α, IL-6, and IL-10 in patients receiving ESPB compared to controls, suggesting additional benefits in reducing postoperative inflammation (12).

No major complications, such as bleeding, hematoma, or catheter-related issues, were observed in our study, corroborating the safety profile of ESPB reported in existing literature (13). Additionally, the use of ESPB may contribute to shorter ICU stays, as suggested by studies like those by Moll et al., although further research is required to confirm this hypothesis (14).

Conclusion

In conclusion, our study demonstrates that ESPB provides superior pain control, reduces opioid requirements, and enhances patient satisfaction compared to multimodal analgesia in OPCAB surgeries. These findings support the inclusion of ESPB in enhanced recovery protocols for cardiac surgeries. Future multi-center trials with larger sample sizes are warranted to validate these results and explore additional benefits, such as reduced ICU stay and hospital length of stay.

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