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Comparison of Continuous Thoracic Epidural Analgesia (TEA) With Continuous Bilateral Erector Spinae Plane (ESP) Block for Perioperative Pain Management in Cardiac Surgery: A Prospective Randomized Controlled Trial (RCT)

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Abstract: ***Pain management in cardiac surgery is critical as sternotomy, sternal retraction, IMA harvesting, and chest tube insertions induce moderate-to-severe heart discomfort. Untreated pain produces hemodynamic abnormalities, systemic issues, and muscle weakness. The ultrasound guided erector spinae plane (ESP) block is a novel technique for thoracic nerve discomfort, fractured ribs, and mastectomy procedures. In this prospective, randomised clinical investigation, we have compared continuous thoracic epidural analgesia (TEA) and bilateral erector spinae plane (ESP) block for pain management in cardiac surgery. 40 cardiac surgery patients who met eligibility criteria were randomised to Group A-TEA or Group B-ESP block. Participants' demographics were well-documented. Both groups recorded the primary result on a visual analogue scale during repose post-extubation. Secondary outcomes included incentive spirometry, complications, and rescue analgesia. Visual Analogue Scoring was done at 0, 3, 6, 12, and 24 hour time points for both groups. According to VAS, Erector spinae plane block is more effective than thoracic epidural analgesia. Group B's mean VAS score was lower than GroupA's. Timepoints eliminated Group B's painscore. Peak inspiratory spirometry of both groups at 0, 3, 6, 12, and 24 hour was also carried out and revealed that the group B exhibited higher peak inspiratory flow and lung capacity than group A.In comparison to other methods, the ESP block has a lot of advantages due to its efficiency, safety, and dependability. Blocking the ESPs is a analgesic option for patients having elective, urgent, or emergency heart surgery or who have sustained chest trauma.***

Keywords: Epidural analgesia, erector spinae block, pain management in cardiac surgery, visual analogue score , peak inspiratory spirometry

1. Introduction

Over 1.5 million individuals worldwide undergo heart surgery annually. Procedures such as sternotomy, vascular catheters, drainages and thoracotomy, might induce discomfort in cardiac surgery patients[1]. Drug combinations employed for pain management are determined by the patient's pathophysiology as well as the anesthesiologist's personal choice and experience[2]. Surgical pain may be nociceptive, neuropathic, mixed, psychogenic or idiopathic and as such cannot be effectively treated with a single medication.[3]

High levels of post-operative pain are linked to hemodynamic perturbations with systemic complications which include pulmonary (atelectasis, pneumonia, and stasis of bronchial secretions), cardiovascular (increased oxygen consumption and tachycardia), musculoskeletal (muscle weakness), and increased neurohormonal response , hence effective pain management is essential for a speedy recovery. However, appropriate pain control is difficult due to a combination of inadequate pain reporting, high variance across individuals, and the adverse effects of potent analgesics, particularly opioids[4].

Thoracic epidural analgesia is an integral part of anesthesia used to treat acute pain following thoracic surgery when a moderate-to-large thoracic incision is expected[5].Many studies have highlighted the advantages of high thoracic epidural anesthesia (HTEA) in cardiac surgery due to its capacity to attenuate the response to surgical stress [3] and improve myocardial oxygen balance, increase coronary perfusion, and reduce problems such as supraventricular arrhythmias after surgery[6], shortened length-of-hospital stay and improved post operative analgesia. Even with these benefits, worries about possible side effects like spinal cord injury (caused by neuroaxial hematoma), epidural infection, and low blood pressure (secondary to sympatholysis induced by anaesthetic blockade) persists[7].

In 2016, anaesthesiologist Mauricio Forero initially described the erector spinae plane (ESP) block, a multi-dermatomal sensory block that offers regional anaesthetic to the ipsilateral chest wall [8]. The ESP block is a successful method for analgesia as it provides great pain management while decreasing the need for narcotics. For any regional block

approach to be broadly adopted, the research demonstrating its benefits must withstand rigorous evaluation.

Our study aims at comparing continuous TEA with ultrasound guided bilateral erector spinae block for perioperative pain management in cardiac surgery patients

2. Methods

After approval from ethical committee, this prospective randomized comparative clinical study was conducted with a total of 40 adult patients in age group of 18 to 70 year scheduled for elective cardiac surgery who underwent median sternotomy, belonging to ASA class II and III. Patients were randomized to either Group A: TEA (n = 20) or Group B: ESP block (n = 20).
A detailed pre anesthetic check-up was done a day before surgery and patients were explained about Visual Analogue Scale score (VAS) of 0-10 with 0 being "no pain" 10 being "worst possible pain". Procedure to be performed was explained to patient and patient's relatives and written informed consent was taken.

A day before the surgery, TEA or ESP block was performed as per the pre-planned simple randomization. An 18G IV cannula was inserted and the patient was connected to standard monitors. In the left lateral decubitus position, either of the block was performed.

In Group A, TEA was performed under the strict aseptic precautions in T2/T3 intervertebral space .In Group B, ultrasound guided bilateral ESP block was also performed under strict aseptic precautions using high-frequency 12 MHz linear ultrasound transducer (Sonosite, Model M Turbo, USA) which was placed in a longitudinal orientation 3 cm lateral to the T6 spinous process corresponding to the T5 transverse process.

On the day of surgery, before the induction of general anesthesia (GA), correct placement of the catheters were confirmed by sensation to pinprick after 20–30 min of bolus dose of local anesthetic (LA).

- In Group A (TEA), 15 ml bolus dose of 0.25% plain bupivacaine was administered through the catheter followed by a continuous infusion of 0.125% plain bupivacaine at the rate of 0.1 ml/kg/h till 24 h post extubation.
- In Group B (ESP Block), 15 ml bolus dose of 0.25% plain bupivacaine was injected via bilateral catheters followed by a continuous infusion of 0.125% plain bupivacaine at the rate of 0.1 ml/kg/h till 24 h post extubation.

The postoperative pain assessment using VAS at rest and during cough were performed at 0(extubation), 3, 6, 12 and 24 hrs. Pain was classified as mild (VAS 0-4), moderate (VAS 5-7), and severe (VAS 8-10).Peak inspiratory flow spirometry (incentive spirometry) was performed post extubation at 0, 3, 6, 12 and 24 hrs to assess the number of balls raised in the spirometer as an indicator of peak inspiratory flow rate (1 ball = 600 ml, 2 balls = 900 ml, and 3 balls = 1,200 ml).

Breakthrough pain is defined as VAS > 4 at rest. IV Paracetamol 1 g every 6th hourly was administered to the group of patients. Rescue analgesia was administered, if VAS was >4 at rest or on patient's demand, with IV Fentanyl 1 mcg/kg. The second rescue analgesic planned was IV Diclofenac 1 mg/kg diluted in 100 ml normal saline and was administered slowly if VAS remained persistently >4 after 30 min of the first rescue analgesic administration.

Sample size estimation was based on the reported data for pain score (0-10 VAS) at 12 hours with TEA (1.92±0.90) and ESP (1.68 ± 1.35). Considering as a pilot study and availability of subjects at the hospital that met the inclusion, 20 subjects were included in each of the two study groups. Statistical analysis was performed using the independent Student's t-test.

Measured data was expressed as mean ± standard deviation (Mean ± SD), whereas nominal data was expressed as numbers with percentages (proportions).

The mean values for pain score (VAS) and other measurement data will be compared between the two groups (TEA and ESP) using two-independent sample t-test. Comparisons between the two groups for ordinal data was using Mann-Whitney 'U' test. Nominal data was compared between the two groups for difference using Chi-square test. All testing was done using two-sided tests with alpha 0.05. A value of $p < 0.05$ was considered statistically significant. Data analysis was done using graph pad prisms Version 8, CA.

3. Results

A prospective, randomized comparative clinical study was conducted with a total of 40 patients meeting eligibility criteria and were randomized to either Group A-TEA (n = 20) or Group B- ESP block (n = 20). Visual analogue scale (VAS) was recorded in both the groups during rest at the various time intervals post-extubation. Both the groups were compared for incentive spirometry, complications and the need for rescue analgesia.

Table 1 represents demographics of the study participants undergoing cardiac surgery. Age and gender of all the patients was recorded. This results also signifies the unbiased categorization of the participants to the two groups.

Table 1: Demographics of the study participants undergoing cardiac surgery

Demographic	Group A (TEA)	Group B (ESP)	P value	95% CI
Age (years)	54 ±10.1	51.45±17.5	0.5758	-6.5964 to 11.6964
Gender				
Female	12 (60%)	9 (45%)		
Male	8 (40%)	11 (55%)		
Total	20 (100%)	20 (100%)		

Table 2 represents distribution count of diagnosis and surgery. 24 (60%) subjects were diagnosed with CAD-TVD for CABG. An equal number of subjects i.e., 12 was allocated to both the group (group A and B). Further, 12 (30%) subjects were RHD with MS for MVR and 4 (10%) subjects with severe AS for AVR were randomized and equally allocated to both groups.

Table 2: Distribution count of diagnosis and surgery

Diagnosis and surgery	Total	Group A	Group B
CAD-TVD for CABG	24	12	12
RHD with MS for MVR	12	6	6
Severe AS for AVR	4	2	2
Grand Total	40	20	20

Table 3: VAS was recorded in both the groups at different time points
Visual analog scale between Group A (thoracic epidural analgesia) and Group B (erector spinae plane block)

VAS	0 hr	3 hr	6 hr	12 hr	24 hr
Group A (n= 20)	4.6 ± 1.6	3.9 ± 1.8	2.6 ± 1.6	1.9 ± 1.5	1.2 ± 1.2
Group B (n= 20)	2.9 ± 1.1	1.5 ± 1.1	0.4 ± 0.8	0	0
P	0.0002	0.0001	0.0001	0.0001	0.0001
95% CI	0.8736 to 2.6264	1.4567 to 3.3433	1.3862 to 3.0138	1.2119 to 2.5881	0.657 to 1.743

Upon statistical analysis, the mean VAS score of group B was found to be significantly different from that of the group A. Group Bpain score was alleviated with increase in timepoint finally touching the zilch score. The overall comparison of the VAS score signifies the efficiency and effectiveness of erector spinae plane block over thoracic epidural analgesia.

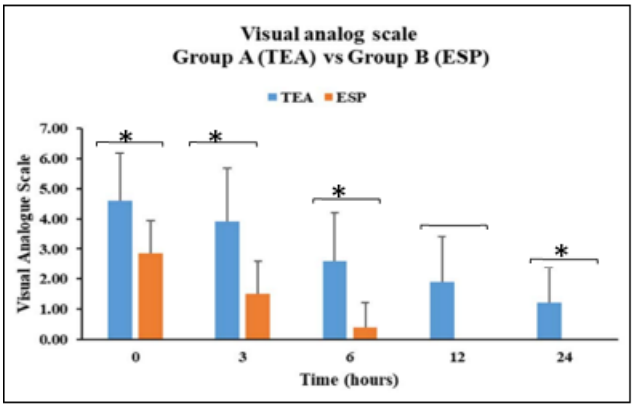

Figure 1: Visual analog scale between Group A (thoracic epidural analgesia) and Group B (erector spinaeplane block). Symbols in the figure represent statistical significance, ***p<0.001

Table 4: Represents Peak inspiratory flow (spirometry) of both the groups at different time points
Peak inspiratory flow (spirometry) between Group A (thoracic epidural analgesia) and Group B (erector spinae plane block)

Spirometry	0 hr	3 hr	6 hr	12 hr	24 hr
Group A (n= 20)	330 ± 349.6	3.9 ± 1.8	2.6 ± 1.6	1.9 ± 1.5	1.2 ± 1.2
Group B (n= 20)	390 ± 338.6	1.5 ± 1.1	0.4 ± 0.8	0	0
P	0.5846	0.0768	0.0087	0.0022	0.0041
95% CI	-280.311 to 160.311	-507.093 to 27.093	-519.416 to -80.584	-484.572 to -115.428	-2.74.459 to -55.541

Upon statistical analysis, the difference in the values was found to be insignificant at 0 and 3hrs whereasthe results were found to be extremely significant for 6 (p=0.08), 12 (p=0.022) and 24hrs (p= 0.0041). From our data, we found out that group B which erector spinae plane block had better PIF values and lung capacity when compared to group A.

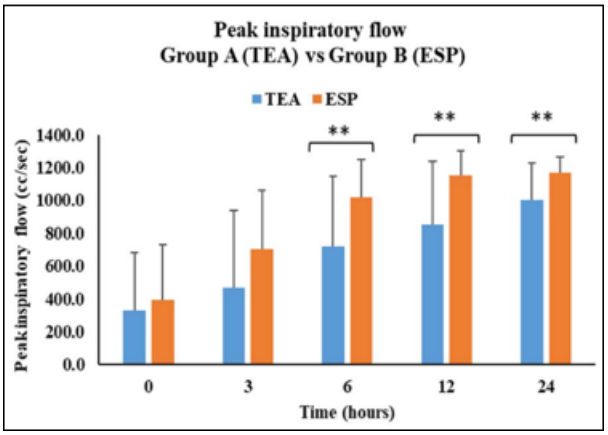

Figure 2: Peak inspiratory flow (spirometry) between Group A (thoracic epidural analgesia) and Group B(erector spinae plane block). Symbols in the figure represent statistical significance, **p<0.01

Need for rescue analgesia

Table 5: Requirement of rescue analgesia in study groups

Group A (TEA)		Group B (ESP)	
No. of patients	No. of doses of rescue analgesia	No. of patients	No. of doses of rescue analgesia
13	0	20	0
3	1	0	1
3	2	0	2
1	3	0	3

The expected and reported complications are summarized in Table 6

Table 6: Expected and reported complications

Expected	Reported
Hematoma	Nil
Patchy Action	Nil
No Action	Nil
Delayed action	Nil
Misplacement of catheter	Nil
Accidental removal of catheter	Nil
Local infection at site of catheter	Nil

4. Discussion

Pain control during cardiac surgery is crucial. Procedures can cause moderate-to-severe cardiac surgical pain. Ineffective pain treatment causes hemodynamic disturbances, systemic problems, and muscle weakening [9]. Multidisciplinary approaches are recommended for pain management by the American Society of Anesthesiologists' task group on the treatment of acute postoperative pain. These encompass local anaesthetics, analgesics administered intravenously (IV), and analgesics taken orally. Parenteral analgesics have been given to the patient in the form of opiates, paracetamol, and NSAIDs. When used exclusively for analgesia, opioids can produce nausea, vomiting, itching, and respiratory depression. Several localized treatments,particularly thoracic epidural analgesia (TEA), have been widely characterized to minimizepostoperative discomfort and enhance prognosis in heart surgery. In thoracotomies, the reported incidence of side effects with paravertebral blocks (PVB) were lower than with TEA[10].The ultrasound guided (USG) erector spinae plane (ESP) block is a new approach for local analgesia in thoracic nerve pain, fractured ribs, and mastectomy operations

The visual analogue scale (VAS) is a type of psychometric response scale that is useful for collecting data via surveys. It's a tool for gauging qualities and sentiments that are difficult to quantify otherwise. In a VAS response, the respondent places an indicator on a continum between two extremes to indicate their level of agreement with a statement.

Maximum airflow (in litres per minute) during a forced inspiratory maneuver is known as peak inspiratory flow (PIF). The volume of a patient's lungs and the strength of their respiratory muscles determine work of breathing (functional residual capacity [FRC], residual volume [RV])[11]. Spirometry is a typical test used to evaluate lung function by measuring inhalation volume, expiration volume, and expiration rate.

CABG is frequently accompanied by a decline in pulmonary function. There is a 30-60% drop in slow critical capacity in the first week following CABG surgery and a 12% drop that persists even a year later[12].

Prevention and reduced incidence of atelectasis, hospital stay, mechanical ventilation time, and enhanced postoperative oxygenation with higher lung function have all been linked to preoperative incentive spirometry for two days and also serve as a driving force for the usage of neuraxial analgesia.

In the present investigation, rescue analgesia was administered to the patients depending upon the need and demand.

The risk of epidural hematoma is predicted to be 1 in 12,000 with TEA and 1 in 5493 with a catheter in cardiac surgical procedures as there is use of intraoperative systemic anticoagulation, chronic antiplatelet drug use, and cardiopulmonary bypass-induced coagulopathy.

The dorsal and ventral rami of the thoracic spinal neurons were found to be the likely location of action of ESP block. Administering 25 ml of LA via a continuous catheter after ESP block at the T5 level showed cutaneous sensory blockade extending cephalad and dorsoventrally from T1 to T11, covering the entire anterior and posterior thorax.

In this analysis, patients with a continuous catheter insitu experienced pain alleviation that was adequate as evidenced by VAS scores of 4 or lower, which lasted for 48 hours after extubation. There were no adverse events in either group during this research. Therefore, the authors conclude that ESP block is a viable substitute for TEA in perioperative analgesia.

Despite the fact that anesthesiologists and thoracic surgeons have deployed a variety of strategies for the alleviation of thoracic distress, the ESP block is efficient, safe, and dependable, offering a number of advantages over other methods. Therefore, it can be contemplated in any patient having elective, urgent, or emergency thoracic surgical intervention or experiencing thoracic trauma and it adds to the arsenal of analgesic treatments now accessible.

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