

Efficacy of Transversus Thoracic Muscle Plane Block for Analgesia After Pediatric Cardiac Surgery

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Abstract

Background: Perioperative pain management plays a key role in the management of patients undergoing pediatric cardiac surgery. We studied the effect of transversus thoracic muscle plane block (TTPB) on acute postoperative pain and 24-hour opioid consumption in pediatric cardiac surgical patients.

Methods: Patients in whom transversus thoracic muscle plane catheter was placed were kept in one group and in the other group patients who were given conventional medicines for pain management were kept. The primary study end point was to compare the consumption of fentanyl and to assess FLACC pain scale in postoperative period in the first 24 hours post extubation in both groups.

Results: The 24-hour fentanyl consumption was 8.00 +/- 5.49 micrograms in the transversus thoracic muscle plane group and 32.20 +/- 10.53 micrograms in the control group in the first 24 hours postoperatively, which was statistically significant ($p < 0.001$). The FLACC score was also significantly lesser in the TTPB group compared to the control group in the first 24 hours postoperatively.

Conclusion: Transversus thoracic plane block is superior to the conventional opioid injection method for postoperative pain management in pediatric cardiac surgical patients.

Keywords: Opioids, Pain, TTPB

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Background

Cardiac surgery, which is performed via midline sternotomy, causes significant postoperative pain.¹ If the postoperative pain isn't adequately managed, it will lead to various systemic complications, including pulmonary atelectasis, pneumonia, increased oxygen consumption, and tachycardia, resulting in prolonged ICU stay as well as increased cost. Systemic opioids have been used for pain management for a long; however, they are associated with side effects like nausea and vomiting, respiratory depression, and delayed extubation.² Fast-track protocols have been introduced to clinical practice recently. This has enabled early extubation by

the development of multimodal analgesic strategies, which aim at reducing perioperative opioid use.³

The introduction of ultrasonography into regional anesthesia practice paved the way for less-invasive techniques, most recently with the increased use of interfascial plane blocks.⁴ These blocks drew attention in cardiac procedures because they are relatively safe and simple and bear the advantage of proximity to the surgical field.⁵ Ultrasound-guided transversus thoracic muscle plane block (TTPB) is a newly developed technique that was defined by Ueshima et al. in 2015. Local anesthetic (LA) is injected into the fascial plane between the transversus thoracic muscle and the internal intercostal muscles

to block the anterior cutaneous branches of intercostal nerves from thoracic (Th) 2 to Th 6⁶. Blockage of these nerves can contribute to the management of pain associated with surgical procedures involving the anterior thorax and sternum.

There are only a few studies in the literature, mainly consisting of case reports, regarding the efficacy of TTPB⁷. The aim of this study is to evaluate whether this technique improves the acute postoperative pain and reduced the opioids consumption in pediatric cardiac surgery patients.

Methods

This was a prospective observational cohort study performed at Shahid Gangalal National Heart Center of Nepal. After obtaining Institutional review board approval, the routine pediatric cardiac surgical patients undergoing open heart surgery via median sternotomy under cardiopulmonary bypass with the ages between 2 to 6 years were enrolled in the study. The exclusion criteria were the patients who were hemodynamically unstable or intubated preoperatively requiring emergency surgery, patients with a known history of hypersensitivity reaction to local anesthetics, and patients who remained intubated more than 6 hours post-surgery.

The sample size was calculated from a previous similar study done by Meltem Cakmak et al.,⁸ and 30 patients were taken in each group for the study.

Some anaesthesiologist prefer the conventional opioids technique for postoperative pain management, and some prefer doing TTPB. The duration of the study was from May 2024 to October 2024. There were a total of 30 pediatric cardiac surgical patients who underwent cardiac surgery with sternotomy who had undergone TTPB block at the end of surgery and were placed in group T. For comparison, 30 pediatric cardiac surgical patients who underwent cardiac surgery with sternotomy and for whom pain management was done by conventional opioid injection method were kept in group C. Patients under group T underwent ultrasound-guided transversus thoracic muscle plane block postoperatively after completion of surgery and received local anesthetic bupivacaine 0.25% (0.25ml/kg) on each side. Both groups of patients received 15mg/kg of IV paracetamol six hours in the postoperative period. Postoperatively, patients having pain (FLACC score >4) were given rescue analgesics (Fentanyl 0.5 mcg/kg) in both of the groups. The cumulative dose of opioids consumed in the 24 hours post-extubation was recorded from the ICU chart. FLACC scores at 0,6,12, 18, and 24 hours post-extubation were recorded from the ICU chart.

Collected data were analyzed by means of the statistical software SPSS22. Statistical analysis for demographic variables was done by chi-square test, and student's paired t-test was applied to compare the mean 24-hour opioid consumption and FLACC score at 0,6,12,18 and 24 hours post extubation in both groups. A P-value of < 0.05 was considered to be statistically significant.

Results

The demographic data of the two groups were comparable, as shown in Table 1. The 24-hour fentanyl consumption was 8.00 +/- 5.49 micrograms in the Transversus thoracic muscle plane group and 32.20 +/- 10.53 micrograms in the control group in the first 24 hours postoperatively, which was statistically significant (p <0.001) as shown in Table 2. The FLACC score was also significantly lesser in the TTPB group compared to the control group in the first 24 hours postoperatively, as shown in Table 3 and Figure 1.

Table 1: Demographic data of the patients

Variables	Group T	Group C
Age in years median (Range)	4(3-5)	3(2-6)
Gender male: female	12:18	14:16
Weight in kg median (Range)	14 (11.15-18.20)	10.15 (8.25-19.00)
Height in cm median (Range)	98(86-114)	85(80-117)
BMI in kg/m ² median (Range)	14(13.5-16.5)	13.8 (12.3-15.9)

Table 2: Comparison of total Fentanyl consumption

	Group T (mean +/- SD)	Group C (mean +/- SD)	P value
Fentanyl (mcg)	8.00 +/- 5.49	32.20 +/- 10.53	<0.000

Table 3: Comparison of FLACC score

Time(Hours post extubation)	Group T (mean +/- SD)	Group C (mean +/- SD)	P value
0	2.6 +/- 1.22	5.60 +/- 0.81	0.001
6	3.0 +/- 1.43	6.60 +/- 1.03	0.006
12	4.6 +/- 1.88	7.0 +/- 0.64	<0.001
18	2.0 +/- 0.64	6.6 +/- 1.03	0.045
24	1.8 +/- 0.40	5.0 +/- 1.11	<0.001

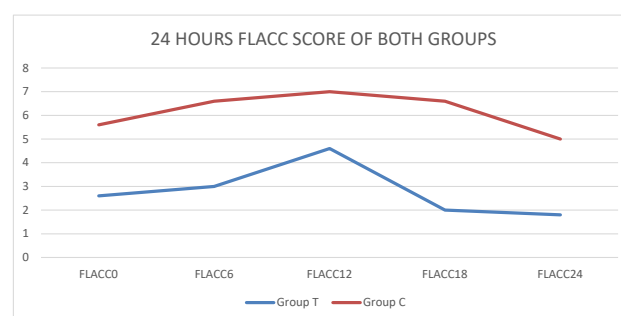


Figure 1: Comparison of 24 hours FLACC score in both groups

Discussion

The perioperative pain management plays a key role in the management of patients undergoing cardiac surgery. Postoperative surgical pain due to sternotomy and sternal retraction is severe.¹ Ineffective pain management results in systemic complications for example, pulmonary atelectasis, pneumonia, increased oxygen consumption and tachycardia, resulting in prolonged ICU stay as well as increase cost.⁹

Numerous modalities of pain management techniques have been used for cardiac surgery, like Thoracic Epidural Anesthesia (TEA),

Paravertebral block (PVB), and Erector Spinae Plane (ESP) Block, as well as perioperative opioids. Cardiac surgery is often performed in patients receiving anticoagulant therapy. Hence, Thoracic Epidural Anesthesia is associated with epidural hematoma and hypotension.¹⁰ PVB, on the other hand, has a high risk of puncturing the pleura, resulting in pneumothorax.¹¹ The use of perioperative opioids produces side effects such as nausea and vomiting, respiratory depression, postoperative chronic opioid use, and increased risk of chronic pain.¹²

However, the Ultrasound-guided fascial plane block technique can be performed safely in anticoagulated patient as compared to TEA and PVB, as the fascial plane has less number of vessel and it avoids epidural vessels.¹³

The result of this study has demonstrated that the use of Transversus thoracic muscle plane block has significantly reduced the consumption of opioids in the TTPB group in comparison to the control group in the first 24 hours post extubation postoperatively. Furthermore, the TTPB block group showed that the FLACC pain score was significantly lower than in the control group in the postoperative period, which signifies adequate pain management. The result of our study was consistent with the findings in the study done by Meltem Cakmak et al.⁸ We also didn't notice any significant procedure-related complications in our study, and local site hematoma formation. This was the limitation of our study.

Though there are very few studies describing TTPB in pediatric cardiac surgical patients, the study findings have shown promising results in reducing postoperative pain. So, we recommend using the TTPB technique in all pediatric cardiac surgical patients as it significantly reduces overall opioid consumption and significantly allays pain, thereby contributing to the patient's comfort and satisfaction.

Conclusion

Transversus thoracic plane block is superior to the conventional opioid injection method for postoperative pain management in pediatric cardiac surgical patients. TTPB block not only decreases the overall opioid consumption but also the FLACC pain score in these patients.

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Authors' Contributions: SS Parajuli and S Shrestha designed the study, took part in the acquisition, analysis, and interpretation of data, created the initial draft of the manuscript, and made critical revisions.

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