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The effect of combined ultrasound-guided transverse thoracic muscle plane block and rectus sheath plane block on the peri-operative consumption of opioids in open heart surgeries with median sternotomy

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ABSTRACT

Background: Patients undergoing heart surgery with a midline sternotomy typically get intravenous opioids as their primary form of post-operative pain management. Due to its possible drawbacks, regional neuraxial anesthesia is still controversial. There have been reports on the impact of rectus sheath plane (RSP) block in conjunction with ultrasound-guided transverse thoracic muscle plane (TTP) block on postoperative pain following sternotomy.
Aim Of The Study: The efficiency of combining TTP and RSP blocks in lowering the targeted patients' perioperative requirement for opioids, minimizing opioid adverse effects, and attaining a potential Fast-Tract Extubation.
Patients And Methods: 50 patients undergoing open cardiac surgery via median sternotomy were randomly assigned to one of two groups in this randomized, prospective, comparative trial. Group (B) got combined ultrasound-guided TTP and RSP blocks, while Group (S) received saline in the same planes before to the incision.
Results: There was no significant difference between the groups for the demographic information, postoperative opioid consumption, or VAS pain scores, however there was a very significant difference between the groups for intraoperative opioid intake and time to extubation.
Conclusion: Combining TTP and RSP blocks has improved fast-track extubation, decreased hemodynamic changes in response to surgical stress, and decreased intraoperative opioid usage. The blocks directed by routine pain score evaluation did not, however, have a significant impact on postoperative opioid use.

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KEYWORDS
Transverse thoracic muscle; TTP block; sternotomy; open heart surgeries; rectus sheath block

1. Background

In patients following open heart surgery, pain management plays a critical role in facilitating an earlier return to regular activities. Although opioid-based analgesic techniques play a major part in cardiac procedures, they are not without drawbacks, including respiratory depression, nausea, vomiting, itching, urine retention, delayed recovery, and the potential for opioid dependence. Pain can result in respiratory issues such inadequate secretion clearance, protracted weaning, acute respiratory failure from shallow breathing that causes hypoventilation, and ineffective coughing. Effective pain management reduces postoperative mortality and morbidity [1].

Lower opioid dosages may be used to achieve the benefits of the fast-track method. An extended hospital stay in the intensive care unit (ICU) is exacerbated by postoperative pain. As a result, efficient analgesic techniques such as peripheral nerve blocks are required. After sternotomies, the impact of ultrasound-guided TTP block on postoperative pain has been documented; nevertheless, major postoperative issues following cardiac surgery also include epigastric pain and discomfort brought on by chest drainage tubes inserted via the rectus abdominis muscle [2].

Despite the many advantages of regional neuraxial anaesthesia, its use in open heart surgery is still debatable due to the risk of developing hypotension from a high thoracic epidural, technical challenges, and the requirement to stop anticoagulation/antiplatelet therapy to prevent the development of an epidural hematoma, particularly after permissive anticoagulation for cardiopulmonary bypass (CPB) and coagulopathy that may happen after cardiac surgery [3].

In 2015, the first description of transverse thoracic muscle plane block appeared. In a cadaver investigation, it was demonstrated that the T2-T6 intercostal nerves are covered by the local anaesthetic inserted between the intercostal muscles and the transverse thoracic muscle [4].

In light of earlier research, it was assumed that the combination of the TTP block and the RSP block could have a more preemptive analgesic impact than that of

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TTP block only, covering more area for possible analgesia, and in fact, the preemptive effect was seen in the study's participants.

2. Methodology

Between March 2022 and March 2023, a randomized, prospective, double-blinded, comparative study was carried out. Using the PASS 11 Program for sample size calculation and according to "Aydin et al., 2020", the expected proportion of patients who need rescue analgesia in TTP group = 25% and in control group = 75%, setting power at 90% and α-error at 0.05, sample size of 25 patients per group was needed to detect difference between two groups.

After receiving approval from the departmental ethical committee, ethical committee at Ain Shams University, clinical trials registration number: PACTR202203859764512, and after obtaining written informed consent from the participants, 57 patients were eligible for this study. Only 50 patients – after losing 7 during the follow up due to re-exploration, post-surgical complications, and delayed recovery – of American Society of Anesthesiology (ASA) III – IV, from both genders, aged between 19 and 70 years, planned for an open heart surgery through median sternotomy, were included in this study.

Patients were randomly assigned by black sealed envelope method to one of the following groups: the **block group "B-group"** got TTP + RSP blocks with 20 ml of 0.25% Bupivacaine at each plane of injection (total dose 200 mg of Bupivacaine), staying within the Bupivacaine maximum dose limit of 2.5 mg/kg, and the **saline (control) group "S-group"** received normal saline at each plane of injection.

The study excluded procedures such urgent cardiac surgery, ascending aortic surgery that needs deep hypothermic complete circulatory arrest, pericardial effusion drainage, debridement, rewiring of the sternum, and CABG using the Internal Thoracic Artery (IMA). Patients with known hypersensitivity to local anesthetics (LA) or local infections at the site of needle penetration were also eliminated. Exclusion criteria included also patients hardly to be candidates for Fast Tract Extubation in ICU such as: patients on high doses of inotropes and/or vasopressors, high drain(s) in the first 6 hours post-operatively, who needed an intra-aortic balloon pump (IABP) post-CPB, who needed a temporary cardiac pacing, and with delayed recovery (≥6 hours post-operative) in the ICU due to hypotension, stroke, brain edema, hypothermia, or metabolic acidosis.

3. Study procedure

All of the patients who were intending to participate in this study had preoperative evaluations. Patients who met the criteria for inclusion were chosen at random to join one of the pre-designated groups. As soon as the patient entered the pre-induction room, an intravenous (I.V.) line was placed, an antibiotic was infused after a skin sensitivity test, and sedation in the form of 2–5 mg of midazolam was administered.

Basic monitoring leads (5-lead ECG, pulse oximeter, and IBP) were attached to the patient after they had been lying down on the OR table and were used to record the patient's vital signs. The non-dominant hand's radial artery had an arterial line put into it.

Following sufficient pre-oxygenation, 0.03–0.05 mg/kg of midazolam, 1 mg/kg of propofol, 3–5 mcg/kg of fentanyl, and 0.5–0.6 mg/kg of atracurium were administered to induce general anaesthesia. After supporting the patient's ventilation, an appropriately sized cuffed tube was used for intubation. By modulating the current volume and respiratory frequency, mechanical ventilation was managed to keep the final CO_2 end tidal pressure ($ETCO_2$) between 30 and 35 mmHg.

A temperature probe was used on the patient after a central venous catheter (CVC) was placed. Isoflurane (1.0–1.5%), FiO_2 (0.5–0.6), and a circuit with CO_2 absorption were used to maintain anaesthesia. Atracurium was infused at a rate of 0.3 mg/kg/hr to sustain neuromuscular blockade.

An expert anesthesiologist in ultrasound carried out the TTP and RSP blockings, while an another anesthesiologist – in charge of opioid administration – adjusted the opioid dose by adding 100 mcg of Fentanyl as boluses or by introducing Morphine in doses of 5–10 mg according to the change in the hemodynamics in response to surgical stimulus. Any rise in the systolic blood pressure with a value above 20 mmHg from the pre-incision reading and/or any rise in the heart rate above 10 bpm from the pre-incisional basal heart rate were considered a stress response and an indication for opioid administration. The Morphine was used pre-CPB when an opioid of longer duration was needed. The use of Morphine only during the CPB time was due to its favorable pharmacokinetics. Post-CPB, 100 mcg of Fentanyl only was given to all patients as a single bolus regardless of the hemodynamics. The total consumption of each opioid was calculated separately.

In the third or fourth intercostal space, a linear ultrasonic probe is positioned in the sagittal plane 1 cm laterally to the edge of the sternum. Over the pleura, the internal thoracic artery and vein are visible, along with the internal intercostal and transverse thoracic muscles (Figure 1). Using the in-plane approach, a 50-mm block needle is positioned in the interfacial plane between the transverse thoracic and the inner intercostal muscles. Before injecting, the location is verified by performing a 3-mL saline hydro-dissection (by observing the downward displacement of the pleura). Bilaterally, 20 mL of 0.25% bupivacaine were administered.

Rectus Sheath Plane block was done by placing the linear probe in a transverse orientation above the

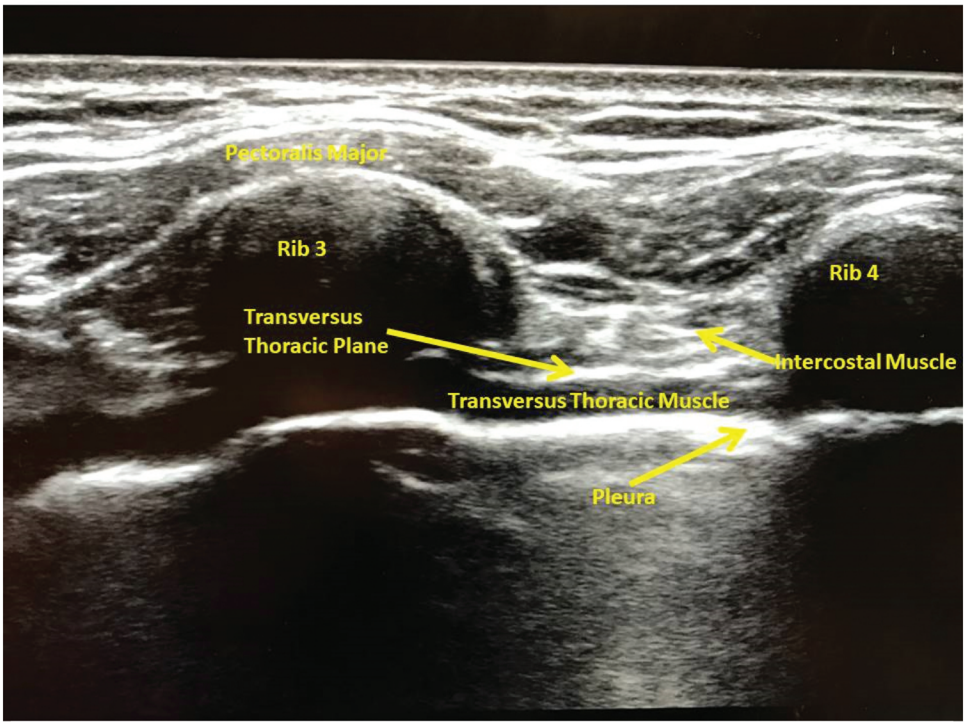

Figure 1. Ultrasound view of the transverse thoracic muscle plane.

umbilicus, 1 cm lateral to the midline. After identifying the rectus abdominis muscle and posterior rectus sheath (Figure 2), a needle in-plane was inserted through the rectus abdominis muscle until the tip reaches the space between the muscle and posterior rectus sheath, and 20 mL of 0.25% of Bupivacaine were injected bilaterally.

All of the patients in both groups underwent close observation for the skin and sternal incisions, as well as for the detection of any complications (such as pneumothorax, hematoma, bradycardia, hypotension, or infection "later on") in the nerve block group. The surgeons were asked to inject 10 mL of 0.25% bupivacaine into both groups' pleural chest tube locations. Every block is carried out using sterile procedures. If extubation on the table was the intended procedure, neuromuscular blockade was reversed using the medications neostigmine 0.05 mg/kg and atropine 0.02 mg/kg, as well as with careful aspiration of the oropharyngeal secretion. The ETT was then removed once all indications of the neuromuscular blockade's reversion were visible.

Patients from both groups were transported to the ICU for follow-up and additional monitoring while sedated,

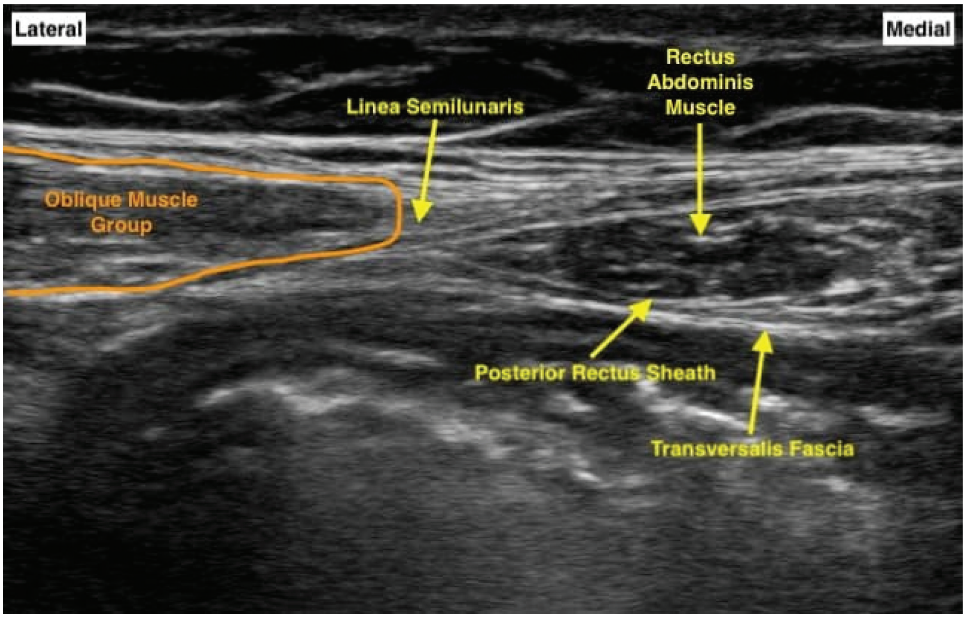

Figure 2. Ultrasound view of the rectus sheath plane.

mechanically ventilated (or, in the case of patients who were successfully extubated on a table, on an oxygen mask 5–10 L/min). Up to recovery from GA and extubation, a post-operative cardiac care plan with a stringent pain management strategy was in place according to the visual analogue score (VAS) assessment. VAS consisted of a 10 cm straight line with the endpoints defining extreme levels of "NO pain at all" (0 cm) and "pain as bad as it could be" (10 cm). A blind observer is asked to mark the pain level he observed on the patient in the ICU on the line between these two endpoints. The distance between 0 and the mark then denotes the patient's pain score. Based on the pain severity (evaluated by VAS score every 2 hours) and how frequently the patient requested painkillers post-extubation, doctors administered morphine increments of 5 mg per dose or 50–100 mcg of fentanyl per dose (100 mcg of Fentanyl are equivalent to 10 mg of Morphine) according to the availability without any favor of one opioid over the other. The goal is to keep all patients from both groups in the VAS range value below "4" when considering post-operative pain, which provides a good result for both groups.

4. Results

Statistical Package for Social Science (SPSS) programme (version 22.0) was used to update, code, and introduce the acquired data to a PC. For quantitative parametric data, the data were given as mean and standard deviation (± SD), for quantitative nonparametric data, as median and range, and for qualitative data, as numbers and percentage. The following was used to determine the significance of the probability (p-value): P-values 0.05, 0.001, and >0.05 were regarded as significant, extremely significant, and non-significant, respectively.

All information was gathered, plotted, and updated. The intraoperative opioid consumption was the primary outcome. The secondary outcomes included the time to extubation, postoperative pain assessment using VAS, and the total amount of opioids consumed from the time of skin incision through the first 6 hours following surgery.

The following information was analyzed:

4.1. Demographics

Age, sex, type and duration of surgery, and ASA demographic data were compared between groups, but no statistically significant difference was found.

4.2. Hemodynamics

Systolic arterial blood pressure (SPB) and heart rate (HR) showed no significant difference at pre-surgical incision time but both significantly decreased in B-group in comparison to S-group after skin and sternotomy incisions, respectively.

4.3. Intraoperative narcotic consumption

Data on intraoperative narcotic consumption by groups were looked at. Regarding the Fentanyl consumption, there was a statistically significant increase in S-group in comparison to that of the block group (Figure 3). However, there was no significant difference statistically between both groups as per Morphine consumption although patients belong to B-group needed less Morphine than those of the other group.

4.4. Extubation time

There was statistically significant decrease in extubation time in B-group in comparison to S-group (Figure 4). Two patients from the Block group had successful on-table extubations.

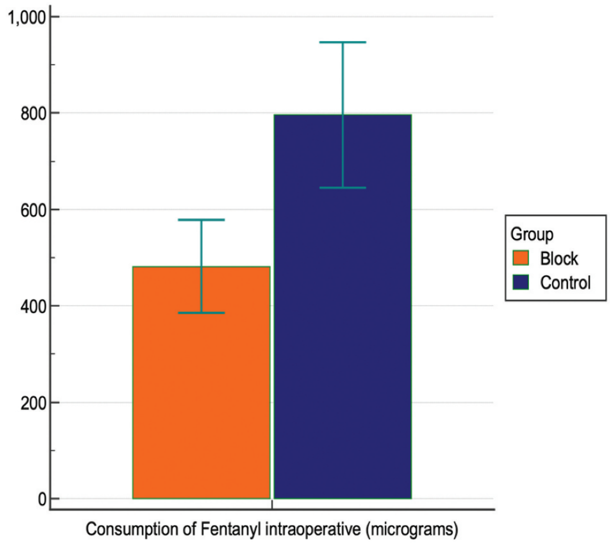

Figure 3. Bar graph between groups as regard intraoperative fentanyl consumption.

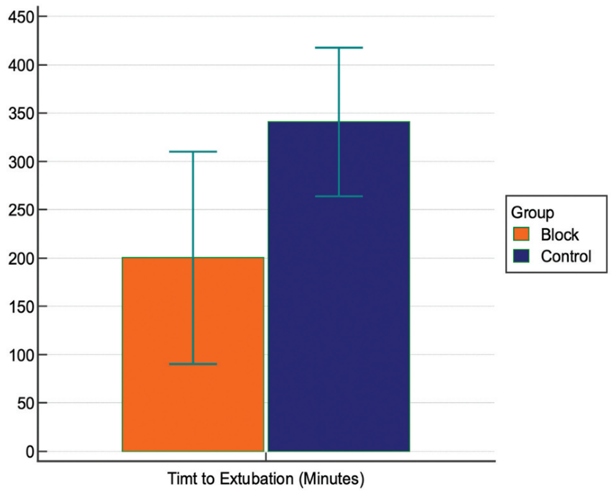

Figure 4. Bar graph between groups as regard postoperative extubation time.

4.5. Postoperative narcotic consumption

There was no statistically significant difference between the groups when postoperative narcotic use data within 6 hours of transfer to the ICU were analysed.

4.6. Postoperative VAS score

There was no statistically significant difference between groups when the postoperative VAS scores were done every 2 hours within the first 6 hours from the ICU admission (3 times assessment for each patient).

4.7. Postoperative complications

In the study population, there were no postoperative complications found.

5. Discussion

It has been established that the cornerstone for the management of postoperative pain in patients undergoing cardiac surgery through a median sternotomy is intravenous opioid analgesics. Combining local anaesthetic methods with low dose opioid-based general anaesthesia can reduce the stress response and enable early extubation. Raj N. noted this in his assessments of studies involving paediatric patients [5].

Patients who have had cardiac surgery frequently report severe postoperative discomfort at the site of the median sternotomy. According to Mueller et al. [6] and Lahtinen et al. [7], the sternal region experiences the most postoperative pain from postoperative day (POD) 1 to 7. On POD 4, 75% of patients reported continuing chest pain. Acute postoperative pain is linked to delirium, hemodynamic instability, pulmonary problems, and sympathetic activation [8–10].

The transversus thoracic muscle plane (TTP) block is a promising recently [11] developed muscle plane block technique that enables local anaesthetics to be deposited very close to the sternum in the muscle plane between the internal intercostal and transversus thoracic muscles and can produce perioperative analgesia for anterior chest wall surgical incisions. Various treatments have been successful in the past to reduce post-sternotomy pain [12] and may allow for early extubation [13]. In two surgical patients who needed median sternotomies, Ueshima et al. described the effective use of bilateral continuous TTP blocks for perioperative pain management. One patient had a thymectomy, whereas the another one had their aortic valve replaced. The TTP blocks were carried out while the patient was under general anaesthesia in both situations. Under ultrasound guidance, 40 mL of 0.25% bupivacaine was administered bilaterally into the fascial plane at the fourth and fifth intercostal spaces, which is located between the transversus thoracis muscle and the intercostal muscle. Through catheters implanted at each injection site, a continuous infusion of 0.1% levobupivacaine was then given at a rate of 10 mL per hour per side. Every 30 minutes, further demand doses of 3 mL of 0.1% bupivacaine were made available. Neither patient needed any extra analgesia following surgery. Their research demonstrated that after median sternotomy, bilateral continuous TTP blocks alone were sufficient for postoperative analgesia [14].

Fifty seven patients ($n = 57$) who met the inclusion criteria for the trial and had previously been scheduled for elective heart surgery were allocated into two groups at random. The block group (B-group) received 20 ml of 0.25% bupivacaine in each transverse thoracic muscle plane and rectus sheath plane ($n = 25$), while the saline group (S-group) received normal saline injections in the same planes ($n = 25$), with a net sample size of 50 patients ($n = 50$), after excluding three patients ($n = 3$) from S-group and four patients ($n = 4$) from B-group due to re-exploration and post-surgical complications (Figure 5).

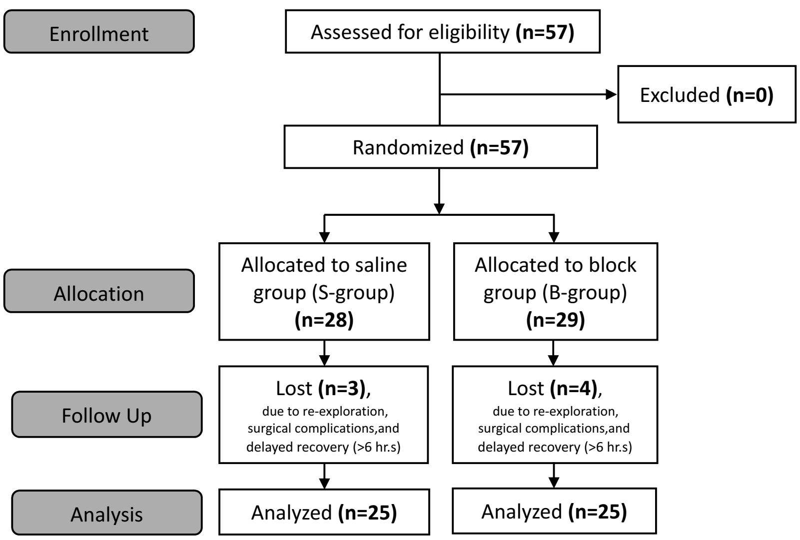

Figure 5. Flow chart of patient randomization.

As regard the patients' demographic information (table 1), numerous research with various sample sizes and patient types revealed no appreciable variance as seen in Ibrahim I. and Nabil A. study that involved 80 pediatric patients who were scheduled for elective surgery to treat congenital cardiac conditions [3]. The same findings were reached by Jeffrey P. and his colleagues, who also conducted a trial on 190 adult patients to determine whether early extubation with the TTP block was possible [13]. In their investigation, there was no statistically significant difference between the groups. Additionally, there were nothing found across the study groups in terms of procedure-related complications. This provided a uniform platform to evenly compare the results obtained.

Regarding the intraoperative hemodynamics monitoring between the groups, there was a significant difference between them favoring the B-group, where less hemodynamic fluctuations occurred and hence the need for more opioids and less need to vasoactive medications, with HR (mean±SD) of value (70.56 ± 13.9) bpm and (75.2 ± 14.9) bpm just after skin incision and sternotomy, respectively vs (81.92 ± 17.2) bpm and (84.64 ± 12.2) bpm in S-group during the same moments with p-values (0.01) after skin incision and (0.02) after sternotomy incision. Also, when comparing the SBP between the groups, it was noticed that B-group showed (mean±SD) of value (116.04 ± 13.7) mmHg just after skin incision and (125.44 ± 17.1) mmHg after sternotomy incision Vs (138.56 ± 17.1) mmHg and (133.88 ± 10.8) mmHg after skin and sternotomy incisions, respectively, in S-group with p-values (<0.001) and (0.04) (table 2). These results were similar to that of Ibrahim I. and Nabil A. study in 2020.

Ueshima and his colleagues explained how there was a significant difference between the two groups with regard to the use of opioids intraoperatively [4]. Our findings were consistent, particularly with regard to intraoperative Fentanyl consumption, with the B-group consuming less of the drug (482 ± 96.7) micrograms vs. (796 ± 151.3) micrograms in the S-group, yielding a p-value of (0.001). These findings placed this study as the best option for managing intraoperative pain and supporting the advantages of regional anaesthesia in any elective cardiac surgery. Although the B-group consumed less morphine intraoperatively, there was no discernible difference between the two groups with p-value (0.14) (table 3). The perfusionists choosing mor-

Table 1. Comparison between groups with regard to demographic data.

Demographic data		Block group (*n*=25)	Saline group (*n*=25)	T/x2	*p*-Value
Age (years)		39.12 ± 12.2	41.16 ± 9.9	0.7^{t}	0.52
Sex	Male	16 (64%)	12 (48%)	1.3^{x2}	0.26
	Female	9 (36%)	13 (52%)		
Surgery	ASD Closure	1 (4%)	0 (0%)	6.3^{x2}	0.78
	Atrial Myxoma Excision	1 (4%)	1 (4%)		
	AVR	5 (20%)	5 (20%)		
	CABG	5 (20%)	3 (12%)		
	CABG + MVR	1 (4%)	2 (8%)		
	MVR	4 (16%)	8 (32%)		
	MVR + AVR	3 (12%)	3 (12%)		
	MVR + AVR + TV repair	0 (0%)	1 (4%)		
	MVR + TV repair	3 (12%)	2 (8%)		
	Supracoronary Aortic Aneurysmal Repair	1 (4%)	0 (0%)		
	TVR	1 (4%)	0 (0%)		
Duration of surgery (minutes)		222.0 ± 61.8	220.8 ± 57.3	0.07^{t}	0.94

Data expressed as mean ± SD, proportion. *t* = student t test, x2= Chi square test.

Table 2. Comparison between groups with regard to hemodynamics data.

Hemodynamics data	Block group (*n*=25)	Saline group (*n*=25)	t	*p*-Value
HR before skin incision	63.92 ± 13.6	70.6 ± 15.7	1.6	0.11
HR after skin incision	70.56 ± 13.9	81.92 ± 17.2	2.6	**0.01**
HR before sternotomy incision	72.64 ± 13.8	79.04 ± 11.7	1.8	0.08
HR after sternotomy incision	75.2 ± 14.9	84.64 ± 12.2	2.5	**0.02**
SBP before skin incision	98.64 ± 11.9	99.88 ± 10.3	0.4	0.70
SBP after skin incision	116.04 ± 13.7	138.56 ± 17.1	5.1	**<0.001**
SBP before sternotomy incision	117.08 ± 11.8	123.28 ± 9.9	2.0	**0.05**
SBP after sternotomy incision	125.44 ± 17.1	133.88 ± 10.8	2.1	**0.04**

Data expressed as mean ± SD. *t* = student t test.

Table 3. Comparison between groups with regard to intraoperative narcotic consumption data.

	Block group (*n*=25)	Saline group (*n*=25)	t	*p*-Value
Consumption of Fentanyl intraoperative (micrograms)	482 ± 96.7	796 ± 151.3	8.7	**<0.001**
Consumption of Morphine intraoperative (milligrams)	3.4 ± 3.5	4.6 ± 2.0	1.5	0.14

Data expressed as mean ± SD. *t* = student t test.

Table 4. Comparison between groups as regards time to extubation.

	Block group (*n*=25)	Saline group (*n*=25)	t	*p*-Value
Time to extubation (minutes)	198.0 ± 105.3	321.6 ± 57.1	5.15	**<0.0001**

Data expressed as mean ± SD. *t* = student t test.

Table 5. Comparison between groups with regard to postoperative narcotic consumption data.

	Block group (*n*=25)	Saline group (*n*=25)	t	*p*-Value
Consumption of Fentanyl postoperative (micrograms)	104 ± 73.5	120 ± 64.5	0.8	0.42
Consumption of Morphine postoperative (milligrams)	3 ± 2.5	3.4 ± 2.4	0.6	0.57

Data expressed as mean ± SD. *t* = student t test.

Table 6. Comparison between groups with regard to postoperative VAS score.

	Block group (*n*=25)			Saline group (*n*=25)			
	Range	Median	IQR	Range	Median	IQR	P-value
VAS	2–6	3	3–4	2–5	3	3–4	0.8

Data expressed as range, median and IQR, *p* = Mann–Whitney test.

phine over fentanyl during CPB time – due to its favourable pharmacokinetics – is the rationale for this large disparity between intraoperative morphine and fentanyl consumption.

There was a significant difference in the study groups' extubation times in the ICU, with the B-group patients were extubated sooner than the S-group patients (mean±SD) of (198.0 ± 105.3) minutes compared to (321.6 ± 57.1) minutes in the S-group, with a p-value of (0.0001) (table 4). With an average skin-to-skin time of roughly 150 minutes, two patients from the B-group who underwent the identical procedure (mitral valve replacement) were successfully extubated on the operating room table. This led to better results in the postoperative period. In their investigation, which had 190 adult patients, Jeffrey P. and his colleagues reported and strongly backed similar findings.

In contrast to what M. E. Aydin and his colleagues concluded in their study, our findings in the current study revealed that although the block group's postoperative opioid consumption was lower than that of the saline group's even though we used the same Aydin's technique, there was no significant difference between them (table 5). Additionally, the median postoperative VAS scores were nearly identical in both groups, with a p-value of (0.8) (table 6). The relative short duration of action of bupivacaine to cover the entirety of the procedure may be the cause of this. The unequal distribution of the LA in the targeted block plane and the surgical dissection in the same plane during the internal thoracic artery harvesting are further potential causes of the TTP block's limited postoperative analgesic impact. Previous surgery in the TTP plane can further reduce the effectiveness of the TTP block. The spread of local anaesthetic following TTP block in a patient who had previously undergone internal thoracic artery harvest was examined in a cadaver study by Fujii et al. The transversus thoracis plane experienced nonuniform local anaesthetic dissemination due to tissue displacement and scar remodelling during surgery, which could have resulted in a poor or ineffective block [15].

Regarding pneumothorax, hematoma formation at the site of injection, LA toxicity/allergy, or infection at the site of injection in the first week retrospectively during the routine wound dressing, there were no complications plotted out or reported during following up the patients in the first postoperative 24 hours, according to the eligible cardiac surgeons.

Finally, this study on 50 patients undergoing elective cardiac surgery (after excluding 7 patients) demonstrated the benefit of the TTP block combined with the RSP block as a helpful pain modality rather than the massive amounts of intravenous opioids consumed during the intraoperative period. It has been demonstrated in practice that early extubation reduces the risk of hemodynamic affliction, ventilator-associated pneumonia (VAP), and barotraumas linked with positive-pressure ventilation (PPV). Controlling one of the main factors that raises the failure rates of weaning from mechanical ventilation (MV) and re-intubation is essential for achieving early but safe extubation. This factor is post-sternotomy pain. The latter results in respiratory failure by causing hypoventilation and pulmonary atelectasis. Less opioid use promotes fast-tract extubation, reduces side effects, and generates greater financial gains for cardiac centers.

6. Conclusion

As a pain management technique, using TTP block in combination with RSB in cardiac patients undergoing elective cardiac surgery through a median sternotomy has decreased intraoperative opioid consumption, produced less hemodynamic fluctuations in response to surgical stress, and improved fast-tract extubation. Opioid use after surgery was not significantly affected by routine pain score assessment.

Abbreviations

ASA	American Society of Anesthesiology
CABG	Coronary Artery Bypass Graft
CPB	Cardio-Pulmonary Bypass
CVC	Central Venous Catheter
ETCO2	End Tidal CO2
ETT	Endo-Tracheal Tube
FiO2	Fraction of Inspired Oxygen
HR	Heart Rate
IABP	Intra-Aortic Balloon Pump
IBP	Invasive Blood Pressure
ICU	Intensive Care Unit
IMA	Internal Mammary Artery
LA	Local Anesthetic
mcg	Microgram
mg	Milligram
MV	Mechanical Ventilation
NRS	Numerical Rating Scale
POD	Postoperative Day
PPV	Positive-Pressure Ventilation
RSP	Rectus Sheath Plane
SBP	Systolic Blood Pressure
SD	Standard Deviation
TTP	Transverse Thoracic muscle Plane
VAP	Ventilator-Associated Pneumonia
VAS	Visual Analogue Score

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Disclosure statement

No potential conflict of interest was reported by the author(s).

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