Original Article

Is Continuous Erector Spinae Plane Block (ESPB) Better than Continuous Serratus Anterior Plane Block (SAPB) for Mitral Valve Surgery via Mini-Thoracotomy? Results from a Prospective Observational Study

Antonio Toscano[1], Paolo Capuano[2], Andrea Costamagna[1], Federico G. Canavosio[1], Daniele Ferrero[1], Elisabetta M. Alessandrini[2], Matteo Giunta[1], Mauro Rinaldi[2,3], Luca Brazzi[1,2]

Departments of [1]Anesthesia, Critical Care and Emergency, [3]Cardiovascular and Thoracic Surgery, 'Città della Salute e della Scienza' Hospital, Turin, [2]Department of Surgical Sciences, University of Turin, Turin, Italy

ABSTRACT

Aims: Chest wall blocks are effective alternatives for postoperative pain control in mitral valve surgery in right mini-thoracotomy (mini-MVS). We compared the efficacy of Serratus Anterior plane block (SAPB) and Erector Spinae plane block (ESPB) on postoperative pain relief after mini-MVS.

Settings and Design: It is a prospective, observational study.

Material and Methods: A total of 85 consecutive patients undergoing continuous SAPB and continuous ESPB for mini-MVS from March 2019 to October 2020 were included. The primary outcome was the assessment of postoperative pain evaluated as absolute value of NRS at 12, 24 and 48 h. Secondary outcomes were assessment of salvage analgesia (both opioids and NSAIDs), incidence of mild adverse effects (i.e. nausea, vomiting, and incorrect catheter placement) and timing of postoperative course (ICU and hospital length of stay, duration of mechanical ventilation, ventilator-free days).

Results: The median NRS was 0.00 (0.00–3.00) at 12 h and 0.00 (0.00–2.00) at 24 and 48 h. No significant differences were observed between groups. Postoperative morphine consumption in the first 24 h was similar in both groups ($P = 0.76$), whereas between 24 and 48 h was significantly less in the ESPB group compared with SAPB group, $P = 0.013$. NSAIDs median consumption and Metoclopramide consumption were significantly lower in the ESPB group compared to SAPB group ($P = 0.002$ and $P = 0.048$, respectively).

Conclusions: ESPB, even more than SAPB, appears to be a feasible and effective strategy for the management of postoperative pain, allowing good quality analgesia with low consumption of opioids, NSAIDs and antiemetic drugs.

Keywords: Cardiac surgery, Erector Spinae Plane Block, pain management, regional anesthesia, Serratus Anterior Plane Block

Address for correspondence: Dr. Antonio Toscano, Department of Anesthesia, Critical Care and Emergency, 'Città della Salute e della Scienza' Hospital, Corso Bramante 81, CAP 10126, Torino, Italy.
E-mail: antoniotoscano@me.com

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INTRODUCTION

Postoperative pain contributes to many postoperative complications in patients undergoing cardiac surgery[1] such as prolonged mechanical ventilation and lung infections.[2,3] Neuraxial anesthesia, mainly thoracic epidural

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analgesia, and deep plexus blocks, has been proposed to achieve a better postoperative pain control[4] particularly in the context of minimally invasive cardiac surgery.

Unfortunately, in cardiac surgery patients, anticoagulant and antiplatelet administration increase the risk of epidural hematoma classically related to neuraxial procedures.[5] It follows that the American Society of Regional Anesthesia and Pain Medicine (ASRA) is still recommending a conservative approach to neuraxial techniques and other deep blockades, such as thoracic paravertebral block.[6]

Nonetheless, recent evidence suggests that chest wall blocks such as continuous Serratus Anterior Plane Block (SAPB) and continuous Erector Spinae Plane Block (ESPB) are effective alternatives for postoperative pain control in patients undergoing minimally invasive cardiac surgery,[7-12] also in patients receiving antiplatelet and anticoagulant therapy.[13] This has been confirmed by a panel of seven experts of the Regional Anaesthesia and Acute Pain Section of the Canadian Anaesthesiologists' Society who reviewed the evidence and classified the risk of bleeding complication after thoracic Erector Spinae Plane Block and Serratus Anterior Plane Block as low and intermediate, respectively.[14]

We designed the present prospective observational cohort study to compare the efficacy of SAPB and ESPB on postoperative pain relief in the first 48 postoperative hours after right mini-thoracotomy mitral valve surgery.

MATERIALS AND METHODS

It is prospective, observational study conducted from March 2019 to October 2020 (local Ethics Committee approval number 401/2019, March 25, 2019).

All consecutive patients undergoing continuous Serratus Anterior Plane Block (SAPB) or continuous Erector Spinae Plane Block (ESPB) for right mini-thoracotomy mitral valve surgery and providing written consent to data collection were included. Exclusion criteria were age below 18 years, history of opioid abuse and postoperative analgesia performed with intravenous opioid.

According to local peri-operative protocols, general anesthesia was induced by intravenous (IV) Midazolam, Propofol or Etomidate, plus an IV opiate (Fentanyl or Sufentanil, according to anesthesiologist choice). Neuromuscular blockade was achieved with induction bolus and continuous infusion of Cisatracurium. Anesthesia was maintained by total intravenous infusion of Propofol, and intraoperative analgesia was achieved by total intravenous infusion of Sufentanil, tailored on patient's heart rate, blood pressure and Bispectral Index values.

Deep continuous Serratus Anterior Plane Block (SAPB)

Deep SAPB was performed before the surgical incision, using a 20-gauge, 50 mm Contiplex S Ultra 360 (B. Braun Melsungen AG) with ultrasound in-plane guidance. Target site was fascial plane localized between Serratus Anterior muscle posterior surface and lateral periosteum of 5th right rib on mid-axillary line. Preoperative SAPB was accomplished by ropivacaine 0.375% 150 mg single-shot injection, followed by a peripheral nerve catheter positioning [Figure 1]. At the end of surgery continuous infusion with Ropivacaine 0,3% 7ml/h infusion rate was initiated and maintained according to clinical needs. The regional catheter was removed after 48h, immediately after the last pain detection.

Continuous Erector Spinae Plane Block (ESPB)

ESPB was performed before general anesthesia, with patients in sitting position and using a linear ultrasound transducer placed on the parasagittal plane about 3 cm lateral to the

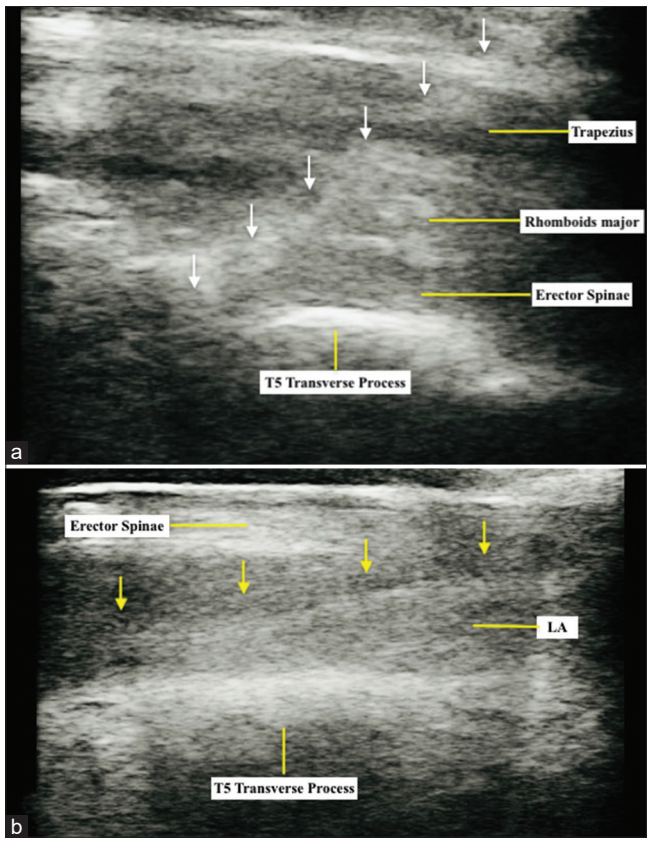

Figure 1: Continuous Erector Spinae Plane block. a) The tip of the needle reaches the point between the T5 transverse process and the erector spinae muscle. b) Ultrasound image of catheter positioned above the T5 transverse process and below the erector spinae muscle after local anesthetic (LA) injection

T5 spinous process. Trapezius (uppermost), rhomboids major (middle), and erector spinae (lowermost) muscles were identified superior to the hyperechoic transverse process. After Local infiltration with 2% of lignocaine, using in-plane approach, an a 22-gauge, 50 mm SonoPlex Stim needle (Pajunk Medical System, Tucker GA) was inserted in caudal–cephalad direction having the tip of T5 transverse process below the erector spinae muscle as endpoint for the needle tip.

Preoperative ESPB was accomplished by ropivacaine 0.375% 150 mg single-shot injection, followed by a peripheral nerve catheter positioning (Pajunk Plexolong NanoLine) [Figure 2].

At the end of surgery, continuous infusion with Ropivacaine 0,3% 7 ml/h infusion rate was initiated and maintained according to clinical needs. The regional catheter was removed after 48h, immediately after the last pain detection.

Perioperative management

Intraoperative care, including Cardio-Pulmonary Bypass (CPB), was managed within standard practice, thus encompassing One-Lung Ventilation techniques, ultrasound-guided vascular cannulation, mild hypothermic CPB with indirect anterograde cardioplegia, and intra-operative homeostasis (glycemic control and hemotransfusion according to patient's need).

At the end of surgery, patients were transferred in cardiac surgical intensive care unit (ICU) for monitoring, respiratory weaning and standard postoperative management. Sedation was maintained by Propofol infusion until deemed necessary by on-duty intensivist. The postoperative pain was managed with a multimodal opioid-sparing strategy based on loco-regional analgesia and continuous local anesthetic infusion (SAPB or ESPB).

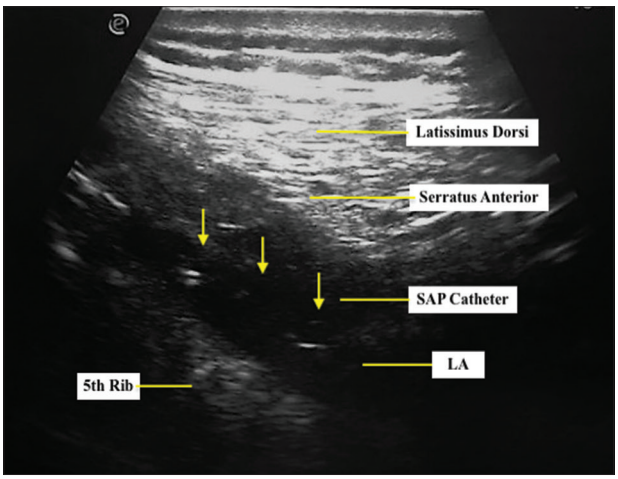

Figure 2: Continuous Serratus Anterior Plane Block. Ultrasound image of catheter positioned between the fifth rib and the serratus anterior muscle after local anesthetic (LA) injection

All patients received timed administration of paracetamol (1g every 8 h) for 48 h and rescue doses of Morphine, Tramadol or Ketorolac were utilized according to on-duty intensivist judgment to ensure pain control if breakthrough pain did occur.

Data collection and analysis

Demographics characteristics, type and duration of surgery, timing and dosage of pain-related medications and data regarding postoperative course were collected. Pain was evaluated by attending physicians using Number Rating Scale (NRS) at least at 3hs intervals in first postoperative day, and subsequently at least once a day. Recovery from anesthesia was evaluated by Richmond Agitation Sedation Scale (RASS), recorded by attending physicians at regular intervals like before. Recovery was classified 'deep-to-moderate', when RASS was below –3, or 'light-to-no sedation', when RASS was between –2 and +1. Nausea was evaluated using a scale from 0 to 3 (0 = absence; 1 = weak nausea; 2 = strong nausea; 3 = very strong nausea) according to local protocol, and bowel function was evaluated using a scale from 0 to 2 (0 = absence of bowel activity; 1 = gas; 2 = feces).

Postoperative morphine use was computed as the cumulative morphine dose resulting from eventual postoperative infusion and/or rescue dose in the postoperative period. If tramadol was used, we computed tramadol 100 mg equal to morphine equation 10 mg. Nonsteroidal anti-inflammatory drug (NSAID) medication rescue was computed separately.

Study outcomes

The primary outcome was postoperative pain evaluated as absolute value of NRS at 12, 24, and 48 h. Secondary outcomes were the need for salvage analgesia (both opioids and NSAIDs), incidence of mild adverse effects (i.e. nausea, vomiting, and incorrect catheter placement), quality (RASS) and timing of postoperative course (ICU and hospital length of stay, duration of mechanical ventilation, ventilator-free days).

Statistical analysis

There is evidence[10] that the mean postoperative NRS score at 24 h after surgery is 2.15 [95% CI 1.22–3.09] in cases where SAPB is performed. With the aim of highlighting a 35% difference in NRS with α =0.05, β =0.15 and assuming a possible drop-out rate of 15%, it was decided to include 85 patients in the study (37 per arm + 15%).

Data were tested for normal distribution by Shapiro–Wilk test and are expressed as mean and standard deviation (SD), mean with 95% confidence interval or median with interquartile range 25-75 (IQR), as appropriate. Data analysis was performed for parametric variables with test for independent sample. The Wilcoxon equality test for matched data was used for non-parametric continuous variables. Categorical variables were analyzed with Chi2 or Fisher's exact test, as appropriate. Statistical analyses were performed using SPSS statistics software, version 27 (IBM). A value of $P < 0.05$ was considered statistically significant.

RESULTS

During study period, 179 patients underwent mitral valve surgery via mini thoracotomy: 94 patients received intravenous analgesia via opioids infusion and 85 received multimodal analgesia. Among them, 47 patients were treated with SAPB and 38 with ESPB. Four and two in the SAPB and ESPB groups, respectively, had the fascial catheter for postoperative analgesia accidentally removed and were therefore considered dropouts and removed from the analysis [Figure 3]. There were no statistical differences between the two groups [Table 1].

The median NRS was 0.00 (0.00 – 3.50) and 0.00 (0.00 – 2.00), 0.00 (range 0.00 to 3.50) and 0.50 (range 0.00 to 2.00), 1.00 (range 1.00 to 3.00) and 0.00 (range 0.00 to 2.00) in SAPB and ESPB group at 12 ($P = 0.93$), 24 ($P = 0.41$) and 48 h ($P = 0.17$), respectively.

Postoperative median total morphine consumption was 0.00 mg (range 0.00 to 4.00 mg) and 0.00 mg (range 0.00 to 3.00 mg) in SAPB and ESPB group, respectively ($P = 0.38$). Postoperative morphine consumption in the first 24 h was similar in both groups ($P = 0.76$) while between 24 and 48 h was significantly less in the ESPB group compared with SAPB group ($P = 0.013$) [Table 2].

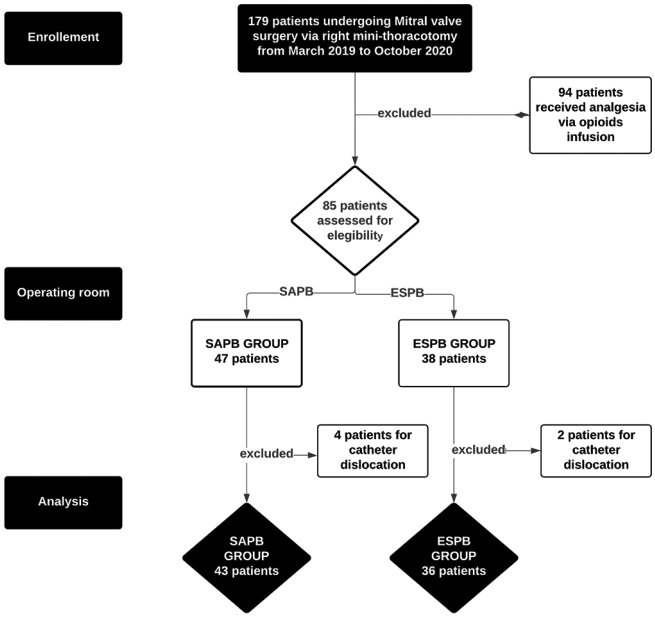

Figure 3: Flow-chart Study

NSAIDS rescue analgesia median consumption was significantly lower in the ESPB group compared to SAPB group: 0.00 mg (range 0.00 to 0.00) versus 0.00 mg (range 0.00 to 30.00 mg), respectively ($P = 0.002$).

Metoclopramide consumption was significantly lower in ESPB group compared with SAPB group ($P = 0.048$) while no significant difference in Ondasetron use was observed between groups. No significant differences were observed in the incidence of postoperative nausea and vomiting (PONV) and return to bowel function between groups.

Median RASS values were –4,00 (range –4.00 to –4.00) and –5.00 (range –5.00 to –3.00), 0.00 (range 0.00 to 0.00) and –2.00 (range –3.50 to 0.00) in ESPB and SAPB group at 3 and 6 h, respectively, while median RASS was 0.00 in both groups at 12, 24, and 48 h post-surgery [Table 3].

Mechanical ventilation lasted 420.00 min (range 330.00 to 520.00 min) and 495.00 min (range 330.00 to 700.00 min) in the ESPB and SAPB group, respectively ($P = 0.12$). Ventilator free days were 27.00 (range 26.00 to 27.00) in both groups ($P = 0.053$).

No significant differences were observed in ICU and hospital length of stay.

No adverse effects directly attributable to analgesic technique were observed. One patient needed surgical drainage of right hemothorax five days after ICU discharge, due to surgical bleeding in systemic anticoagulation setting. No in-hospital death was observed.

DISCUSSION

The results of this prospective observational study suggest that either continuous Erector Spinae Plane Block or continuous Serratus Anterior Plane Block seem able to guarantee good quality analgesia and low consumption of opioids in the 24 h following right mini-thoracototomy for mitral valve surgery. Continuous Erector Spinae Plane Block seems even able to decrease the incidence of postoperative nausea and vomiting and the total amount of postoperative NSAID and antiemetics drugs needed in the postoperative period.

Table 1 Baseline characteristics of patients and surgery related variables

Variables	Overall *n*=79	SAPB group *n*=43	ESPB group *n*=36	*P*
Age (years)	62.03±15.13	60.55±15.79	63.85±14.28	0.35
Gender (M/F)	42/37	22/21	20/16	0.69
Weight (Kg)	70.66±13.03	69.23±12.27	72.36±13.86	0.29
Height (cm)	168.86±10.68	168.93±10.68	168.78±10.83	0.95
BMI (kg/m^2)	24.79±4.14	24.23±3.70	25.45±4.58	0.19
ASA	3 (3-3)	3 (3-3)	3 (3-3)	0.10
Surgery MV replacement	31 (39.25%)	18 (41.86%)	13 (36.12%)	0,60
MV repair	48 (60.75%)	25 (58.14%)	23 (63.88%)	
CPB (min)	118.74±28.58	122.92±28.08	111.83±28.66	0.14
Clamp (min)	89.75±24.15	94.11±23.81	82.57±23.47	0.07
Intraoperative Sufentanil (µg)	174.86±58.38	186.03±68.67	161.25±39.57	0.5

BMI: Body Mass Index; ASA score: American Society of Anesthesiologists physical status classification system; CPB: Cardiopulmonary bypass; Clamp: aortic clamp; MV, mitral valve; SAPB, serratus anterior plane block; ESPB, erector spinae plane block

Table 2: Outcomes measures

Variables	Overall *n*=79	SAPB group *n*=43	ESPB group *n*=36	*P*
NRS 12 h	0.50 (0.00-3.00)	0.00 (0.00-3.50)	1.00 (0.00-2.00)	0.93
NRS 24 h	0.00 (0.00-2.00)	0.00 (0.00-3.50)	0.50 (0.00-2.00)	0.41
NRS 48 h	0.00 (0.00-2.00)	1.00 (0.00-3.00)	0.00 (0.00-2.00)	0.17
Morphine consumption 24 h (mg)	0.00 (0.00-2.00)	0.00 (0.00-0.00)	0.00 (0.00-0.75)	0.76
Morphine consumption 24-48 h (mg)	0.00 (0.00-0.00)	0.00 (0.00-0.00)	0.00 (0.00-0.00)	0.013*
Morphine total consumption (mg)	0.00 (0.00-3.00)	0.00 (0.00-4.00)	0.00 (0.00-3.00)	0.38

NRS: numeric rating scale; Morphine tot: total morphine consumption (continue infusion + rescue dose); Morphine consumption 24 h: total morphine doses in the first 24 postoperative hours; Morphine consumption 24-48: total morphine doses between 24 and 48 postoperative hours; SAPB, serratus anterior plane block; ESP, erector spinae plane block; *, significant result; Note: Results are presented as means with 95% confidence intervals

Table 3: Secondary outcomes and other drugs consumption

Variables	Overall *n*=79	SAPB group *n*=43	ESPB group *n*=35	*P*
Rass 3h	-4.00 (-5.00 to -4,00)	-5.00 (-5.00 to -3,00)	-4,00 (-4,00 to -4,00)	0.25
Rass 6h	0.00 (-3.00 to 0.00)	-2.00 (-3.50 to 0,00)	0.00 (-0.00 to 0.00)	0.002*
Rass 12 h	0.00 (0.00 to 0.00)	0.00 (0.00 to 0.00)	0.00 (0.00 to 0.00)	0.31
Nausea 24 h	3 (3.80%)	3 (100%)	0 (0%)	0.24
Nausea 48 h	2 (2.53%)	2 (100%)	0 (0%)	0.49
Bowel activity 24 h	23 (29.11%)	11 (47.80%)	12 (52.20%)	0.46
Bowel activity 48 h	32 (40.50%)	15 (46.90%)	17 (53.10%)	0.36
Mv duration (min)	425.00 (330.00-600.00)	495.00 (330.00-700.00)	420.00 (330.00-520.00)	0.12
Vfds (days)	27.00 (26.00-27.00)	26.00 (26.00-27.00)	27.00 (26.00-27.00)	0.14
Icu discharge (days)	1.00 (1.00-1.00)	1.00 (1.00-1.00)	1.00 (1.00-1.00)	0.54
Hospital discharge (days)	6.00 (5.00-7.00)	6.00 (5.00-8.00)	6.50 (6.00-7.00)	0.85
Ketorolac (mg)	0.00 (0.00-30.00)	0.00 (0.00-30.00)	0.00 (0.00-0.00)	0.002*
Metoclopramide (mg)	0.00 (0.00-0.00)	0.00 (0.00-0.00)	0.00 (0.00-0.00)	0.048*
Ondasetron (mg)	0.00 (0.00-1.00)	0.00 (0.00-0.00)	0.00 (0.00-4.00)	0.14

MV duration: Mechanical ventilation duration, time (min) between ICU admission and extubation; VFDS: ventilator free days, one point [for] each day during the measurement period that [patients] are both alive and free of mechanical ventilation in the first 28 days; ICU discharge: time (days) between ICU admission and discharge; Hospital discharge: time (days) between ICU discharge and hospital discharge; RASS: Richmond Agitation Sedation Scale; SAPB: serratus anterior plane block; ESPB: erector spinae plane block; Note: Results are presented as median (range 25-75), mean with 95% confidence interval and percentages, *, significant result

The efficacy of single injection Serratus Anterior Plane Block and Erector Spinae Plane block has been previously evaluated in two randomized studies designed to evaluate pain after minimally invasive thoracic surgery.[15,16] It has been reported that Erector Spinae plane block was able to reduce intraoperative and postoperative opioids use and to allow a better quality of recovery and fewer postoperative complications compared to the deep Serratus Anterior Plane Block.

In the context of minimally invasive cardiac surgery, only a single retrospective observational study compared the efficacy of continuous Erector Spinae Plane Block, Serratus Anterior plane block and single-shot Paravertebral block versus no block after robotic minimally invasive direct coronary artery bypass graft.[17] And no significant differences among blocks in terms of milligram equivalents of total morphine consumed during the first 72 h after surgery were found. Notwithstanding, continuous ESPB allowed a significantly shorter length of hospital stay in comparison with continuous SAPB. No pain assessment was reported.

With the development of the Enhanced Recovery program also in the context of cardiac surgery, the interest in regional anesthesia approaches for minimally invasive cardiac surgery has progressively grown and several studies compared the effectiveness of Serratus Anterior plane block and Erector Spinae plane block with traditional opioid-based anesthesia[10,13] or with alternative strategies, such wound infiltration,[17] thoracic epidural anesthesia,[18] pectoral nerve block[8] and intercostal nerve block.[19]

Despite the growing evidence suggesting the use of opioid-free and opioid-sparing techniques, the optimal management to apply in the specific context of cardiac surgery is undetermined yet.[20]

Even the optimal volume of local anesthetic to be administered to obtain the ESPB has not been established yet.[21,22] There are evidence suggesting a greater paravertebral spread after injection of 30 mL of local anesthetic.[23] And, based on this finding, a 40 mL volume of 0.375% Ropivacaine was chosen in our study.

Similarly, 2 recent human cadaver studies, showed that using SAPB and 40 ml of volume the block's distribution provided a more reliable analgesic coverage from T2 to T9.[24,25] Based on these findings, the same volume was used for the SAPB in our study.

Complications after ESPB and SAPB, such as local anesthetic systemic toxicity, pneumothorax, nerve injury and bleeding, are rarely reported in the literature. In the present study, no anesthesia-related complications were recorded even in a high bleeding risk population such as cardiac patients undergoing Cardio-Pulmonary Bypass. The incidence of minor side effects was also limited in our study and in line with what has already been observed in other studies analyzing the incidence of postoperative nausea and vomiting in fast-track cardiac surgery.[26]

The present study has some limitations: first, lack of randomization which is a potential source of bias; secondly, the lack of a standardized protocol for general anesthesia. Moreover, we did not perform dermatomal sensory testing; this could even help to better understand the differences in efficacy areas between the two blocks.

CONCLUSIONS

Both Erector Spinae Plane Block and Serratus Anterior Plane Block appears to be feasible and effective postoperative pain management in patients undergoing right mini-thoracotomy mitral valve surgery, allowing good quality analgesia with low consumption of opioids.

Continuous Erector Spinae Plane Block seems to be particularly able to maximize the reduction of postoperative morphine and NSAID consumption ensuring a better postoperative course and a lower incidence of postoperative nausea and vomiting.

Future randomized studies are needed to confirm these preliminary results.

Compliance with ethical standards

Research involving human participants and/or animals. The study has been performed in accordance with the ethical standards of the Declaration of Helsinki and its later amendments.

All the patients signed the informed consent.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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