A Comparison of the Analgesic Efficacy of Serratus Anterior Plane Block Vs Paravertebral Nerve Block for Video-assisted Thoracic Surgery: a Randomized Controlled Trial

Yi Zhang
China Medical University First Hospital
Ze Fu
China Medical University First Hospital
Te Fang
China Medical University First Hospital
Kexin Wang
China Medical University First Hospital
Zimeng Liu
China Medical University First Hospital
Hongqing Li
China Medical University First Hospital
Wenwen Jiang
China Medical University First Hospital
Xuezhao Cao (xuezhaocao2011@163.com)
First Hospital of China Medical University

Research article

Keywords: postoperative pain, serratus anterior plane block, deep serratus plane block, superficial serratus anterior plane block, paravertebral nerve block, video-assisted thoracic surgery

Posted Date: December 11th, 2020

DOI: https://doi.org/10.21203/rs.3.rs-125277/v1

Version of Record: A version of this preprint was published at Videosurgery and Other Miniinvasive Techniques on January 1st, 2021. See the published version at https://doi.org/10.5114/wiitm.2021.105725.

Abstract

Background: Patients who undergo video-assisted thoracic surgery (VATS) that impair the integrity of the chest wall frequently experience moderate to severe postoperative pain. Serratus anterior plane block (SAPB) is a relatively novel technique that can block the lateral cutaneous branches of the intercostal nerves as well as the long thoracic nerve.

Methods: Our study aimed to evaluate the analgesic efficiency of deep serratus plane block (DSPB) and superficial serratus anterior plane block (SSPB) as well as paravertebral nerve block (PVB) in the patients undergoing VATS. A total of 74 patients aged from 20-80 undergoing VATS were randomized to receive either DSPB or SSPB as well as PVB. Ultrasound (US) guided DSPB or SSPB as well as PVB with 20ml 0.5% ropivacaine was performed preoperatively to the patients according to their groups. All patients were provided with patient-controlled intravenous analgesia (PCIA) for postoperative analgesia. The primary outcomes were the levels of postoperative pain at rest and on coughing evaluated by visual analog scale (VAS), intraoperative and postoperative opioids consumption. The secondary outcomes included PCIA pressed times, side effects and satisfaction of analgesia, duration of nerve block, intraoperative hemodynamic changes and vasoactive drug dosage.

Results: No significant differences of VAS score were found in the three groups at each time points. During operation, PVB reduced consumption of opioids (27.23±5.10mg) compared to DSPB (31.20±3.80mg) and SSPB (32.61±5.28mg) (p<0.05). The effective pressed times of PCIA in SSPB group (0.18±0.65) was significantly lower compared to PVB group (1.09±1.50) (p=0.009) at postoperative 12h. Accordingly, SSPB group reduced the dosage of PCIA (26.55±4.72ml) than PVB group (31.45±7.60ml) (p=0.046). Time consuming of PVB procedure was longer (11.14±1.66min) than DSPB (5.68±1.10min) and SSPB (4.77±1.04min) (p<0.001, respectively). PVB group was associated with more intraoperative atropine consumption (0.14±0.24mg) than DSPB group (0mg) (P=0.043).

Conclusion: DSPB and SSPB are easy to perform and can serve as a promising alternative technique to PVB that may offer comparable analgesic effectiveness and a better side-effect profile for patients who undergoing VATS.

Trial registration: This study was registered to Chinese Clinical Trials Registry on July 20, 2019. (Registration No: ChiCTR1900024678)

Introduction

Video-assisted thoracic surgery (VATS) is a standard surgical procedure for both minor and major oncological lung surgery. Over 85% Patients who undergoing VATS often suffer from moderate to severe postoperative pain when coughing and moving(1). Furthermore, 22–63% are converted to chronic pain(2). Uncontrolled postoperative pain, which is attributed to muscle incisions, rib retractions, and intercostal nerve damage, can result in respiratory complications such as hypoxia and atelectasis, which preclude early recovery(3, 4).

Effective analgesia can alleviate the pain of thoracic surgery, which is provided by pleural epidural, paravertebral block, vertical vertebral muscle block, anterior plane block and venous analgesia(5). Thoracic epidural analgesia (TEA) is the current gold-standard analgesia in thoracotomy. However, TEA has a 30% failure rate, which carries the risk of epidural hematoma or abscess(6). In recent years, paravertebral nerve block (PVB) warrants greater attention with its advantages of small trauma, low anticoagulation requirements, hemodynamic stability and good analgesic effect(7, 8). However, PVB is not only technically difficult to perform especially in obese patients, but also could be less efficient after pleurodesis due to pleural inflammation or surgical dilaceration of the parietal lining of the pleura(9). TEA and PVB exhibit certain difficulties with regard to its administration and side effects, and minimally invasive surgery might require less-invasive analgesia. Therefore, the clinical standard minimally invasive analgesic technique for VATS is highly recommended.

Serratus anterior plane block (SAPB) which is less difficult and have fewer severe complications may be more suitable for VATS(10). SAPB can completely cover the range of the long thoracic nerve as well as the lateral cutaneous branches of T2 to T5 intercostal nerves, and complement the deficiency of PVB, TEA, and selective intercostal nerve blocks(11). It was simple to operate, not restricted to the patients who were obese or use anticoagulants, and also exhibited satisfied analgesic effect(2, 5, 12, 13). More recently, a single-center, double-blinded study with 40 patients showed that compared to PVB, SAPB was non-inferior in terms of 48-hour opioid consumption and was associated with improving functional measures in thoracic surgical patients(14). SAPB might be performed at superficial or deep planes(15–17). Blanco et al showed superficial serratus anterior plane block (SSPB) had a wider range and longer block time compared to deep serratus plane block (DSPB)(15). Conversely, Piracha et al found that DSPB could relieve the uncontrollable pain of SSPB(16). However, whether DSPB and SSPB were as good as PVB remained unclear. This study investigated the analgesic effectiveness of DSPB and SSPB for patients undergoing VATS and the potential for SAPB as an alternative to PVB for VATS.

Methods

This randomized, comparative, double-blinded study was performed in Shenyang, from July 2019 to December 2019 after receiving the approval of the institutional ethical committee of the First Hospital of China Medical University and was registered to Chinese Clinical Trials Registry (Registration No: ChiCTR1900024678). All patients were aged 20–80 years with ASA I or II scheduled for VATS. The patients were excluded as follow: (1) allergy to local anesthetics; (2) ASA III or IV; (3) severe obese patients (BMI > 30 kg/m^2); (4) motion sickness; severe cardiorespiratory, hepatic, renal disorders; chronic chest pain; (5) opioid abuse and inability to communicate. According to our preliminary study data, intraoperative opioids consumptions in DSPB, SSPB and PVB groups were 31.22 mg, 34.71 mg and 27.5 mg. 22 patients per group were required to achieve a significance level of 0.05 with a power of 80%. The statistical test used for sample size calculation was One Way ANOVA Power Analysis. Power calculation was completed using PASS (NCSS LLC, Kaysville, Utah). Finally, a total of 74 patients were

recruited and provided their written informed consent to participate in this study. They were randomly assigned to receive either DSPB or SSPB as well as PVB.

Intraoperative management

On arrival in the operating room (OR), after routine ASA monitoring and arranging the patients in the lateral decubitus position with the diseased side up, ultrasound-guided nerve block was performed. A 5 μg dose of sufentanyl was administered preemptively.

In DSPB group, a US probe was placed parallel to the midaxillary line at the level of T3-4 and moved laterally to visualize the rib, pleura, front serratus, latissimus dorsi. A 100 mm blunt-tipped needle was advanced beneath the serratus anterior muscle. Then, saline (1 ml) was injected to confirm the position followed by 20 ml of 0.5% ropivacaine. In SSPB group, the tip of needle was arrived the plane superficial to the serratus anterior muscle. Similarly, a total of 20 ml of 0.5% ropivacaine was injected. In PVB group, the US probe was placed parallel to the posterior midline at the level of T5 and moved laterally to visualize the transverse process and pleura. In the same way, 20 ml of 0.5% ropivacaine was injected.

General anesthesia was induced after nerve block with propofol 2.0 mg/kg, sufentanil 0.4 μg/kg, cis-atracurium 14 mg and dexamethasone 5 mg. Pharyngeal local anesthesia was performed with 3 ml of 2% lidocaine and a double-lumen tube was intubated. The tidal volume (6–8 ml/kg) and the ventilatory frequency were adjusted to maintain an end-tidal carbon dioxide tension of 35–45 mmHg and airway pressure below 30cmH_2O. Anesthesia was maintained with propofol (30 ml/h) and sevoflurane (0.7%-1.5%) to maintain a bispectral index of 40–60. Hypertension was treated with oxycodone hydrochloride 2 mg or ebrantil 5 mg. Hypotension was treated with ephedrine 6 mg or phenylephrine 0.1 mg. Bradycardia was treated with atropine 0.3 mg. At the end of the surgery, tropisetron 5 mg was given intravenously to prevent postoperative nausea and vomiting. All patients were transferred to post anesthesia care unit (PACU) after surgery. Postoperative analgesia followed by patient-controlled intravenous analgesia (PCIA). The PCIA regimen consisted of hydromorphone 14 mg mixed with normal saline to a total volume of 150 ml. The disposable PCA device was set background infusion of 2 ml/h, demand bolus 6 ml and a 10-min lockout. If patients reported a VAS score ≥ 4, flurbiprofen axetil 100 mg was administered every 12 hours as a rescue analgesia. If severe nausea or vomiting occurs, we treated the patients with 5 mg tropisetron or stopping PCIA temporarily. After these symptoms reversed, the PCIA restarted.

The primary outcomes were postoperative visual analogue score (VAS score), intraoperative and postoperative opioids consumption. The secondary outcomes included PCIA pressed times, side effects, satisfaction with analgesia, duration of operating nerve block, intraoperative hemodynamic changes and vasoactive drug consumption. VAS scores at rest and on coughing were collected at postoperative 12 h, 24 h, 48 h and 72 h. The different types of opioids were converted to IV morphine equivalents using the GlobalRPh morphine equivalence calculator at http://www.globalrph.com. Effective and ineffective PCIA pressed times were collected at postoperative 12 h, 24 h, 48 h and 72 h. The dosage of PCIA was also

recorded at the same time. Patients ranked their satisfaction with analgesia in the first 72 postoperative hours, from “highly unsatisfactory” to “highly satisfactory”. Intraoperative hemodynamic changes contained the blood pressure and heart rate when the patients entering the OR, before operation, 5 minutes after surgical incision, before endotracheal extubation, 5 minutes after extubation and before leaving PACU, as well as the duration of intraoperative hypotension. All of the outcomes and perioperative data were collected by an investigator who was blinded to the group allocation.

Statistical analysis

Data were analyzed using GraphPad prism 8. Continuous numerical variables were presented as the mean and standard deviation or standard error of the mean, categorical variables were presented as the ratio or as the number and percentage, and between-group differences were compared using Fisher’s exact test (for nominal data) or the chi-squared test for trend (for ordinal data). Primary and secondary endpoints for each analgesic technique used were compared using the Kruskal-Wallis test with Dunn’s correction. The reported P-value is two-sided. $P < 0.05$ were considered statistically significant. The Cochran–Armitage test was used for satisfaction score analysis.

Results

1. Patient Characteristics

74 patients were enrolled in the study, 8 were excluded: 1 for VATS conversion to thoracotomy, 1 for secondary thoracotomy in the next day, 6 for severe nausea and vomiting stopped using PCIA (3 in SSPB group, 2 in DSPB group, 1 in PVB group). Ultimately, a total of 66 patients completed the study, each group included 22 patients, which is showed in Fig. 1. The demographic data, ASA classes, personal history, medical history, duration of the surgery of the study patients are summarized in Table 1. There was no significant difference with respect to the demographic data ($P > 0.05$).

Table 1. Demographic data of 22 patients for each group

	DSPB group	SSPB group	PVB group	*P*-Value
Age(years), Mean ± SD	55±12.53	57.95±7.65	58.64±6.78	0.514
Gender(male), n (%)	14(63.64%)	11(50%)	8(36.36%)	0.305
BMI ($kg.m^{-2}$)	23.11±2.90	24.40±2.01	23.79±2.72	0.275
ASA I(n)	14	10	12	
ASA II(n)	6	11	10	
ASA III(n)	2	1	0	0.377
Smoking(n)	7	9	7	0.766
Drinking(n)	8	7	4	0.383
Hypertension(n)	5	8	8	0.533
Diabetes mellitus(n)	1	3	2	0.577
Coronary heart disease(n)	1	1	3	0.421
History of surgery(n)	6	7	6	0.929
Duration of surgery(min)	130.82±70.28	143.18±90.23	105.32±37.98	0.221

Notes: Values of age, BMI and duration of surgery are expressed as mean ± standard deviation.

2. Postoperative VAS score

There were no significant differences of VAS scores at rest and on coughing among the three groups at postoperative 12 h, 24 h, 48 h, and 72 h (Table 2). None of the patients suffered severe pain. During the first postoperative 24hrs, the patients presented with mild to moderate pain when coughing (13 in DSPB group, 13 in SSPB group and 17 in PVB group). At the rest of the time, they presented with mild pain.

Table 2. Postoperative VAS scores at rest and on coughing

	DSPB group	SSPB group	PVB group	*P*-Value	*P* for DSPB group versus SSPB group	*P* for DSPB group versus PVB group	*P* for SSPB group versus PVB group
VAS-R							
12h	1.3 [0.8, 1.8]	1.6 [0.8, 2.4]	1.5 [0.6, 2.4]	0.240	0.282	0.606	0.834
24h	1.1 [0.4, 1.8]	1.0 [0.3, 1.7]	1.3 [0.7, 1.9]	0.297	0.797	0.669	0.297
48h	0.4 [0.0, 0.9]	0.3 [0.0, 0.9]	0.5 [0.0, 1.1]	0.662	0.960	0.850	0.694
72h	0.0 [0.0, 0.0]	0.0 [0.0, 0.0]	0.1 [0.0, 0.4]	0.131	>0.999	0.186	0.186
VAS-C							
12h	3.5 [2.8, 4.2]	3.8 [3.0, 4.6]	3.8 [2.9, 4.7]	0.305	0.410	0.314	0.982
24h	2.9 [1.7, 4.1]	3.0 [2.2, 3.8]	3.3 [2.7, 3.9]	0.304	0.939	0.218	0.374
48h	1.6 [0.5, 2.7]	1.7 [1.0, 2.4]	2.2 [1.5, 2.9]	0.051	0.936	0.069	0.143
72h	0.5 [0.0, 1.0]	0.5 [0.0, 1.1]	0.9 [0.2, 1.6]	0.165	0.967	0.127	0.204

Notes: Values are expressed as the mean [95% confidence interval]. When the lower limit value of the 95% confidence interval is less than 0, use 0 instead.

Abbreviations: VAS-R, the values of VAS scores at rest; VAS-C, the values of VAS scores on coughing.

3. Intraoperative dosage of opioids

Sufentanil and oxycodone hydrochloride were converted to morphine, and the consumption were compared in three groups. In intergroup comparisons, PVB group (27.23 ± 5.10 mg) was associated with reducing intraoperative opioid consumption compared to DSPB (31.20 ± 3.80 mg) and SSPB group (32.61 ± 5.28 mg, $P < 0.05$). Therefore, PVB had better analgesic effect than DSPB and SSPB during operation.

4. PCIA pressed times and dosage of postoperative analgesics

PCIA pressed times included effective and ineffective times (Table 3). During postoperative 0-12hrs, there were statistically significant differences for effective pressed times in DSPB group (1.23 ± 1.31), SSPB group (0.77 ± 1.00) and PVB group (2.05 ± 1.64) ($P < 0.05$). Moreover, the pressed times in SSPB group was significantly lower compared to PVB group ($P < 0.05$). There was no significant difference in ineffective PCIA pressed times.

Postoperative analgesics included PCIA and flurbiprofen axetil. At the first 12hrs postoperatively, SSPB group had significantly lower PCIA dosage compared with PVB group ($P < 0.05$). The maximum dose of flurbiprofen axetil is 100 mg every 12 hours. In this study, a maximum of 300 mg was given, which was happened in SSPB group. They were not significantly different of average consumption in three groups.

Table 3. Postoperative analgesics

	DSPB group	SSPB group	PVB group	*P*-Value	*P* for DSPB group versus SSPB group	*P* for DSPB group versus PVB group	*P* for SSPB group versus PVB group
Effective times							
0-12hrs	1.23±1.31	0.77±1.00	2.05±1.64	0.012*	0.519	0.126	0.009*
12-24hrs	1.86±2.68	1.09±1.93	2.00±2.20	0.131	0.522	0.980	0.408
24-48hrs	0.72±1.32	0.36±0.77	1.09±1.50	0.210	0.320	0.599	0.320
48-72hrs	0	0	0.05±0.21	0.368	>0.999	0.443	0.443
Dosage of PCIA (ml)							
0-12hrs	27.86±6.92	26.55±4.72	31.45±7.60	0.024*	0.791	0.184	0.046*
12-24hrs	27.77±9.28	30.18±11.81	34.64±15.91	0.811	0.492	0.191	0.492
24-48hrs	49.95±10.62	48.91±4.03	52.68±15.70	0.788	0.951	0.711	0.522
48-72hrs	33.14±14.98	39.73±12.58	40.68±17.52	0.023	0.343	0.248	0,977
Postoperative							
Flurbiprofen Axetil (mg)	59.09±77.81	54.55±72.16	72.73±80.80	0.744	0.980	0.835	0.726

Notes: * represents significant difference

5. Satisfaction with analgesia

There were no statistical differences of satisfaction with analgesia in three groups (Table 8). Both DSPB and SSPB, as well as PVB could provide good analgesic effect postoperatively, eighty percent of the patients showed “neutral” and “satisfactory” approximately. Patients in PVB group showed more “highly unsatisfactory” and “approximately” than in DSPB group and SSPB group.

6. Side effects

No patient exhibited block-related complications, such as urinary retention, pneumonia, local anesthetic toxicity, bleeding, or infection. The side effects of opioids included nausea, vomit and dizzy showed no significant differences among three groups.

7. Duration of operating nerve block

The duration of operating nerve block recorded from disinfection to nerve block needle extraction, all of the groups were done once by the same experienced anesthesiologist. Duration of DSPB (5.77 ± 1.20 min) and SSPB group (4.77 ± 1.04 min) were significantly shorter than that of PVB group (11.14 ± 1.66 min, $P < 0.05$). PVB was more complex for anesthesiologist to operate.

8. Intraoperative hemodynamic changes and the dosage of vasoactive drugs

Intraoperative blood pressure changes were showed with MAP, which were compared at six time points (Fig. 2). At 5 minutes after operation, MAP was lower in PVB group (85.45 ± 16 mmHg) than that in DSPB (99.21 ± 15.27 mmHg, $P < 0.05$) and SSPB group (104.70 ± 16.33 mmHg, $P < 0.05$). At 5 minutes after extubation and before leaving PACU, DSPB group showed lower MAP than SSPB group ($P < 0.05$). The three groups were comparable regarding the changes of heart rate (Fig. 3) and the duration of intraoperative hypotension, which were no significant differences ($P > 0.05$).

Vasoactive drugs included ephedrine, atropine and phenylephrine (Table 4). In-group analyses showed that PVB (0.14 ± 0.24 mg) was associated with more intraoperative atropine consumption than DSPB (0 mg, $P < 0.05$). However, there were no differences in ephedrine and phenylephrine consumption.

Table 4. Intraoperative consumption of vasoactive drugs

	DSPB group	SSPB group	PVB group	*P*-Value	*P* for DSPB group versus SSPB group	*P* for DSPB group versus PVB group	*P* for SSPB group versus PVB group
Ephedrine (mg)	1.91±4.57	1.09±2.94	1.50±4.02	0.879	0.776	0.938	0.938
Atropine (mg)	0	0.05±0.21	0.14±0.24	0.003*	0.708	0.043*	0.225
Phenyleph -rine(mg)	0.33±0.73	0.10±0.32	0.33±0.57	0.196	0.407	>0.999	0.393

Notes: * represents significant difference

Discussion

This randomized, double-blind study demonstrated DSPB, SSPB or PVB combined with PCIA reduced the postoperative pain and showed similar satisfaction with analgesia in patients undergoing VATS. Intraoperative opioid consumption remained significantly lower in PVB. SSPB showed less PCIA pressed times and PCIA dosage than PVB. Furthermore, DSPB and SSPB were easy for anesthetist to operate, with significantly lower operating duration than PVB. PVB was associated with maintaining hemodynamic stability. However, PVB consumed more atropine intraoperatively.

There were different opinions about the postoperative analgesic effect of DSPB, SSPB and PVB. PVB has long been referred as the best possible choice for postoperative analgesia of VATS(18). In recent studies, SSPB proponents have described successful analgesia without the potentially hazardous need for advancing the needle deeper toward the pleura(15, 17). However, anatomy arguably favored DSPB as injection in the fascial plane below the serratus muscle which blockade of the lateral cutaneous branches of the intercostal nerves, might show better analgesic effect(19). In our study, DSPB, SSPB and PVB showed similar postoperative analgesic effect, and most patients were satisfied with the analgesic effect. All three can be used for postoperative analgesia of VATS. However, in the early postoperative period (12hrs), SSPB group provided a superior pain relief with significantly lower effective PCIA pressed times and dosage compared to PVB group. Some studies showed that the duration of the sensory blockade produced by SSPB and DSPB was 730–780 min and 380–400 min respectively(20–22). The effective time of PVB persisted for 48hrs postoperatively(23). In our study, the duration of postoperative analgesia for PVB was shorter, probably due to the pharmacological properties of ropivacaine.

During operation, compared with DSPB and SSPB, PVB showed superior analgesic effect. PVB significantly decreased intraoperative consumption of opioids comparing to DSPB and SSPB, which indicated the short-term analgesic effect of PVB was better than that of DSPB and SSPB. These findings support observations from previous reports that showed the effectiveness of PVB(24).

The ideal analgesic techniques should not only have perfect analgesia effect, but also have the advantages of simple operation, accurate control, high success rate and few complications. The puncture duration of PVB was significantly longer than that of DSPB and SSPB in our study. It might be related to the difference of anatomical position. The serratus anterior muscle was superficial which could be scanned by high-frequency linear array ultrasound probe to easily obtain clear images of the serratus anterior muscle and its neighbors. During the puncture, the angle between the needle and skin was small that the puncture needle could be imaged clearly(25). J Richardson et al also found that the deep fascia of the serratus anterior muscle had poor adhesion to the intercostal external muscles and was easier to separate than the superficial plane of the serratus anterior muscle, which was also showed in our study(26). The location of thoracic paravertebral nerve was deeper and should be scanned low-frequency

convex array probe or high-frequency linear array probe. The puncture needle was difficult to image due to the large angle.

A few studies have described analgesia effect of SSPB was similar to an epidural but perhaps with less hemodynamic instability(17). In our study, both DSPB and SSPB, as well as PVB could maintain hemodynamic stability. However, PVB consumed more atropine intraoperatively. Previous studies also have shown that PVB can cause the incidence of bradycardia and hypotension with rate of 0.47% ~ 2.2%, which might be related to sympathetic block(27).

In addition, the incidence of side effects did not show significant differences in three groups. There were 6 patients who had motion sickness reported severe nausea and vomiting. After stopping PCIA, the side effects were disappeared, which indicated that might be associated with the opioid. They withdrew from our study on the basis of exclusion criteria. We did not report any complication associated with nerve block, but pneumothorax was potential. The deep surface of the paravertebral area was the pleura, and there was a risk of puncture of the pleura, pneumothorax and other complications. Naja et al performed PVB in 662 patients, and the probability of developing pneumothorax was about 0.5%(28). J Richardson's study showed that PVB punctures occasionally entered the epidural or puncture the pleura, and had a transient occurrence of Horner syndrome(26). This could explain why many clinicians are reluctant to operate PVB in daily work. Accordingly, patients with narrow intercostal space, obesity, poor coagulation function should use DSPB or SSPB.

Nonetheless, the present study had several limitations. First, as an observational study, our conclusions might have been limited by inadequate data collection, the pain of nerve block procedure was not recorded. Meanwhile, due to the time limitation of preoperative preparation, we could only confirm the diffusion of local anesthetics by ultrasound, but did not collect the data of spread level of analgesia. Second, the research subjects recruited in this study were not performed by the same surgeon, and there were uncontrollable differences. Third, it should be noted that during operation, when surgeons cut open the skin and subcutaneous tissue of patients who received DSPB or SSPB, it showed a slight edema of subcutaneous tissue, which indicated the possible loss of local anesthetics. Finally, this study did not explore the appropriate local anesthetic dose for nerve block, which will be described in further research.

Conclusion

In conclusion, DSPB, SSPB or PVB combined with PCIA could provide good postoperative analgesia for patients who undergoing VATS. PVB showed better analgesic effect than DSPB and SSPB intraoperatively. However, the operation of PVB was complex and had potential complications. DSPB or SSPB can serve as a promising alternative to PVB in optimal perioperative pain management in VATS. In the further study, large-scale prospective randomized controlled trials are required to compare the efficacy of postoperative analgesia by continuous infusion through a catheter.

List Of Abbreviations

Video-assisted thoracic surgery (VATS)

Thoracic epidural analgesia (TEA)

Paravertebral nerve block (PVB)

Serratus anterior plane block (SAPB)

Superficial serratus anterior plane block (SSPB)

Deep serratus plane block (DSPB)

Operating room (OR)

Post anesthesia care unit (PACU)

Patient-controlled intravenous analgesia (PCIA)

Visual analogue score (VAS score)

Declarations

Ethics approval and consent to participate

Study received the approval of the institutional ethical committee of the First Hospital of China Medical University (No.2018-305-2).

Consent for publication

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

Not applicable

Funding

This work is supported by the Special Program for Key Research of the Ministry of Science and Technology, China (Grant No. SQ2018YFC200044). Xuezhao Cao was responsible for performing nerve block.

Authors' contributions

ZY had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. LHQ and JWW were responsible for collecting research data of previous studies. FZ and WKX were responsible for collating data of this study. CXZ was responsible for performing nerve block. FT was responsible for preparation of materials. All authors have read and approved the manuscript.

Acknowledgements

The authors wish to thank nursing, medical and allied medical colleagues for their co-operation and support during the conduct of this study.

References

1. Semyonov M, Fedorina E, Grinshpun J, Dubilet M, Refaely Y, Ruderman L, et al. Ultrasound-guided serratus anterior plane block for analgesia after thoracic surgery. J Pain Res. 2019;12:953-60.
2. Okmen K, Metin Okmen B. Evaluation of the effect of serratus anterior plane block for pain treatment after video-assisted thoracoscopic surgery. Anaesth Crit Care Pain Med. 2018;37(4):349-53.
3. Ochroch EA, Gottschalk A. Impact of acute pain and its management for thoracic surgical patients. Thorac Surg Clin. 2005;15(1):105-21.
4. Ochroch EA, Gottschalk A, Augostides J, Carson KA, Kent L, Malayaman N, et al. Long-term pain and activity during recovery from major thoracotomy using thoracic epidural analgesia. Anesthesiology. 2002;97(5):1234-44.
5. Park MH, Kim JA, Ahn HJ, Yang MK, Son HJ, Seong BG. A randomised trial of serratus anterior plane block for analgesia after thoracoscopic surgery. Anaesthesia. 2018;73(10):1260-4.
6. Rosero EB, Joshi GP. Nationwide incidence of serious complications of epidural analgesia in the United States. Acta Anaesthesiol Scand. 2016;60(6):810-20.
7. Hiro K, Sugiyama T, Kurata M, Oi Y, Okuda M. [Postoperative Analgesia for Video-assisted Thoracoscopic Surgery--Continuous Intravenous Infusion of Fentanyl Combined with Intercostal Nerve Block v.s. Continuous Epidural Analgesia]. Masui. 2016;65(2):114-8.
8. Scarci M, Joshi A, Attia R. In patients undergoing thoracic surgery is paravertebral block as effective as epidural analgesia for pain management? Interact Cardiovasc Thorac Surg. 2010;10(1):92-6.
9. Allain PA, Carella M, Agrafiotis AC, Burey J, Assouad J, Hafiani EM, et al. Comparison of several methods for pain management after video-assisted thoracic surgery for pneumothorax: an observational study. BMC Anesthesiol. 2019;19(1):120.
10. Tighe SQ, Karmakar MK. Serratus plane block: do we need to learn another technique for thoracic wall blockade? Anaesthesia. 2013;68(11):1103-6.
11. Chu GM, Jarvis GC. Serratus Anterior Plane Block to Address Postthoracotomy and Chest Tube-Related Pain: A Report on 3 Cases. A A Case Rep. 2017;8(12):322-5.

12. Corso RM, Piraccini E, Byrne H, Poggi P, Tedesco M. The serratus anterior plane block for pediatric non-intubated video-assisted thoracoscopic surgery. Minerva Anestesiol. 2017;83(7):775-6.
13. Kim DH, Oh YJ, Lee JG, Ha D, Chang YJ, Kwak HJ. Efficacy of Ultrasound-Guided Serratus Plane Block on Postoperative Quality of Recovery and Analgesia After Video-Assisted Thoracic Surgery: A Randomized, Triple-Blind, Placebo-Controlled Study. Anesth Analg. 2018;126(4):1353-61.
14. Hanley C, Wall T, Bukowska I, Redmond K, Eaton D, Ni Mhuircheartaigh R, et al. Ultrasound-guided continuous deep serratus anterior plane block versus continuous thoracic paravertebral block for perioperative analgesia in videoscopic-assisted thoracic surgery. Eur J Pain. 2020;24(4):828-38.
15. Blanco R, Parras T, McDonnell JG, Prats-Galino A. Serratus plane block: a novel ultrasound-guided thoracic wall nerve block. Anaesthesia. 2013;68(11):1107-13.
16. Piracha MM, Thorp SL, Puttanniah V, Gulati A. "A Tale of Two Planes": Deep Versus Superficial Serratus Plane Block for Postmastectomy Pain Syndrome. Reg Anesth Pain Med. 2017;42(2):259-62.
17. Khalil AE, Abdallah NM, Bashandy GM, Kaddah TA. Ultrasound-Guided Serratus Anterior Plane Block Versus Thoracic Epidural Analgesia for Thoracotomy Pain. J Cardiothorac Vasc Anesth. 2017;31(1):152-8.
18. Steinthorsdottir KJ, Wildgaard L, Hansen HJ, Petersen RH, Wildgaard K. Regional analgesia for video-assisted thoracic surgery: a systematic review. Eur J Cardiothorac Surg. 2014;45(6):959-66.
19. Mayes J, Davison E, Panahi P, Patten D, Eljelani F, Womack J, et al. An anatomical evaluation of the serratus anterior plane block. Anaesthesia. 2016;71(9):1064-9.
20. Bhoi D, Pushparajan HK, Talawar P, Kumar A, Baidya DK. Serratus anterior plane block for breast surgery in a morbidly obese patient. J Clin Anesth. 2016;33:500-1.
21. Lopez-Matamala B, Fajardo M, Estebanez-Montiel B, Blancas R, Alfaro P, Chana M. A new thoracic interfascial plane block as anesthesia for difficult weaning due to ribcage pain in critically ill patients. Med Intensiva. 2014;38(7):463-5.
22. Madabushi R, Tewari S, Gautam SK, Agarwal A, Agarwal A. Serratus anterior plane block: a new analgesic technique for post-thoracotomy pain. Pain Physician. 2015;18(3):E421-4.
23. Vogt A, Stieger DS, Theurillat C, Curatolo M. Single-injection thoracic paravertebral block for postoperative pain treatment after thoracoscopic surgery. Br J Anaesth. 2005;95(6):816-21.
24. Chalam KS, Patnaik SS, Sunil C, Bansal T. Comparative study of ultrasound-guided paravertebral block with ropivacaine versus bupivacaine for post-operative pain relief in children undergoing thoracotomy for patent ductus arteriosus ligation surgery. Indian J Anaesth. 2015;59(8):493-8.
25. Ueshima H, Iwamoto W, Otake H. Serratus Plane Block for a Contraction of the Latissimus Dorsi Muscle. Reg Anesth Pain Med. 2016;41(3):411.
26. Richardson J, Lonnqvist PA, Naja Z. Bilateral thoracic paravertebral block: potential and practice. Br J Anaesth. 2011;106(2):164-71.
27. Pace MM, Sharma B, Anderson-Dam J, Fleischmann K, Warren L, Stefanovich P. Ultrasound-Guided Thoracic Paravertebral Blockade: A Retrospective Study of the Incidence of Complications. Anesth

Analg. 2016;122(4):1186-91.
28. Naja Z, Lonnqvist PA. Somatic paravertebral nerve blockade. Incidence of failed block and complications. Anaesthesia. 2001;56(12):1184-8.

Figures

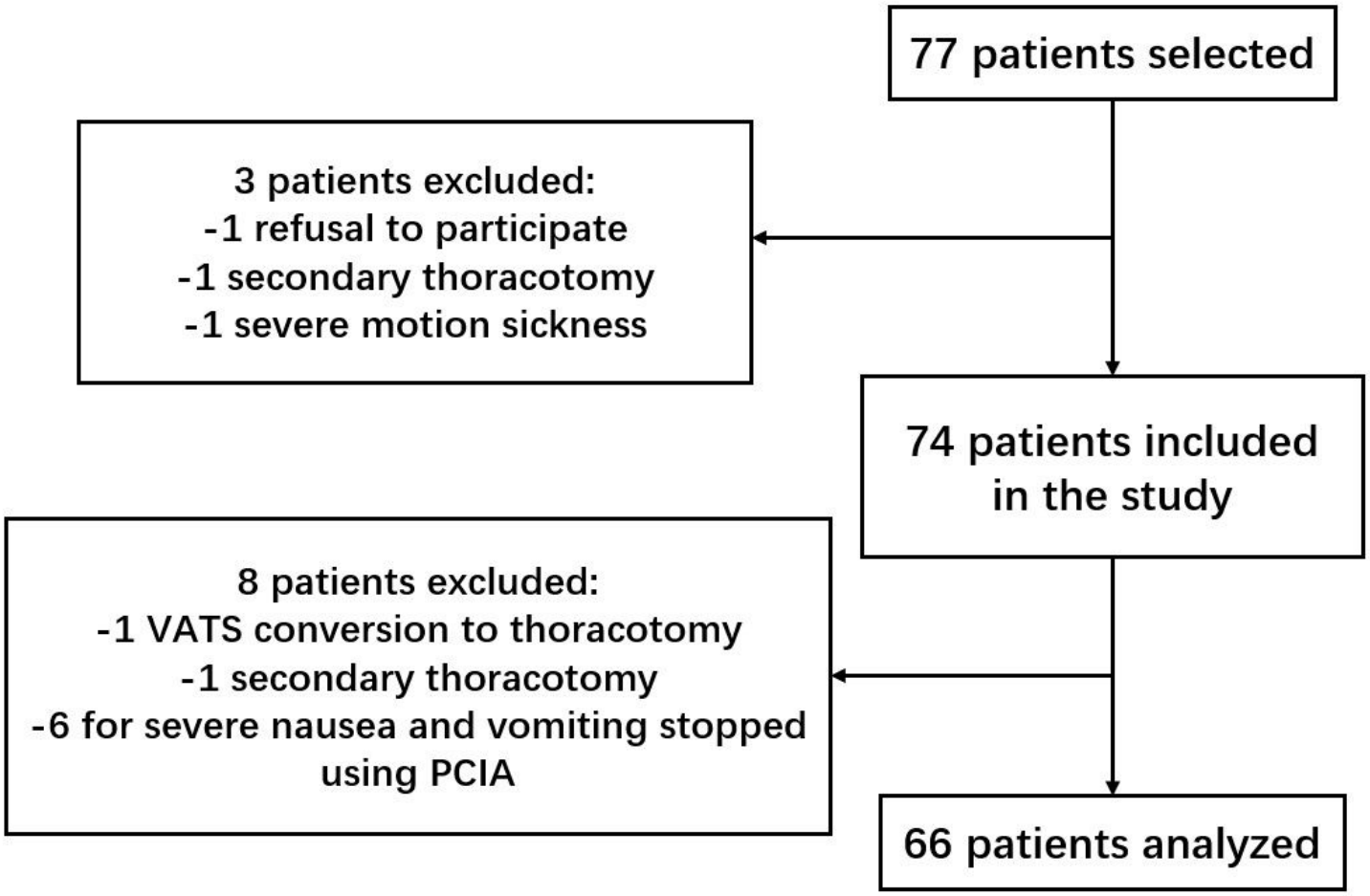

Figure 1

Flow diagram of the study

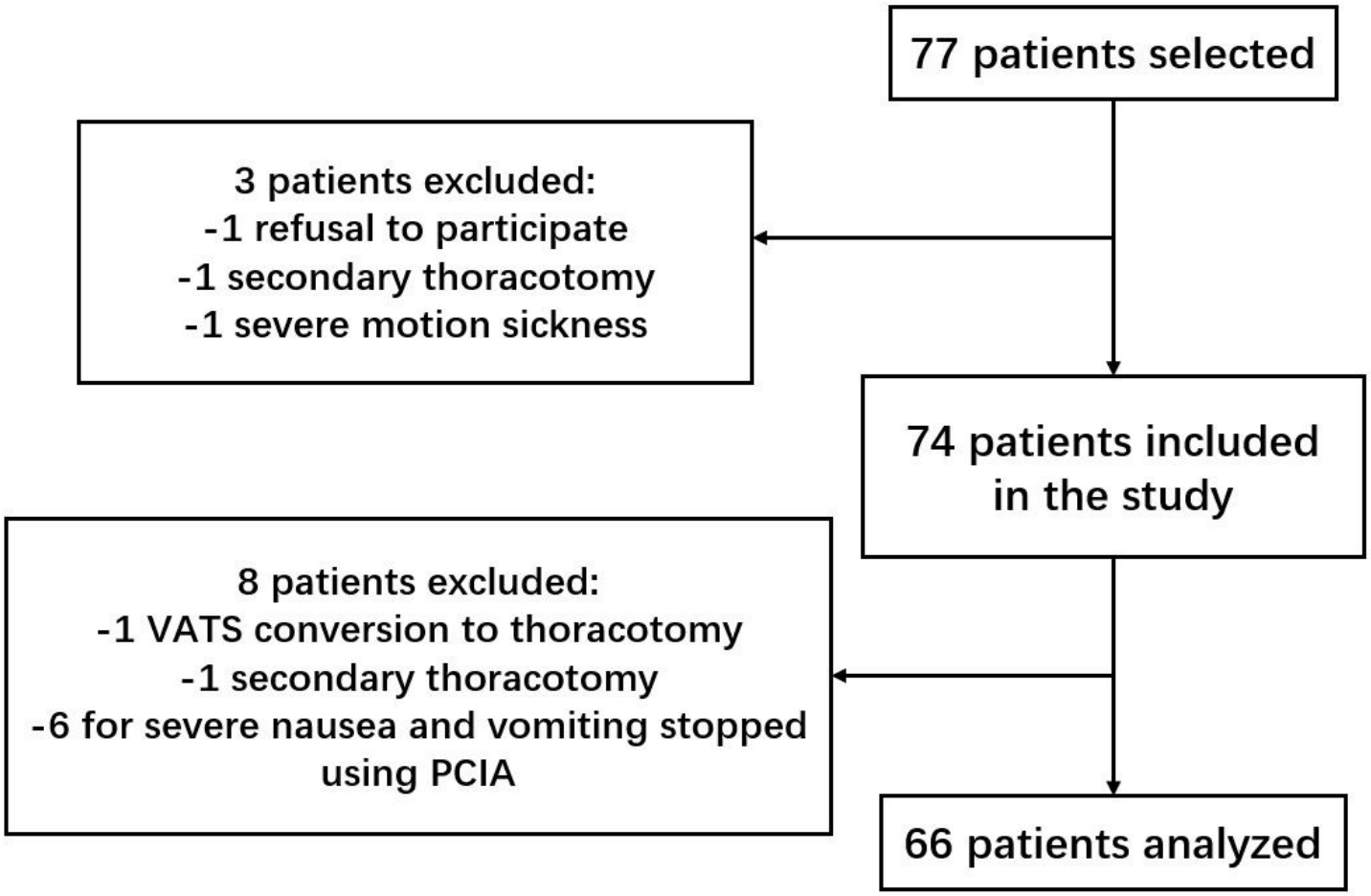

Figure 1

Flow diagram of the study

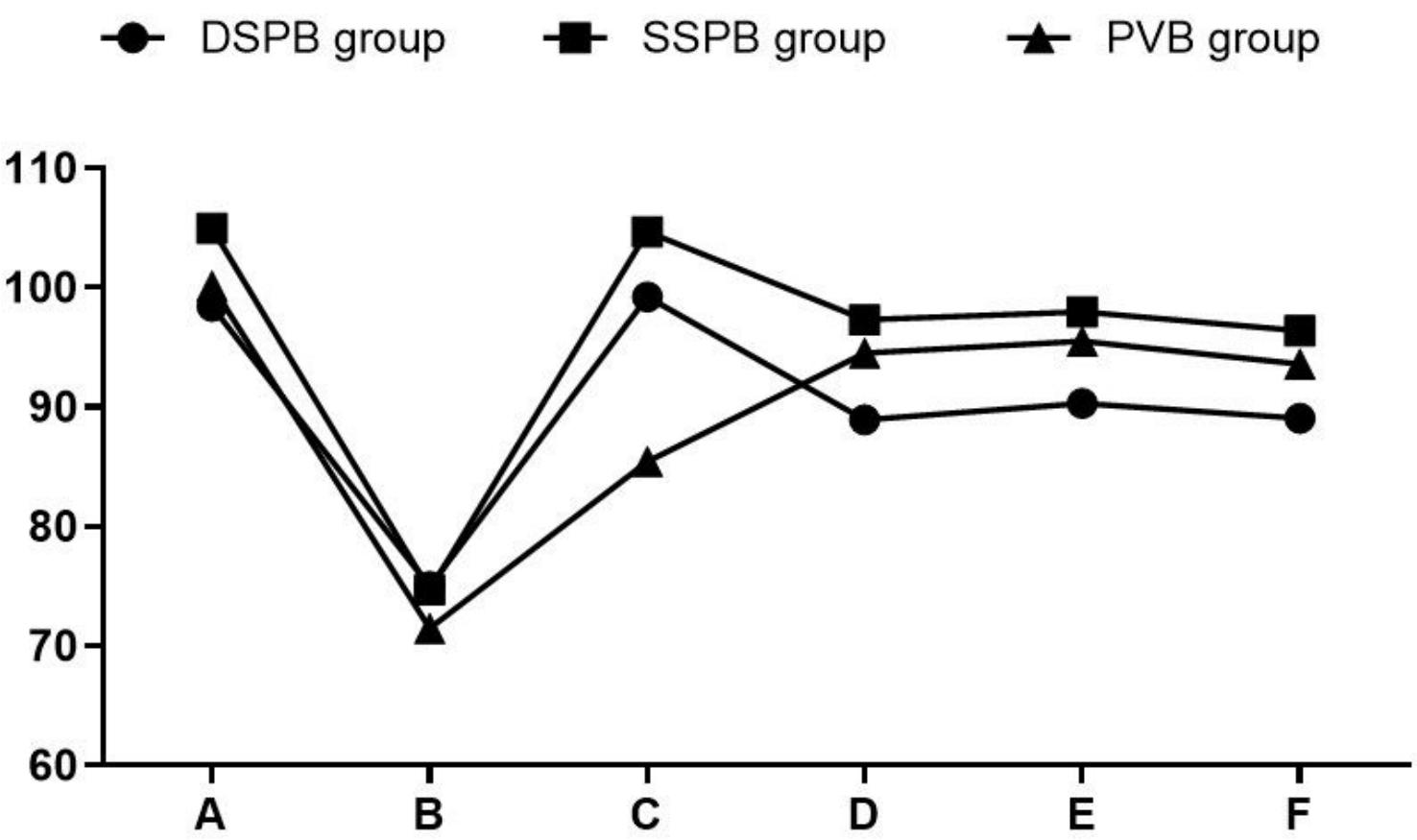

Figure 2

Intraoperative MAP changes Notes: A. Enter the OR; B. Before operation; C. 5 minutes after operation; D. Before extubation; E. 5 minutes after extubation; F. After leaving PACU.

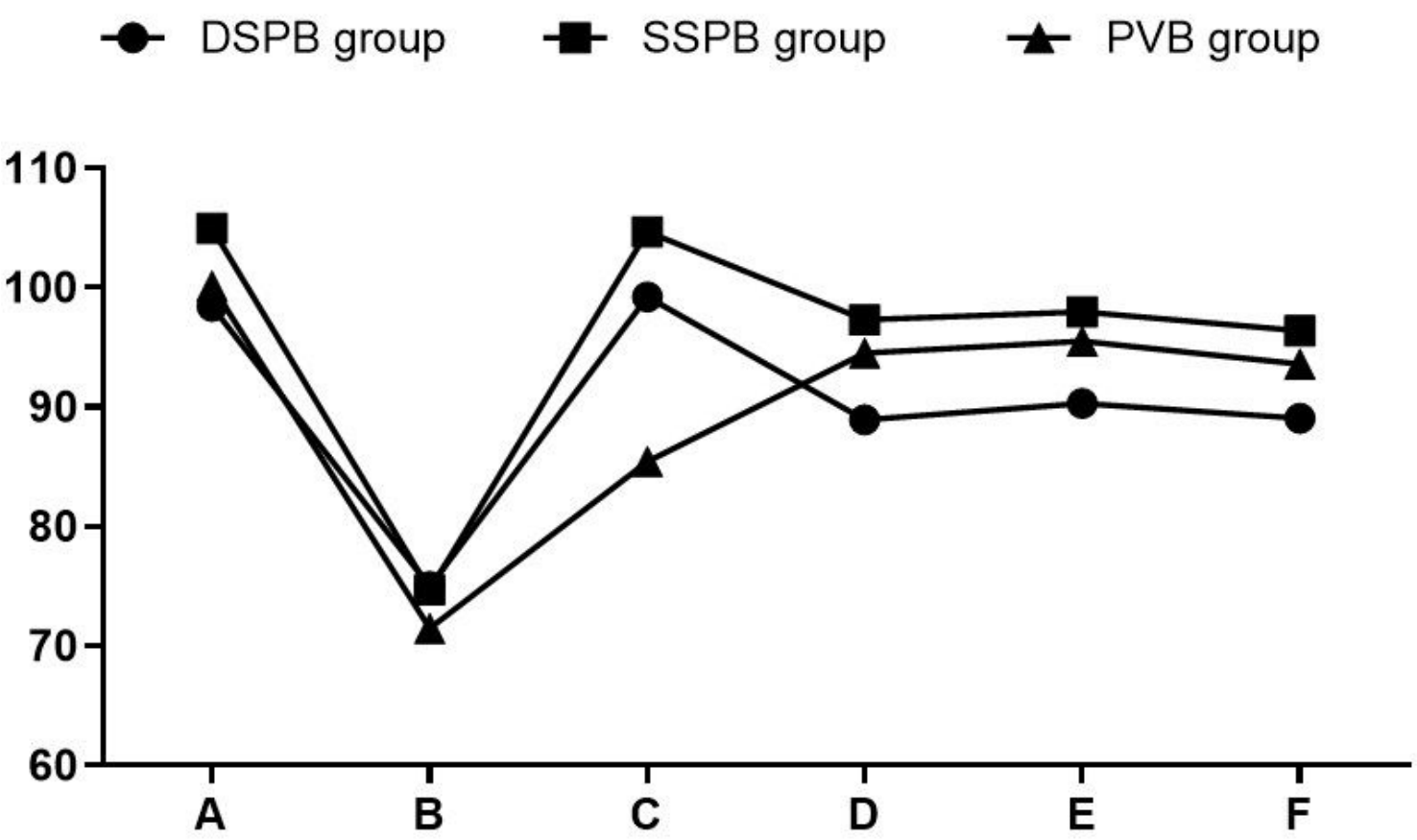

Figure 2

Intraoperative MAP changes Notes: A. Enter the OR; B. Before operation; C. 5 minutes after operation; D. Before extubation; E. 5 minutes after extubation; F. After leaving PACU.

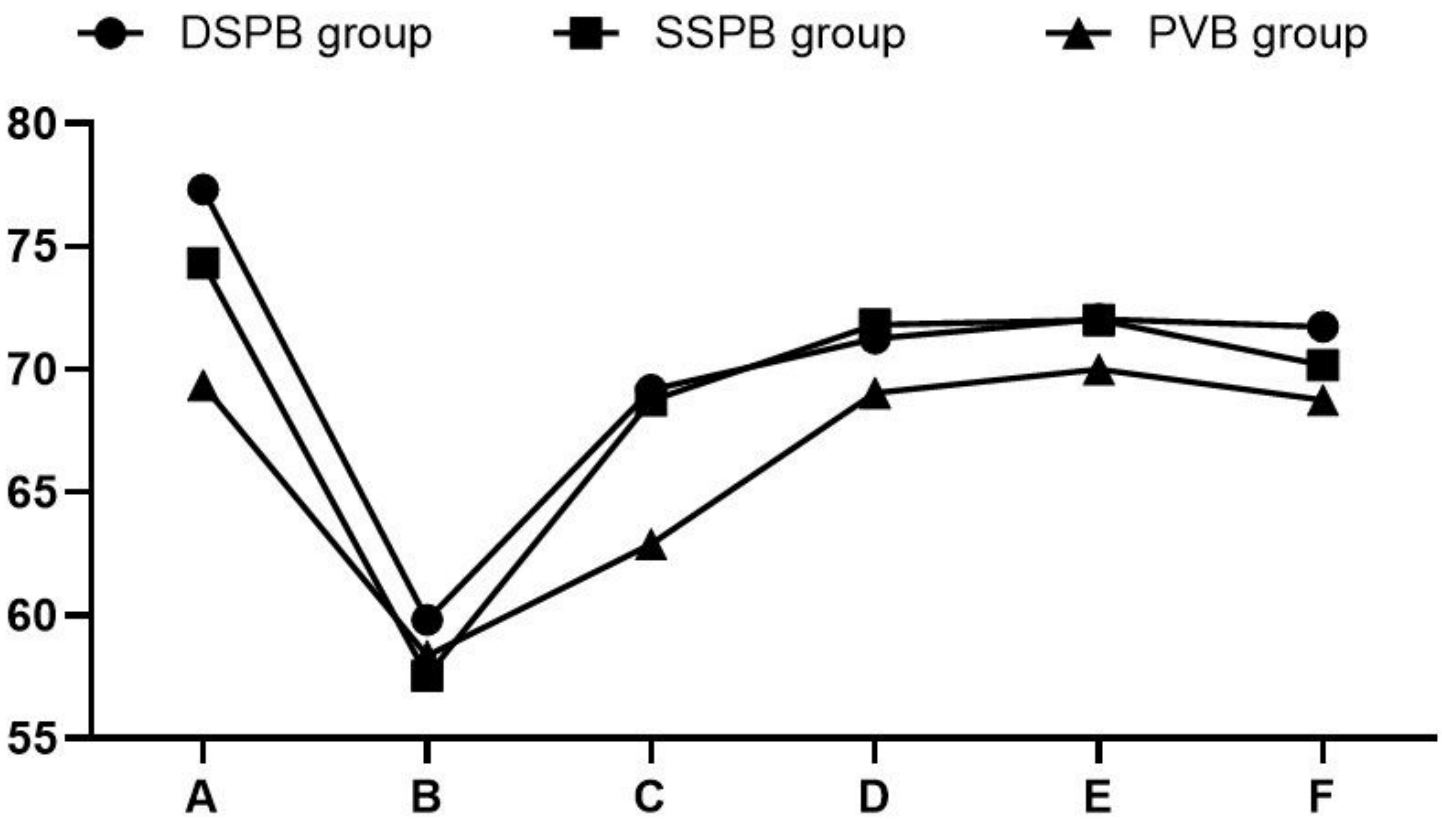

Figure 3

Intraoperative heart rate changes Notes: A. Enter the OR; B. Before operation; C. 5 minutes after operation; D. Before extubation; E. 5 minutes after extubation; F. After leaving PACU.

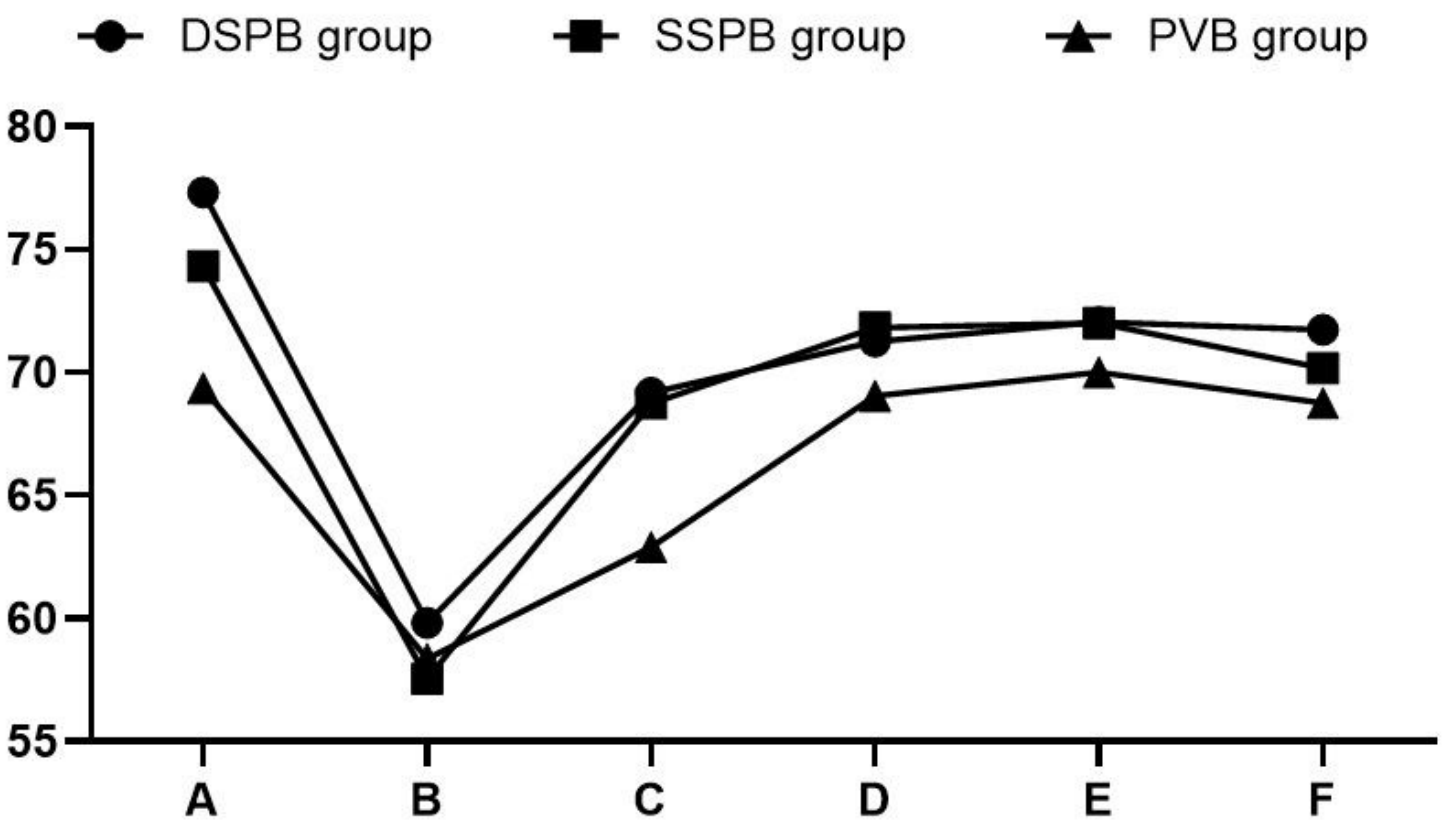

Figure 3

Intraoperative heart rate changes Notes: A. Enter the OR; B. Before operation; C. 5 minutes after operation; D. Before extubation; E. 5 minutes after extubation; F. After leaving PACU.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- CONSORT.doc
- CONSORT.doc