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Original Article / *Özgün Makale*

The effect of ultrasound-guided serratus anterior plane block in addition to intrathecal morphine on early postoperative period after video-assisted thoracoscopic surgery

Video yardımlı torakoskopik cerrahi sonrasında intratekal morfine eklenen ultrason eşliğinde serratus anterior plan blokunun erken ameliyat sonrası dönem üzerindeki etkisi

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ABSTRACT

Background: The aim of this study was to evaluate the effect of serratus anterior plane block in addition to intrathecal morphine for early postoperative period after video-assisted thoracoscopic surgery on the amount of morphine consumption and the Visual Analog Scale scores.

Methods: This single-blind, randomized-controlled study included a total of 64 patients (39 males, 25 females; mean age: 53.6±17.0 years; range, 20 to 89 years) who were scheduled for video-assisted thoracoscopic surgery in a tertiary hospital between September 2019 and March 2020. Postoperative pain control was achieved with intrathecal morphine 0.6 mg addition to serratus anterior plane block (Group ITM+SAPB) or with only intrathecal morphine (Group ITM) after an induction of anesthesia. The serratus anterior plane block was performed with a single injection of 0.4 mL/kg of 0.25% bupivacaine at the level of fifth rib with ultrasound guidance. Morphine consumption, pain scores, and side effects were recorded in the postoperative period.

Results: The mean morphine consumption was significantly lower in the ITM+SAPB group at all time points. Compared to the control group, the Visual Analog Scale-resting and coughing scores were significantly lower in the first 12 h after surgery. Pain scores were significantly higher in the ITM+SAPB group in patients where the trocar was inserted at upper level of the fifth rib than the lower level (3-5 *vs*. 5-8) during the first 6 h after surgery.

Conclusion: The use of serratus anterior plane block in addition to intrathecal morphine is a safe and effective way to improve pain control for early postoperative period after video-assisted thoracoscopic surgery. The serratus anterior plane block ensures better analgesia until the peak effect of spinal morphine occurs.

Keywords: Intrathecal injections, nerve block, opioid analgesics, video-assisted thoracoscopic surgery, ultrasonography.

ÖZ

Amaç: Bu çalışmada video yardımlı torakoskopik cerrahiyi takiben ameliyat sonrası erken dönemde intratekal morfine ek olarak serratus anterior plan blokunun morfin tüketimi ve Görsel Analog Ölçeği üzerine etkisi değerlendirildi.

Çalışma planı: Bu tek kör, randomize kontrollü çalışmaya, Eylül 2019-Mart 2020 tarihleri arasında üçüncü basamak bir hastanede video yardımlı torakoskopik cerrahi yapılması planlanan toplam 64 hasta (39 erkek, 25 kadın; ort. yaş: 53.6±17.0 yıl; dağılım, 20-89 yıl) alındı. Ameliyat sonrası analjezi, anestezi indüksiyonundan sonra 0.6 mg intratekal morfine ek olarak serratus anterior plan bloku (Grup ITM+SAPB) veya yalnızca intratekal morfin (Grup ITM) ile sağlandı. Serratus anterior plan bloku, ultrason eşliğinde, tek doz 4 mL/kg'lik %0.25 bupivakain ile beşinci kosta seviyesinden uygulandı. Ameliyat sonrası dönemde morfin tüketimi, ağrı skorları ve yan etkiler kaydedildi.

Bulgular: Ortalama morfin tüketimi tüm zaman noktalarında ITM+SAPB grubunda anlamlı düzeyde daha düşük bulundu. Kontrol grubu ile karşılaştırıldığında, ameliyat sonrası ilk 12 saatte Görsel Analog Ölçeği dinlenme ve öksürme skorları anlamlı düzeyde daha düşük idi. Ameliyatın ilk 6. saatinde ITM+SAPB grubunda beşinci kosta seviyesinin üzerinden yapılan girişimlerde, altından yapılan girişimlere kıyasla (3-5'e kıyasla 5-8), ağrı skorları anlamlı düzeyde daha yüksek idi.

Sonuç: İntratekal morfine ilave olarak serratus anterior plan blok kullanımı, video yardımlı torakoskopik cerrahi sonrası erken dönemde daha iyi ağrı kontrolü sağlamada güvenli ve etkili bir yoldur. Serratus anterior plan bloku, spinal morfinin pik etkisi gözlenene kadarki dönemde daha iyi analjezi sağlar.

Anahtar sözcükler: İntratekal enjeksiyon, sinir bloku, opioid analjezikler, video yardımlı torakoskopik cerrahi, ultrasonografi.

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Video-assisted thoracoscopic surgery (VATS) is a procedure that can provide less invasive interventions for some thoracic surgeries. It can be performed with a small incision and, therefore, postoperative pain complaints are less severe and, additionally, surgical trauma is less than open surgeries.[1,2] However, it can be associated with severe acute postoperative pain and the occurrence of chronic pain.[3] Although thoracic epidural analgesia (TEA) and paravertebral block (PVB) are recommended as the first choice for thoracotomy, it is thought to be an invasive method for VATS[4] and its necessity is questioned in patients undergoing VATS due to the technical difficulties, requirement of experience, serious side effects, and contraindications.[5] Therefore, there is no consensus for pain control after VATS[6] and postoperative pain management remains one of the major problems.[4] A multimodal analgesic management is recommended to control postoperative pain after thoracic surgeries.[3] In addition to PVB and epidural analgesia, serratus anterior plane block (SAPB), erector spina block, and intercostal nerve blocks have been used for this purpose in recent years.[3]

Intrathecal morphine (ITM) has been used for over a century for pain relief. It is one of the easiest, cost-effective, and reliable technique for postoperative analgesia in orthopedic, abdominal and thoracic surgeries.[7,8] The ITM administration provides prolonged postoperative analgesia lasting approximately 24 h, but the peak analgesic effect occurs up to 6 h after administration.[9] Although ITM can provide effective analgesia, its use is limited due to its long onset of action in short operations.[8] Even if ITM is administered before the operation, an additional analgesia method is required during the first few hours after VATS.

Since the use of ultrasound (US) and described novel techniques, the use of nerve blocks has increased for both open thoracic surgeries and VATS.[10] The SAPB can provide analgesia between the second and ninth thoracic level dermatomes.[11] This technique can be easily performed and has a high success rate and low side effect, when performed by an experienced anesthesiologist under the US guidance.[12] The SAPB reduces opioid consumption and provides effective analgesia after VATS.[13,14] However, as a single-shot application, it may not provide sufficient analgesic efficacy in the late postoperative period due to its short duration of action.[15]

To the best of our knowledge, there is no randomized study investigating this administration in terms of early postoperative analgesia on patients undergoing thoracoscopic surgery. In the present study, therefore, we aimed to evaluate the effect of SAPB in addition to ITM administration for early postoperative period after VATS on the amount of morphine consumption and the Visual Analog Scale (VAS) scores.

PATIENTS AND METHODS

Study design and patient selection

This single-blind, randomized-controlled study was conducted at Mersin University Faculty of Medicine, Department of Anesthesiology and Reanimation between September 2019 and March 2020. A total of 64 patients (39 males, 25 females; mean age: 53.6±17.0 years; range, 20 to 89 years) who were scheduled for triple-port VATS and were in the American Society of Anesthesiologists (ASA) physical status I-III were included in the study. Exclusion criteria were as follows: having a reoperation, known malignancy, chronic analgesic treatment or anticoagulant therapy, drug misuse, liver or renal failure, pregnancy, communication problem, switching to open surgery, and the need for any additional analgesic intervention in the postoperative period. The study flow chart is shown in Figure 1. A written informed consent was obtained from each participant. The study protocol was approved by the Mersin University Clinical Research Ethics Committee (07/08/2019-337). The study was conducted in accordance with the principles of the Declaration of Helsinki.All patients were randomly assigned (1:1 ratio) to receive either ITM (Group ITM, n=32) or ITM + SAPB (Group ITM+SAPB, n=32) using computerized randomization method. All surgical procedures were performed by a single surgical team. The VATS procedure was performed in all patients with three-trocar insertion. The patients were familiar with VAS (0-10) evaluation preoperatively.

Anesthesia protocol

No premedication was applied to the patients before operation. All patients were monitored with electrocardiogram (ECG), invasive blood pressure (IBP), pulse oximetry (SaO_2) and end-tidal carbon dioxide ($EtCO_2$) in the operation room. A radial artery catheter was inserted under local anesthesia before surgery. General anesthesia was induced with propofol 0.5 to 2.0 mg/kg and remifentanil 1 µg/kg. Rocuronium 0.5 mg/kg was administered to facilitate tracheal intubation with a double-lumen endotracheal tube. Anesthesia was maintained with O_2/N_2O 50/50% fresh gas, 0.5 to 1.5% sevoflurane, and 0.2 to 0.5 µg/kg/min remifentanil. Tidal volume was set at 6 mL/kg and fraction of inspired oxygen (FiO_2)

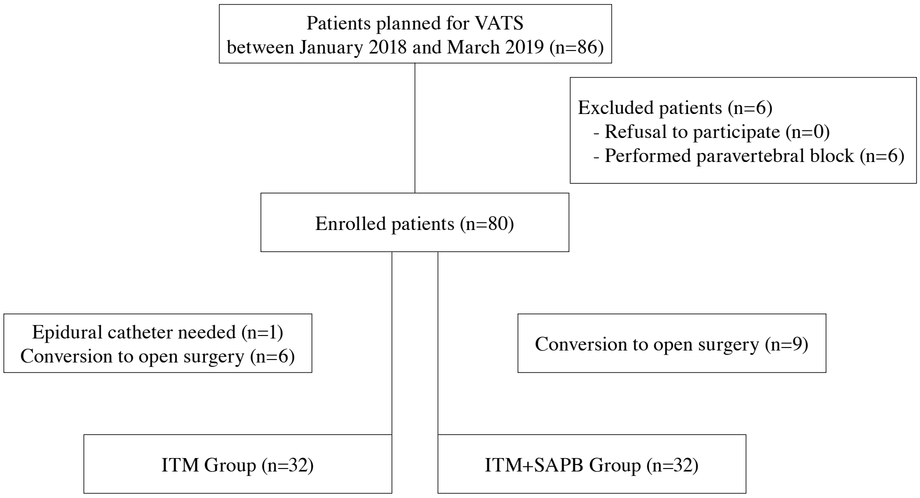

Figure 1. Study flow chart.

VATS: Video-assisted thoracoscopic surgery; ITM: Intrathecal morphine; SAPB: Serratus anterior plane block.

was increased to 80% during one-lung ventilation. All SAPB and ITM administrations were performed by a single anesthesiologist who is experienced in neuraxial and peripheral nerve blocks. Neuromuscular blockade was antagonized with neostigmine 2.5 mg and atropine 1 mg before extubation. The trachea was extubated, after the patient was completely awake and had sufficient breathing after surgery. The patients received 5 mg/kg/h of crystalloid fluid during the operation.

Analgesic interventions

Intrathecal morphine

Intrathecal morphine was applied after intubation with using anatomical landmark technique at the lateral position. The L3-L4 intervertebral space was identified and marked and the skin was, then, disinfected and covered with sterile drape. A total of 0.6 mg of morphine in 3 mL normal saline was administered intrathecally with an 18-gauge pencil-point spinal needle after detection of free flow of cerebrospinal fluid (CSF). The spinal needle was removed after injection.

Intrathecal morphine + serratus anterior plane block

The SAPB was also applied at lateral position with using different 18-gauge spinal needle in accordance with the technique described by Blanco et al.[11] after intubation and before ITM application. The SAPB was performed under US guidance using a 6 to 18 MHz linear US transducer. The probe was placed over the midaxillary line at the fifth rib level and moved until the latissimus dorsi and serratus muscle were identified after skin was disinfected and covered with a sterile drape. The needle was introduced in the craniocaudal direction until the tip lay in the space between the serratus muscle and rib with in-plane technique. Totally, 0.4 mL/kg of 0.25% bupivacaine was injected under serratus anterior muscle and the needle was removed after injection. Intrathecal morphine 0.6 mg in 3 mL normal saline was administered at the level of L3-L4 intervertebral space according to the conditions described above.

Since the distribution of local anesthetic can be clearly seen when SAPB is performed under the guidance of US, nerve block injections were performed after anesthesia induction for the patient comfort.

Postoperative pain management and measurement

Rescue analgesia was provided with intravenous (IV) morphine 0.5 mg and repeated, if the VAS >3 after controlling that the Ramsay Sedation Scale (RSS) was <3 in the emergence period. The patient-controlled analgesia (PCA) device was set at 0.5 mg morphine as needed with 15-min lockout interval for each group. The patients were evaluated at 0, 1, 6, 12, and 24 h after surgery by an experienced anesthesiologist who was a member of the postoperative pain management team and blinded to group allocation. All patients in both groups received paracetamol 1 g IV every 6 h for the first 24 h.

The patients were monitored in the post-anesthesia care unit (PACU) to closely monitor vital signs and pain level for early intervention, if needed during the first postoperative hour after surgery. The respiratory rate, SpO_2 level, heart rate, and arterial pressure were recorded every 10 min in the PACU and hourly after discharge to the intensive care unit (ICU). The patients were followed in the ICU for the first 24 h postoperatively. Postoperative VAS scores (VAS-R: during resting and VAS-C: during coughing) and morphine consumptions at 0, 1, 6, 12, and 24 h were recorded in the postoperative period. Respiratory depression was defined as respiratory rate under 10 bpm or SpO_2 value under 90% for more than 5 min or partial pressure of carbon dioxide ($PaCO_2$) more than 55 mmHg. Hypoxemia was defined as an SpO_2 value under 93% for more than 3 min with 2 L/min O_2 deliver with a nasal cannula. A mean arterial blood pressure of <60 mmHg or a decrease in mean arterial pressure by 20% of baseline value for more than 3 min was accepted as hypotension. Nausea/vomiting was evaluated with the Nausea and Vomiting Scale (NVS) and a score of ≥3 was considered nausea/vomiting. Type and duration of the surgery, trocar insertion level, and length of hospital stay were also recorded. Naloxone was planned to be used to treat the side effects associated with ITM. The patients who complained of nausea and vomiting were planned to be treated with ondansetron 4 mg and the patients who exhibited hypotension were planned to be treated with boluses of crystalloid fluid and, if required, noradrenaline infusion.

All patients were called by phone and questioned whether they had pain or not after six months of surgery. One-year mortality was obtained from the patient follow-up records. Primary outcomes were to compare the amount of morphine consumption, VAS-R, and VAS-C. Secondary outcomes were to compare the length of stay (LOS) and incidence of side effects for each group. Additionally, the patients in the SAPB group were further divided into two groups as the upper and lower trocar insertion level (i.e., 3-5th *vs.* 5-8th intercostal space), and morphine consumption and pain scores were compared according to the trocar insertion level.

Statistical analysis

The required sample size was calculated based on a previous study using an online software (www.e-picos.com).[16] The mean meperidine consumption was found to be 28.7±12.9 mg in the ITM group for 48 h after VATS. Assuming a half of standard deviation (SD) reduction (equal to 20% reduction) in morphine consumption with a power of 80% and a risk of 0.05 for type I error, the minimum number of patients required in each group was 31.[17]

Statistical analysis was performed using the MedCalc version 19.4.0 statistical software (MedCalc Software Ltd, Ostend, Belgium). Descriptive data were expressed in mean ± SD, median or number and frequency. Comparison between the two groups was performed using the Student t-test for normally distributed continuous variables or the Mann-Whitney U test for non-normally distributed variables. Categorical data were examined using the Fisher's exact test. A p value of <0.05 was considered statistically significant.

RESULTS

A total of 86 patients were scheduled for VATS during the study period. Six of these patients were not enrolled in the study due to PVB was planned. Fifteen patients were excluded from the study due to the unsuccessful VATS and switching of the surgical team to open surgery (Group ITM; n=6, Group

Table 1. Demographic and surgery characteristics of patients

	ITM+SAPB group (n=32)			ITM group (n=32)			
	n	%	Mean±SD	n	%	Mean±SD	*p*
Age (year)			51.1±15.4			56.0±18.3	0.25
Sex							0.79
Male	19	30		20	31		
Female	13	20		12	19		
Surgery duration (h)			111.9±53.5			115.2±46.1	0.79
Length of stay (days)			5.6±3.1			5.4±3.4	0.81
Operation type							0.80
Diagnostic	18	28.1		19	29.6		
Wedge resection	14	21.8		13	20.3		

SAPB: Serratus anterior plane block; ITM: Intrathecal morphine; SD: Standard deviation.

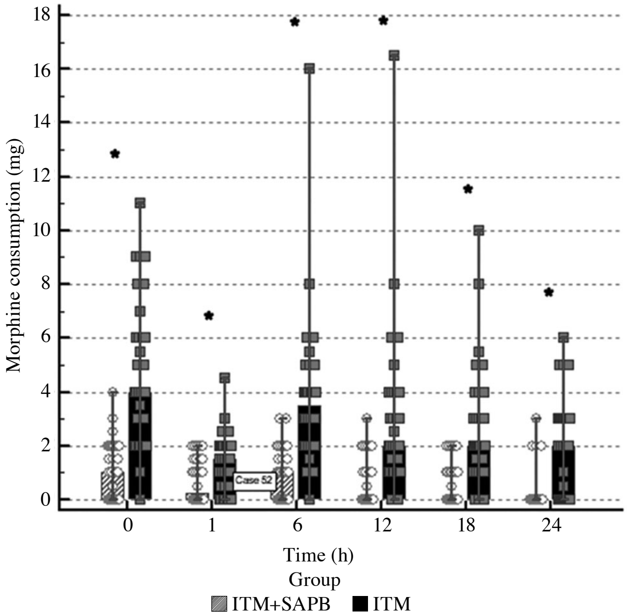

Figure 2. Comparison of morphine consumption between the two groups.

ITM+SAPB: Intrathecal morphine and serratus anterior plane block group; ITM: Intrathecal morphine group. Boxplots show median, 25-75th percentiles and min-max values. Median [25-75th percentiles] were as follows: 0th h: 2[0-2] *vs.* 4.5[2-6.5] mg, 1st h: 0.25[0-1.5] *vs.* 1.50[0.5-2] mg, 6th h: 1[0-2] *vs.* 3.5[2-5] mg, 12th h: 0[0-1] *vs.* 3[1.5-4] mg, 18th h: 0[0-1.5] *vs.* 2[2-4] mg, 24th h: 0[0-0] *vs.* 2[0-3] mg and total: 3.5[2-6] *vs.* 15.5[11-23] mg, respectively; p<0.05 for all).

ITM+SAPB; n=9). One patient who needed epidural catheter for pain control (Group ITM) was also excluded and a total of 64 patients were included in the study. Demographic and surgical characteristics of the patients are summarized in Table 1. There were no statistically significant differences between the two groups with respect to age, sex, and type and duration of surgery (p>0.05 for all).

Total morphine consumption in the first 24 h and the mean morphine consumption were significantly lower in the ITM+SAPB group than ITM at all time points (p<0.05 for all) (Figure 2). Compared to the control group, the VAS-R and VAS-C scores were significantly lower at 0, 1, 6, and 12 h after surgery (p<0.05, Figures 3 and 4). However, both VAS scores were found to be similar at 18 and 24 h after surgery in both groups (p>0.05, Figures 3 and 4). The mean LOS and mortality rates were found to be similar in both groups (p>0.05 for all).

There were no significant differences between the groups in terms of incidence of nausea/vomiting, hypotension, hypoxia, pruritis, and chronic pain (p>0.05 for all; Table 2). None of the patients received naloxone, but seven patients in both groups who complained of nausea and vomiting were treated with

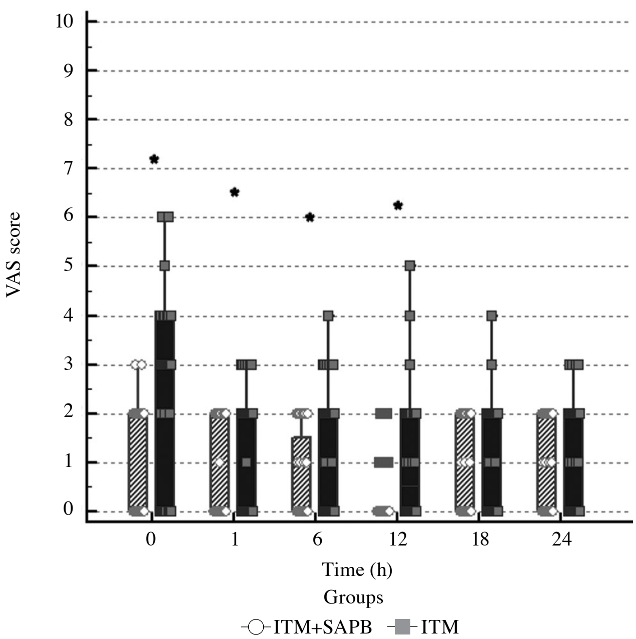

Figure 3. Comparison of VAS-R values between two groups.

VAS-R: Visual Analog Scale-Resting; ITM+SAPB: Intrathecal morphine and serratus anterior plane block group; ITM: Intrathecal morphine group. Boxplots show median, 25-75th percentiles and min-max values. Median [25-75th percentiles] were as follows: 0th h: 2[0-2] *vs.* 3[0-4], 1st h: 0[0-2] *vs.* 2[0-2], 6th h: 0[0-1.5] *vs.* 2[0-2], 12th h: 0[0-0] *vs.* 0.5[0-2], respectively; p<0.05; 18th h: 0[0-2] *vs.* 1[0-2], 24th h: 0[0-2] *vs.* 1[0-2], respectively; p>0.05.

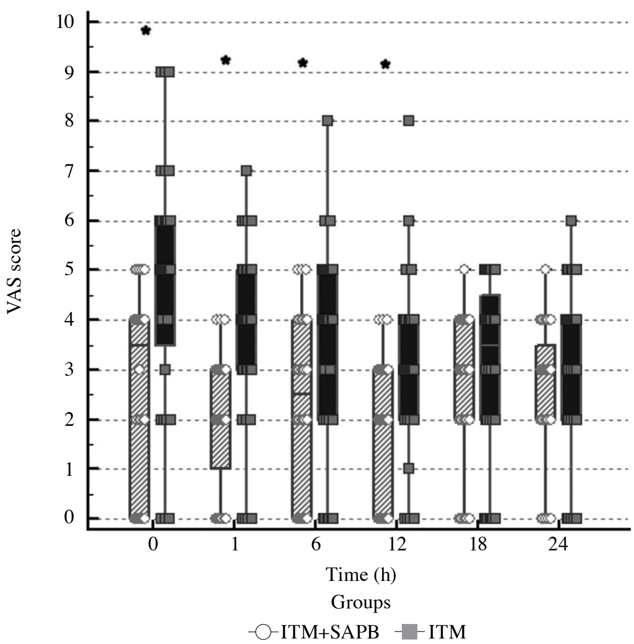

Figure 4. Comparison of VAS-C values between two groups.

VAS-C: Visual Analog Scale-Coughing; ITM+SAPB: Intrathecal morphine and serratus anterior plane block group; ITM: Intrathecal morphine group. Boxplots show median, 25-75th percentiles and min-max values. Median [25-75th percentiles] were as follows: 0th h: 3.5[0-4] vs 5[3.5-6], 1st h: 2[1-3] *vs.* 4[3-5], 6th h: 2.5[0-4] *vs.* 4[2-5], 12th h: 2[0-3] *vs.* 3[2-4], respectively; p<0.05; 18th h: 3[2-4] *vs.* 3.5[2-4.5], 24th h: 3[2-3.5] *vs.* 4[2-4], respectively; p>0.05.

Table 2. Incidence of side effects between both groups

	ITM+SAPB group		ITM group		
	n	%	n	%	*p*
Nausea/vomiting	3/32	9.3	4/32	12.5	0.69
Hypotension	4/32	12.5	5/32	15.6	0.72
Hypoxia	3/32	9.3	5/32	15.6	0.45
Pruritis	4/32	12.5	2/32	6.2	0.40
Chronic pain	7/25	28	11/22	50	0.12

ITM: Intrathecal morphine; SAPB: Serratus anterior plane block; p>0.05 for all.

Table 3. Comparison of morphine consumption and VAS scores according to trocar insertion level in the ITM+SAPB group

	Upper insertion level (n=17)		Lower insertion level (n=15)		
ITM+SAPB group	Median	25th-75th quartiles	Median	25th-75th quartiles	*p*
Morphine consumption					
0th h	1.5	0.75-2	0	0-1.75	0.04*
1st h	1	0.87-1.62	0	0-0	0.00*
6th h	1	0.75-2	0	0-1	0.04*
VAS-R					
0th h	2	2-2	0	0-0	0.00*
1st h	2	2-2	0	0-0	0.00*
6th h	1	0-2	0	0-2	0.01*
VAS-C					
0th h	4	4-5	0	0-2	0.00*
1st h	3	3-5	0	0-2	0.00*
6th h	3	2.75-4	2	0-2	0.00*

ITM: Intrathecal morphine; SAPB: Serratus anterior plane block; VAS: Visual Analog Scale; VAS-R: Visual Analog Scale-resting; VAS-C: Visual Analog Scale-coughing.

ondansetron 4 mg. Nine patients exhibited hypotension and they were treated with IV bolus fluid, and none of them required vasopressor treatment.

The patients in the SAPB group were further divided into two groups according to trocar insertion level as above (2-5th ribs) and below (5-8th ribs) the fifth rib. Pain scores were significantly higher in patients where the trocar was inserted at the upper intercostal space at 0, 1, and 6 h in the SAPB group. Moreover, morphine consumption was found to be lower in the patients with trocar inserted below compared to upper the fifth rib at 0, 1, and 6 h (Table 3).

DISCUSSION

This prospective, randomized-controlled study showed that combination of SAPB and ITM could reduce morphine consumption during the first 24 h and the pain scores at rest and coughing during the first 12 h with similar side effects, compared to ITM alone in patients undergoing VATS. Our study findings also confirmed that ITM at a dose of 0.6 mg had no analgesic effect on the immediate postoperative period, but SAPB showed satisfying analgesic effects, which is useful for this period. Furthermore, single-injection SAPB combined with ITM provided superior pain relief at lower trocar entry levels than upper levels in the immediate postoperative period.

A multimodal analgesic management is recommended to control postoperative pain after thoracic surgeries.[3] Although TEA and PVB are recommended as the first choice, its necessity is on debate in patients undergoing VATS due to the technical difficulties, serious side effects and contraindications.[4,5] The ITM is one of the simple, cost-effective, and reliable technique for postoperative analgesia,[7] but it is seldomly used alone for the management of postoperative pain in thoracic surgeries. A wide range of ITM doses have been studied in various types of surgeries.[18] According to recent studies, intrathecal administration of 0.2 to 0.5 mg of morphine improves pain control in the first 24 h after orthopedic and major abdominal surgeries, but the dose of ITM used in thoracic surgery patients was considerably high. It is recommended that the drug dose should be determined as the amount that would not cause respiratory depression, but would provide effective analgesia for intrathecal opioid administrations. It is necessary to apply at least 0.6 mg to be effective in thoracic surgeries.[19] Gwirtz et al.[19] recommended 0.65 to 0.8 mg of ITM application for these operations and the dose was reduced by 0.1 mg in patients over 65 years of age or debilitated, or increased by 0.1 mg in tall patients. However, the incidence of respiratory depression was found to be 3% in their study. In most of the studies, ITM was administered to the patients at the same standard dose for ease of administration.[8,20-22] Therefore, we believe that an ITM dose of 0.6 mg would be appropriate in our study to provide the risk of respiratory depression as low as possible and to provide maximum analgesic efficacy. The ITM can provide effective analgesia in the first postoperative day; however, its use in the clinical settings is limited due to the late onset of action.[8] Providing the peak analgesic effect may prolong to 6 h in thoracic surgeries.[23] This study demonstrates that patients in the ITM groups required a high dose of IV morphine and had high VAS score at resting and coughing in the immediate postoperative period.

To overcome the late onset of action of morphine, sufentanil has been employed in addition to morphine by intrathecal route. Although Mason et al.[8] showed that 20 µg sufentanil combined with 0.2 mg morphine provided adequate pain control after thoracotomy, there was no significant difference between the control group in terms of morphine consumption during the first 8 h.[8] On the other hand, 0.2 mg ITM administration was reported to be insufficient in thoracic surgery.[20] Madi-Jebara et al.[21] suggested that 0.5 mg of morphine combined with 5 µg sufentanil was as effective as epidural infusion of fentanyl added bupivacaine for pain control after thoracic surgeries. The combination of ITM and SAPB was more effective than ITM alone in the early postoperative period.

Previous studies have shown that SAPB reduces opioid consumption and provides effective analgesia after VATS operations.[13,14] Moreover, US-guided SAPB provided similar pain control compared to the epidural analgesia with fewer side effects in the early postoperative period for thoracic surgery.[12,14] On the other hand, longer duration of analgesia can be ensured by ITM administration compared to the SAPB. Therefore, we planned this prospective study to evaluate SAPB combined with ITM as a part of multimodal analgesia. The findings of this prospective study suggest that the use of 0.6 mg of ITM with SAPB for VATS is beneficial for postoperative analgesia in the immediate and extended postoperative period. This combination may have some advantages when thoracic epidural or PVB cannot be performed, predicted to be failure for technical reasons such as very elderly or kyphoscoliotic patients in thoracoscopic surgeries. While epidural and PVB are associated with severe sympathetic block, neither SAPB nor ITM cause sympathetic block. Therefore, it can be considered an alternative technique in patients who are not suitable for sympathetic blockade due to hypotension. Additionally, this method of pain control can be also performed after failure of TEA or PVB application.

In addition to the effective pain control of SAPB and ITM combination, another important finding in our study was that morphine consumption and VAS scores were higher in the first 6 h for the patients with higher trocar entry points above the fifth rib. This situation can be explained by two possible mechanisms. First, morphine could have provided a later onset analgesia in the upper areas depending on the intrathecal spreading rate. Second, SAPB provided more effective analgesia in the lower zone than the upper sides. Local anesthetic spread is crucial to achieve effective analgesia in SAPB, but there is still controversy regarding the mechanism and effectiveness of this technique.[24,25] Although it is suggested that the injection above the serratus muscle provides wider blockade, this issue is on debate.[24] Some authors have suggested that cephalic spread of local anesthetic can vary in the same injection volume.[24,25] Theoretically, due to the location of the injection site and the nature of innervation at the upper levels of the hemithorax, SAPB is not expected to provide adequate blockade at the second and third intercostal levels in patients where local anesthetic does not have enough cephalic spread. This may explain why morphine consumption and pain scores were higher in patients with trocar entries above the fifth rib level in our study. Increasing the local anesthetic volume provided blockage in a wider area.[26] It has also been demonstrated that local anesthetic distribution reaches higher levels by additional injection from the third rib level.[24] With the future studies, different single and divided local anesthetic doses at different injection sites should be investigated to provide the better analgesic effect with SAPB for VATS patients.

Morphine spreads to all CSF and binds to specific opioid receptor in the spinal cord. Respiratory depression is a possible complication of ITM and it is considered to be the most annoying clinical problem.[20] In our study, the ITM dose (0.6 mg) was selected to be effective for pain in thoracic surgeries and to be safe in terms of respiratory depression risk. A significant level of respiratory depression was reported at a dose of 0.6 mg in a study conducted in volunteers.[9] However, none of the patients exhibited respiratory depression in our study. Due to the fact that, close monitoring is recommended for patients receiving ITM therapy and all of the study group patients were followed in the ICU after thoracic surgery in our study.

There were no serious or life-threating complications. We found similar a side effect incidence in terms of hypotension, nausea/vomiting and pruritis between ITM+SAPB and ITM groups. Additionally, none of the patients needed naloxone to relieve respiratory depression or other side effects related to morphine administration. According to our study results and the literature data, we can speculate that both of these techniques are relatively easy to apply with a low incidence of side effects compared to other interventions.[10,20]

Many factors are associated with chronic pain and are thought to be caused by central sensitization via these factors. Although some studies have focused on nerve injury as the most important factor in the development of chronic neuropathic and non-neuropathic pain, no serious nerve damage is expected after VATS.[27] On the other hand, the incidence of chronic pain after VATS is similar to open thoracic surgeries.[27] Therefore, multimodal and preemptive analgesic strategy is recommended. Although the definition and efficacy of preemptive analgesia are still debated, several studies strongly suggest that preemptive approaches lead to reductions in pain and/or analgesic use after thoracic surgeries.[28] In the present study, we performed interventions before surgery, which might be more effective in reducing acute and chronic pain than postoperative blocks. Chronic pain incidence was found to be lower in the ITM+SAPS group, although this difference was not statistically significant. Further studies with larger groups are needed to draw a firm conclusion, as the sample size is small in our study and the patients were reached by phone call.

This study has certain limitations. First, dermatomal evaluation could not be performed, as the SAPB was performed after anesthesia induction to the patients. Second, this study was not powered to detect the difference in the incidence of chronic pain.

In conclusion, our study results showed that the combination of serratus anterior plane block and intrathecal morphine could reduce morphine consumption with similar side effects, compared to intrathecal morphine alone in the first 24 h in patients undergoing video-assisted thoracoscopic surgery. However, the Visual Analog Scale scores were found to be lower in the combination therapy group than monotherapy group during first 12 h after video-assisted thoracoscopic surgery. These findings confirm that intrathecal morphine administration at a dose of 0.6 mg provides effective pain control in the first 24 h, except for in the immediate postoperative period. Serratus anterior plane block may be used for this purpose with early analgesic benefits. Thus, this combination can be considered an alternative pain control method in patients who are technically difficult to apply thoracic epidural or paravertebral block, such as kyphoscoliosis, or in patients who are not suitable for sympathetic blockade due to hypotension. Additionally, this method of pain control can be also performed after failure of thoracic epidural analgesia or paravertebral block application. Further comparative studies are needed to identify the most appropriate approach for postoperative analgesia after video-assisted thoracoscopic surgery in which the trocar is inserted in the upper intercostal space.

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