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COMPARISON OF INTERCOSTAL NERVE BLOCK VERSUS PATIENT-CONTROLLED INTRAVENOUS ANALGESIA FOR POST-THORACOTOMY PAIN

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ABSTRACT

Introduction: Acute pain after thoracic surgery is frequent, intense and can raise morbidity. Effective postoperative pain control is essential to support early mobilization, optimal respiratory function, and recovery. Different pain relief methods, such as systemic opioids, patient-controlled analgesia, and intercostal nerve blocks, have been studied to reduce problems and enhance recovery for patients who have had thoracic surgery.
Objectives: This research aims to compare the difference in analgesic effect of intercostal nerve block (ICNB) versus patient-controlled intravenous analgesia (PCIA) for post-thoracotomy analgesia in cardiac surgery.
Methods: This prospective, single-blind, randomized comparative study involved 128 patients aged 30-60 years undergoing cardiac surgery through a thoracotomy under general anesthesia. Patients were randomly assigned to two groups. Group A received ICNB with 2.5 mg/kg of 0.5% ropivacaine and 0.5 mcg/kg fentanyl at the end of surgery; rescue analgesia with fentanyl 1mcg/kg was given if VAS score exceeded 4 within 24 hours post-intubation. Group B received PCIA with IV fentanyl (25 mcg/ml) at a basal rate of 1 ml/hour, with 1 ml bolus doses available every 15 minutes post-extubation for 24 hours. Pain was assessed using the Visual Analogue Scale (VAS), and total fentanyl consumption and sedation score were recorded. Significance level was kept at 95%.
Results: The demographic data were comparable between the two groups. The VAS score was significantly lower in the ICNB group than in the PCIA group (p value < 0.05). The total dose of fentanyl required in 24 hours after extubation was significantly higher in the PCIA group than in the ICNB group. The mean Ramsay sedation score was higher in the PCIA group compared to the ICNB group. Patients in ICNB group showed a lower incidence of side effects.
Conclusion: Our study suggests that the ICNB is more effective than PCIA for post-thoracotomy analgesia and also requires a lesser total dose of opioid.

Keywords: Fentanyl; Intercostal Nerve Blocks; Patient-Controlled Intravenous Analgesia; Thoracotomy

ABSTRAK

Pendahuluan: Nyeri akut setelah operasi torakotomi adalah hal yang sering terjadi, bersifat intens, dan dapat meningkatkan morbiditas. Pengendalian nyeri pascaoperasi yang efektif sangat penting untuk mendukung mobilisasi dini, fungsi pernapasan yang optimal, dan pemulihan pasien. Berbagai strategi analgesik, termasuk opioid sistemik, analgesia intravena yang dikendalikan pasien, dan blok saraf intercostal, telah dieksplorasi untuk meminimalkan komplikasi dan meningkatkan hasil pada pasien pembedahan toraks.
Tujuan: Penelitian ini bertujuan membandingkan efek analgesik antara blok saraf interkostal (ICNB) dan analgesia intravena terkendali (PCIA) untuk analgesia pasca torakotomi pada pembedahan jantung.
Metode: Penelitian ini merupakan studi prospektif, *single-blind*, dan acak terkontrol yang melibatkan 128 pasien usia 30-60 tahun yang menjalani operasi jantung melalui torakotomi dengan anestesi umum. Pasien dibagi secara acak menjadi 2 kelompok. Kelompok A menerima ICNB dengan 2,5 mg/kg ropivakain 0,5% dan 0,5 mcg/kg fentanil di akhir operasi; analgesia tambahan diberikan berupa fentanil 1 mcg/kg bila skor VAS > 4 dalam 24 jam pasca ekstubasi. Kelompok B menerima PCIA dengan IV fentanyl (25 mcg/ml) dengan laju infus basal 1 ml/jam dan bolus 1 ml tersedia setiap 15 menit selama 24 jam pasca ekstubasi. Skor nyeri diukur menggunakan Skala Analog Visual (VAS), total konsumsi fentanil, dan skor sedasi dicatat. Tingkat signifikansi ditetapkan pada 95%.
Hasil: Data demografis sebanding antara kedua kelompok. Skor VAS secara signifikan lebih rendah pada kelompok ICNB dibandingkan dengan kelompok PCIA (nilai p < 0,05). Dosis total fentanyl yang diperlukan dalam 24 jam setelah ekstubasi secara signifikan lebih tinggi pada kelompok PCIA dibandingkan dengan kelompok ICNB (nilai p < 0,05). Rata-rata skor sedasi Ramsay lebih tinggi pada kelompok PCIA dibandingkan kelompok ICNB. Pasien dalam kelompok ICNB menunjukkan insiden efek samping yang lebih rendah.
Kesimpulan: Studi kami menunjukkan bahwa Blok Saraf Interkostal lebih efektif daripada PCIA untuk analgesia pasca torakotomi dan juga memerlukan dosis total opioid yang lebih rendah.

Kata kunci: Fentanil; Blok saraf interkostal; Analgesia intravena terkendali; Torakotomi

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INTRODUCTION

Pain is the major concern for both the patient and the anesthesiologist in the perioperative period (1). Acute pain after thoracic surgery is common and severe, increasing morbidity (2). The pain hinders the patient from coughing effectively, breathing deeply, or moving. Severe post-operative pain, in general, increases post-operative complications and may lead to chronic pain (3). Optimal postoperative pain management for cardiothoracic surgery patients enables early mobilization, respiratory physiotherapy, and sufficient sleep. It also reduces stress, mechanical breathing time, stay duration in the hospital, and the risk of comorbidities like pneumonia, atelectasis, deep vein thrombosis, and cardiac ischemia (4). Systemic opioid-based treatment regimens, intramuscular or intravenous opioids, nonsteroidal anti-inflammatory drugs, per rectal administration of drugs, intercostal nerve block (ICNB), thoracic epidural block, thoracic paravertebral block, and erector spinae block are all options for controlling acute pain after thoracic surgery (1,3).

Patient-controlled analgesia (PCA) allows patients to self-administer modest bolus doses of opioids, allowing them to achieve effective blood concentrations as needed. It shortens the interval between pain perception and drug administration and reduces the overall analgesic dose necessary (1).

Morphine, tramadol, fentanyl, sufentanyl, oxycodone, and ketamine are among the drugs that can be utilized in a PCA pump. Continuous morphine infusion increases morphine intake, sedation, and, most likely, the prevalence of respiratory depression (5). Fentanyl has analgesic strength comparable to morphine, and its high lipid solubility shortens the onset time, making it suited for IVPCA. Unlike morphine, fentanyl does not create active metabolites that cause respiratory depression and has a shorter duration of effect. However, the use of IVPCA with fentanyl for acute post-thoracotomy pain management is still uncommon (6). Because nociception travels primarily through the intercostal nerves in the thorax, blockade of the intercostal nerve is used to provide analgesia after thoracic surgery. Intercostal nerve blocks are a regular component of multimodal analgesia following thoracic surgery (2).

Intercostal nerve blocks are an efficient means of relieving post-thoracotomy pain that can be performed using anatomic landmarks or ultrasound guidance (3). It offers technical simplicity, analgesia, enhanced pulmonary mechanics, less central nervous system depression, and avoidance of urine retention (5). It is also quite simple to perform and, when administered at the desired dermatome level, delivers segmental analgesia. Cardiac surgery by thoracotomy has the added benefit of allowing ICNB to be administered directly at the location before the surgical incision is closed. Ropivacaine has a low-fat solubility, cardiac and central nervous system toxicity (7), and is likely to provide a longer duration of anesthesia in digital nerve blocks than bupivacaine and lidocaine (5).

In this study, we compared the intercostal nerve block (ICNB) versus patient-controlled intravenous analgesia (PCIA) for relief of post-thoracotomy pain for adult cardiac surgery.

METHODS

This prospective, randomized, comparative study was conducted at a tertiary care cardiothoracic center after approval from the Institutional Ethical Committee No. 34/MC/EC/2021. The study was registered in the Clinical Trial Registry (CTRI/2022/10/046882). The study included 128 American Society of Anesthesiologists (ASA) physical status II-III patients in the age group of 30-60 years scheduled for an elective cardiac surgery through a thoracotomy incision. Written informed consent was obtained after a complete explanation of the study protocol and the procedures. Patients who had prior chest surgeries, were allergic to ropivacaine, could not complete the visual analogue scale (VAS) score, had trouble using the

PCIA pump, or did not provide informed consent were not included in the study.

Sample Size

A sample size of 64 patients in each group was required at 95% confidence and 80% power to verify the expected difference of 0.7±1.4 µg/kg in the mean difference of total amount of fentanyl used after surgery between the two groups (5). Pre-procedure complete blood counts, chest X-ray (CXRs), electrocardiogram (ECGs), and coagulation profiles were acquired for every patient.

Intravenous (IV) access was acquired, and standard monitors were connected after establishing nil per oral status. An internal jugular line & an arterial line were secured under local anesthesia. General anesthesia (GA) was induced with an injection of Midazolam 0.05 mg/kg, Fentanyl 3 mcg/kg, Etomidate 0.3 mg/kg and Rocuronium 0.9 mg/kg for pre-anesthetic drugs, intermittent positive pressure ventilation (IPPV) was done for 60 seconds, and the patient was intubated with a proper-size cuffed endotracheal (ET) tube. Following standard institutional policy, GA was maintained in conjunction with capnography and bispectral index monitoring. The hemodynamic parameters were maintained within 20% of baseline.

A computer-generated random number table was used to divide the patients into two groups of 64 each, and coded, opaque, and sealed envelopes were used to keep them concealed. VAS score, dose of fentanyl needed, and sedation score were assessed immediately, and 1, 2, 4, 6, 8, 10, 12, and 24 hours after extubation. Total dose of fentanyl, Time to first rescue analgesia, length of stay in the Intensive Care Unit (ICU) and side effects if any were assessed for 24 hours post-extubation.

A day prior to the procedure, the patient's complete medical and surgical history, including any known drug allergies, was obtained. Vital parameters (blood pressure, pulse rate, temperature and respiratory rate), and body weight of the patients were noted. Standard monitors were attached once intravenous (IV) access was secured after establishing nil per oral status. General anesthesia was given, and hemodynamic parameters were maintained within 20% of baseline.

Group A (ICNB)

After completion of surgery, an intercostal nerve block was given. The area between the adjacent ribs showed the contour of three layers of intercostal muscles: the innermost, internal, and external. The needle was then gently inserted and advanced into the innermost layer of intercostal muscle, and divided doses of 0.5% ropivacaine and 0.5 µg/kg fentanyl were given at the incisional level and two spaces below and above the incision [after negative aspiration for air or blood]. The total drug amounted to 2.5 mg/kg ropivacaine & 0.5 µg/kg fentanyl, and rescue analgesia was provided in the form of 1 µg/kg IV fentanyl whenever the VAS was ≥ 4.

Group B (PCIA)

IV fentanyl (25 µg/mL) at a basal infusion rate of 1mL/hour (fentanyl 25 µg/hour) was started after extubation, and a bolus of 1mL (fentanyl 25 µg) was given by patients him/herself whenever needed with a lockout interval of 15 minutes.

Statistical analysis

Categorical or nominal variables were summarized as numbers and proportions and were analyzed using the chi-square test or Fisher exact test as applicable. Continuous variables were summarized as mean and standard deviation and were analyzed using an independent sample t-test as applicable, for comparison between two groups. A p-value < 0.05 was taken as statistically significant.

RESULTS AND DISCUSSION

The study was conducted on 128 patients, were divided into 2 groups, each consisting of 64 patients. The demographic profile and baseline characteristics were comparable between the two

groups. There were no significant differences between age, weight, height, MAP, and heart rate (HR) of group A and group B [Table 1].

Table 1. Demographic and Baseline Data

Variable	Group A (ICNB)	Group B (PCIA)	p-Value
Age (Years)	42.61±10.12	42.14±8.9	0.781
Weight (kg)	61.78±12.68	61.63±11.12	0.941
Height (cm)	166.5±5.62	166.13±5.62	0.707
MAP	76.00±4.02	75.96±4.39	0.957
Heart Rate	103.56±15.8	97.77±14.6	0.052

*Result of the independent T-test, it is significant if α < 0.05

Total fentanyl dose requirement in 24 hours was higher in group B (648.44±35) than in group A (90.63±15) [Figure 1], and fentanyl mean dose requirements at different time intervals were significantly different (p < 0.001) in group A than in group B [Table 2].

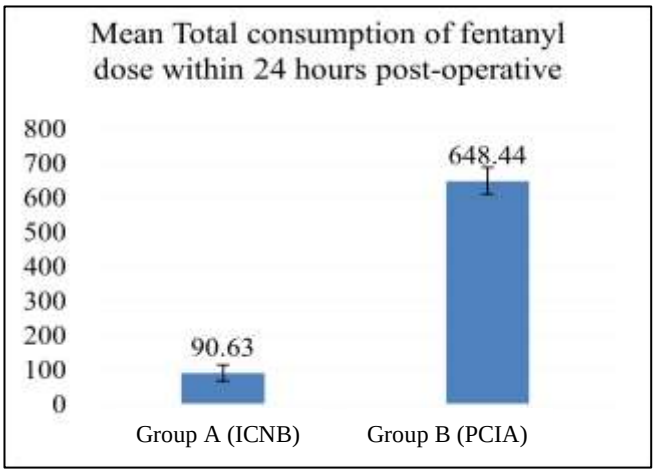

Figure 1. Mean total consumption of fentanyl (mcg) in the two groups in 24 hours

The mean time for first rescue analgesia requirement was significantly longer in group A (11.84±3.69) than in group B (3.59±1.34). In contrast with time of first rescue analgesia, the length of stay in the ICU was not statistically different, the mean was longer in group B than in group A [Table 3].

Table 2. Fentanyl dose (µg) between two groups in 24 hours

Time intervals	Group A (ICNB)	Group B (PCIA)	p-Value
Immediately after extubation	-	-	-
1st hour	-	-	-
2nd hour	2.81±5.77	27.34±7.34	**<0.001**
4th hour	3.43±5.47	64.45±13.22	**<0.001**
6th hour	4.84±5.34	67.97±18.08	**<0.001**
8th hour	7.34±6.66	59.38±12.2	**<0.001**
10th hour	23.43±9.03	51.56±6.1	**<0.001**
12th hour	30.15±12.68	53.13±11.36	**<0.001**
24th hour	13.35±12.43	-	-

*Result of the independent T-test, it is significant if α < 0.05

The mean postoperative VAS score at different time intervals in both study group was significantly higher in group B than group A at almost all times intervals (p value < 0.05) except at 10 hours. Mean sedation score in group B was significantly higher than in group A (p value < 0.05) at all intervals [Table 4].

Table 3. Time of first rescue analgesia requirement and length of stay in ICU

Variable	Group A (ICNB)	Group B (PCIA)	p-Value
Time for first rescue analgesia requirement (hour)	11.84±3.69	3.59±1.34	**<0.001**
Length of stay in ICU (day)	3.58±0.85	3.78±0.77	0.158

*Result of the independent T-test, it is significant if α<0.05

The incidence of nausea, vomiting, and pruritus was higher in group B than in group A, while this difference in proportion was significant for nausea only (p value < 0.05) and insignificant for vomiting and pruritus (p value > 0.05). None of the patients had respiratory depression and bradycardia [Table 5]. Hemodynamic parameter measured in this study was mean arterial pressure (MAP) between both the groups was comparable throughout the study periods [Figure 2].

Table 4. Mean VAS score and Mean sedation score at different time intervals

Time intervals	VAS Score		p-Value	Mean Sedation Score		p-Value
	Group A (ICNB)	Group B (PCIA)		Group A (ICNB)	Group B (PCIA)	
Immediately after extubation	1.98±0.58	1.91±0.5	0.697	1.8±0.16	2.89±0.36	**<0.001**
1st hour	2.16±0.54	2.88±0.33	**<0.001**	2.31±0.26	3.09±0.41	**<0.001**
2nd hour	2.78±0.42	4.52±0.59	**<0.001**	2.34±0.49	3.1±0.49	**<0.001**
4th hour	2.95±0.49	5.17±0.92	**<0.001**	2.53±0.52	3.15±0.5	**<0.001**
6th hour	2.97±0.25	5.03±0.99	**<0.001**	2.93±0.46	3.32±0.59	**<0.001**
8th hour	2.91±0.39	4.78±0.81	**<0.001**	2.57±0.48	3.51±0.74	**<0.001**
10th hour	4.09±1.26	3.02±0.13	**<0.001**	2.11±0.56	3.19±0.52	**<0.001**
12th hour	4.2±0.86	4.66±0.54	**<0.001**	1.95±0.34	2.81±0.41	**<0.001**
24th hour	4±0.78	4.61±0.58	**<0.001**	1.62±0.21	2.64±0.38	**<0.001**

*Result of the independent T-test, it is significant if $\alpha < 0.05$

After thoracic surgery, acute discomfort can be managed in a variety of methods. These include systemic opioid-based treatment, thoracic epidural block, intercostal nerve block, and newer methods of fascial plane block (3). We compared intercostal nerve block versus patient-controlled intravenous analgesia for thoracotomy pain.

Table 5. Distribution of side effects between the two groups

Side effects	Group A (ICNB) (N (%))	Group B (PCIA) (N (%))	X^2	p-Value
Nausea	1 (1.6)	11 (17.2)	7.448 (Df=1)	**0.006**
Respiratory depression	0	0	-	-
Bradycardia	0	0	-	-
Vomiting	0	2 (3.1)	0.508 (Df=1)	0.476
Pruritus	0	2 (3.1)	0.508 (Df=1)	0.476

*Result of the Fisher exact test, it is significant if $\alpha < 0.05$

In this study, consumption of fentanyl was significantly more ($p < 0.001$) in group B as compared to group A, and also the time to administer the first dose of rescue analgesic (fentanyl 1 µg/kg) was significantly longer in group A (11.84±3.69 hours) as compared to group B (3.59±1.34 hours). M Luo et al. (5) also found in their study that fentanyl dose requirement more in PCIA group (6.65 mcg/kg) than ICNB group (2.66 mcg/kg) in the Nuss procedure in children for postoperative period of 24 hours. The results were also similar to the study conducted by Jinghong Xu et al. (8) where the fentanyl dose requirement was statistically significantly ($p < 0.001$) more in the PCIA group (27.96±8.49) than in the ICNB group (14.37±4.20). Z Ahmed et al. (9) in their study reported that 24-hour morphine consumption was lower in the ICNB group than in the PCIA group.

K Mahmoudi et al. (3) in their study found that time for first rescue analgesia requirement in the ICNB group was 13.2±3.8 hours, and a study conducted by Rohan Magoon et al (10), mean time to rescue analgesic (fentanyl 0.5-1 mcg/kg) requirement in the ICNB group (using 0.5% ropivacaine) was (10.92±0.61 hours) for post-thoracotomy analgesia in cardiac surgery, which is almost similar to our study.

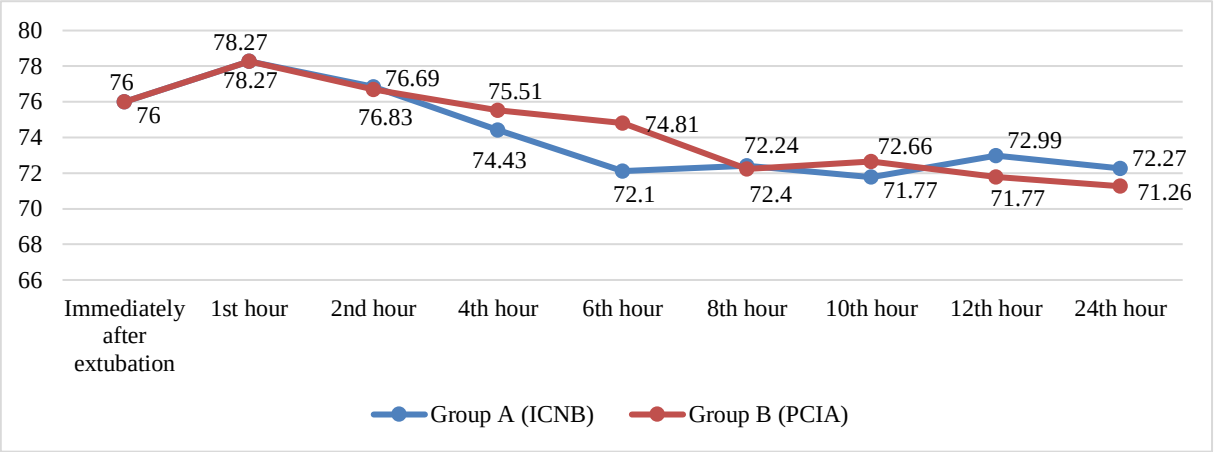

Figure 2. Comparison of Mean Arterial Pressure (MAP) of two groups

In the present study, the mean VAS score at different time intervals after extubation was less than 4 in the ICNB group in comparison to the PCIA group, which was more than 4 till 8 hours. Mean VAS was significantly higher ($p < 0.001$) in the PCIA group than the ICNB group at different time intervals. J Xu et al. (8) also found that mean VAS score was higher ($p < 0.05$) in the PCIA group than the ICNB group for 24 hours study period. Similar results were seen by M Luo et al. (5) where FPS-R score was significantly ($p < 0.05$) less in the UG-ICNB group (< 3) than the PCIA group (> 4) throughout the study period of 24 hours in the Nuss procedure in children.

The Ramsay sedation score in group A was between 1.5 and 3 at all research time intervals, indicating that patients in this study group were calm, comfortable, and responding to commands for most of the time during the study period since they had good pain relief and were not sedated. However, in group B, the sedation score was between 2 and 3 for the majority of the time due to the fentanyl PCIA pump, and the patients were somewhat sedated but arousable. In a study conducted by J Xu et al. (8) sedation score for the ICNB group (using 0.375% ropivacaine) and the PCIA group (using fentanyl) was also between 2 and 3.

On comparing the two groups with regard to adverse effects, the incidence of nausea was significantly higher in group B than in group A. The incidence of vomiting and pruritus was also common in group B. None of the patients had respiratory depression and bradycardia. M Luo et al. (5) found that 5.9% of patients in the ICNB group and 17.8% of patients in the PCIA group had nausea and vomiting, which is quite similar to our study. In their study 2.9% patient in the ICNB group and 28.6% patients in the PCIA group also had respiratory depression.

The advantages of intercostal nerve block over patient-controlled intravenous analgesia include technical simplicity, effective analgesia, improved pulmonary mechanics, and less central nervous system depression, which is more common with systemic opioid-based treatment regimens (11). One of the factors that may make PCIA an effective postoperative analgesia technique is that it allows the patient to regulate their pain management. Many drugs can be used. Since fentanyl acts more quickly and produces less sedation than morphine, we used it. As fentanyl is not eliminated by renal excretion, it is appropriate for patients with renal insufficiency.

CONCLUSION

Intercostal nerve block is more effective than patient-controlled intravenous analgesia for postoperative pain in patients undergoing cardiac surgery through thoracotomy incision. ICNB was linked to a lower fentanyl dose required and a lower sedation score. There are no notable side effects associated with the administration of intercostal nerve blocks.

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Conflict of Interest
The authors declare there is no conflict of interest.

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Authors' Contributions
All authors contributed in all processes of the writing and publishing in manuscript.

REFERENCES

1. Kavishvar N, Prajapati B. A comparative study of intravenous patient-controlled analgesia with tramadol alone and tramadol plus dexmedetomidine for major lower abdominal surgery. Indian Journal of Pain. 2017; 31(2): 107. [Website]
2. Guerra-Londono CE, Privorotskiy A, Cozowicz C, Hicklen RS, Memtsoudis SG, Mariano ER, et al. Assessment of Intercostal Nerve Block Analgesia for Thoracic Surgery. JAMA Netw Open. 2021; 4(11): e2133394. [PubMed] [Website]
3. Mahmoudi K, Rashidi M, Soltani F, Savaie M, Hedayati E, Rashidi P. Comparison of Intercostal Nerve Block with Ropivacaine and Ropivacaine-Dexmedetomidine for Postoperative Pain Control in Patients Undergoing Thoracotomy: A Randomized Clinical Trial. Anesth Pain Med. 2021;11(6). [PubMed]
4. Lakdizaji S, Zamanzadeh V, Zia Totonchi M, Hosseinzadeh A. Impact of patient-controlled analgesia on pain relief after coronary artery bypass graft surgery: a randomized clinical trial. J Caring Sci. 2012; 1(4): 223–9. [PubMed]
5. Luo M, Liu X, Ning L, Sun Y, Cai Y, Shen S. Comparison of Ultrasonography-guided Bilateral Intercostal Nerve Blocks and Conventional Patient-controlled Intravenous Analgesia for Pain Control After the Nuss Procedure in Children: A Prospective Randomized Study. Clin J Pain. 2017; 33(7): 604–10. [PubMed]
6. Tseng WC, Lin WL, Lai HC, Huang TW, Chen PH, Wu ZF. Fentanyl-based intravenous patient-controlled analgesia with low dose of ketamine is not inferior to thoracic epidural analgesia for acute post-thoracotomy pain following video-assisted thoracic surgery: A randomized controlled study. Medicine. 2019; 98(28): e16403. [PubMed]
7. Wang Y, Cheng J, Yang L, Wang J, Liu H, Lv Z. Ropivacaine for Intercostal Nerve Block Improves Early Postoperative Cognitive Dysfunction in Patients Following Thoracotomy for Esophageal Cancer. Med Sci Monit. 2019; 25: 460–5. [PubMed]
8. Xu J, Pu M, Xu X, Xiang J, Rong X. The postoperative analgesic effect of intercostal nerve block and intravenous patient-controlled analgesia on patients undergoing lung cancer surgery. Am J Transl Res. 2021; 13(8): 9790–5. [PubMed]
9. Ahmed Z, Samad K, Ullah H. Role of intercostal nerve block in reducing postoperative pain following video-assisted thoracoscopy: A randomized controlled trial. Saudi J Anaesth. 2017; 11(1): 54–7. [PubMed] [Website]
10. Magoon R, Kaushal B, Chauhan S, Bhoi D, Bisoi AK, Khan MA. A randomised controlled comparison of serratus anterior plane, pectoral nerves and intercostal nerve block for post-thoracotomy analgesia in adult cardiac surgery. Indian J Anaesth. 2020; 64(12): 1018–24. [PubMed] [Website]
11. Xiao W, Zhou W, Chen X, Zhu J, Xue Q, Shi J. Analgesic effect of intercostal nerve block given preventively or at the end of operation in video-assisted thoracic surgery: a randomized clinical trial. Braz J Anesthesiol. 2022; 72(5): 574–8. [PubMed] [Website]