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ORIGINAL INVESTIGATION

Ultrasound-guided erector spinae plane block for open inguinal hernia repair: a randomized controlled trial

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Abstract
Background and objectives: Inguinal hernia repair is associated with significant postoperative pain. We assessed the analgesia efficacy of unilateral Erector Spinae Plane block (ESP) performed under ultrasound guidance in patients submitted to open unilateral inguinal hernia repair, comparing ESP to spinal anesthesia administered with or without opioid.
Methods: Forty-five patients with ages ranging from 27 to 83 years were randomly allocated into three groups: control group receiving spinal anesthesia (n = 14), ESP group receiving ESP block combined with spinal anesthesia (n = 16), and spinal morphine group receiving spinal anesthesia with morphine 1 mcg.kg^{-1} as adjuvant drug (n = 15). ESP was performed at the T8 level using 0.5% ropivacaine, 20 mL. We assessed the pain intensity in the initial 24 hours after surgery using the Visual Analogue Scale – VAS and rescue opioid requirement.
Results: The ESP group showed four times higher consumption of rescue opioids than the spinal morphine group, or 26.7% vs. 6.2%, respectively (RR = 4.01; 95% CI: 0.82 to 19.42; $p = 0.048$). The spinal morphine group showed higher incidence of adverse effects than the ESP group, 37.5% vs. 6.7%, respectively ($p = 0.039$). There were no statistically significant differences among groups for the mean values of VAS score at 24 hours after surgery ($p = 0.304$).
Conclusion: At the doses used in this study, the ESP block was an ineffective technique for providing postoperative analgesia in unilateral open inguinal hernioplasty and was associated with higher consumption of rescue opioids when compared to spinal anesthesia with or without opioid.

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Introduction

Inguinal hernia repair is one of the most frequent surgeries, with an estimated total of 20 million procedures performed annually.[1] It is usually executed on an outpatient basis under local anesthesia, regional anesthesia such as peripheral blocks (ilioinguinal and iliohypogastric nerve blocks) or neuraxial (spinal or epidural anesthesia), or general anesthesia.[1,2]

Notwithstanding several analgesia regimens available, many studies have revealed that postoperative pain control is still inadequate.[3] Opioids, non-steroid anti-inflammatory drugs and analgesics are often used for postoperative pain control. These drugs are associated with undesirable effects in addition to uncertain efficacy.[4] Pain is a determining factor averting early patient discharge due to the associated ambulation delay and paralytic ileus in the postoperative period.[5] Furthermore, there is great concern of post-inguinal hernia repair chronic pain, which may occur in up to 50% of patients.[5,6]

Spinal anesthesia, with or without morphine, is commonly used for inguinal hernia repair. Among the complications related to neuraxial opioid use we can underline the higher incidence of urinary retention, pruritus, and the requirement of surveillance during the initial 24 postoperative hours due to the risk of respiratory depression. As a result, the combination of nerve block with spinal anesthesia for postoperative analgesia, such as the Erector Spine muscle Plane block (ESP), was suggested as an alternative to the use of morphine.[7]

In recent years, interfascial plane blocks have been increasingly accepted because they are easy to perform, have low complication rates, can be performed in patients with contraindications for neuraxial blocks, promote minor hemodynamic changes, present fewer related risks, as they are less invasive, and are performed under US guidance enabling direct visualization of anatomic structures to the operator. The ESP block is an US-guided technique, that was initially performed at the T5 vertebral level and described for thoracic pain management,[7,8] although there are reports of successful use for providing abdominal analgesia when performed at lower vertebral levels (T7 or below).[9–12]

The findings of previous clinical studies,[7–11] that were supported by cadaver studies,[7,13–15] revealed the spread of the local anesthetic injectate within the deep interfascial plane of the erector spinae muscle, adjacent to the intervertebral foramen, contiguous to the dorsal and ventral branches of the roots of thoracic spinal nerves. Forero[7] described the spread from C7 to T8 and T1 to T8 after injection of 20 mL of contrast at the level of the transverse process of T5. Subsequently, the same author revealed craniocaudal spread from T2 to L3 and C5 to L2 with the injection of 20 mL of contrast at the T7 level.[11] The nerve fibers supplying the incision line for inguinal hernia repair originate from dermatomes T10 to T12 and intestinal viscera traction stimuli are carried by fibers originating from T6 to T8. Thus, it seems that an ESP block performed at the level of the T8 vertebra with a volume of 20 mL, would reach the level required for inguinal hernia repair. Furthermore, according to cadaver studies and published case reports published so far, it appears this block would also cover abdominal procedures if performed at levels below the T7 vertebra.[9–13]

The hypothesis studied was if the ESP block would provide analgesia similar to the use of morphine as spinal anesthesia adjuvant in the initial 24 hours of follow-up, with a lower incidence of adverse effects.

The objective of the present study was to compare the association of spinal anesthesia with the Erector Spinae Muscle Plane block versus spinal anesthesia with or without morphine for postoperative analgesia for open unilateral inguinal hernia repair.

Methods

After approval by the Human Research Ethics Committee of Universidade do Sul de Santa Catarina (Unisul) (CAAE 97383418.9.0000.5369, Registration with the Ministry of Health of Brazil – ReBEC RBR-29r8nr), we conducted a randomized, single-blind (postoperative evaluator) clinical trial with three parallel arms. Inclusion criteria were patients with age over 18 years, male or female, ASA I and II of the physical status classification of the American Society of Anesthesiology (ASA) to be submitted to open unilateral inguinal hernia repair.

We excluded patients submitted to urgent surgery, scheduled for another concomitant surgery, weighing less than 60 kg or more than 100 kg, with a history of allergy to any study medication, using anticoagulants or presenting other contraindications to neuraxial block, or with cognitive deficit that prevented them from understanding/answering the questionnaire.

All patients underwent mild preoperative sedation (0.05 to 0.1 $mg.kg^{-1}$ of midazolam and 0.5 to 1 $mcg.kg^{-1}$ of fentanyl) and spinal anesthesia with 15 mg of 0.5% hyperbaric bupivacaine. The groups were randomly determined, using Epiinfo software, an Epitable function for generating random entry numbers for each group. Patients were distributed as follows: Control group – spinal anesthesia with 15 mg of hyperbaric bupivacaine without opioid; ESP group – spinal anesthesia with 15 mg of hyperbaric bupivacaine and the erector spinae muscle plane block performed with 20 mL of 0.5% ropivacaine at the T8 vertebra level; and Spinal morphine group – spinal anesthesia with 15 mg of hyperbaric bupivacaine and morphine 1 $mcg.kg^{-1}$ as adjuvant.

Spinal anesthesia was performed with the patient in a sitting position, with a 27G Quincke needle, paramedian approach, at the L3–L4 or L4–L5 vertebral interspace, according to the best space for performing the lumbar puncture.

The intervention group with ESP block was submitted to unilateral erector spinae muscle plane block with patient in a sitting position, using a 5–13 MHz high frequency linear probe (LOGIQe; GE Healthcare) with a parasagittal longitudinal orientation to identify the T8 transverse process by counting from the first rib to the eighth rib, and medially sliding the probe to the surface landmark of the T7 vertebra at the inferior scapular tip. A 10-cm-long 22G needle (BBraun, Stimuplex A100, 22G) was inserted using the in-plane approach, advanced in a cephalic to caudal direction, until the tip was located between the anterior fascia of the erector spinae muscle and the T8 transverse process, and then 20 mL of 0.5% ropivacaine was injected.

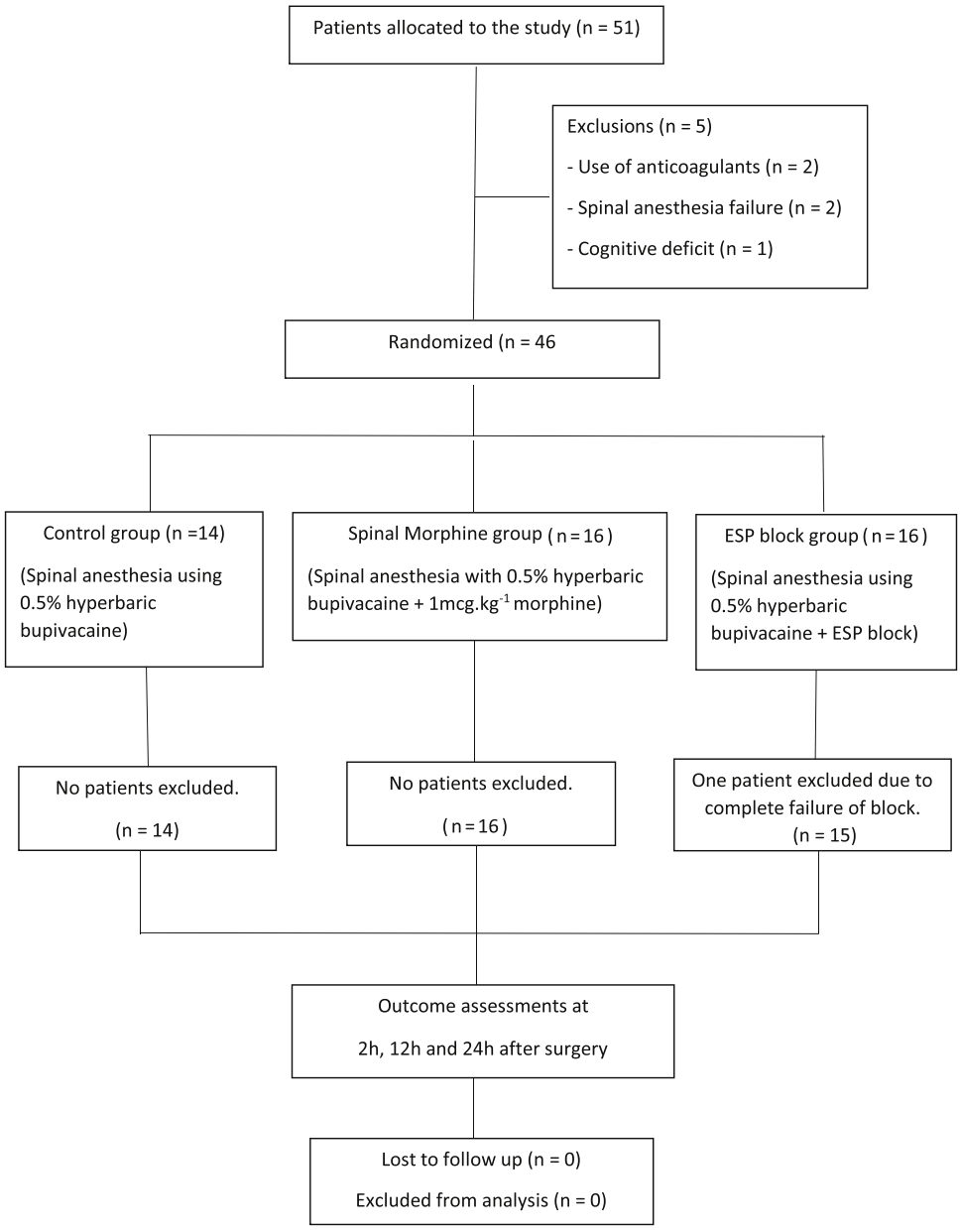

Figure 1 Flowchart of the study.

All patients received 2 g cefazolin for antibiotic prophylaxis, 10 mg dexamethasone and 4 mg ondansetron for PONV prophylaxis, and 2 g dipyrone and 40 mg tenoxicam for perioperative analgesia. A standard postoperative prescription was defined with the surgeons, with 2 g dipyrone and rescue opioids – 100 mg tramadol or 0.1 mg.kg^{-1}morphine – used only used when required (Visual Numeric Scale higher than 5).

Patient pain intensity was assessed in the immediate postoperative period (up to 2 hours after the surgical procedure) and 12 to 24 hours after surgery, using the Visual Analogue Scale (VAS) for pain, and rescue opioid requirement was registered. Adverse reactions (urinary retention – need for urinary catheterization, pruritus, nausea and vomiting), and patient satisfaction with the proposed technique were also recorded.

The minimum number of patients to be assessed to test a 50% difference in the effect of analgesia among groups, with an alpha error of 0.05 and beta of 0.20 was calculated as 14 patients per group. Mean, median and standard deviation were calculated for continuous variables and proportions for categorical variables. The association between categorical variables was tested using Pearson's chi-square test or Fisher's exact test, as appropriate. After the normal distribution of data was verified by the Kolgomorov Smirnov test, the association of numerical variables was analyzed by the one-way Analysis of Variance (ANOVA) test with Tukey's Post-Hoc for comparisons of means, when required. The level of significance adopted was 95%. Cutoff points for independent variables were based on conceptual models. SPSS 20.0 software was used to store and analyze data.

Table 1 Epidemiological profile of patients according to the study groups.

		Control group (14 patients)	Spinal morphine group (16 patients)	ESP group (15 patients)
Gender	**Female**	1 (7.1%)	1 (6.2%)	1 (6.7%)
	Male	13 (92.9%)	15 (93.8%)	14 (93.3%)
Age (years) Mean ± SD		51.43 ± 18.86	47.69 ± 17.64	57.80 ± 15.06
ASA	**ASAI**	8 (57.1%)	10 (62.5%)	5 (33.3%)
	ASAII	6 (42.9%)	6 (37.5%)	10 (66.7%)
BMI (kg.m^{-2}) Mean ± SD		22.83 ± 7.68	27.39 ± 10.83	26.43 ± 8.89

BMI, Body Mass Index; ASA, American Society of Anesthesiologists; ESP, Erector Spinae Plane block; SD, Standard Deviation.

Table 2 VAS pain score at the first 2 postoperative hours and from 12 to 24 hours after surgery according to the groups analyzed.

	Control group (14 patients)	Spinal morphine group (16 patients)	ESP group (15 patients)	*p*
VAS pain score 2 hours after surgery				0.129
0	13 (92.9%)	16 (100%)	11 (73.3%)	
1 – 3	1 (7.1%)	0	2 (13.3%)	
4 – 6	0	0	1 (6.7%)	
7 – 10	0	0	1 (6.7%)	
Mean ± SD	0.14 ± 0.53	0 ± 0	1.13 ± 2.20	0.141
VAS pain score 12 to 24 hours after surgery				0.043[a]
0:	9 (64.4%)	14 (87.5%)[a]	7 (46.7%)	
1 – 3:	3 (21.4%)	1 (6.2%)	4 (26.6%)	
4 – 6:	1 (7.1%)	0	4 (26.6%)	
7 – 10:	1 (7.1%)	1 (6.2%)	0	
Mean ± SD[b]	1.43 ± 2.56	0.75 ± 2.52	1.47 ± 1.73	0.304

VAS, Visual Analogic Scale; ESP, Erector Spinae Plane Block; SD, Standard Deviation.
There was no statistically significant difference for VAS pain scores among the three groups at the first 2 postoperative hours. The spinal morphine group showed statistically significant lower VAS scores than the ESP group from 12 to 24 postoperative hours (Fisher, $p = 0.043$)[a].
[b]ANOVA.

Results

Forty-five patients submitted to open unilateral inguinal hernia repair were analyzed. They were randomly allocated to the following groups: 14 patients in the control group (spinal anesthesia alone), 16 patients in the spinal anesthesia group with morphine as adjuvant, and 15 patients in the ESP group (spinal anesthesia associated with ESP block) (Fig. 1).

Ages ranged from 27 to 83 years, with a predominance of males in all groups – an average of 93% of male patients in all three groups. BMI ranged from 18 to 38 kg.m^{-2}, with BMI ranging between 18 and 24 prevailing in the three groups – an average of 66% in the three groups. BMI ranging between 25 and 29 was the second most prevalent, with an average of 28% in the three groups. The ASA class I physical status classification was predominant both in control and spinal morphine groups (57.1% and 62.5%, respectively), while ASA II was predominant in the intervention group (66.7%) (Table 1).

As for pain score values according to the Visual Analogue Scale (VAS), there were no statistically significant differences among groups regarding mean scores for the assessments performed 2 hours after surgery ($p = 0.141$), and between 12 and 24 hours after surgery ($p = 0.304$). However, when comparing pain score values from 12 to 24 hours postoperatively between the ESP group and the spinal morphine group, there was statistical significance with lower VAS values in the spinal morphine group ($p = 0.043$) (Table 2).

Regarding rescue opioid requirements in the immediate postoperative period (up to 2 hours postoperatively), only one patient in the ESP group received morphine (6.7%), with no statistically significant differences ($p = 0.312$).

As to rescue opioid requirements from 12 to 24 hours after surgery, the ESP group revealed opioid consumption four times higher, than the spinal morphine group or 26.7% vs. 6.2% (RR = 4.01; 95% CI: 0.82 to 19.42; Fisher $p = 0.048$). Among these patients, the most frequently used opioid was 100 mg tramadol (11.1% of patients), followed by morphine (2.2% of patients) (Table 3).

From the point of view of adverse effects, patients in the spinal morphine group showed five-times greater risk compared to the other two groups (RR = 5.20; 95% CI: 1.08 to 24.89; Fisher $p = 0.039$). The incidence was 18.8% in the spinal morphine group and 6.7% in the ESP group, with the control group showing no occurrence of adverse effects. In the spinal morphine group, urinary retention (defined as the need for urinary catheterization in the first 24 postoperative hours) was the most prevalent adverse effect with 4.4%, followed by pruritus, with 2.2% (Table 4).

Table 3 Rescue opioid administration up to two hours after surgery and from 12 to 24 hours after surgery.

Rescue opioid administration	Control group (14 patients)	Spinal morphine group (16 patients)	ESP group (15 patients)	*p*
2 hours after surgery				0.3
Yes	0	0	1[a]	
No	14	16	14	
12 to 24 hours after surgery				0.048[d]
Yes	1[b] (7.1%)	1[c] (6.2%)	4[b] (26.7%)	
No	13 (92.9%)	15 (93.8%)	11 (73.3%)	

ESP, Erector Spinae Plan block.
[a] 4 mg morphine, no further dose required.
[b] 100 mg Tramadol, no further dose required.
[c] 5 mg morphine no further dose required.
[d] RR = 4.01; 95% CI: 0.82 to 19.42; Fisher, $p = 0.048$ (ESP vs. control and spinal morphine).

Table 4 Incidence of postoperative adverse effects.

Adverse effects	Control group (14 patients)	Spinal morphine group (16 patients)	ESP group (15 patients)	*p*
Urinary retention	0	2 (12.5%)	0	
Pruritus	0	1 (6.25%)	1 (6.67%)	
Nausea and vomiting	1 (7.14%)	3 (18.75%)	1 (6.67%)	
Total	1 (7.14%)	2 (13.34%)	0.039[a]	

ESP, Erector Spinae Plane block.
[a] Fisher, $p = 0.039$; RR = 5.20; 95% CI: 1.08 to 24.89 (spinal morphine group vs. control+ESP).

When asked, all patients reported satisfaction both with the anesthesia and analgesia technique used.

Discussion

The present study compared postoperative analgesia of three different anesthetic techniques for open unilateral inguinal hernia repair: spinal anesthesia, spinal anesthesia with morphine as adjuvant, and spinal anesthesia associated with erector spinae muscle plane block.

Although previous reports have suggested that ESP block is also effective for abdominal surgeries when performed at lower vertebral levels (T7 or lower), it could not be shown in the present study. Based on available literature reviews, we chose to execute the block at the T8 level using 20 mL of local anesthetic solution,[9,11] however we cannot exclude that perhaps a more effective ESP block can be attained, if the block is performed at lower levels, such as T10, with a larger volume of local anesthetic, such as 30 mL.

This negative result may be partially explained by the learning curve of the procedure, nonetheless, analgesia has been shown to be satisfactory for other types of surgery with the same work settings and anesthesiologists.

The literature has shown emphasized enthusiasm for the ESP block for analgesia in several types of surgery. On the other hand, after extensive publication of reports and case series showing early encouraging results, subsequent randomized clinical trials seem to show lack of the effectiveness suggested by early studies, depicting borderline statistical differences.[2,4,9,10] These differences in favor of the new treatment, may also indicate publication bias and raise questions about blinding and randomization methods of these trials.

Forero et al.[7] initially described the technique at the T5 level for the management of thoracic neuropathic pain. ESP block is an interfascial plane technique performed between the thoracic transverse process and the erector spinae muscle, that enables local anesthetic to spread towards the intercostal space and the thoracic paravertebral space through the porous tissue surrounding the costotransverse foramen and the costotransverse ligament.[7,12–15]

The local anesthetics injected at this point seem to act in the ventral and dorsal branches of the thoracic spinal nerves, explaining the blockade of the ventral branches and the sympathetic fibers responsible for somatic and visceral pain, and, to reach the epidural space, subsequently.[7,12,13] However, although the ESP block is described to be effective for mitigating somatic and visceral pain, there are still inconsistent findings concerning visceral pain improvement.[12,14,15] This may be due to the local anesthetic spread being restricted to only the ventral branches and not to the thoracic paravertebral space,[14] or due to a dispersion that could be confined to the dorsal branch and with only 10% of the local anesthetic solution attaining the ventral branch or the dorsal root of the ganglion.[14–16]

Studies have reported the use of single-shot ESP block performed at the thoracic level.[7–9,12–18] Others have described ESP block performed at the lumbar[9–13] and even cervical[19] levels. The ESP block shares similarities with other fascial blocks, such as the quadratus lumborum type I and II blocks and the standard retrolaminar interfascial block, and studies have not shown ESP block to be more advantageous than more conventional techniques in abdominal surgeries.[12–22]

The advantages of performing ESP block in several types of surgical procedures include the straightforward

approach, low risk of vital structure injury, and single injection (or catheter insertion) enabling the extension of the block to multiple levels of nerve roots and the blockade of ventral branches and sympathetic fibers providing visceral pain control.[7,12,17,20–22]

The higher incidence of adverse effects in the spinal morphine group supports the findings previously reported in the literature,[1,2,5] especially regarding urinary retention, which delays patient recovery and discharge. Patients receiving spinal anesthesia without adding morphine as adjuvant did not show adverse effects nor any differences concerning rescue opioid requirement from 12 to 24 hours after surgery. Only the immediate postoperative assessment presented lowered statistically significant differences in VAS pain score for the spinal morphine group. However, it is noteworthy that chronic postoperative pain in patients undergoing hernioplasty without morphine has already been reported,[6] and should be pondered when one considers using the technique.

Because the rescue opioid requirement was higher for the intervention group (spinal anesthesia associated with spinal erector block), we suggest that the technique provided less effective postoperative pain control in the present study.

Conclusion

In the doses performed in the present study, the ESP block associated with spinal anesthesia was an ineffective technique for postoperative analgesia for open unilateral inguinal hernia repair, requiring more administration of rescue opioid when compared to spinal anesthesia with morphine.

Conflicts of interest

The authors declare no conflicts of interest.

References

1. Kulacoglu H, Alptekin A. Current options in local anesthesia for groin hernia repairs. Acta Chir Iugosl. 2011;58:25–35.
2. Bakota B, Kopljar M, Baranovic S, et al. Should we abandon regional anesthesia in open inguinal hernia repair in adults? Eur J Med Res. 2015;20:76.
3. Santos GC, Braga GM, Queiroz FL, Navarro TP, Gomez RS. Avaliação da dor pós-operatória e alta hospitalar com bloqueio dos nervos ilioinguinal e ílio-hipogástrico durante herniorrafia inguinal realizada com raquianestesia: estudo prospectivo. Rev Assoc Med Bras. 2011;57:545–9.
4. Bellows CF, Berger DH. Infiltration of suture sites with local anesthesia for management of pain following laparoscopic ventral hernia repairs: a prospective randomized trial. JSLS. 2006;10:345–50.
5. Aasvang E, Kehlet H. Chronic postoperative pain: the case of inguinal herniorrhaphy. Br J Anaesth. 2005;95:69–76.
6. Eklund A, Montgomery A, Bergkvist L, Rudberg C, Swedish Multicentre Trial of Inguinal Hernia Repair by Laparoscopy Study Group (SMIL). Chronic pain 5 years after randomized comparison of laparoscopic and Lichtenstein inguinal hernia repair. Br J Surg. 2010;97:600–8.
7. Forero M, Adhikary SD, Lopez H, Tsui C, Chin KJ. The erector spinae plane block: a novel analgesic technique in thoracic neuropathic pain. Reg Anesth Pain Med. 2016;41:621–7.
8. Forero M, Rajarathinam M, Adhikary SD, Chin KJ. Erector spinae plane block for the management of chronic shoulder pain: a case report. Can J Anesth. 2018;65:288–93.
9. Restrepo-Garces CE, Chin KJ, Suarez P, Diaz A. Bilateral continuous erector spinae plane block contributes to effective postoperative analgesia after major open abdominal surgery: a case report. AA Case Rep. 2017;9:319–21.
10. Chin KJ, Malhas L, Perlas A. The erector spinae plane block provides visceral abdominal analgesia in bariatric surgery: a report of 3 cases. Reg Anesth Pain Med. 2017;42:372–6.
11. Chin KJ, Adhikary S, Sarwani N, Forero M. The analgesic efficacy of pre-operative bilateral erector spinae plane (ESP) blocks in patients having ventral hernia repair. Anaesthesia. 2017;72:452–60.
12. Bang S. Erector spinae plane block: an innovation or a delusion? Korean J Anesthesiol. 2019;72:1–3.
13. Adhikary SD, Bernard S, Lopez H, Chin KJ. Erector spinae plane block versus retrolaminar block: a magnetic resonance imaging and anatomical study. Reg Anesth Pain Med. 2018;43:756–62.
14. Yang HM, Choi YJ, Kwon HJ, O J, Cho TH, Kim SH. Comparison of injectate spread and nerve involvement between retrolaminar and erector spinae plane blocks in the thoracic region: a cadaveric study. Anaesthesia. 2018;73:1244–50.
15. Sakae TM, Yamauchi LHI, Takaschima AKK, Brandão JC, Benedetti RH. Comparison between erector spinal plane block and epidural block techniques for postoperative analgesia in open cholecystectomies: a randomized clinical trial. Braz J of Anesth. 2020;70:22–7.
16. Ivanusic J, Konishi Y, Barrington MJ. A cadaveric study investigating the mechanism of action of erectorspinae blockade. Reg Anesth Pain Med. 2018;43:567–71.
17. Tsui BC, Fonseca A, Munshey F, McFadyen G, Caruso TJ. The erector spinae plane (ESP) block: a pooled review of 242 cases. J Clin Anesth. 2018;53:29–34.
18. Muñoz F, Cubillos J, Bonilla AJ, Chin KJ. Erector spinae plane block for postoperative analgesia in pediatric oncological thoracic surgery. Can J Anesth. 2017;64:880–2.
19. Evans HT, Leslie GJ, Rutka O, Keevil E, Burckett-St Laurent D. Bilateral erector spinae plane block for surgery on the posterior aspect of the neck: a case report. A A Pract. 2019;12:356–8.
20. Ueshima H, Otake H. Similarities between the retrolaminar and erector spinae plane blocks. Reg Anesth Pain Med. 2017;42:123–4.
21. Abu Elyazed M, Mostafa SF, Abdelghany MS, Eid GM. Ultrasound-guided erector spinae plane block in patients undergoing open epigastric hernia repair: a prospective randomized controlled study. Anesth Analg. 2019;129:235–40.
22. Aksu C, Gurkan Y. Opioid sparing effect of erector spinae plane block for pediatric bilateral inguinal hernia surgeries. J Clin Anesth. 2018;50:62–3.