İstanbul Med J 2022; 23(2): 149-53
DOI: 10.4274/imj.galenos.2022.13911

Comparison of the Effectiveness of Anesthesia Methods on Percutaneous Kyphoplasty: Erector Spinae Plane Block Versus Local Anesthesia

Meliha Orhon Ergün[1], Yahya Güvenç[2]

[1]Marmara University, Pendik Training and Research Hospital, Clinic of Anesthesiology and Reanimation, İstanbul, Turkey
[2]Marmara University, Pendik Training and Research Hospital, Clinic of Neurosurgery, İstanbul, Turkey

ABSTRACT

Introduction: Currently, local or general anesthesia is commonly applied in patients undergoing percutaneous kyphoplasty (PKP) procedures; however, the best anesthesia method for PKP remains elusive. This study examined the efficacy of erector spinae plane block (ESPB) in comparison with local anesthesia in terms of postoperative analgesia requirement and pain scores, in patients undergoing kyphoplasty.

Methods: The files of 42 patients who underwent kyphoplasty were retrospectively reviewed. PKP procedure was either under local anesthesia (controls, n=20) or using ultrasound-guided ESPB (ESPB group, n=22). Postoperative analgesia requirement and pain scores assessed by visual analog scale (VAS) were recorded and compared.

Result: All control patients (100.0%) required postoperative analgesia, whereas only five patients (22.7%) in the ESPB group required postoperative analgesia ($p<0.001$). At all time-points, ESPB group had significantly lower VAS scores ($p<0.001$ for 0, 2, and 6 hours). At two hours, all patients in the ESPB group had 0 VAS score.

Conclusion: ESPB as a sole anesthesia technique for kyphoplasty procedures is a promising method that may reduce the need for perioperative analgesia and provide superior postoperative pain management, thus allowing pain-free discharge.

Keywords: Erector spinae plane block, percutaneous kyphoplasty, local anesthesia, pain management, postoperative pain

Introduction

Vertebral compression fractures (VCF) may occur due of osteoporosis, trauma, hemangioma, or metastasis in cancer patients (1). Recently, the aim of vertebral fracture treatment is to alleviate pain, prevent new fractures, and achieve spinal stability (2). Prolonged bed rest, analgesic, and corset treatment may lead to systemic complications in elderly patients with VCF (2). Surgical management of VCF in patients with neurological deficits is associated with increased length of hospital stay as well as morbidity and mortality (3). Consequently, minimal invasive procedures such as vertebroplasty, kyphoplasty (KP), and lordoplasty have been developed in recent years in an attempt to obtain anatomical and functional restoration of the vertebrae, to achieve earlier symptomatic relief, to allow earlier return to social life, and to significantly reduce morbidity and mortality (4). KP involves the use of inflatable balloons within bone to restore vertebral body height and low-pressure cement injections into the volume obtained through the use of the balloon (1). Today, local or general anesthesia are commonly applied in patients undergoing percutaneous KP (PKP) procedures, which are carried out in prone position, potentially increasing the risk of cardiopulmonary complications due to anesthesia and poor airway management. General anesthesia may be associated with life-threatening problems, particularly among the elderly with comorbidities. On the other hand, local anesthesia alone fails to provide adequate analgesic activity (1). Anesthesia management effectively controlling anxiety and pain without any interventions to maintain respiratory and cardiac functions may represent a more appropriate approach (1), although the best anesthesia method for PKP remains controversial. Ultrasound-guided erector spinae plane block (ESPB) is an inter-fascial plane block involving injecting local anesthetic into the fascial plane. The injection occurs deep in the erector spinae muscle reaching the tip of the transverse process of the vertebra. Therefore, the local anesthetic diffuses not only into the cranio-caudal fascial plane but also into the paravertebral and epidural spaces anteriorly, and intercostal space laterally at several levels (5). This method provides both intraoperative and postoperative analgesia. To the best of our knowledge, use of ESPB in KP to achieve analgesia was reported in only one previous case report, with no comprehensive studies examining the utility of this approach in this procedure (6). Thus, this study was undertaken to examine the efficacy of ESPB in comparison

Address for Correspondence: Meliha Orhon Ergün MD, Marmara University, Pendik Training and Research Hospital, Clinic of Anesthesiology and Reanimation, İstanbul, Turkey
Phone: +90 541 340 20 01 **E-mail:** dr.meliha@gmail.com **ORCID ID:** orcid.org/0000-0001-8158-1393

Cite this article as: Orhon Ergün M, Güvenç Y. Comparison of the Effectiveness of Anesthesia Methods on Percutaneous Kyphoplasty: Erector Spinae Plane Block Versus Local Anesthesia. İstanbul Med J 2022; 23(2): 149-53.

Received: 19.04.2022
Accepted: 07.05.2022

with local anesthesia in terms of the need for intra-operative and post-operative analgesia requirements and pain scores, in a group of patients undergoing KP.

Methods

Patients who underwent percutaneous KP between June 2019 and November 2021 at our institution were included in this retrospective study. The procedure had been performed either under local anesthesia (controls) or using ultrasound-guided ESPB (ESPB group). Written informed consent was obtained from each patient. This study was approved by the Marmara University Faculty of Medicine Clinical Research Ethics Committee (approval number: 09.2021.101, date: 07.01.2022). The study was conducted in accordance with the Declaration of Helsinki.

Anesthesia management: In addition to standard monitoring, all patients were monitored the analgesia nociception index (ANI) to objectively evaluate perioperative pain. Two ANI electrodes were placed on the sternum and at the level of the left nipple, and ANI was continuously displayed throughout surgical procedure. All patients received nasal oxygen with a rate of 2 liters per minute. Following ESPB or local anesthesia, the procedure was initiated when ANI ≥50. In the local anesthesia group, sedation with 1-2 mg midazolam and 50-100 mcg fentanyl was administered, when necessary.

ESPB: In the ESPB group, ESPB was performed bilaterally in the prone position by the same experienced anesthesiologist before the procedure. The procedure was performed under ultrasound guidance using a linear probe (6-13 MHz) with in-plane technique. C-arm fluoroscopy was used to identify the fracture level. A 22G block needle (100 mm, B-braun, Germany) was inserted 3 cm lateral to the spinous process (either at the right or left side). The needle was advanced in cranio-caudal direction and 1-2 mL saline was injected to separate the erector spinae muscle from the transverse process. Then, 20 mL 0.25% bupivacaine and 50 mg 0.2% lidocaine were injected, and the needle was removed. The same procedure was performed on the contralateral side. Thus, totally 100 mg bupivacaine and 100 mg of lidocaine were injected. No additional analgesics were used during the procedure.

Local anesthesia: In the control group, following the identification of fracture level using C-arm fluoroscopy, 100 mg prilocaine plus 25 or 50 mg bupivacaine were injected into 20 mL solution in the prone position for infiltration anesthesia before the procedure.

Surgical technique: Injection site was identified with the aid of fluoroscopy. First, the trocar was advanced from the skin to the pedicle and then to the vertebral body under fluoroscopy guidance. The working cannula was placed, then the balloon was placed using a catheter and inflated within the collapsed vertebra, thus a space was made for cement. Then, the vertebral body was filled with cement through the working cannula under fluoroscopy guidance.

Postoperative pain management: Pain was assessed using 0 to 10-point visual analog scale (VAS): 0, no pain; 6, severe pain; 10, worst imaginable pain. Self-assessed VAS scores of all patients were recorded upon termination of the procedure and at 2 and 6 hours. Patients received 1 gr i.v. paracetamol when the VAS score was 2 or 3; whereas they received 1.5 mg/kg i.v. tramadol when VAS ≥4. Patients were discharged eight hours after the procedure.

Statistical Analysis

SPSS version 21 software was used for data analysis. Both hypothesis tests and graphical method were used to test the distribution of continuous variables. Student's t-test for independent samples or Mann-Whitney U test was used to test between-group differences in continuous variables. Pearson's chi-square test was used to compare categorical variables. Two-sided p values <0.05 were considered as an indication of statistical significance.

Results

Table 1 shows patient characteristics. The two groups were similar in terms of mean age as well as sex and vertebral site distribution (p>0.05; for all). In the control group, six of 20 patients (30.0%) required sedation. All control patients (100.0%) required postoperative analgesia, whereas only five patients (22.7%) in the ESPB group required postoperative analgesia (p<0.001).

Changes in Postoperative VAS Scores

Figure 1 shows changes in VAS scores within 6 hours of the procedure. At all time points, ESPB group had significantly lower VAS scores (p<0.001

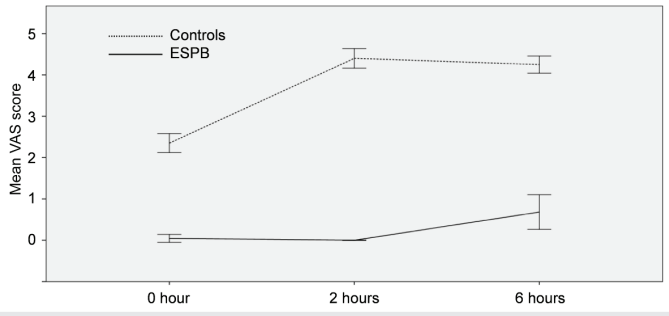

Figure 1. Changes in mean postoperative visual analog scale scores over time (immediately after the procedure, at 2 hours and at 6 hours). Upper dotted line, control group; lower straight line, erector spinae plane block group. Error bars indicate 95% confidence intervals for the mean
ESPB: Erector spinae plane block, VAS: Visual analog scale

Table 1. Patient characteristics

Characteristic	All patients (n=42)	ESPB group (n=22)	Controls (n=20)	p
Age, mean ± SD	62.2±15.0	61.7±14.0	62.8±16.3	0.791*
Female sex	29 (69.0%)	14 (63.6%)	15 (75.0%)	0.426[ı]
Vertebral site				
Thoracic	21 (50.0%)	11 (50.0%)	10 (50.0%)	1.000[ı]
Lumber	21 (50.0%)	11 (50.0%)	10 (50.0%)	
Postoperative VAS scores, median (range)				
VAS - 0 hour	0.5 (0-3)	0 (0-1)	2 (2-3)	<0.001[δ]
VAS - 2 hours	0 (0-5)	0 (0-0)	4 (4-5)	<0.001[δ]
VAS - 6 hours	2.5 (0-5)	0 (0-0)	4 (4-5)	<0.001[δ]

Unless otherwise stated, data presented as n (%). *Student's t-test for independent samples, [ı]: chi-square test, [δ]: Mann-Whitney U test, SD: Standard deviation, VAS: Visual analog scale

for 0, 2, and 6 hours, Table 1). At two hours, all patients in the ESPB group had 0 VAS score.

Discussion

Our results suggest that bilateral ESPB is a promising method for perioperative pain control in patients undergoing KP. To our knowledge, use of ESPB in KP procedures has not been reported before, except for a case report. In that case report, 30 cc of 0.05% bupivacaine was administered bilaterally under ultrasound guidance at T5 level as the primary anesthesia method in an elderly patient with chronic obstructive pulmonary disease and comorbidities who could not lie in the supine position due to intractable back pain. In addition, the patient received mild perioperative sedation with propofol infusion. The patient required no additional local anesthesia during the procedure, and was discharged home with no pain symptom. The authors of that case report suggested that ESPB provided a good level of patient comfort (6). In contrast with that case report, our patient did not require additional sedation during the procedure following bilateral ESPB. Vertebral augmentation procedures are associated with significant pain since they involve the insertion of needles of varying calibers into the vertebral body. If local anesthesia is preferred, a good level of anesthesia should be achieved to prevent needle malposition with consequent spinal cord or nerve injury (7). Several previous reports have suggested that ESPB offers a successful block strategy for managing acute and chronic pain. It has also been found to be effective for analgesia at the cervical, thoracal, and abdominal levels (8). In addition, ESPB at T4-T5 level was reported to provide effective postoperative pain management in video-assisted thorax surgery, pneumothorax surgery, open thoracotomy, and breast surgery (9-12). Other reported uses in analgesia management include costal fractures, post-thoracotomy syndrome, and chronic shoulder pain (13-15). In some other studies, low-thoracic ESPB for perioperative analgesia in patients undergoing lumbosacral spinal surgery was associated with reduced postoperative opioid need and postoperative pain scores (16,17). Similarly, in our study, VAS scores were lower in the ESPB group at postoperative 6 hours. Postoperatively, only five patients in the ESPB group required opioids, as compared to all in the other group. Opioid use is associated with relatively milder side effects such as vomiting or hypotension, as well as more severe effects, including loss of consciousness and respiratory depression (18). In the study by Apan et al. (1) comparing general anesthesia with segmental epidural anesthesia in patients undergoing percutaneous KP, the latter method was found to be more advantageous compared to general anesthesia in terms of postoperative analgesia and recovery. Hannallah et al. (19) administered low dose spinal anesthesia in conjunction with mild sedation for high-risk patients undergoing KP. Although adequate analgesia could be achieved, some of the pain control could be attributed to the concomitant administration of intravenous fentanyl and propofol. In another study, experience with spinal anesthesia was reported in 11 patients undergoing KP. Despite the administration of local anesthesia, pain was reported in four patients, and problems with the baricity of the preferred local anesthetic were seen, with hemodynamic instability (20). As compared to general anesthesia, although regional anesthesia may provide superior analgesia and may allow better maintenance of cardiovascular and respiratory reserves, adjustment of the baricity of the local anesthesia is also an important consideration since hemodynamic stability is impaired during KP when hyperbaric lidocaine is used in the prone position. This may lead to a number of adverse effects such as hypotension, vomiting, and nausea. Also, the anesthetic effect may not reach the desired segments, or may reach higher levels, potentially leading to cardiac or respiratory arrest (21). In a retrospective cohort study, a single dose ketamine administration in elderly patients with comorbidities undergoing KP, postoperative narcotic use and VAS scores at 6 hours was not reduced, and only a reduction in intraoperative narcotic use was noted. Intraoperative epidural block did not affect postoperative narcotic usage, and postoperative narcotic use was comparable across patient groups with or without epidural anesthesia (22). A prospective randomized study by Nitta et al. (23) showed no effect of intraoperative ketamine infusion on postoperative analgesia. In another prospective and randomized study, remifentanil and dexmedetomidine were compared in KP patients (24). Although propofol and remifentanil are frequently preferred because of their rapid and short acting effects, they may also be associated with hypoxemia and oxygen desaturation. Dexmedetomidine has both sedative and analgesic effects, with much less pronounced respiratory depression. However, they could not provide adequate analgesia when used as a single agents in KP (24). Mohr et al. (25) reported that oxycodone and midazolam were useful and well-tolerated agents for sedative and analgesic effects in KP. On the other hand, analgesics may aggravate oxygenation and increase right ventricular afterload due to hypercapnia (7). In our study, patients receiving ESBP did not require perioperative local anesthesia or sedative use. On the other hand, six patients in the local anesthesia group required sedation due to pain sensation. Intraoperative pain can lead to increased platelet aggregation, reduced fibrinolysis, and elevated thromboembolic risk due to stress (26). Furthermore, pain sensation may have marked effects on the psychological health of the patients with the emergence of negative emotions such as fear and anxiety, as well as distracting the surgeons with potentially reduced surgical quality (26). Similarly, Mao et al. (26) reported severe pain and intolerance among patients undergoing percutaneous KP during balloon dilatation and cement injection, and therefore these authors administered vertebral anesthesia in addition to traditional local anesthesia and found significant pain reduction without any side effects throughout the procedure. Poor perioperative pain management is associated with increased morbidity and mortality and reduced patient satisfaction, particularly among subjects with comorbidities. In patients with underlying cardiovascular conditions, pain may increase mortality via arrhythmias, hypertension, and cranial hemorrhage (26). Surgeons may prefer to operate an awake patient to be able to directly assess any neural injury. Although a lack of general anesthesia has certain advantages such as reduced risk of cardiopulmonary complications, lower medical costs, earlier discharge and early mobilization (27), Fang et al. (28) failed to observe any effect of the type of anesthesia on percutaneous KP. In our unit, surgeons did not seem to experience any problem during KP procedures in patients receiving an ESPB. In addition, these patients could be discharged at postoperative 8 hours without pain. Most authors agree that ESP block may offer certain advantages compared with traditional techniques akin to neuraxial anesthesia. Firstly, this is an easy technique, given the ultrasound guidance for

inserting the needle into the target location. Secondly, the technique is associated with a low risk of complications, since the site of administration is distant from significant anatomical structures such as the major vasculature and pleura. For this reason, ESPB has been proposed as a part of multimodal analgesia (29). So far, only a few complications of ultrasound guided ESPB has been documented. The first of these reports was published by Selvi and Tulgar (30), who observed motor weakness associated with ESPB in a patient following cesarean section. In our retrospective analysis, no ESPB-related complications were found in our patient groups that received ESPB for any indication. High-quality studies with larger sample sizes have clearly established the safety of ESPB (18).

Study Limitations

Our study included a small sample size and a retrospective design. Also, a questionnaire could have been used to assess surgeon satisfaction.

Conclusion

Our results suggest that ESPB as a sole anesthesia technique for kyphoplasty procedures is a promising method that may reduce the need for perioperative analgesia and provide superior postoperative pain management, thus allowing pain-free discharge. Further studies with a larger number of patients will shed more light on its role in this setting.

Ethics Committee Approval: This study was approved by the Marmara University Faculty of Medicine Clinical Research Ethics Committee (approval number: 09.2021.101, date: 07.01.2022).

Informed Consent: Written informed consent was obtained from each patient.

Peer-review: Externally and internally peer-reviewed.

Authorship Contributions: Surgical and Medical Practices - M.O.E., Y.G.; Concept - M.O.E., Y.G.; Design - M.O.E., Y.G.; Data Collection or Processing - M.O.E., Y.G.; Analysis or Interpretation - M.O.E.; Literature Search - M.O.E.; Writing - M.O.E.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

References

1. Apan A, Cuvaş Apan Ö, Köse EA. Segmental epidural anesthesia for percutaneous kyphoplasty: comparison with general anesthesia. Turk J Med Sci 2016; 46: 1801-7.
2. Wilson DR, Myers ER, Mathis JM, Scribner RM, Conta JA, Reiley MA, et al. Effect of augmentation on the mechanics of vertebral wedge fractures. Spine (Phila Pa 1976) 2000; 25: 158-65.
3. Wong W, Reiley MA, Garfin S. Vertebroplasty/kyphoplasty. J Women's Imaging 2000; 2: 117-24.
4. Theodorou DJ, Theodorou SJ, Duncan TD, Garfin SR, Wong WH. Percutaneous balloon kyphoplasty for the correction of spinal deformity in painful vertebral body compression fractures. Clin Imaging 2002; 26: 1-5.
5. Kot P, Rodriguez P, Granell M, Cano B, Rovira L, Morales J, et al. The erector spinae plane block: a narrative review. Korean J Anesthesiol 2019; 72: 209-20.
6. Verduzco LA. Erector spinae plane block as primary anesthetic for kyphoplasty. J Clin Anesth 2020; 61: 109670.
7. Luginbühl M. Percutaneous vertebroplasty, kyphoplasty and lordoplasty: implications for the anesthesiologist. Curr Opin Anaesthesiol 2008; 21: 504-13.
8. Singh S, Choudhary NK, Lalin D, Verma VK. Bilateral Ultrasound-guided Erector Spinae Plane Block for Postoperative Analgesia in Lumbar Spine Surgery: A Randomized Control Trial. J Neurosurg Anesthesiol 2020; 32: 330-4.
9. Adhikary SD, Pruett A, Forero M, Thiruvenkatarajan V. Erector spinae plane block as an alternative to epidural analgesia for post-operative analgesia following video-assisted thoracoscopic surgery: A case study and a literature review on the spread of local anaesthetic in the erector spinae plane. Indian J Anaesth 2018; 62: 75-8.
10. Forero M, Rajarathinam M, Adhikary S, Chin KJ. Continuous Erector Spinae Plane Block for Rescue Analgesia in Thoracotomy After Epidural Failure: A Case Report. A A Case Rep 2017; 8: 254-6.
11. Ohgoshi Y, Ikeda T, Kurahashi K. Continuous erector spinae plane block provides effective perioperative analgesia for breast reconstruction using tissue expanders: A report of two cases. J Clin Anesth 2018; 44: 1-2.
12. Singh S, Chowdhary NK. Erector spinae plane block an effective block for post-operative analgesia in modified radical mastectomy. Indian J Anaesth 2018; 62: 148-50.
13. Hamilton DL, Manickam B. Erector spinae plane block for pain relief in rib fractures. Br J Anaesth 2017; 118: 474-5.
14. Forero M, Rajarathinam M, Adhikary S, Chin KJ. Erector spinae plane (ESP) block in the management of post thoracotomy pain syndrome: A case series. Scand J Pain 2017; 17: 325-9.
15. Forero M, Rajarathinam M, Adhikary SD, Chin KJ. Erector spinae plane block for the management of chronic shoulder pain: a case report. Can J Anaesth 2018; 65: 288-93.
16. Melvin JP, Schrot RJ, Chu GM, Chin KJ. Low thoracic erector spinae plane block for perioperative analgesia in lumbosacral spine surgery: a case series. Can J Anaesth 2018; 65: 1057-65.
17. Ueshima H, Inagaki M, Toyone T, Otake H. Efficacy of the Erector Spinae Plane Block for Lumbar Spinal Surgery: A Retrospective Study. Asian Spine J 2019; 13: 254-7.
18. Liu MJ, Zhou XY, Yao YB, Shen XU, Wang R, Shen QH. Postoperative Analgesic Efficacy of Erector Spinae Plane Block in Patients Undergoing Lumbar Spinal Surgery: A Systematic Review and Meta-Analysis. Pain Ther 2021; 10: 333-47.
19. Hannallah M, Gibby E, Watson V. Fluoroscopy-guided, small-dose spinal anesthesia for kyphoplasty: a collaborative effort between the anesthesiologist and interventional radiologist. Anesth Analg 2008; 106: 1329-30.
20. Souvatzis X, Katonis PG, Licoudis SA, Marouli DG, Askitopoulou H. Case report: subarachnoid anesthesia for kyphoplasty: is anesthesia adequate? Anesth Analg 2010; 111: 238-40.
21. Soulioti E, Efstathiou G, Papanastasiou J, Igoumenou V, Kostopanagiotou G, Batistaki C. Low-dose epidural anesthesia for percutaneous spinal fusion and kyphoplasty due to metastatic fracture of L2 lumbar vertebrae. J Anaesthesiol Clin Pharmacol 2020; 36: 560-2.
22. Sharp SM, Chance EA, Karsonovich T, Cubbison S, Ugokwe KT. Single Dose of Ketamine During Kyphoplasty Procedures Does Not Reduce Postoperative Narcotic Consumption. AANA J 2019; 87: 199-204.
23. Nitta R, Goyagi T, Nishikawa T. Combination of oral clonidine and intravenous low dose ketamine reduces the consumption of postoperative patient-controlled analgesia morphine after spine surgery. Acta Anaesthesiol Taiwan 2013; 51: 14-7.

24. Lee JM, Lee SK, Lee SJ, Hwang WS, Jang SW, Park EY. Comparison of remifentanil with dexmedetomidine for monitored anaesthesia care in elderly patients during vertebroplasty and kyphoplasty. J Int Med Res 2016; 44: 307-16.

25. Mohr M, Pillich D, Kirsch M, Mueller JU, Fleck S, Hosten N, et al. Percutaneous balloon kyphoplasty with the patient under intravenous analgesia and sedation: a feasibility study. AJNR Am J Neuroradiol 2011; 32: 649-53.

26. Mao G, Alemayehu DG, Yang Y, Wen T, Ou Y, Cheng Y, et al. The Effect of Intraoperative Vertebral Anesthesia on Osteoporotic Fractures Treated With Percutaneous Kyphoplasty: A Prospective Cohort Study. Clin Spine Surg 2019; 32: E289-E96.

27. Zhang S, Xu S, Yang J, Wang S, Wang Q. Analysis of percutaneous kyphoplasty under different types of anesthesia for the treatment of multiple osteoporotic vertebral fractures. BMC Musculoskelet Disord 2020; 21: 743.

28. Fang XT, Yu F, Fu SL, Chen GQ, Yuan XM, Li HC, et al. Clinical outcomes of percutaneous kyphoplasty under local anesthesia for osteoporotic vertebral compression fractures. Zhonghua Yi Xue Za Zhi 2013; 93: 2654-8.

29. Macaire P, Ho N, Nguyen T, Nguyen B, Vu V, Quach C, et al. Ultrasound-Guided Continuous Thoracic Erector Spinae Plane Block Within an Enhanced Recovery Program Is Associated with Decreased Opioid Consumption and Improved Patient Postoperative Rehabilitation After Open Cardiac Surgery-A Patient-Matched, Controlled Before-and-After Study. J Cardiothorac Vasc Anesth 2019; 33: 1659-67.

30. Selvi O, Tulgar S. Ultrasound guided erector spinae plane block as a cause of unintended motor block. Rev Esp Anestesiol Reanim (Engl Ed) 2018; 65: 589-92.