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Efficacy of erector spina plane blocks and paravertebral blocks in kyphoplasty surgery

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ABSTRACT

Aims: Kyphoplasty (KP) surgeries are commonly performed under local, general and regional anesthesia. The purpose of our study was to compare the perioperative and postoperative effects of ultrasound (USG) guided erector spinae plane blocks (ESPB) and paravertebral blocks (PVB) in patients with KP.

Methods: Forty patients who underwent kyphoplasty were evaluated retrospective as Group 1 (ESPB, n=20) and Group 2 (PVB, n=20). Perioperative additional opioid, hemodynamic parameters, complications, postoperative analgesia requirement, pain with visual analog scale (VAS) at specified times, amount of analgesic used within 24 hours, first mobilization and discharge time, and complications were compared.

Results: There was no difference between the study groups regarding demographic data, ASA, preoperative analgesic use, mean arterial pressure (MAP), heart rate (HR), SpO_2, additional opioid requirement, perioperative complication rates, VAS and surgical level. A significant difference was observed between Group 1 and Group 2 regarding the VAS score and paracetamol dose at 6 hours postoperatively (p:0.023 and p:0.006, respectively). There was no statistical difference between the groups first mobilization and discharge time, postoperative complications, postoperative intensive care needs (PICU), and tramadol dose rates used (p>0.05).

Conclusion: The USG-guided ESPB and PVB did not appear superior to one another in kyphoplasty procedures regarding 12 and 24-hour VAS scores, first mobilization and discharge time, postoperative complications, PICU needs and tramadol dose. The analgesic effect of ESPB in KP surgery was superior to that of PVB, 6 hours postoperatively. Therefore, it is possible to consider them a safe and alternative method of anesthesia and analgesia.

Keywords: Anesthesia, analgesia, erector spina plane block, paravertebral nerve block, ultrasound, percutaneous kyphoplasty, postoperative pain.

INTRODUCTION

Vertebral compression fractures results morbidity and mortality in osteoporotic patients. Symptomatic with significant pain, dysfunction and majorly impact public health.[1] A multimodal approach to management consists of analgesics, osteoporosis medication, and physical therapy. The patients resistant to conservative management are eligible for vertebroplasty or kyphoplasty (KP).[2] As an alternative to stabilization surgery, KP is preferred because of its less invasive nature, its ability to restore the anterior and middle vertebral columns, its ability to alleviate symptoms quickly, and its ability to bring a patient back into society rapidly. Trocar placement, balloon dilation, and cement injection are painful procedures in KP surgery. Pain management in the elderly population involves many different anesthetic techniques, all of which have limitations. General anesthesia application is risky for the older adults of KP patients with comorbidities. It may also prevent clinical evaluation of bone cement leakage.[3,4] As patients are awake during local anesthesia, surgeons can detect early neurological symptoms and prevent nerve damage. Additionally, anxiety, agitation, and the possibility of a painful reaction from the patient may result in patient and surgeon dissatisfaction during local anesthesia.[4] Although sedative analgesia is an alternative, safe and feasible method, here, we have a potential risk of respiratory depression due to systemic opioid administration.[5]

Recently, there have been thoracic paravertebral block, central and fascial plan block approaches have been described. Most PVBs and ESPB are interfacial plane blocks that create sensory blockades of local anesthetics' spinal nerve dorsal roots as part of multimodal analgesia.[6] ESPB is a representative method of indirect thoracic PVB, first described in 2016.[6] It is preferred safely because it does not affect hemodynamics, does not cause respiratory depression, is easy to apply and has low complication risks. So, it has been used as an analgesic option for many surgeries.[7]

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Our study aimed to compare perioperative and postoperative affects of USG-guided ESPB and PVB methods KP patients in our clinic.

METHODS

Study Design

A retrospective study was conducted on patients who underwent USG-guided ESPB and PVB procedures for kyphoplasty surgery between January 15 and December 31, 2021. Written consent was obtained for each patient. Local ethics committee approval was obtained with the protocol date and the number of 2011- KAEK-25 2022/04-10 from Bursa High Specialized and Education Hospital.

Recruitment and Data Collection

Forty adult patients with pathological vertebral fractures who applied to the hospital due to symptoms and did not benefit from previous conservative treatments were included in our research. Patients with an inability to communicate, the presence of neurological symptoms and disease, diagnosis of a metastatic bone tumor or multiple myeloma, asymptomatic fractures, systemic or local infections, and patients with coagulation disorders were excluded from the study. Demographic characteristics of the patients (age, gender, Body mass index (BMI), The American Society of Anesthesiologists (ASA) classification scores), preoperative analgesic use and mobilization level, preoperative pain values, hemodynamic parameters, and level surgery were recorded. Mean arterial pressure (MAB), Heart rate (HR), peripheral oxygen saturation (SpO_2); T1: the beginning of surgery; T2: 15th minute during surgery; T3: 30th minute during surgery; T4: 45th minute during surgery; and T5: end of the surgery, the dose and type of sedation, the need for additional opioids, complications (such as arrhythmia, respiratory depression, total spinal block, hypotension), the duration of anesthesia and surgery were determined. As a anesthesia technique, the patients were seperated to Group 1 (ESPB) and Group 2 (PVB). In the postoperative period, VAS values at 2, 6, 12, and 24 hours (as a routine procedure of patients who has one of the block technique for analgesia in the postoperative period), the time of first analgesic administration, dose of the analgesic administered within 24 hours, first mobilization and the discharge time, postoperative intensive care need (PICU), and complications were recorded. For all patients postoperative rescue analgesia procedure was 1 mg/kg of tramadol and 1gr of paracetamol intravenously at any time if the patient declares VAS score over 4 and 2, respectively.

Sedoanalgesia

All patients were administered 1 mg midazolam iv after routine monitoring (MAB, HR, SpO_2) in the operating room. Hemodynamically stable patients were placed in the prone position and the fascial plane block method chosen by the blind anesthesiologist for multimodal analgesia and anesthesia was applied to the study.

The Ultrasound-guided Erector Spinae Blane block Technique

After infiltration of 1 mL of 2% prilocaine into the subcutaneous tissue, 40 mL of local anesthetics (combination of 25 mL 0.25% bupivacaine+10 mL 2% lidocaine+5 mL saline) was applied from the vertebral level one below the surgical level. The 22-gauge, 50 mm peripheral block needle (Stimuplex A®; B Braun, Melsungen, Germany) placement was applied via low frequency (2-5MHz) USG linear probe (GE Healthcare Logiq P5, USA) at 3 cm lateral, longitudinal, and parasagittal to the vertebrae.

The Ultrasound-guided Paravertebral Nerve Block Technique

After infiltration, 1 mL of 2% prilocaine into the subcutaneous tissue 2–2.5 cm lateral to the spinous processes, 40 mL local anesthetics (combination of 25 mL 0.25% bupivacaine+10 mL 2% lidocaine+5 mL saline) injected bilaterally from the vertebral level one below the surgical level. The 22-gauge, 50 mm peripheral block needle (Stimuplex A®; B Braun, Melsungen, Germany) was used for the PVB, and placement was applied via high frequency (5-13 MHz) USG linear probe (GE Healthcare Logiq P5, USA) placed longitudinally to the lower vertebral level of the selected surgical level. The needle was moved into the selected paravertebral area by passing the trapezius, rhomboids, erector spinal muscles, and superior costotransverse ligament. In each procedure, downward displacement of the parietal pleura was observed.

Statistical Analysis

Descriptive data are presented in numbers and percentages, while measurement data are presented in the mean±standard deviation and median (minimum-maximum) values. Chi-square and Fisher tests were used to compare categorical data. The normality distribution of measurements was evaluated using the Shapiro-Wilk test and histogram graphs. Student-T Test was used to compare normally distributed measurements in independent groups, and the Mann-Whitney U test was used to compare non-normally distributed measurements. $P<0.05$ was accepted for statistical significance. All analyzes were analyzed with the SPSS 20 for the mac version program.

RESULTS

Forty patients who underwent ESPB (n=20) and PVB (n=20) as the anesthesia method were evaluated. Of the patients, 19 were female, and 21 were male. There was no statistical difference between the groups regarding age, gender, smoking, ASA, surgical level, analgesic use, chronic diseases (hypertension, diabetes mellitus, presence of coronary artery disease), and preoperative VAS scores. The rate of obesity was significantly higher in Group 1 compared to Group 2 (p=0.041). The general features of the study patients are presented in **Table 1** in detail.

Table 1. Distribution of the general demographic data of the patients

	Group 1	Group2	P
Gender			0.527[c]
Female	8 (40.0)	11 (55.0)	
Male	12 (60.0)	9 (45.0)	
Age (median(min-max)	71.0 (66.0-82.0)	70.5 (64.0-81.0)	0.738[m]
ASA (median(min-max)	3.0 (2.0-4.0)	3.0 (2.0-4.0)	0.841[m]
Level			1,000[c]
Thoracic, n (%)	9 (45.0)	8 (40.0)	
Lumbar, n (%)	11 (55.0)	12 (60.0)	
HT, n (%)	8 (40.0)	11 (55.0)	0.527[c]
DM, n (%)	10 (50.0)	11 (55.0)	1,000[c]
CAD, n (%)	12 (60.0)	12 (60.0)	1,000[c]
Obesity, n (%)	10 (50.0)	3 (15.0)	0.041[c]
Smoking, n (%)	5 (25.0)	8 (40.0)	0.501[c]
Other, n (%)	8 (40.0)	10 (50.0)	0.751[c]
VAS0 (median(min-max)	7.5 (6.0-9.0)	7.0 (6.0-9.0)	0.108[m]
Preoperative analgesic used, n (%)	13 (65.0)	9 (45.0)	0.341[c]

m: Mann Whitney U test, c: Chi-square test, HT: Hypertension, DM: Diabetes Mellitus, CAD: Coronary Artery Disease VAS 0: Preop erative visual analog scale pain severity score.

Other: Rheumatological diseases, Goiter, Hiperlipidemi

There was no statistical difference between the groups regarding MAP, SpO_2 values, additional opioid need, and perioperative complication rates at the specified times during surgery (p>0.05). The perioperative conditions of the study patients are given in **Table 2** in detail.

Table 2. Analyzing perioperative data according to study groups

	Group 1	Group 2	P
	Mean±Std. Deflection	Mean±Std. Deflection	
MAP1	75.6±14.4	81.6±14.4	0.190[t]
MAP2	71.3±12.1	79±13.7	0.064[t]
MAP3	67.7±11.2	73.9±12.3	0.099[t]
MAP4 (median(min-max)	62.5 (52.0-87.0)	76.0 (55.0-87.0)	0.102[m]
HR1	81.3±9.8	78.4±9.6	0.351[t]
HR2	81.3±9.3	79.6±9.0	0.573[t]
HR3 (median(min-max)	77.5 (61.0-112.0)	79.0 (65.0-92.0)	0.862[m]
HR4 (median(min-max)	78.5 (57.0-109.0)	75.0 (67.0-98.0)	0.327[m]
SpO_2-1 (median(min-max)	96.0 (94.0-98.0)	96.0 (94.0-98.0)	0.901[m]
SpO_2-2 (median(min-max)	97.0 (94.0-98.0)	96.5 (95.0-98.0)	0.602[m]
SpO_2-3 (median(min-max)	96.5 (92.0-98.0)	96.5 (86.0-98.0)	0.968[m]
SpO_2-4 (median(min-max)	96.5 (94.0-98.0)	96.5 (92.0-98.0)	0.968[m]
Need for additional opioids n (%)	4 (20.0)	6 (30.0)	0.716[c]
Operation time (min) (median (min-max)	50.0 (35.0-65.0)	60.0 (40.0-70.0)	0.009[m]
Peroperative complication n (%)	6 (30.0)	5 (25.0)	1,000[c]

I: Independent T test in groups m Mann Whitney U test , c Chi- square test min: Minute
MAP1: mean arterial pressure at 15th minute of surgery, MAP2: mean arterial pressure at 30th minute of surgery, MAP3: mean arterial pressure at 45th minute of surgery, MAP4: mean arterial pressure at 60th minute of surgery, HR1: Heart rate at 15th minute of surgery HR, HR2: Heart rate at 30th minute of surgery HR, HR3: Heart rate at 45th minute HR of surgery, HR4: Heart rate at 60th minute of surgery HR, SpO_2-1: 15th minute of surgery SpO_2, SpO_2-2: 30th minute of surgery SpO_2, SpO_2-3: 45th minute of surgery SpO_2, SpO_2-4: 60.min SpO_2 of surgery

Postoperative 6th-hour VAS scores and median paracetamol doses used in Group 1 patients were significantly lower compared to Group 2 patients (p=0.023 and p=0.006, respectively). There was no statistical difference between the groups regarding VAS scores, first mobilization time, time to discharge, postoperative complications, PICU needs and the dose of tramadol after surgery (p>0.05). Postoperative characteristics of the study patients are detailed in **Table 3**.

Table 3. Analyzing postoperative data according to study groups

	Group 1	Group 2	p
	Median (Min-Max)	Median (Min-Max)	
VAS1	1.5 (0.0-3.0)	2.0 (0.0-4.0)	0.068[m]
VAS2	1.5 (0.0-4.0)	2.0 (0.0-4.0)	0.023[m]
VAS3	1.0 (0.0-3.0)	2.0 (0.0-4.0)	0.355[m]
VAS4	1.0 (0.0-2.0)	1.0 (0.0-4.0)	0.211[m]
Mobilization time (h)	6.0 (5.0-10.0)	7.0 (6.0-10.0)	0.102[m]
Discharge time (h)	20.0 (12.0-48.0)	30.0 (12.0-56.0)	0.142[m]
Complication n (%)	3 (15.0)	3 (15.0)	0.669f
PICU n (%)	5 (25.0)	7 (35.0)	0.731[c]
Paracetamol dose (mg)	0.0 (0.0-3000.0)	1000.0 (0.0-3000.0)	0.006[m]
Tramadol dose (mg)	0.0 (0.0-100.0)	0.0 (0.0-200.0)	0.102[m]

M: Mann Whitney U test, c Chi- square test , f Fisher test
PICU: postoperative need for intensive care unite. h : Hour , mg: Milligram
VAS1: Postop 2nd hour visual analog scale pain severity score, VAS2: Postop 6th hour visual analog scale pain severity score, VAS3: Postop 12th hour visual analog scale pain severity score, VAS4: Postop 24th hour visual analog scale pain severity score.

DISCUSSION

This is the first study to compare ESPB and PVB techniques in anesthesia and analgesia of KP surgery according to us. The primary outcome of this research: The postoperative 6th-hour VAS score and the paracetamol doses used were lower in Group 1. At all other times, hemodynamic parameters during the perioperative period, the dosage of opioids used, the postoperative VAS scores, the first mobilization and discharge times, the need for the intensive care unit, the amount of analgesic used, and complications were similar in groups.

Compression fractures in the thoracolumbar region, osteoporotic fractures, and accompanying chronic pain are the most critical indications of kyphoplasty.[8] In anesthesia techniques, there are options for using local or general anesthesia, depending on the patient's ability to the prone position. In patients undergoing kyphoplasty, a high rate of symptomatic improvement and early discharge in the first days after the procedure are significant advantages, especially for elderly patients. A relatively new technique is restoring vertebral height by applying inflatable balloon pads to the collapsed vertebra in KP and injecting cement with low pressure into the volume created by the balloon.[9] The fact that kyphoplasty is minimally invasive and can be performed under local anesthesia, the duration of the procedure is significantly short even when general anesthesia is applied, and the risks of surgery and pain experienced by elderly patients in stabilization surgery are significantly reduced, increasing the frequency of application.[10] Although local sedation and general anesthesia are often used together, the expectations of patients and surgeons and the search for safer anesthesia techniques have increased the use of other anesthesia methods.

A central block, such as spinal anesthesia or epidural anesthesia, is frequently used in kyphoplasty surgeries. Still, it is associated with severe complications such as epidural leakage, spinal hematoma, infection, hypotension, and urinary retention.[11,12] The undesirable side effects of central block methods have made fascial area blocks considered. The distribution of local anesthetics in PVB includes both ventral and dorsal spinal branches, according to a review of anatomical research. In contrast, regional anesthetic distribution in ESPB is limited (it cannot block dorsal and intercostal nerves), which makes it less effective.[13]

USG-guided PVB and local anesthesia applications have been studied for their effects on postoperative opioid use, pain scores, and opioid-related side effects following kyphoplasty surgery. This technique is considered an effective anesthesia method.[14,15] Based on a meta-analysis, PVB has been shown successful pain control and less side effects when administered with or without general anesthesia. Compared with the general anesthesia groups administered by other analgesic modalities, PVB has been shown to be better and more effective.[16] As an outcome of our study, we reported a significant reduction in VAS scores postoperatively, with fewer side effects, especially those associated with analgesics and opioids. In association with pain reduction, early mobilization and early discharge were observed. Various complications have been related to paravertebral blockages, such as pneumothorax, intrathecal injection or hemothorax, ipsilateral brachial plexus block, and hemidiaphragmatic paresis.[17] The outcome of our study did not reveal any PVB-related complications.

Perioperative thoracic ESPB has been shown to provide good analgesia and reduce postoperative nausea, vomiting, and pain scores in patients following lumbosacral spinal surgery.[18,19] A decrease in perioperative and postoperative opioid consumption, early patient mobilization and chest tube removal has been observed, particularly in cardiac surgery.[20] There is consensus among most authors that ESPB has certain advantages over central blocks. An increase in the use of ESPB in perioperative pain control has been noted among patients undergoing kyphoplasty.[21,22] Two critical complications related to ESPB were reported in the literature; The first is iatrogenic pneumothorax, and the other is motor weakness after cesarean section.[23] According to our study, ESPB is associated with reduced opioid consumption during surgery, reduced postoperative pain scores, and reduced analgesic use. We did not observe any ESPB-related complications during the course of our study. PVB is an advanced difficulty technique compared to ESPB.[24] Since the needle tip in ESPB is located at a superficial position than PVB technique, ultrasonography provides more precise visualization of the needle than in PVB. Therefore, ESPB is preferred in obese patients. A similar trend was observed in our study, where obese patients were more likely to undergo ESPB.

Several randomized studies comparing PVB and ESPB in thoracic and breast surgery patients found a significant reduction in postoperative pain scores, opioid usage, and additional analgesic usage following PVB.[25] PVB and ESPB had similar effects on pain scores and analgesic consumption following breast surgery. PVB and ESPB provided different analgesic effects postoperatively depending on the surgical site. According to another study comparing ESPB and PVB in patients for video-assisted thoracic surgery (VATS), the pain scores were similar between the two groups when moving, and the pain scores were lower in the PVB group at rest.[26] As part of our study, we compared VAS scores during movement between ESPB and PVB in patients with KP; 6 hours postoperatively, ESPB provided a superior analgesic effect to PVB. According to our hypothesis, the ESPB group's lower postoperative 6th-hour VAS values may be related to a quicker distribution of local anesthetic and a faster decrease in its effect because of its richer vascularity of paravertebral space in PVB group. A study in the VATS patients showed that combination of PVB and ESPB had superior analgesia to ESPB.[27] Even though the general VAS values were similar between the ESPB and PVB groups in our study, we are considering the possibility of combining the two techniques for better anesthesia management and early analgesia.

Study Limitations

Although our study is the first in the literature to compare the efficacy of ESPB and PVB techniques in anesthesia and analgesia of KP surgery, it does have some limitations. One of the most important limitations of our study is the small sample size. Our other limitations include the lack of prospective long-term follow-up of the patient and the absence of ongoing pain evaluations. Another limitation of our study was the inability to assess VAS separately at rest and in motion.

CONCLUSION

The ESPB and PVB techniques provided adequate postoperative analgesia in KP surgery, early mobilization, and discharge, reducing perioperative opioid requirements and associated side effects. Additionally, the ESPB technique's postoperative VAS score at 6 hours was lower than the PVB technique, and paracetamol use after ESPB was lower than following PVB. We suggest more likely use ESPBs and PVBs as safer alternatives for KP surgeries in geriatrics and fragile groups, which generally have limited or difficult access to general anesthesia.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of University of Health Sciences, Bursa Yüksek İhtisas Training and Research Hospital Ethics Committee (Decision No: 2011-KAEK-25 2022/04-10).

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

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Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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