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Evaluation of Anesthesia Methods in Patients Undergoing Percutaneous Kyphoplasty: A Prospective Study

Perkütan Kifoplasti Uygulanan Hastalarda Anestezi Yöntemlerinin Değerlendirilmesi: Prospektif Bir Çalışma

Tuğba Onur, Ümran Karaca, Asiye Demirel, Şeyda Efsun Özgünay, Anıl Onur

University of Health Sciences Turkey, Bursa High Specialization Training and Research Hospital, Clinic of Anesthesiology and Reanimation, Bursa, Turkey

Abstract

Objective: The aim of this research is to examine the effects of the anesthesia method and preoperative characteristics on postoperative results and complications in patients who underwent percutaneous kyphoplasty (PKP).

Method: Patients were put into three groups according to the anesthesia methods used: (1) General anesthesia (sedation), (2) Central block (spinal and epidural anesthesia), (3) Peripheral block (erector spina plane block, and paravertebral block). Patients' pain values, hemodynamic parameters, additional need for sedation, and perioperative and postoperative complications were recorded prospectively together with visual pain scales (VAS).

Results: There were 22 individuals in group 1, 20 individuals in group 2, and 24 individuals in group 3. The average paracetamol and tramadol doses, postoperative VAS scores, and additional need for sedation were statistically significantly higher in group 1 (for all p<0.001) compared to other groups. Postoperative time to first mobilization and discharge were significantly lower in group 3 (for both, p<0.001). Patient satisfaction in group 3 was found to be significantly higher than that in group 1 (p<0.001). The rate of post-anesthesia care unit was higher in group 1 and lower in group 3 (p<0.001) and the rate of perioperative nausea rate was statistically significantly lower (p=0.008). The research samples did not differ statistically significantly from one another with regard to mean arterial pressure, heart rate, SpO_2, operation time, perioperative, and postoperative complication rates.

Conclusion: We think that central and especially peripheral block methods might be preferred because anesthesia methods in PKP surgery

Öz

Amaç: Bu çalışmanın amacı perkütan kifoplasti (PKP) cerrahisi uygulanan hastalarda uygulanan anestezi yöntemi ile preoperatif özelliklerinin, postoperatif sonuçlar ve komplikasyonlar üzerindeki etkisini incelemektir.

Yöntem: Anestezi yöntemlerine göre hastalar; 1: Genel anestezi (sedasyon), 2: Santral blok (spinal ve epidural anestezi), 3: Periferik blok (erector spina düzlem bloğu ve paravertebral blok) şeklinde 3 gruba ayrıldı. Hastaların preoperatif özellikleri, belirlenen zamanlarda visual ağrı skalası (VAS) ile kaydedilen ağrı değerleri, hemodinamik parametreleri, ek sedasyon gereksinimi, perioperatif ve postoperatif komplikasyonları prospektif olarak kaydedildi.

Bulgular: Grup 1'de 22, grup 2'de 20 ve grup 3'te 24 hasta yer aldı. Grup 1'de ortalama parasetamol, tramadol dozları, postoperatif VAS skorları ve ek sedasyon ihtiyacı, diğer gruplara göre istatistiksel olarak anlamlı derecede daha yüksek düzeyde bulundu (tümü için p<0,001). Postoperatif ilk mobilizasyon ve taburculuk zamanı grup 3'te diğer gruplara kıyasla istatistiksel olarak anlamlı düzeyde daha düşük izlendi (her ikisi için de p<0,001). Grup 3'te hasta memnuniyeti grup 1'e göre istatistiksel olarak anlamlı düzeyde daha yüksek gözlendi (p<0,001). Postoperatif bakım ünitesi oranı grup 1'de diğer gruplara göre daha yüksek ve grup 3'te diğer gruplara kıyasla anlamlı düzeyde daha düşüktü (p<0,001). Perioperatif bulantı oranı ise istatistiksel olarak anlamlı düzeyde daha düşük gözlendi (p=0,008). Çalışma grupları ile ortalama arter basıncı, kalp atış hızı, SpO_2, operasyon süresi, perioperatif ve postoperatif komplikasyon oranları bakımından istatistiksel olarak anlamlı bir fark görülmedi.

Sonuç: İleri yaş ve komorbiditeleri çok olan hastalarda PKP cerrahilerinde anestezi yöntemi olarak santral ve özellikle periferik blok yöntemlerinin

Address for Correspondence: Tuğba Onur, University of Health Sciences Turkey, Bursa High Specialization Training and Research Hospital, Clinic of Anesthesiology and Reanimation, Bursa, Turkey
E-mail: doktor-t@hotmail.com **ORCID:** orcid.org/0000-0002-5080-4555 **Received:** 06.01.2022 **Accepted:** 14.09.2022

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are safer and they provide satisfaction in patients with advanced age and various comorbidities.

Keywords: Erector spina plane block, paravertebral block, percutaneous kyphoplasty, sedoanalgesia, vertebroplasty

daha güvenle ve daha yüksek hasta memnuniyeti ile tercih edilebileceğini düşünmekteyiz.

Anahtar kelimeler: Erektör spina plan bloğu, paravertebral blok, perkütan kifoplasti, sedoanaljezi, vertebroplasti

Introduction

Trauma, osteoporosis, malignancy-related metastases, and hemangiomas can all cause vertebral compression fractures (VCF), especially in the advanced age group (1). While VCF can cause chronic pain, if not treated adequately, it can lead to nerve damage, psychiatric problems, bed dependency, kyphosis that reduces the quality of life (2-4), aim to provide pain relief and deformity correction quickly and safely (5). Percutaneous kyphoplasty (PKP) has been performed for earlier anatomical and symptomatic treatment, life of patient, and decreased mortality and morbidity (6).

In a meta-analysis (7), PKP was shown to have greater efficiency compared to PVP. PKP is a method applied in the form of injections into the volume obtained using an inflatable balloon in the bone to restore the low-pressure cement and vertebral body height (1).

PKP is a treatment method that is thought to reduce the quality of life and reduces morbidity and mortality, especially in the geriatric age group, for VCF patients who cannot endure pain or do not benefit enough from conservative treatment (8). The prone position of the patient in PKP surgery may cause increased cardiopulmonary risk and difficulty in airway management. Although general anesthesia provides a comfortable surgical procedure, it is associated with life-threatening problems, anesthetic side effects, prolonged hospital stay, and an increase in the cost, especially among the elderly with comorbidities (9). Local anesthesia, which is frequently preferred, may be insufficient in adequate analgesic activity alone. Pain during surgery, difficulty in intervention, and the possibility of patient dissatisfaction generally cause other anesthesia methods to be preferred (10). Despite the growing number of studies regarding the therapeutic efficacy, surgical technique, and adverse effects of those various treatments, it remains unclear which type of anesthesia is best for PKP. Our goal was to carry out a prospective research comparing the effects of preoperative patient characteristics and different anesthesia methods applied during PKP in our clinic on perioperative results, complications, postoperative mobilization and discharge time, and patient satisfaction.

Materials and Methods

Study Design

Data on demographic characteristics [body mass index, gender, age, ASA use, preoperative pain value (VAS0)], analgesic use habits, anesthesia technique chosen by anesthesiologist blind to the study, perioperative hemodynamic parameters, additional opioid during surgery, analgesic or anesthetic need, and perioperative complications (patients who willingly stopped the procedure during the intervention, moaning, hypotension, hypertension, bradycardia, respiratory depression, desaturation and need for mask ventilation) were taken from the records of the individuals with the treatment of PKP between 01 January-28 June 2022 after the approval of the University of Health Sciences Turkey, Bursa High Specialization Training and Research Hospital Ethics Committee (2021-KAEK-25 2021/12-09), clinical trials number NCT05526794 and the patient's consent. Inclusion criteria were determined as being aged 18-100 years, being scheduled for kyphoplasty surgery, and giving written consent to participate in the study. Exclusion criteria were unwillingness to participate in the study, major bleeding on surgery, presence of communication and perception problems, not knowing Turkish, previous cerebrovascular disease and personal dysfunction (Figure 1). In addition, the first mobilization time, additional analgesic need, total amount of analgesic used in 24 hours, discharge time, VAS values at 2 (VAS1), 6 (VAS2), 12 (VAS3), and 18 (VAS4) hours, and complications (nausea, vomiting, pain, delirium, respiratory insufficiency, infection, deep vein thrombosis, pulmonary embolus, need for re-operation, need for intensive care or mechanic ventilator) were also recorded. 1 gr intravenous (iv) paracetamol was applied for all patients with a VAS value of 2 or 3; 1 mg/kg iv tramadol was administered additionally for those with a VAS value of 4 and over. Also, on the day of discharge, the satisfaction level of the patients with the anesthetic method was recorded as satisfied, not satisfied, or undecided.

Anesthesia Method

After standard monitoring, all anesthesia methods [general anesthesia, sedation, spinal anesthesia, epidural

anesthesia, erector spina plane block (ESPB), paravertebral block (PVB)], drug doses used, and additional analgesic or anesthetic needed during surgery were recorded by the blind anesthesiologist and surgeon, within the patient's knowledge. Patients were in the prone position during surgery. Necessary intervention (such as oxygen support, increased fluid replacement, ephedrine, or vasoactive drug application) was made in case of any complication. The patients were separated into three groups: (1) General anesthesia and sedation, (2) spinal and epidural anesthesia, and (3) ESPB and PVB. Central and peripheral regional anesthesia methods were planned for the patients one level below the surgical site.

Sedation and general anesthesia: Patients were monitored and peripheral vascular access was opened. While they were in a prone position, 1-2 mg midazolam and 1 μg/kg fentanyl and 4 Lt/min mask O_2 support were started. In case of desaturation, it was planned to correct the position of the patients, curarize them, and switch to orotracheal intubation.

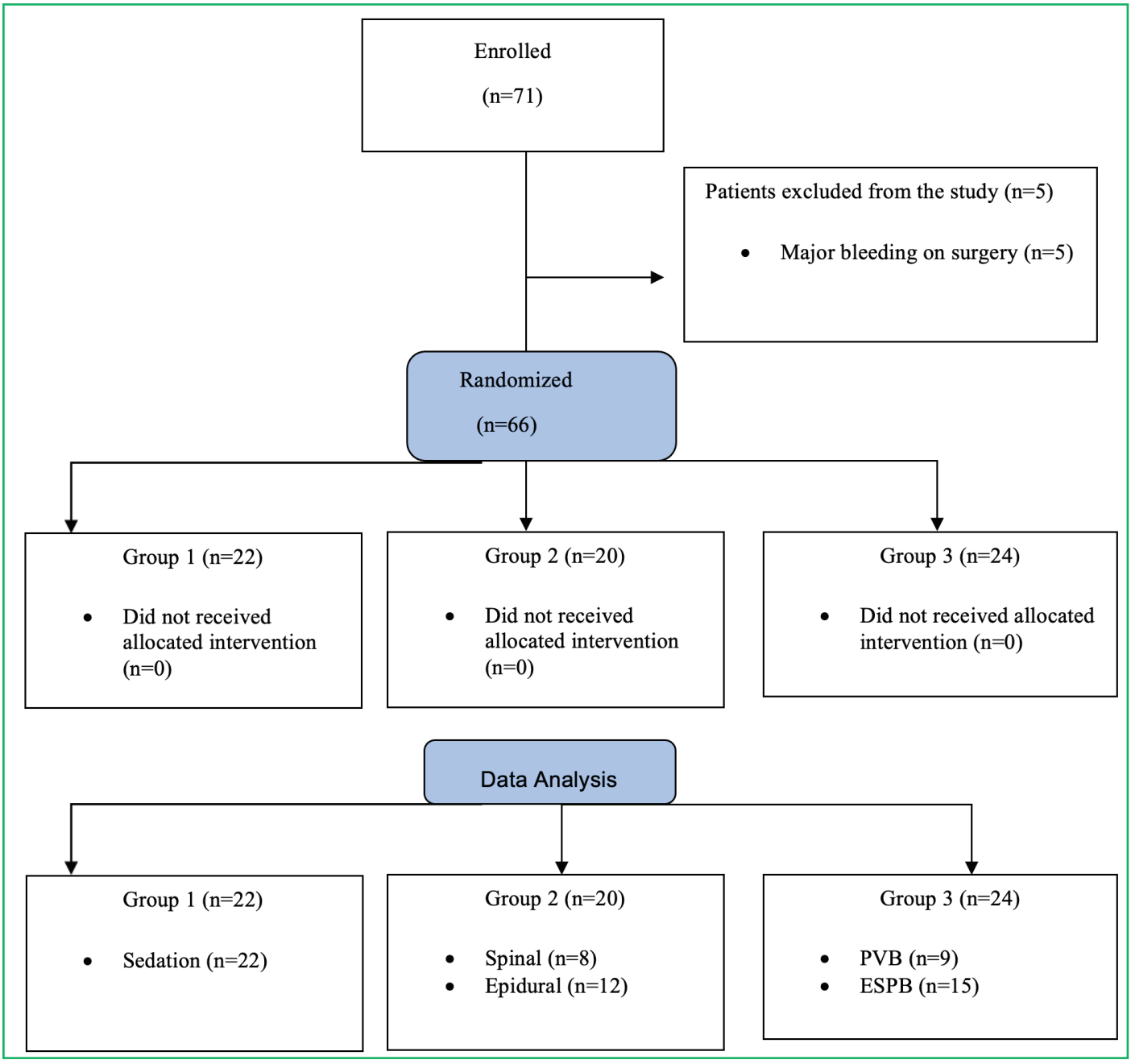

Figure 1. Flow chart of procedure

Spinal anesthesia: In a monitored sitting or reclining position, 1.5 mL of 1% isobaric bupivacaine (Marcaine® 0.5% vial, Eczacıbaşı) and 3.5 mL of a mixture of distilled water as 4.5 mg were given to the selected intrathecal area under sterile conditions. When it was ensured that adequate sensory blockade was achieved approximately 10 min after the procedure, surgery was allowed in the prone position.

Epidural anesthesia: After the individual was monitored, the epidural space was entered sterile conditions at the level determined by the surgery in a sitting position. When negative pressure was felt, 10 mL of 0.5% bupivacaine, 2 mL of fentanyl, and 8 mL of saline mixture were administered through an epidural catheter. Surgery was allowed when the adequate sensory blockade was achieved.

ESPB: The same skilled anesthesiologist who was blind to the study conducted bilateral ESPB with ultrasonography (USG) in the prone position. The process was carried out with the in-plane technique by means of a linear probe (6-13 MHz). A block needle of 22G (100 mm, Germany, B-braun) was applied bilaterally at the level determined according to the location of the fracture, lateral to the spinous process by 3 cm. By moving the needle in the craniocaudal direction, erector muscle was separated from transverse process with the help of 1-2 mL of SF. When the correct site was followed, 20 mL of 0.25% bupivacaine and 50 mg of 0.2% lidocaine were aspirated. The process was repeated on the opposite side in the same way.

PVB: After the patient was monitored, PVB was applied at the level determined by USG in the prone position. The process was carried out with the in-plane technique by means of a linear probe (6-13 MHz). After observing the transverse process and pleura, 20 mL of 0.5% bupivacaine in total was applied bilaterally by aspiration into the paravertebral area, which was seen as a triangle. When sensory blockade occurred, surgery was started.

Surgical Procedure

Experienced surgeons performed all PKP procedures. The patient was positioned face down. To complete entire PKP, a unilateral transverse process-pedicle technique was used. Under pinhole fluoroscopy, it was carried out via the anterior portion of the vertebrae. A balloon was then placed on the vertebral body and expanded. Lastly, lateral fluoroscopy was used to guide the injection of bone cement into the vertebral body. The anatomical level at which surgery was performed was recorded. The surgical technique was applied similarly to that in the literature (11).

Visual Analogue Scale (VAS)

VAS is a real-time, non-invasive, rapidly responding, patient-to-patient, and easy-to-apply pain assessment scale (12). No pain was scored with 0 point, and very severe pain with 10 points.

The Universe of the Study and the Sample

The population of the study consisted of male/female patients aged 18-100 years, who underwent PKP surgery in our hospital between January and July 2022.

Sample calculation was not made for the study, and 66 patients were included in the study, except for 5 patients who had major bleeding during surgery. After the study was completed, a post-hoc power analysis was conducted to examine whether the power of the study was sufficient. In the analyses made for pain scores, discharge and mobilization times, which constituted the main hypothesis of the study, the power level was found above 99.8% for all three parameters, showing that the study sample was sufficient for the study. Power analyses were performed with the G*Power 3.1 program.

Statistical Analysis

In the study, descriptive data are shown as percentages and numbers, and measurement data are shown as median (minimum-maximum) values. In the comparison of categorical data, the chi-square and Fisher tests were used where appropriate. The Kolmogorov-Smirnov tests were used to analyze the normal distribution of measurements. The Kruskal-Wallis test was employed to compare the measurements since the data did not exhibit a normal distribution. The value of $p<0.05$ was accepted for statistical significance. Bonferroni correction was applied for p-values in post-hoc analysis. All analyses were performed with the SPSS 20 program.

Results

No statistically significant difference was observed with regard to gender, ASA use, smoking, comorbidities, mobilization levels, level of surgery, need for preoperative analgesic use, and baseline VAS values in a total of 66 patients, 38 of whom were female and 28 were male (Table 1). As the anesthesia method, sedation was applied in 22 patients, central block in 20 patients (spinal anesthesia in 8 patients, epidural anesthesia in 12 patients), and peripheral block in 24 patients (PVB in 9 patients, ESPB in 15 patients).

The rate of need for additional sedation, VAS scores at all postoperative measured times, and paracetamol and

tramadol doses were found to be statistically significantly higher in group 1 than in group 2 and group 3 (for all, p<0.001). No statistically significant difference was found among the study groups and heart rate, peripheral oxygen saturation (SpO_2), operation time, mean arterial pressure (MAP), and perioperative complication rates (Table 2).

Postoperative time to first mobilization and discharge was longer in group 1 than in other samples. It was significantly shorter in group 3 than in other samples (for both, p<0.001). The patient satisfaction rate in group 3 was statistically significantly higher than in group 1 (p<0.001). The rate of PACU was higher in group 1 than in other groups, and significantly lower in group 3 than in other groups (p<0.001). Postoperative complication rates were found to be statistically similar in the study groups (p>0.50) (Table 3). When the postoperative complications were examined, patients in group 1 and group 3 had nausea and vomiting, 2 patients had hypotension (starting with mobilization), and 1 patient had respiratory distress. Prolongation of sensory blockade was observed in 1 patient in group 2 and 3.

Perioperative nausea rate was found statistically significantly lower in group 3 than in group 1 and group 2 (p=0.008). The rates of perioperative hypotension, arrhythmia, and desaturation were found to be statistically similar in the study samples (p>0.05) (Table 4).

Discussion

Since spine augmentation procedures include the injection of needles with different diameters into the vertebral body, they are associated with significant pain.

Table 1. Assessment of demographic data according to study groups

		Group 1	Group 2	Group 3	p
Med (Min-max)		Med (Min-max)	Med (Min-max)		
Age		73.5 (65.0-81.0)	72.5 (66.0-83.0)	71.0 (66.0-82.0)	0.897[a]
Gender	Female	13 (59.1)	13 (65.0)	12 (50.0)	0.596[b]
	Male	9 (40.9)	7 (35.0)	12 (50.0)	
ASA		3.0 (2.0-3.0)	3.0 (2.0-3.0)	3.0 (2.0-3.0)	0.970[a]
Level	Thoracal	14 (63.6)	10 (50.0)	11 (45.8)	0.457[b]
	Lumbar	8 (36.4)	10 (50.0)	13 (54.2)	
Analgesic	Yes	22 (100.0)	20 (100.0)	24 (100.0)	*
	No	0 (0.0)	0 (0.0)	0 (0.0)	
Mobilization	Self-sufficient	5 (22.7)	5 (25.0)	5 (20.8)	0.880[c]
	Only meet his/her needs such as toilette	10 (45.5)	10 (50.0)	10 (41.7)	
	Bed-ridden, able to stand up with support	6 (27.3)	4 (20.0)	9 (37.5)	
	Immobilized	1 (4.5)	1 (5.0)	0 (0.0)	
HT	Yes	10 (45.5)	12 (60.0)	10 (41.7)	0.452[b]
	No	12 (54.5)	8 (40.0)	14 (58.3)	
DM	Yes	13 (59.1)	13 (65.0)	13 (54.2)	0.767[b]
	No	9 (40.9)	7 (35.0)	11 (45.8)	
HR	Yes	13 (59.1)	11 (55.0)	15 (62.5)	0.881[b]
	No	9 (40.9)	9 (45.0)	9 (37.5)	
Obesity	Yes	5 (22.7)	2 (10.0)	8 (33.3)	0.184[c]
	No	17 (77.3)	18 (90.0)	16 (66.7)	
Tobacco	Yes	5 (22.7)	7 (35.0)	7 (29.2)	0.680[b]
	No	17 (77.3)	13 (65.0)	17 (70.8)	
Other	Yes	8 (36.4)	8 (40.0)	10 (41.7)	0.933[b]
	No	14 (63.6)	12 (60.0)	14 (58.3)	
VAS 0		7.0 (6.0-9.0)	7.5 (6.0-9.0)	7.5 (6.0-9.0)	0.770[a]

Med: Median, k.: Met, *Not calculated, [a]: Kruskal-Wallis test, [b]: Chi-square test, [c]: Fisher test VAS0: Preoperative VAS, HT: Hypertension, DM: Diabetes mellitus, HR: Heart rate, VAS: Visual pain scales

Table 2. Assessment of perioperative data according to study groups

Median (Min-max)		Group 1	Group 2	Group 3	p
		Median (Min-max)	Median (Min-max)		
MAP1		65.0 (57.0-98.0)	65.5 (55.0-86.0)	67.0 (58.0-96.0)	0.747[a]
MAP2		63.0 (40.0-92.0)	59.5 (48.0-80.0)	64.5 (55.0-84.0)	0.296[a]
MAP3		60.0 (44.0-86.0)	57.0 (45.0-79.0)	60.5 (48.0-80.0)	0.167[a]
MAP4		60.5 (48.0-80.0)	60.0 (51.0-78.0)	60.5 (52.0-82.0)	0.842[a]
HR1		80.5 (67.0-102.0)	79.0 (67.0-98.0)	79.5 (60.0-98.0)	0.931[a]
HR2		79.5 (65.0-98.0)	79.5 (70.0-112.0)	79.5 (65.0-98.0)	0.756[a]
HR3		78.0 (68.0-108.0)	79.0 (69.0-112.0)	78.0 (65.0-112.0)	0.430[a]
HR4		77.5 (67.0-90.0)	77.5 (67.0-98.0)	75.5 (68.0-109.0)	0.830[a]
SpO_2-1		96.0 (92.0-98.0)	97.0 (95.0-98.0)	96.0 (94.0-98.0)	0.500[a]
SpO_2-2		96.0 (86.0-98.0)	97.0 (92.0-98.0)	97.0 (94.0-98.0)	0.110[a]
SpO_2-3		96.0 (86.0-98.0)	96.0 (88.0-98.0)	97.0 (86.0-98.0)	0.154[a]
SpO_2-4		96.0 (90.0-98.0)	97.0 (95. 0-98.0)	97.0 (92.0-98.0)	0.428[a]
Additional dose	Yes	18 (81.8)	6 (30.0)	5 (20.8)	**<0.001[b*]**
	No	4 (18.2)	14 (70.0)	19 (79.2)	
Operation time (dk)		55.0 (40.0-70.0)	47.5 (35.0-75.0)	47.5 (35.0-65.0)	0.346[a]
Perioperative complication	Yes	9 (40.9)	10 (50.0)	7 (29.2)	0.365[b]
	No	13 (59.1)	10 (50.0)	17 (70.8)	

[a]: Kruskal-Wallis test, [b]: Chi-square test, *p<0.001, MAP1: MAP at the 15. min of operation, MAP2: MAP at the 30. min of operation MAP3: MAP at the 45. min of operation, MAP4: MAP at the 60. min of operation, HR1: HR at the 15. min of operation, HR2: MAP at the 30. min of operation, HR3: HR at the 45. min of operation, HR4: MAP at the 60. min of operation, SpO_2-1: SpO_2 at the 15. min of operation, SpO_2-2: SpO_2 at the 30. min of operation, SpO_2-3: SpO_2 at the 45. min of the operation, SpO_2-4: SpO_2 at the 60.min of the operation, HR: Heart rate, MAP: Mean arterial pressure

In group 1, the need for additional sedation was observed to be significantly higher in VAS scores, paracetamol and tramadol doses at all postoperative measurement times compared to other groups. Perioperative nausea, PACU need, postoperative first mobilization and discharge times were lower in group 3 than in other groups. The time to discharge and mobilization was highest in group 1, and the patient satisfaction rate was highest in group 3.

Regardless of which anesthesia method is preferred, it is important to provide a good depth of anesthesia at a level that will prevent spinal cord or nerve damage and prevent needle malposition. Poor perioperative pain management was linked to higher rates of morbidity and death as well as worse levels of patient satisfaction, particularly in patients with comorbid conditions. The pain is correlated with increased arrhythmia, hypertension, and cranial bleeding, especially in patients with underlying cardiovascular comorbidities (13). An increase in opioid associated complications (such as consciousness, respiratory depression, hypotension, vomiting, and nausea) may be observed with an opioid preference for perioperative pain control (14). Although many methods such as local, general (sedoanalgesia), regional and peripheral block are applied in PKP surgery, there is still no consensus on the ideal method. In the older age group, any of these options can be problematic.

Although local anesthesia is preferred in PKP surgery, it may not be satisfactory for both the surgeon and the patient if it cannot provide adequate analgesia, especially balloon inflation. In a study in the literature, individuals were separated into 2 groups as local and general anesthesia groups. Both local and general anesthesia might be used in PKP. However, it is stated that local anesthesia is less costly and more effective, and safe with bearable pain compared to general anesthesia (15). Although local anesthesia and sedation provide adequate surgical conditions in studies, surgeons find general anesthesia to be more reliable and comfortable for this procedure (16,17). In these patients with various comorbidities, general anesthesia poses more risks and is linked to longer hospital stays and stays in the PACU as well as a higher frequency of postoperative pulmonary problems (18). In a similar study, local, general and monitoring anesthesia methods were compared. In this study, local anesthesia was performed in ropivacaine (n=55), iv anesthesia with dexmedetomidine (n=55) and general anesthesia with fentanyl/propofol/sevoflurane (n=55). Better sedation and analgesia, shorter operation time, better cooperation with patients, and fewer

Table 3. Assessment of postoperative data according to study groups

Median (Min-max)		Group 1	Group 2	Group 3	p
		Median (Min-max)	Median (Min-max)		
Postop VAS1		4.0 (2.0-6.0)	2.0 (1.0-4.0)	2.0 (0.0-4.0)	**<0.001**[**a]
Postop VAS2		4.0 (2.0-5.0)	2.0 (1.0-4.0)	2.0 (0.0-4.0)	**<0.001**[**a]
Postop VAS3		4.0 (2.0-5.0)	2.0 (1.0-4.0)	2.0 (0.0-4.0)	**<0.001**[**a]
Postop VAS4		4.0 (2.0-4.0)	2.0 (1.0-4.0)	2,0 (0.0-4.0)	**<0.001**[**a]
Postop time to first mobilization		10.0 (8.0-14.0)	8.5 (6.0-12.0)	6.0 (4.0-8.0)	**<0.001**[**a]
Discharge		26.0 (18.0-48.0)	20.0 (14.0-30.0)	16.0 (10.0-30.0)	**<0.001**[**a]
Satisfaction	Satisfied	9 (40.9)	12 (60.0)	21 (87.5)	**0.010**[*b]
	Uncertain	11 (50.0)	7 (35.0)	3 (12.5)	
	Unsatisfied	2 (9.1)	1 (5.0)	0 (0.0)	
Postop complication	Yes	6 (27.3)	1 (5.0)	1 (4.2)	0.055[b]
	No	16 (72.7)	19 (95.0)	23 (95.8)	
PACU	Yes	19 (86.4)	9 (45.0)	3 (12.5)	**<0.001**[**c]
	No	3 (13.6)	11 (55.0)	21 (87.5)	
Paracetamol dose (mg)		3.000 (1.000-3.000)	1.000 (0-3.000)	0 (0-3.000)	**<0.001**[**a]
Tramadol dose (mg)		250 (0-300)	0 (0-200)	0 (0-200)	**<0.001**[**a]

[a]: Kruskal-Wallis test, [b]: Fisher test, [c]: Chi-square test, *p<0.05, **p<0.001, VAS1: Postoperative 2. hour, VAS2: postoperative 6. hour, VAS3: Postoperative 12. hour, VAS4: Postoperative 18. hour, PACU: Postanesthesia care unit

Table 4. Assessment of perioperative complications according to study groups

Median (Min-max)		Group 1	Group 2	Group 3	p
		Median (Min-max)	Median (Min-max)		
Periop hypotension	Yes	5 (22.7)	7 (35.0)	2 (8.3)	0.097[a]
	No	17 (77.3)	13 (65.0)	22 (91.7)	
Periop arrhythmia	Yes	6 (27.3)	7 (35.0)	5 (20.8)	0.576[b]
	No	16 (72.7)	13 (65.0)	19 (79.2)	
Periop nausea	Yes	8 (36.4)	10 (50.0)	2 (8.3)	**0.008**[*b]
	No	14 (63.6)	10 (50.0)	22 (91.7)	
Periop desaturation	Yes	7 (31.8)	7 (35.0)	2 (8.3)	0.072[b]
	No	15 (68.2)	13 (65.0)	22 (91.7)	

[a]: Fisher test, [b]: Chi-square test, *p<0.05

perioperative side effects were observed in monitoring anesthesia with dexmedetomidine (19). In a study, patients were put into the conventional group (0.5% local anesthesia with lidocaine (1); n=42), the prevention group [(1) + celecoxib 200 mg orally the night before surgery and iv 40 mg parecoxib sodium 1 hour before surgery (2); n=43] and the combined group [(1) + (2) + additional intraoperative dexmedetomidine 0.5 µg/kg/hour intravenously; n=43]. For kyphoplasty under local anesthesia, it was observed that combined intraoperative sedation gave better results with preemptive analgesia in reducing intraoperative pain and preventing intra and postoperative hemodynamic changes compared to extra preemptive analgesia or local anesthetic alone (20).

In our study, 81.8% of the patients in group 1 required additional perioperative anesthesia. Ketamine, midazolam, and fentanyl weighted sedation were added. While the average postoperative VAS values were 4 at all measurement times, the average time to the first mobilization and discharge were 10 hours and 26 hours, respectively. While 40.9% of patients were satisfied with anesthesia, 86.4% of the patients needed PACU. We can attribute the general reason for dissatisfaction with pain during surgery, increased nausea due to additional intraoperative sedation, and high

rates of PACU hospitalization. Postoperative complications such as the need for reoperation, bleeding, surgical site infection, and pain were seen in 27.3% of the patients. The average postoperative paracetamol dose was 3 gr, while average tramadol dose was 200 mg. Nausea, desaturation, arrhythmia and hypotension were observed in patients preoperatively, respectively. We associate desaturation with respiratory depression caused by anesthetics; and others with both hypotension caused by anesthetics and changes in the prone position.

Although it is not very common, there have been recent publications in the literature about the utilization of spinal anesthesia for kyphoplasty. In a study (21), a case in which low-dose spinal anesthesia with low dose sedation was applied to patients. It was stated that although there was an adequate sensory blockade, some of the pain control could be achieved by co-administration of iv fentanyl and propofol. It was emphasized that although spinal anesthesia was effective in pain control, attention should be paid in terms of hemodynamic instability and cardiovascular complications that might develop due to local anesthesia baricity (14). In a similar study, the experience of spinal anesthesia in 11 patients who underwent kyphoplasty was published (22). Despite the fact that spinal anesthetic and local anesthetic infiltrations were employed, it was noted that 4 individuals felt discomfort throughout the surgery. Selecting the baricity of the local anesthetic to be injected intrathecally was another difficulty for them. They used hyperbaric lidocaine in the first 6 individuals, but changes to isobaric lidocaine because of a high incidence of hemodynamic instability; they suggested that there is an increase in complications, probably due to more cephalic spread of hyperbaric lidocaine on prone. The third constraint they noted was the unexpected prolongation of the procedure and inability to extend block time, especially if more level of vertebrae was included in the surgery (23). In another study on subarachnoid anesthesia for kyphoplasty, patients were given intrathecal hyperbaric or plane bupivacaine with or without fentanyl. It was stated that 5 individuals had pain while having the surgery and additional iv analgesia was needed. Other patients were comfortable, except that one patient felt pain pressure on the ribs. No patient had respiratory distress or the need for deep sedation. As a result of the study, it was stated that for kyphoplasty, subarachnoid anesthesia might be a suitable method (24).

According to some reports in the literature, segmental epidural anesthesia is superior to general anesthesia with regard to analgesic consumption, postoperative analgesia, and speed of treatment in patients with PKP. However, it should be noted that epidural anesthetic leakage into the subarachnoid space could be resulted in total spinal anesthesia (1). In our study, 30% of patients in group 2 needed additional need for sedation. Additional ketamine and midazolam were administered. The average VAS values in the first 12 hours after surgery were around 2. The average time to the first mobilization and discharge were 8.5 hours and 20 hours, respectively. While the average need for paracetamol was 2 gr postoperatively, that was 0 for tramadol. While 60% of the patients were satisfied with anesthesia, 45% needed PACU. Reoperation was required in 1 patient due to postoperative bleeding complications. The most common perioperative complication was nausea, which we associated with sympathetic blockade and opioid use. Postoperative complications were hypotension, arrhythmia, and desaturation similar to other groups.

It has been shown that good acute or chronic pain control at the cervical, thoracic and lumbar levels are achieved with ESPB, which has recently become widespread in PKP (10,25,26). In a study in which ESPB-related motor weakness was reported, ESPB was shown as a piece of multimodal analgesia (27). In a similar study performed on patients who underwent kyphoplasty with local anesthesia and ESPB, postoperative analgesia was required in all of the patients operated under local anesthesia and in 22.7% of the patients who underwent ESPB. In the ESPB group, no additional sedation was needed during the intraoperative procedure (28). In the case reports, the view that ESPB offers comfortable anesthesia management for PKP was supported by the possibility of anesthesia maintenance without the need for any additional intraoperative sedation (28,29).

In our study, the need for additional sedation in group 3 was seen the least with 20.8% compared to other groups. Perioperative complications were observed in 29.2% of patients. While the average measured postoperative VAS value was 2, the need for paracetamol and tramadol use was significantly lower than in other groups. The average times to first mobilization and discharge were 6 and 16 hours, respectively, and were significantly lower compared to other groups. 12.5% of patients needed PACU. We think that this group has the highest satisfaction rate with 87.5% due to more comfort and early recovery. Only 1 patient had postoperative sensory blockade for a long time. This resulted in patient dissatisfaction, delay in mobilization,

and prolonged discharge time. Perioperative nausea, hypotension, arrhythmia and desaturation were observed significantly less than in other groups.

Study Limitations

The limitations of our study were the low number of cases due to rarity of the surgeries, surgeon satisfaction and inability to look for their effects on long-term chronic pain. Also, in order to obtain statistical data, combining small groups and examining them in 3 main groups prevented the investigation of the effectiveness of different methods.

Conclusion

We observed that patients who underwent peripheral block in anesthesia management in kyphoplasty surgery had fewer intraoperative complications, need for additional sedation and PACU, shorter postoperative mobilization and discharge time, lower VAS values at specified measurement times, and increased patient satisfaction. We think that peripheral anesthesia methods, especially ESPB and PVB, can be safely preferred by experienced people in these surgeries, where anesthesia management is risky due to advanced age, increased co-morbidities, and the preferred prone position during surgery.

Ethics

Ethics Committee Approval: Were taken from the records of the individuals with the treatment of PKP between July 01 and 22, 2022 after the approval of the University of Health Sciences Turkey, Bursa High Specialization Training and Research Hospital Ethics Committee (2021-KAEK-25 2021/12-09), clinical trials number NCT05526794.

Informed Consent: Patient signed consent was obtained.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Concept: T.O., Design: T.O., Data Collection or Processing: T.O., Ü.K., Analysis or Interpretation: T.O., A.D., Ü.K., Drafting Manuscript: T.O., A.D., Critical Revisation of Manuscript: A.O., Ü.K., Ş.E.Ö., Final Approval and Accountability: Ş.E.Ö., A.O., Technical and Material Support: A.D., A.O., Supervision: T.O., Ş.E.Ö., Writing: T.O.

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