

Evaluation of anesthesia methods in percutaneous kyphoplasty procedures in vertebral compression fractures

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ABSTRACT

Aim: Kyphoplasty is a much less invasive technique than conventional methods to strengthen vertebral body fractures. This study aimed to demonstrate a safe and effective anesthesia method by retrospectively investigating the clinical conditions, perioperative pain experiences, and anesthesia methods of patients who underwent kyphoplasty in our institution.

Material and Method: A total of 76 patients who had kyphoplasty operations performed under elective conditions between January 2018 and March 2021 have been enrolled in this research. Demographic data of patients, injury mechanisms, anesthesia method, duration of surgery, severe perioperative complications (heart attack, lung disease, delirium, etc.), duration of postoperative stay in intensive care, pre and postoperative pain degrees with visual analogue scale (VAS) has been interpreted.

Results: There was a statistically significant difference between the groups in terms of duration of operation, duration of anesthesia, postoperative discharge time, postoperative 24-hour VAS score, intraoperative hemodynamic status, and presence in the post-anesthesia care unit (PACU) ($p < 0.05$). The operation time, anesthesia time, postoperative discharge time, and the postoperative 24-hour VAS score of individuals with general anesthesia were higher than those under local anesthesia and sedation. Regarding intraoperative hemodynamic status, 37.5% of those under general anesthesia were stable, while 73.5% of individuals under local anesthesia and sedation were stable. While 37.5% of those under general anesthesia were in the post-anesthesia care unit, this rate was 7.4% in those under local anesthesia and sedation.

Conclusion: The most appropriate anesthesia type should be determined according to the patient's individual health status. Each method has its advantages, such as no need for a stable position in general anesthesia and availability of motor functioning evaluation and verbal communication in local anesthesia; hence local anesthesia and sedoanalgesia were together. This seems to be more advantageous with the appropriate sedation.

Keywords: Kyphoplasty, vertebral fractures, local anesthesia, general anesthesia, PACU

INTRODUCTION

It is known that vertebral compression fractures (VCF) can cause severe and long-lasting pain, nerve damage, depression, and even permanent disability without appropriate treatment (1). These patients have long-lasting pain, irregularity in bowel functions, disruption in sleep patterns, and lung problems that cause severe declines in their quality of life (2).

Kyphoplasty is a much less invasive technique than conventional methods to strengthen the vertebral body. Polymethylmethacrylate (PMMA) (popularly called bone cement) is given to the vertebral corpus by the external percutaneous route. With these methods, it has been possible to treat such fractures without open surgery (3). Infection, bleeding, and limitation of movement

secondary to long-term surgery are almost non-existent with these methods. Thromboembolism, lung problems, bedsores, long-term drug use, and corset use are avoided due to prolonged lying down (4).

Patients undergoing kyphoplasty procedures usually have significant comorbidities. Therefore, it is difficult to determine the intraoperative anesthesia method. Both local anesthesia and general anesthesia are commonly used. However, it remains unclear which anesthetic method is better for kyphoplasty (5). Generally surgeons recognize the advantage of local anesthesia to prevent fragile elderly patients with multiple organ dysfunction (6).

Surgeons usually assess whether the nerve injury occurred while the patient is awake. Moreover, patients who receive local anesthesia do not need postoperative care and can get out of bed earlier, conducive to postoperative rehabilitation (7-8). On the other hand, there are certain downsides of local anesthesia, such as the prolongation of fluoroscopy time resulting in extended operation or the termination of the surgery due to posture-related discomfort. Moreover, abundant local anesthetic administration may induce a toxic reaction of bone cement and abrupt fluctuation of vital signs (9).

Local anesthesia are an option for pain relief during kyphoplasty. On the other hand, it may be insufficient in pain control. The need for sedation and analgesics may cause complications such as respiratory depression, hypotension, and delirium in the patient in the prone position. Although it is recommended to perform kyphoplasty under general anesthesia due to severe pain, it has been shown that general anesthesia brings life-threatening problems, especially in the elderly and comorbid disease group (10).

Spinal anesthesia and epidural anesthesia are alternative methods, especially in these patients with comorbid diseases. However, the baricity of the chosen local anesthetic and its inadequacy in pain control limit its application. Currently, it remains unclear which anesthesia is ideal for PKP. The anesthesia method may vary according to the clinical findings of the patient and the knowledge and experience of the anesthetist (9,10).

Study Hypothesis

As in every surgery, the main purpose stands for achieving the best possible clinical effect without increasing the incidence of complications. At this stage, a multidisciplinary approach is crucial with a team of surgeons and anesthesiologists for better outcomes in pain improvement rate, vertebral height recovery, and kyphosis correction (11).

This study aimed to demonstrate a safe and effective anesthesia method by retrospectively investigating the clinical conditions, perioperative pain experiences, and anesthesia methods of patients who underwent kyphoplasty in our institution.

MATERIAL AND METHOD

A total of 76 patients who had a kyphoplasty operation performed under elective conditions between January 2018 and March 2021 have been enrolled in this research. The study has a retrospective nature. The study was carried out with the permission of Bursa Training and Research Hospital, Non-interventional Clinical Researches Ethics Committee (Date: 28.04.2021, Decision No: 2011-KAEK-25 2021/04-17). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Demographic data of patients, injury mechanisms, anesthesia method, duration of surgery, severe perioperative complications (heart attack, lung disease, delirium, etc.), duration of postoperative stay in intensive care, pre and postoperative pain degrees with visual analogue scale (VAS) has been interpreted.

Inclusion Criteria

Patients classified as ASA Group 1-3, preoperative VAS >5, and subjects with single-level vertebral compression fractures were included in the analysis.

Exclusion Criteria

Patients classified as ASA Group 4-5 (high risk of mortality and morbidity), subjects free of pain, individuals with symptomatic neurological damage, fracture due to secondary osteoporosis, and metastatic cancer have been excluded from the analysis.

Anesthesia & Surgical Procedure

In all kyphoplasties, the surgeon was the same but the anesthesiologists were different. Group G received general anesthesia with endotracheal intubation. General anesthesia was administered via 2 mg/kg propofol, 2 mcg/kg fentanyl, 0.6-1.2 mg/kg rocuronium during the operation. In addition, maintenance was provided with 2-3% sevoflurane. Group L has received 10 ml of bupivacaine at a concentration of 0.25% for local infiltration anesthesia. Double or triple combinations of sedative and hypnotic (midazolam, propofol, pentothal) and analgesic (fentanyl, ketamine) drugs were used for sedoanalgesia.

Fluoroscopy imaging performed a unilateral transpedicular (lumbar vertebrae) or extrapedicular (thoracic vertebra) puncture. After reaching the posterior edge of the vertebral body, the bone needle was replaced with a working cannula. A radiopaque medium balloon was placed over the fractured vertebral body to restore the damaged vertebral body until adequate height restoration, and kyphosis correction were achieved. The balloon was then deflated and withdrawn, and the resulting intravertebral space was filled with polymethylmethacrylate cement.

Statistical Analysis

Patient data collected within the scope of the study were analyzed with the IBM Statistical Package for the Social Sciences (SPSS) for Windows 23.0 (IBM Corp., Armonk, NY) package program. Frequency and percentage were given for categorical data, and median, minimum and maximum descriptive values for continuous data. "Mann Whitney-U Test" was used for comparisons between groups, and "Pearson Chi-square or Fisher's Exact Test" was used to compare categorical variables. The results were considered statistically significant when the p-value was less than 0.05.

RESULTS

The evaluation of whether there was a difference between demographic and clinical findings of the patients in the study under general anesthesia and local anesthesia and sedation were elaborated in **Table 1**.

When the table was examined, no statistically significant difference was found between the two groups regarding age, gender, and Charlson comorbidity index ($p>0.05$). This outcome indicates that the study population was homogeneous regarding age, gender, and Charlson comorbidity index result.

There was a statistically significant difference between the groups in terms of duration of operation, duration of anesthesia, postoperative discharge time, postoperative 24-hour VAS score, intraoperative hemodynamic status, and presence in the post-anesthesia care unit (PACU) ($p<0.05$).

The operation time, anesthesia time, postoperative discharge time, and the postoperative 24-hour VAS score of individuals with general anesthesia were higher than those under local anesthesia and sedation.

Regarding intraoperative hemodynamic status, 37.5% of those under general anesthesia were stable, while 73.5% of individuals under local anesthesia and sedation were stable. While 37.5% of those under general anesthesia were in the post-anesthesia care unit, this rate was 7.4% in those under local anesthesia and sedation.

DISCUSSION

Kyphoplasty surgery has several complications. The most common of them could be elaborated as leakage from the operation zone and the second one is anesthesia related events (12,13). At this point, the medical team's anesthesia method becomes a controversial issue. The surgeons are prone to local anesthesia rather than general anesthesia because it is a safer method for elderly patients who cannot receive general anesthesia and whose general condition is impaired. On the other hand, comorbid diseases are also another decision point for the elderly population (11).

Liu, et al. (10) have previously published that local anesthesia might be an ideal choice for patients who had undergone single vertebra kyphoplasty. They declared that local anesthesia effectively achieved the sufficient efficacy of general anesthesia. Additionally, local anesthesia was a safer option for cardiac situations and older individuals to reduce anesthesia-related complications. Last but not least, local anesthesia also had better postoperative outcomes such as early mobilization, getting out of bed soon, and reducing hospital stay. Similar to their findings, our study found that the operation time, anesthesia time, postoperative discharge time, and postoperative 24-hour VAS score of individuals with general anesthesia were higher than those under local anesthesia and sedation.

Table 1. Distribution of Demographic and Clinical Findings by Types of Anesthesia

Characteristics (N=76)	Total (n=76)		GA (n=8)		LA+SED (n=68)		P Value
	n (%) or Median (Min-Max)	n (%) or Median (Min-Max)	n (%) or Median (Min-Max)	n (%) or Median (Min-Max)	n (%) or Median (Min-Max)		
Age, years	69 (33-92)		68 (54-83)		69 (33-92)		0.754
Gender							0.234
Male	23 (30.3)		4 (50.0)		19 (27.9)		
Female	53 (69.7)		4 (50.0)		49 (72.1)		
Charlson Comorbidity Index	4 (0-7)		5 (2-7)		4 (0-7)		0.674
Injury Type							0.623
Osteoporosis	4 (5.3)		0 (0.0)		4 (5.9)		
Metastatic Tumor	5 (6.6)		1 (12.5)		4 (5.9)		
Falling	67 (88.2)		7 (87.5)		60 (88.2)		
Pre-op VAS Score	8 (6-10)		8 (7-10)		8 (6-10)		0.257
Operation time, minutes	45 (20-120)		70 (30-120)		45 (20-120)		0.029
Anesthesia time, minutes	60 (30-180)		80 (45-140)		60 (30-180)		0.027
Severe Complications	16 (21.1)		4 (50.0)		12 (17.6)		0.056
Post-op Discharge, days	1 (1-44)		2,5 (1-44)		1 (1-10)		<0.001
Post-op 24 hour VAS Score	2 (1-5)		3 (2-5)		2 (1-4)		0.001
Intraoperative Hemodynamic Status							0.049
Stable	53 (69.7)		3 (37.5)		50 (73.5)		
Unstable	23 (30.3)		5 (62.5)		18 (26.5)		
PACU	8 (10.5)		3 (37.5)		5 (7.4)		0.034

There is also conflicting literature on this subject, indicating that the type of anesthesia did not affect the efficacy of PKP for a single-level OVF. Liu et al. (10) stated that anesthesia type was not a significant parameter of the PKP procedure. This is an important finding as the duration of single kyphoplasty intervention of a single OVF is shorter. On the contrary, our study's patient population mainly consisted of the elderly with several comorbidities, thus considering that general anesthesia will be more risky. Postanesthetic care unit need was less in the local anesthesia sedation group.

One important aspect of comparing local and general anesthesia during PKP surgery lies beneath each individual's vital signs, hemodynamic parameters, and intraoperative situation. However, data on this strategic point is lacking in the previous studies. Fluctuations in these parameters determine the duration of PACU patients with a variety of factors such as cardiac status (mean arterial pressure, heart rate, vital signs during the operation), postoperative cognitive dysfunction, and other complications (14,15). In this study, there was a statistically significant difference in favor of the local anesthesia group between the groups in terms of duration of operation, duration of anesthesia, postoperative discharge time, postoperative 24-hour VAS score, intraoperative hemodynamic status, and presence in the post-anesthesia care unit (PACU) ($p < 0.05$).

At this stage, one should consider the differential advantages of each anesthesia method at a patient centric approach. General anesthesia has definite advantages on vital signs (arterial pressure and heart rate) due to narcotic analgesics, sedatives, and muscle relaxants, combined with efficient respiratory ventilation management. This enables the prevention of cardiovascular and cerebral complications via controlling heart rate and blood pressure (16-18). However, this data was challenged in our findings as the intraoperative hemodynamic status of our study population has been found as 37.5% of those under general anesthesia were stable, while 73.5% of individuals under local anesthesia and sedation were stable.

Another technical advantage of general anesthesia is reducing surgery period and fluoroscopy exposure, especially in multiple vertebral PKP. During local anesthesia, the patient needs to change his/her position frequently due to body position-related discomfort or stimulation of intraoperative pain. Due to the combination of muscle relaxation and analgesia, it seems appropriate to prefer general anesthesia at this point (19).

The downside of local anesthesia could be elaborated as inadequate efficacy leading to severe pain during the surgery. Multiple osteoporotic vertebral fracture surgery such as rib, humerus, or intertrochanteric fracture

requiring a prone position at the operation might lead to discomfort. At this point, the patient may need sedation and analgesia. However, it is difficult for anesthesiologists to adjust the appropriate sedation level without causing respiratory depression and unconsciousness in the patient population (elderly and patients with comorbid diseases) and prone position. The experience of the surgeon is also another aspect. If the puncture point angle could not be achieved at one time, repeated puncture increases the damage to surrounding soft tissue and nerve injury, resulting in muscle tension in the intraoperative period (20). In our study, the same surgeon has performed the operations, but the anesthetists were different. The main challenge has been preserving patient cooperation while administering sedation without respiratory depression. Although there was no statistically significant difference in the study analyses, complications in the local anesthesia sedoanalgesia group (respiratory distress in 4 patients, hypertensive crisis in 2 patients, hypotension in 3 patients, nausea and vomiting in 1 patient) were life-threatening.

One should also admit the proven advantages of local anesthesia. The major strength could be emphasized as no requirement for postoperative PKP recovery. The patients get out of bed very soon, thus alleviating wound healing. Another strength is no impairment in cognitive functions compared to general anesthesia, which is essential for elderly patients (21). The results of our study have provided supportive outcomes on this aspect. The 37.5% of those under general anesthesia were in the post-anesthesia care unit while this rate was 7.4% in those under local anesthesia and sedation.

The surgery team's skills and the patient's positive motivation increase the success rate. The experienced surgeon and an individual who has been informed about the surgery, position, and sedation/analgesia requirement case can be attributed as the best possible combination. Hence, physicians prefer local anesthesia in single OVF repair by kyphoplasty (10).

Limitations of the Study

The main limitation of this study could be attributed to its retrospective nature. The second limitation was the lack of comparison between local and general anesthesia during PKP surgery in terms of each individual's vital signs, hemodynamic parameters, and intraoperative situation. However, one should mention that this was the most significant gap in published literature up to date.

In our study, the type of anesthesia was decided with the surgical team. Regional anesthesia methods, neuraxial blocks (spinal, epidural), ultrasonography-assisted trunk blocks were not performed. Prospective studies are needed to compare these methods to determine the advantageous anesthesia method for kyphoplasties.

CONCLUSION

Regarding the results of this study, one can say that the most appropriate anesthesia type should be determined according to the patient's individual health status. Thus each method has its advantages, such as no need for a stable position in general anesthesia and availability of motor functioning evaluation and verbal communication in local anesthesia. When the anesthesia method was compared, since local anesthesia and sedoanalgesia were together, local anesthesia seemed to be more advantageous with the appropriate sedation level.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Bursa Training and Research Hospital, Non-interventional Clinical Research Ethics Committee (Date: 28.04.2021, Decision No: 2011-KAEK-25 2021/04-17).

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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