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Spinal Anesthesia versus General Anesthesia in Elderly Patients Undergoing Lumbar Instrumentation: A Retrospective Study

Lomber Enstrümantasyon Uygulanan Yaşlı Hastalarda Spinal Anestezi ile Genel Anestezinin Karşılaştırması: Retrospektif Çalışma

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ABSTRACT Objective: Spine surgery poses serious risks in elderly patients due to long operating time and massive blood loss. The aim of the study was to evaluate whether anesthesia techniques (general versus spinal) would have an effect on perioperative outcomes in patients older than 65 years who underwent lumbar instrumentation. **Material and Methods:** A retrospective review was performed using hospital's database after ethics committee approval. Patients with American Society of Anesthesiologists physical status I-III and aged between 65-90 years were included in the study who underwent elective primary lumbar instrumentation (1-5 levels) surgery were included in the study. Primary outcome measures were perioperative blood loss, blood transfusion requirement and postoperative pain relief. Secondary outcome measures were hospital discharge time and complications. **Results:** Forty-five patients received general anesthesia (Group GA) using inhalational sevoflurane combined with intravenous remifentail infusion and 44 patients received spinal anesthesia (Group SA). Blood loss was higher in Group GA than Group SA (470.8±91.1 mL vs. 387.8±100.5 mL, p=0.02). More patients in the Group GA were received packed red blood cell transfusion (16.4% vs. 9.1%, p=0.02). Pain scores were higher (5.6±1.1 vs. 4.0±1.8, p=0.02), in Group GA. Hospital discharge time was longer (4.0±1.0 days vs. 3.0±0.6 days; p=0.02) and complication rate was higher in Group GA (61.8% vs. 29.5%, p=0.01). The most common complication was postoperative nausea and vomiting (18.1%). **Conclusion:** It is concluded that SA may be performed as a safe and effective alternative for GA in older adults undergoing lumbar instrumentation.

Keywords: Anesthesia; aged; orthopedic procedures; lumbar vertebrae

ÖZET Amaç: Spinal cerrahi, uzun ameliyat süresi ve masif kan kaybı nedeniyle yaşlı hastalarda ciddi riskler oluşturmaktadır. Çalışmamızın amacı, lomber enstrümantasyon uygulanan 65 yaş üstü hastalarda, anestezi tekniklerinin (genel ve spinal), perioperatif sonuçlar üzerinde bir etkisinin olup olmadığını değerlendirmektir. **Gereç ve Yöntemler:** Etik kurul onayı alındıktan sonra hastanenin veri tabanı kullanılarak geriye dönük bir inceleme yapıldı. Amerikan Anestezistler Derneği fiziksel durum I-III olan, 65-90 yaş arası ve elektif primer lumbar enstrumentasyon (1-5 seviye) cerrahisi uygulanan hastalar çalışmaya alındı. Birincil sonuç ölçümleri; kan kaybı miktarı, kan transfüzyonu gerekliliği ve postoperatif analjeziydi. İkincil sonuç ölçümleri; hastaneden taburculuk süresi ve perioperatif komplikasyonlardı. **Bulgular:** Kırık beş hastaya sevofluran inhalasyonu ile intravenöz remifentanil infüzyonunun kombine edildiği genel anestezi (Grup GA) ve 44 hastaya spinal anestezi (Grup SA) uygulanmıştı. Kan kaybı miktarı; Grup GA'daki hastalarda (470,8±91,1 mL), Grup SA'dakilere göre (387,8±100,5 mL) daha yüksek bulundu (p=0,02). Eritrosit transfüzyon oranı Grup GA'da daha fazlaydı (%16,4'e karşı %9,1; p=0,02). Grup GA'daki hastalarda Grup SA'dakilere göre ağrı skorları daha yüksek (5,6±1,1 vs. 4,0±1,8, p=0,02) bulundu. Grup GA'da hastaneden taburcu olma süresi Grup SA'ya göre daha fazlaydı (4,0±1,0 güne karşı 3,0±0,6 gün; p=0,02). Grup GA'da (%61,8) komplikasyon oranı Grup SA'ya (%29,5) göre daha yüksekti (p=0,01). En sık komplikasyonlar postoperatif bulantı ve kusmaydı (%18,1). **Sonuç:** SA'nın lomber enstrümantasyon uygulanan yaşlı hastalarda GA'ya göre güvenli ve etkili bir alternatif olarak uygulanabileceği sonucuna varıldı.

Anahtar Kelimeler: Anestezi; yaşlı; ortopedik prosedürler; lumbar vertebra

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Lumbar degenerative diseases are common in the geriatric population and require often surgical treatment despite conservative therapy.[1] Increasingly more elderly patients are scheduled for lumbar surgery owing to recent advances in surgical techniques, anesthetic management, and postoperative care. However, accompanying comorbidities, long operating time, and massive blood loss make the anesthetic management extremely difficult for anesthesiologists.[2] The procedure is prone to develop complications which have been reported at rates of 3% to 29% in patients over 65 years.[3] Some of them are life-threatening and therefore, protective measures are crucial.

General anesthesia (GA) is widely accepted as the main technique both by the anesthesiologists, surgeons, and patients due to the need for an immobile patient, securing the airway in the prone position, and to the patient's fear for being awake during surgery.[4] In recent years, spinal anesthesia (SA) is increasingly performed in lumbar spine surgery because studies reported that SA better maintains intraoperative hemodynamic stability, decreases postoperative pain and overall complications compared to the GA.[5-7] However, there are limited number of studies in the literature that uses SA as the main anesthetic technique in a specific patient group with older age.[8-11] The aim of the current study was to report a single center's experience using SA for lumbar instrumentation procedures in patients older than 65 years who underwent lumbar instrumentation between January 2014 and December 2020. The perioperative outcomes were compared with the result of patients who received GA in the same period.

MATERIAL AND METHODS

STUDY DESIGN

This retrospective and observational study was conducted in a private hospital after obtaining Gülhane Training and Research Hospital Local Research Ethics Committee approval (project no: 2020/444, date: 11.30.2020). Inclusion criteria were American Society of Anesthesiologists (ASA) physical status classification I-III, age between 65-90 years, lumbar instrumentation (1-5 level), and elective primary surgery. Exclusion criteria were urgent surgery, trauma or malignancy surgery, anticoagulation therapy or coagulation disorder, lost in the follow-up period, and missing data. The study was carried out in accordance with the Code of Ethic of the World Medical Association (Declaration of Helsinki). The study followed the Strengthening the Reporting of Observational Studies in Epidemiology guidelines.

ANESTHETIC MANAGEMENT

All patients were examined in the preoperative visit in the routine practice, and the decision for the anesthetic technique was made in collaboration with the patient and anesthesiologist. Patients underwent either GA or SA. GA was induced using intravenous (IV) propofol, fentanyl, and rocuronium and maintained using an inhalational anesthesia (sevoflurane; minimum alveolar concentration: 2-3) combined with IV remifentanil infusion (1-3 $mcgkg^{-1}h^{-1}$). SA was performed with the patient in the sitting position using a 15-17 mg of hyperbaric bupivacaine (0.5%) via 25-or 27-gauge Quincke spinal needle at L4-L5 or L3-L4 intervertebral space using a midline approach. The patients were positioned with the head of the operation table was elevated with 15 degrees. Bromage scale and pin-prick sensation test were used to confirm the adequate motor and sensory block. Intraoperative sedation was achieved using IV boluses of midazolam (1-3 mg) and/or ketamine (10 mg).

All surgical procedures were performed by the same team which involved a neurosurgeon and an orthopedic surgeon. When needed, a hypotensive agent infusion (nitroglycerine) was given to achieve a deliberate hypotensive anesthesia which aimed to reduce the mean arterial blood pressure (ABP) up to 30% of basal levels or to achieve a mean ABP between 55-65 mmHg. Tranexamic acid was given IV in a bolus dose of 20 $mgkg^{-1}$ followed by an infusion (2 $mgkg^{-1}h^{-1}$) to all patients to reduce the blood loss. The blood loss was estimated by collecting the gauzes saturated with the blood and by measuring the blood content in the suction bottle. When estimated blood loss (EBL) exceeded 20% of

total blood volume (TBV) and hemoglobin level decreased to 8 gdL^{-1}, a packed red blood cell (PRBC) was infused. TBV was estimated using the following traditional formulae: TBV=actual body weight×fixed 70 $mlkg^{-1}$.

POSTOPERATIVE FOLLOW-UP PERIOD

All patients were observed in post anesthesia care unit (PACU) after the surgery. Of them, patients with EBL or blood transfusion higher than 40% of TBV, hemodynamic instability, and peripheral oxygen saturation <90% with supplemental oxygen were admitted in the intensive care unit (ICU).

A multi-modal analgesic (MMA) regimen was used for postoperative pain relief in all patients. MMA regimen included IV paracetamol 10 $mgkg^{-1}$ with 8-h intervals, with 6-h intervals, IV patient-controlled analgesia (IV-PCA; tramadol 4 mgh^{-1} infusion, bolus 4 mg, lock-out time 30 min, 4-h limit 48 mg), and oral diclofenac 75 mg with 12-h intervals. Pain intensity was evaluated in the postoperative period by service nurses using a visual analogue scale (VAS; 0-10 cm) with 2-h intervals in the first 24 hours, then with 4-h intervals. IV pethidine (0.3 $mgkg^{-1}$) was given as rescue analgesic when VAS>3.

OUTCOME MEASURES

The primary outcome measure was to identify perioperative variables which were the rate of induced hypotensive anesthesia (n, %), EBL (mL), the rate of blood transfusion (n, %), PACU discharge time (min), ICU admission rate (n, %), ICU discharge time (h), time to oral intake (hours), time to mobilization (h), postoperative VAS scores (0-10), time to first rescue analgesic requirement (h), and postoperative pethidine consumption (mg). The secondary outcome measures were hospital discharge time (day) and complications. Complications were identified as complications related to the surgery including postoperative bleeding, infection, and nerve damage; complications related to the anesthetic management and other factors including nausea and vomiting, hemodynamic disturbances; i.e. hypotension/hypertension (decrease/increase in the ABP more than 30% of basal levels), arrhythmia, bradycardia/tachycardia (decrease/increase in the heart rate more than 30% of basal levels), respiratory problems; desaturation (SpO_2<92% with supplemental oxygen), dyspnea; cognitive deterioration, thromboembolism etc.

DATA COLLECTION AND STATISTICAL ANALYSIS

Hospital's electronic database, patient and anesthesia files were reviewed by study members to collect data that included demographic and perioperative characteristics. SPSS pocket program (version 21.0; IBM SPSS Inc, Chicago, IL) was used for statistical analysis. Descriptive statistics were used for continuous variables (mean±standard deviation), and frequency and percentage (n, %) for categorical variables. Continuous variables were analyzed with Kolmogorov-Smirnov test when normally distributed. The differences in distributions for categorical variables were analyzed using Pearson's chi-square (χ^2) and Fisher's exact tests between groups. The abnormal distribution for continuous variables was analyzed using Mann-Whitney U test. A p value <0.05 was considered statistically significant.

RESULTS

A total of 143 files were evaluated and 44 files were excluded from the study due to missing data (n=32) and lost to follow-up (n=12) (Figure 1). The remaining 99 files were assigned into 2 groups considering the anesthetic technique. Group general anesthesia (Group GA) consisted of 55 patients and group spinal anesthesia (Group SA) consisted of 44 patients. Mean age was 71.6±4.8 years. Demographic data revealed that the patients in Group GA were younger (70.8±6.4 yrs. vs. 76.4±4.1 yrs., p=0.03), had fewer co-morbidities (63.6% vs. 72.7%, p=0.02), and higher body mass index than the patients in Group SA (33.0±2.4 kgm^{-2} vs. 25.2±0.9 kgm^{-2}, p=0.02). Gender distribution was not different between groups (p=0.61). Instrumentation level and operative time were also similar (p=0.69 and p=0.77, respectively). Baseline characteristics were given in Table 1.

Primary outcome measure: Hypotensive anesthesia was required in 41.4% of all patients and

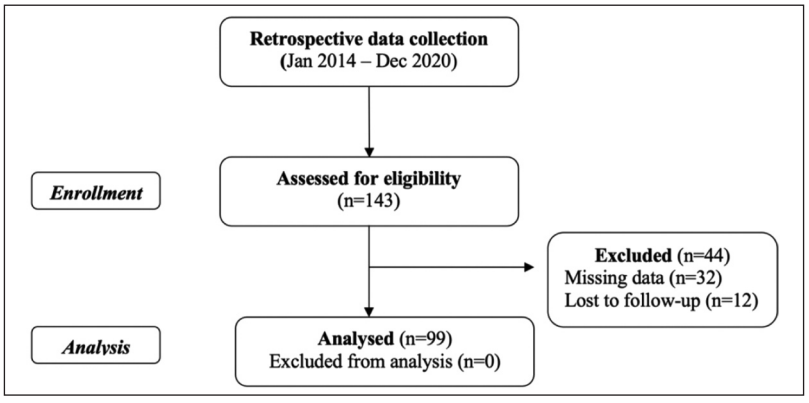

FIGURE 1: The study flow chart.

TABLE 1: Baseline characteristics in study groups.

Parameter	General anesthesia (n=55)	Spinal anesthesia (n=44)	*p value
Mean age yrs., (minimum-maximum)	70.8±6.4 (66-85)	76.4±4.1 (66-89)	0.03
Gender (female/male)	30/25 (54.5/45.5)	25/19 (56.8/43.2)	0.61
ASA physical status n, (%)			
1	20 (36.4)	12 (27.3)	0.01
2	25 (45.4)	20 (45.4)	0.78
3	10 (18.2)	12 (27.3)	0.01
Co-morbidity n, (%)	35 (63.6)	32 (72.7)	0.02
Hypertension	20 (36.4)	10 (22.7)	0.01
Diabetes mellitus	12 (21.8)	6 (13.6)	0.02
Coronary artery disease	2 (3.6)	8 (18.2)	0.01
Pulmonary disease	1 (1.8)	8 (18.2)	0.01
Hemoglobin level ($gdLm^{-1}$)	12.1±1.8	11.9±1.3	0.34
Body mass index (kgm^{-2})	33.0±2.4	25.2±0.9	0.02
Instrumentation level (n)	2.9±1.1 (1-5)	2.8±0.8 (1-5)	0.69
Operative time (min.)	156±10.1	148.3±9.2	0.77

*p<0.05 is considered statistically significant; ASA: American Society of Anesthesiologists.

was induced in more patients in Group GA than Group SA (47.3% vs. 34.1%, p=0.03). EBL was higher in Group GA compared to Group SA (470.8±91.1 mL vs. 387.8±100.5 mL, p=0.02). EBL was higher than 40% of TBV in 2 patients in Group GA. Blood transfusion was required in 13 patients (13.1%). More patients in Group GA received PRBC transfusion [16.4% (9) vs. 9.1% (4), p=0.02].

PACU discharge time was shorter in Group SA (21.0±7.6 min vs. 34.1±91.1 min; p=0.02). A total of 11 (11.1%) patients were followed in the ICU after the surgery for a median 9.1±1.1 hours due to hypertension in 3 patients in Group GA, hypotension in one patient in Group SA, to desaturation in 2 patients each in Group GA and SA, and intraoperative major blood loss (EBL>40% of TBV) in 2 patients in Group GA. ICU admission rate was higher and ICU discharge time was longer in Group GA (12.7% vs. 9.0%, and 10.7±4.6 h vs. 6.1±1.1 h; p=0.02). Time to oral intake and time to mobilization were reduced in Group SA (p=0.03 and p=0.02, respectively) (Table 2). Mean VAS scores were higher (5.6±1.1 vs. 4.0±1.8, p=0.02) and time to first rescue analgesic (pethidine) was lower in Group GA compared to Group SA (2.6±1.2 h vs. 0.4±0.2 h, p=0.01). Mean pethidine consumption was also increased in Group GA than Group SA (40.8±11.3 mg vs. 29.3±10.1 mg, p=0.01) (Table 2).

TABLE 2: Primary outcome measures between study groups.

Parameter	General anesthesia (n=55)	Spinal anesthesia (n=44)	*p value
Induction of hypotensive anesthesia n, (%)	26 (47.3)	15 (34.1)	0.03
Estimated blood loss (mL)	470.8±91.1	387.8±100.5	0.02
Transfusion of PRBC n, (%)	9 (16.4)	4 (9.1)	0.02
PACU discharge time (min)	34.1±91.1	21.0±7.6	0.02
ICU admission n, (%)	7 (12.7)	4 (9.0)	0.02
ICU discharge time (h)	10.7±4.6	6.1±1.1	0.02
Time to oral intake (h)	5.0±0.2	3.9±1.3	0.03
Time to mobilization (h)	10.8±2.2	7.8±1.3	0.02
VAS score	5.6±1.1	4.0±1.8	0.02
Time to first rescue analgesic (h)	0.4±0.2	2.6±1.2	0.01
Pethidine consumption (mg)	40.8±11.3	29.3±10.1	0.01

*p<0.05 is considered statistically significant; PRBC: Packed red blood cell; PACU: Post anesthesia care unit; ICU: Intensive care unit; VAS: Visual analogue scale.

Secondary outcome measure*:* There were 47 (47.4%) complications recorded. The most common complication was postoperative nausea and vomiting (PONV, 18.1%) followed by desaturation (12.1%) and hemodynamic instability (8.1%). The complication rate was higher than two-fold in Group GA compared to Group SA (61.8% vs. 29.5%, p=0.01) (Table 3). PONV was successfully treated using antiemetics. Desaturation was recorded in eleven patients and atelectasis was diagnosed in 5 of them at the postoperative second day. Those patients were treated with antibiotics, bronchodilators, and respiratory physiotherapy. Hemodynamic instability was recorded as hypertension in 8 patients and all patients were treated using antihypertensive drugs. There was no mortality or re-admission into the ICU recorded. All patients were discharged from the hospital. Hospital discharge time was longer in Group GA than Group SA (4.0±1.0 days vs. 3.0±0.6 days; p=0.02). Main reasons for the delay in hospital discharge were atelectasis (5.5% in Group GA vs. 4.5% in Group SA; p=0.03) and delirium (5.5% in Group GA vs. 2.3% in Group SA; p=0.02). Delirium was diagnosed in 4 patients (3 in Group GA and one in Group SA) at the second or third postoperative day. Two patients had a history of neurocognitive disorder, hyponatremia was detected in another patient and one patient suffered from intractable pain. The symptoms of those patients were resolved with individual treatments (treating of underlying cause i.e., hyponatremia management, analgesics; or haloperidol).

DISCUSSION

The results of the study showed that both general and SA provided a safe perioperative course in elderly patients who underwent lumbar instrumentation.

TABLE 3: Secondary outcome measures between study groups.

Parameter	General anesthesia (n=55)	Spinal anesthesia (n=44)	*p value
Length of hospital of stay (days)	4.0±1.0	3.0±0.6	0.02
Adverse events & complications n, (%)	34 (61.8)	13 (29.5)	0.01
Nausea and vomiting n, (%)	14 (25.4)	4 (9.1)	0.01
Desaturation (SpO_2<90 in room air) n, (%)	8 (14.5)	4 (9.1)	0.01
Hemodynamic instability n, (%)	6 (10.9)	2 (4.5)	0.01
Atelectasis n, (%)	3 (5.5)	2 (4.5)	0.03
Delirium n, (%)	3 (5.5)	1 (2.3)	0.02

*p<0.05 is considered statistically significant; SpO_2=Peripheral oxygen saturation.

There was not a mortality recorded and complications were treated successfully in postoperative period. Only 11.1% of patients were transferred into ICU to monitor closely between 6-11 hours. There was no re-admission was recorded after discharge from the hospital.

But, it can be stated that SA was superior than GA regarding outcomes for several reasons: a) SA provided a better hemodynamic stability and prevented excessive elevations in ABP that required induced hypotension, b) the amount of blood loss and blood transfusion were reduced, c) a better postoperative pain relief was achieved because pain scores were lower, time to first rescue analgesic was longer, and opioid consumption was reduced, d) ICU admission rate was lower, e), complication rate was decreased and f) hospital discharge time was shorter.

These results are compatible with previous studies. Erbas et al. reported their experience on SA administered to 497 patients who underwent spinal stabilization surgery.[8] Of them, 92 patients were aged between 71 and 80 years and 27 patients were older than 80 years. There were no pulmonary or cardiac complications recorded. Major complaints were nausea and vomiting. The average hospital discharge time was 2 days.

Lessing et al. reviewed medical records of 56 patients older than 70 years (mean 77; 70-91 years) who underwent lumbar decompression (median 1.91 levels) or decompression and fusion (median 1.96 levels) surgery under SA.[9] Operative time was 101±42 (30-210) minutes. Maximum pain score was 6.2±2.4. The length of hospital stay was 2.4 days (1-6). There were four major complications recorded during hospitalization. A patient (78 years, male) experienced severe bradycardia that stabilized with a pacemaker placement, atrial fibrillation (72 years, male) was recorded in another patient which resolved with time on anticoagulant therapy. Two patients suffered from cognitive deterioration. Delirium was recorded in an 88 years old female patient that resolved with 12 hours, and mild dementia exacerbated in a 72 years old man that resolved before discharge. The study demonstrated the safety of SA in patients older than 84 years and for surgeries lasting up to 3.5 hours.

Finsterwald et al. compared SA with GA in high-risk patients with respect to perioperative hemodynamic stability and cost-effectiveness.[11] The patients in the SA group were older (75 years vs. 69 years) with a higher ASA score (3 vs. 2). It was found that SA was associated better perioperative hemodynamic stability with less need for the use of intraoperative vasopressors and lower hypotension episodes compared to GA. The duration of the surgery, blood transfusion, PONV, pain scores, and costs were lower in the SA group whereas major complication rates were similar.

It is well established that SA reduces blood loss during spinal surgery due to the sympathetic blockade that results in vasodilatation and decrease in ABP.[7,10] Together with the spontaneous ventilation, intrathoracic pressure is reduced and epidural veins are less distended which is the main source of the blood loss of spinal surgery.[7,10,11] Therefore, induced hypotension is less required in patients who underwent SA compared to the GA.

In the current study, postoperative pain scores and analgesic requirements were reduced in patients who received SA compared to GA. Especially; the analgesic effect of SA might be evident in the early postoperative period until the spontaneous recovery of the sensory blockade. Again, preemptive analgesic effect by preventing afferent nociceptive sensitization and residual sensory blockade after the surgery may contribute to the better postoperative pain relief achieved with SA.[5,7]

Atelectasis and delirium were two main complications that caused a delay in the hospital discharge in this study. Respiratory complications are frequent after spine surgery and cause prolonged hospitalization, morbidity, and mortality.[12] Studies reported that atelectasis represents the most common complication with an incidence up to 50% followed by infiltrate, lobar collapse, and pneumonia.[12,13] Chronic obstructive pulmonary disease, diabetes mellitus, smoking, and multilevel fusion are considered to be major risk factors. Decreased functional residual capacity, forced vital capacity

related to the older age and prone positioning lead to atelectasis which is also promoted by GA.[12-14] Also, the increased use of opioids after the surgery under GA might contribute to the respiratory compromise.

In this study, delirium developed in 4% patients which was found higher in the GA group. However, the incidence of delirium has been reported in the literature as high as 24.3% after spine surgery in elderly patients.[15] The cause of this difference might be the lack of recording or misdiagnosis. In particular to old age; preoperative cognitive impairment, poor nutritional status, low physical status, long duration of the surgery, high blood loss, postoperative pain, and opioid use are identified as risk factors for postoperative delirium. If postoperative delirium occurs, the length of hospital stay is prolonged, and morbidity and mortality are also increased.[16]

Studies reported conflicting results to conclude whether GA or regional anaesthesia (RA) is more associated with postoperative delirium.[17,18] A systematic review revealed that GA may increase the risk of developing postoperative cognitive dysfunction, but not postoperative delirium.[19] The higher rate of delirium in patients receiving GA in the current study might be caused by the other risk factors such as higher blood loss, pain scores, and opioid use.

There are two major problems concerning the use of SA in lumbar surgery. First, the surgery may last longer than the duration of the sensory or motor block provided by SA. In that case, it is suggested that the surgeon can apply an additional dose of local anesthetic through the surgical field intrathecally.[8] However, this has not been required in the current study. In 2 case reports, adequate anesthesia was achieved in 2 elderly patients who underwent 5- and 3 -level lumbar spine fusion with SA which lasted 3 hours and 24 minutes and 3 hours and 44 minutes.[20,21] Second, ineffective sedation may lead anxiety, hemodynamic disturbance, or delirium during the surgery whereas over sedation may result in loss of spontaneous ventilation which is a catastrophic situation in prone position.[22] Therefore, it is essential to monitor the patient closely, to titrate sedatives with lower doses to maintain minimal (anxiolysis) or moderate (conscious) sedation, and keep contact with patients. In our daily practice, we use 1-3 mg of midazolam with or without ketamine (5 to 10 mg). In the cases of disinhibition, agitation, and over sedation, flumazenil is used to reverse agitation caused by midazolam. Dexmedetomidine is also reported as an effective sedative agent for minimally invasive spine surgery in prone position and it was advocated that its hypotension and bradycardic effects can be prevented by ketamine.[23]

The results revealed that SA was performed in patients with higher age and co-morbidity rate compared to the patients who received GA. This may be attributable to the fact that the patients with higher risk factors have preferred SA or were directed to decide on SA. As the patients age, the safety concerns increase due to possible complications, and SA becomes more acceptable among the elderly population who underwent orthopedic procedures.[24] However, the rate of GA preference continues to be higher than RA.[25] A decision on an anesthetic technique by the patient is generally influenced by the knowledge, previous experiences, safety concerns, and personal fears. Anxiety for being awake during surgery, pain during the SA and surgical procedure, and fear for permanent paralysis are the most common reasons to refuse SA.[26]

We think that counseling about the anesthetic techniques in the preanesthetic visits together with a sufficient sedation in the intraoperative period may increase patient satisfaction in regional procedures.

This study has several limitations. First, the retrospective design may cause selection and recall biases that would be avoided with a prospective randomized study. It is difficult to control exposure or outcome assessment, so it should be relied on the researcher for accurate recording. Therefore, we used only the data which are routinely recorded in patient files or in electronic database. The files with missing data are excluded from the study. Additionally, the inclusion and exclusion criteria were same for both groups. Second, the sample size of the study might be limited, because retrospective studies may need large sample size for rare outcomes. Third, some

additional information such as total tramadol consumption or bolus button usage via PCA may provide valuable outcomes regarding postoperative pain management. In addition, the tramadol dose in PCA (infusion dose: 4 mgh^{-1}, bolus dose 4 mg) was lower than that is used in our routine practice (infusion dose: 8 mgh^{-1}, bolus dose 10 mg) to prevent respiratory complications and PONV in this aged patient group. Also, recordings about patient satisfaction could provide information about patient's perception for anesthetic techniques.

CONCLUSION

It was concluded that SA is a valid alternative for GA with respect to perioperative outcomes in elderly patients who underwent lumbar instrumentation due to better maintenance of hemodynamic stability, reduced blood loss, better postoperative pain relief, lower complication rate, lower ICU admission, and shorter hospital discharge time. In our opinion, the anesthesiologists should more involve in decision-making process of complicated procedures in old and high-risk population to prevent complications.

Source of Finance

During this study, no financial or spiritual support was received neither from any pharmaceutical company that has a direct connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Mehmet Anıl Süzer, Mehmet Özgür Özhan;* ***Design:*** *Mehmet Anıl Süzer, Mehmet Özgür Özhan, Umut Kara;* ***Control/Supervision:*** *Mehmet Özgür Özhan, Ceyda Çaparlar;* ***Data Collection and/or Processing:*** *Ceyda Çaparlar, Hasan Kamburoğlu;* ***Analysis and/or Interpretation:*** *Mehmet Özgür Özhan, Umut Kara;* ***Literature Review:*** *Mehmet Burak Eşkin;* ***Writing the Article:*** *Mehmet Anıl Süzer, Mehmet Özgür Özhan, Umut Kara;* ***Critical Review:*** *Mehmet Anıl Süzer, Hasan Kamburoğlu;* ***References and Fundings:*** *Mehmet Burak Eşkin, Umut Kara;* ***Materials:*** *Mehmet Özgür Özhan, Ceyda Çaparlar.*

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