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Original Article

Regional versus general anesthesia in patients underwent hip fracture surgery over 80 years old: A retrospective cohort study

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Abstract

Aim: To determine the optimum anesthetic technique, namely general or regional anesthesia, for elderly patients over 80 years old with hip fracture surgery with respect to demographic characteristics, hemodynamics, length of hospital stay, and mortality.

Material and Methods: Patients with the American Society of Anesthesiology (ASA) scores of II–IV aged over 80 years old were included in our study. The patients were retrospectively allocated to two cohort study groups: regional anesthesia (Group GA, n=41) and general anesthesia (Group RA, n=19). The demographic characteristics, hemodynamics, length of hospital stay, and mortality were recorded.

Results: The two groups were similar with respect to age, sex, height, weight, body mass index, ideal body weight, ASA scores, and smoking. The number of patients using drugs in Group RA was significantly more than Group GA. The need for invasive arterial monitorization, central venous catheter, and nasogastric tube in Group RA were significantly less. The duration of anesthesia and surgery in Group RA were significantly shorter than Group GA. The length of ICU and hospital stays in Group RA were significantly shorter than Group GA. Hospital mortality of Group GA was significantly higher than that in Group RA.

Conclusion: The present retrospective cohort study showed that perioperative complications, duration of anesthesia and surgery, admission to the postoperative ICU, length of ICU and hospital stay, and also mortality in regional anesthesia were significantly lower in comparison with general anesthesia. We therefore conclude that regional anesthesia can be used safely with patients during hip fracture surgery.

Keywords: General Anesthesia; Regional Anesthesia; Elderly Patients; Hip Fracture Surgery; Length Of Hospital Stay; Mortality.

INTRODUCTION

Along with aging, functional and anatomical changes occur in the cellular, tissue, and organ structures (1). Specifically decrease in bone density with aging results in increase at fracture risk. Hip fracture is an extremely common orthopedic condition and increasing in incidence with more than 1.6 million occurring each year worldwide (2). Hip fractures are skeletal injuries mostly seen in an elderly population with an average age of around 80 years (3). The majority of the hip fractures are performed with surgical procedure under anesthesia; thus hip fracture surgery represents one of the most common emergency orthopaedic procedures (4).

In elderly patients treated for hip fracture, a mean life time becomes shorter when compared with the same age group (5). Most of these patients survive for at least one year. Surgical treatment may be either fixation of the fracture or replacement of the femoral head with an arthroplasty. However, in spite of technological improvements on medical instruments, surgical and anesthetic techniques, hip fractures are still associated with high morbidity and mortality (6).

A variety of intravenous and/or inhalation drugs are used in general anaesthesia. The patients under general anesthesia require mechanical ventilation. Adverse reactions to the drugs, possible difficult airway management, perioperative hemodynamic instability spesifically including bradycardia and hypotension, aspiration, postoperative nausea and vomiting, and respiratory depression are potential complications during general anesthesia.

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Regional anaesthesia, epidural or spinal anaesthesia, is the most commonly used method for hip fracture surgery. The main complication of regional anesthesia is associated with intraoperative hypotension, which may lead to cerebrovascular or myocardial ischaemia or infarction (7).

Other forms of anesthesia used for hip fracture surgery are the insertion of local nerve blocks around the hip spesifically including a sacral plexus block (8,9).

There is no concensus on the best anesthetic technique for hip fracture surgery. The choice of anesthesia is frequently selected by the personal preference of the anesthesiologist after assessment of the patient's medical status. In this retrospective cohort study, we aimed to determine the optimum anesthetic technique, namely general or regional anesthesia, for high-risk elderly patients over 80 years old with hip fracture surgery with respect to demographic characteristics, hemodynamics, length of hospital stay, and mortality.

MATERIAL and METHODS

Our study protocol was approved by the local ethics committee of Inonu University. We conducted a retrospective cohort clinical study on 60 patients with over 80 years old who underwent hip fracture surgery from January 2008 to December 2018. This study was prepared in accordance with the Consolidated Standards of Reporting Trials guidelines (10).

Patients with the American Society of Anesthesiology (ASA) scores of II–IV aged over 80 years old were included in our study. Patients were excluded if they had incomplete or missing anesthesia records, uncontrolled diabetes mellitus, pulmonary disease, or cerebrovascular disease, or refused to give informed consent.

The patients were taken to the operating room. Premedication of midazolam in appropriate doses was performed when needed. Standard monitoring procedures including heart rate (HR), noninvasive blood pressure, electrocardiogram, peripheral oxygen saturation (SpO_2), and body temperature were used. Preoperative blood preparation was conducted for each patient before the procedure.

Sixty patients were retrospectively allocated to two cohort study groups: hip fractures under regional anesthesia including spinal anesthesia (Group RA, n=41) and hip fractures under general anesthesia (Group GA, n=19). In Group RA, spinal anesthesia was performed with a 20-G or 22-G needle, and 5–15 mg of 5% bupivacaine was injected to the subarachnoid space for the spinal block. The spinal anesthesia procedure was conducted by an experienced anesthetist according to the standard spinal anesthetic technique. Midazolam (0.03–0.2 mg/kg) and/or fentanyl (0.01–0.05 mcg/kg) were administered as necessary. The anesthesiologist was responsible for the patients' comfort, hemodynamic stability, immobility, adequate analgesia, and airway management. For the patients in Group GA, a standardized GA protocol was administered by an experienced anesthesiologist. After preoxygenation (100% 4 L/min O2 for 3 min), the patients were induced with propofol (0.5–2 mg/kg), rocuronium (0.4–0.6 mg/kg), and fentanyl (0.1 µg/kg) through the intravenous route at appropriate doses. The patients were intubated and ventilated mechanically with a tidal volume of 8 mL/kg and a frequency of 8–12 breaths/min using a Dräger Primus ventilator (Dräger AG, Lübeck, Germany). End-tidal carbon dioxide ($EtCO_2$) was continuously monitored after intubation. The tidal volume and ventilation rate were adjusted to maintain the $EtCO_2$ partial pressure of arterial blood at 35–45 mmHg. Anesthesia was maintained at desflurane or sevoflurane inhalation in a 0.5 O_2 oxygen–air mixture. Rocuronium or atracurium was intermittently injected as necessary. In patients who did not experience complications during the surgery, sugammadex (IV, 2–4 mg/kg, Bridion, MSD, Greenville, USA) was administrated to reverse the residual muscle relaxation at the end of surgery. Then, they were extubated in the operating room before being taken to the intensive care unit (ICU). Postoperative analgesia was administered to all patients using appropriate doses of tramadol (0.5–1 mg/kg, IV) and paracetamol (1 gr, IV) at the time skin sutures were performed.

The duration of anesthesia was defined as the time from the patient is taken to the operating room until transfer to the post-anesthesia care unit or ICU. The duration of the procedure was defined as the time from the first incision until the closure of the last skin suture. The length of hospital stay and the mortality rate were obtained from the University Patient Database. The duration of ICU was defined as the time from the post-anesthesia care unit until discharge. Hospital mortality was defined as death from admission to the hospital.

We evaluated the demographic characteristics, procedure data, and hospital records of the 60 patients who had undergone hip fracture surgery. Medication, concomitant diseases, and laboratory parameters were obtained from the University Patient Database. ICU records were also analyzed. Heart rate, mean arterial pressure, peripheral oxygen saturation, and end-tidal carbon dioxide were recorded at clinically important time points (T0: before anesthesia, T1: 5 min after intubation, T2: perioperative 30th minute, and T3: end of procedure). In addition to the duration of anesthesia and surgery, perioperative and postoperative complications were recorded.

All statistical analyses were conducted using the Statistical Package for the Social Sciences program (SPSS 22.0, Chicago, USA). Quantitative data were presented as the mean or standard deviation, and categorical data were shown as numbers or percentages. The differences between groups were evaluated by chi-square testing for discrete variables and Student's t-test for continuous variables. P value<0.05 was considered statistically significant.

RESULTS

The mean age of the 60 patients was 88.55±6.57 years old. The two groups were similar with respect to age, sex, height, weight, body mass index, ideal body weight, ASA physical status, smoking, and values of hemoglobin and hematocrit (p>0.05). The mean age in Group RA and Group GA was 88.68±7.03 and 88.26±5.62 years old, respectively. The number and percentages of smokers in Group RA and Group GA were 8 (%58) and 2 (%10), respectively. The number of patients using drugs (antihypertensive, anticoagulant, etc.) in Group RA was significantly more than that in Group GA (p=0.05). Concomitant diseases were similar in the two groups (p>0.05). Hypertension, diabetes mellitus and coronary artery disease were registered within the two groups.

The demographic characteristics are presented in Table 1.

Table 1. Demographic Characteristics

		GroupRA(n=41)		Group GA(n=19)		
	Range	Mean ±std	Range	Mean ±std	p value
Age, years	80 – 107	88.68 ± 7.03	80 – 100	88.26 ± 5.62	0.820
Sex, male/female	-	12/29	-	7/12	0.557
Height, cm	160 – 172	166.70 ± 2.71	162 – 170	166.94 ± 2.41	0.743
Weight, kg	55 – 90	72.92 ± 9.59	50 – 95	74.42 ± 12.27	0.610
BMI, (kg/m^2)	21 – 30	24.95 ± 2.85	23 – 29	26.44 ± 1.91	0.830
IBW, kg	53 – 65	59.85 ± 3.00	54 – 62	58.73 ± 2.28	0.156
ASA, I/II/III/IV, n	-	1/22/18/0	-	0/9/10/0	0.679
Use of drug, n (%)	-	24 (%58)	-	16 (%84)	0.050
Smoking, n (%)	-	8 (%19)	-	2 (%10)	0.385
Hemoglobin, mg/dl	8.50 – 16.40	11.87 ± 1.70	6.80 – 15.20	11.40 ± 2.12	0.354
Hematocrit, %	24.60 – 44.80	35.59 ± 4.70	20.40 – 46.20	34.33 ± 6.18	0.387
Comorbidity, n					0.574
Hypertension	-	26	-	15	
Diabetes Mellitus	-	10	-	8	
Coronary Artery Disease	-	7	-	5	
Cerebrovascular Disease	-	5	-	1	
Chronic Obstructive Pulmonary Disease	-	3	-	0	
Asthma	-	3	-	0	
Epilepsy	-	1	-	0	
Congestive Heart Failure	-	1	-	0	

ASA; American Society of Anesthesiology, BMI; Body Mass Index, GA: General Anesthesia, RA: Regional Anesthesia, n: number of cases

Thirty-nine cases of Group RA and fifteen cases of Group GA were treated for proximal femur fracture. There was no significant difference between groups in terms of diagnosis (p=0.125). Only two cases in Group RA were performed as emergency surgery procedures and rest of the all cases in two groups were elective surgery (p=0.327). All patients in Group RA had single-shot spinal anesthesia with bupivacaine, and without any complications. The need for invasive arterial monitorization, central venous catheter, and nasogastric tube in Group RA were significantly less than that in Group GA (p=0.002, p=0.005 and p=0.001, respectively). Nearly all paitents in the two groups had urinary catheterization. Perioperative crystalloid consumption of Group GA was significantly more than that in Group RA (p=0.002). There was no significant difference between groups in terms of perioperative colloid consumption (p=0.082).

The duration of anesthesia in Group RA (101.46±30.62 min) was significantly shorter than that in Group GA (161.57±47.40 min) (p=0.001). Similarly, the duration of procedure in Group RA (90.61±29.73 min) was significantly shorter than that in Group GA (129.21±44.94 min) (p=0.001) (Figure 1).

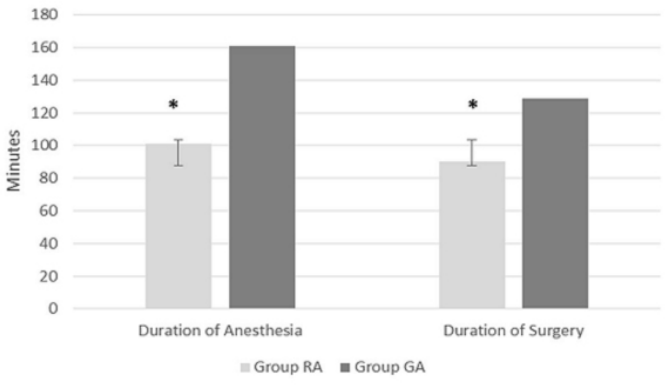

Figure 1. Duration of Anesthesia and Surgery
GA: General Anesthesia, RA: Regional Anesthesia, *p<0.05, compared with each other

Percentages of the patients admitted to postoperative ICU in Group GA (12 patients, 63%) were significantly more than that in Group RA (12 patients, 29%) (p=0.013). The length of ICU stay in Group RA (0.56±0.94 day) was significantly shorter than that in Group GA (1.73±1.55 days) (p=0.001). The length of hospital stay in Group RA (5.70±1.40 days) was significantly shorter than that in Group GA (8.15±1.74 days) (p=0.001).

Hospital mortality of Group GA (5 patients, 26.3%) was significantly higher than that in Group RA (2 patients, 4.9%) (p=0.016) (Figure 2). The procedure data is presented in Table 2.

The heart rate, mean arterial pressure, and peripheral oxygen saturation were similar in two groups, and there was no significant differences between both groups (p > 0.05).

The heart rates, mean arterial pressures, and peripheral oxygen saturation values are presented in Table 3, 4 and 5, respectively.

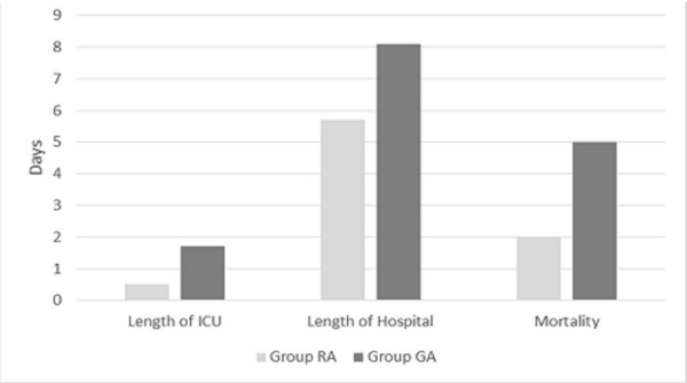

Figure 2. Length of ICU, Hospital and Mortality Legends of Figures
GA: General Anesthesia, RA: Regional Anesthesia

Table 2. Procedure Data

	GroupRA (n=41)		Group GA (n=19)		
	Range	Mean ±std	Range	Mean ±std	p value
Diagnosis, n					
Femur Neck Fracture	-	39	-	15	
Femur Shaft Fracture	-	1	-	1	
Acetabulum Fracture	-	1	-	3	
Emergency / Elective surgery, n	-	2/39	-	0/19	0.327
Invasive Arterial Monitorization, n	-	6	-	10	0.002*
Central Venous Catheter, n	-	2	-	6	0.005*
Nasogastric tube, n	-	3	-	10	0.001*
Urinary catheter, n	-	41	-	18	0.139
Total crystalloid, ml	800 – 3000	1153 ± 412	1000 – 3000	1631 ± 703	0.002*
Total colloid, ml	0 – 500	304 ± 246	0 – 1500	447 ± 368	0.082
Perioperative Hypotension, n (%)	-	8 (19.5%)	-	11 (57.9%)	0.003*
Operative Blood Loss, n (%)	-	3 (7.3%)	-	7 (36.8%)	0.004*
Blood Transfusions, n (%)	-	5 (12.7%)	-	5 (26.3%)	0.172
Duration of anesthesia, min	55 – 190	101.46 ± 30.62	95 – 280	161.57 ± 47.40	0.001*
Duration of surgery, min	45 – 180	90.61 ± 29.73	60 – 240	129.21 ± 44.94	0.001*
Admission to Postoperative ICU, %	-	12 (29%)	-	12 (63%)	0.013*
Length of ICU stay, day	0 – 3	0.56 ± 0.94	0 – 4	1.73 ± 1.55	0.001*
Length of hospital stay, day	4 – 9	5.70 ± 1.40	4 – 12	8.15 ± 1.74	0.001*
Mortality, n %	-	2 (4.9%)	-	5 (26.3%)	0.016*

GA: General Anesthesia, RA: Regional Anesthesia, ICU: Intensive Care Unit, std; Standard Deviation, n: number of cases, *p<0.05, compared with each other

Table 3. Heart Rates

	Heart Rate (/min)(Mean ± std)		
Time	Group RA (n=41)	Group GA (n=19)	p value
T_0	85.80 ± 9.88	83.31 ± 9.24	0.359
T_1	77.63 ± 8.90	78.84 ± 7.72	0.613
T_2	76.87 ± 13.38	77.15 ± 6.93	0.932
T_3	79.78 ± 7.77	73.89 ± 19.06	0.093

T_0; Before Anesthesia, T_1; After Anesthesia, T_2; perioperative 30th minute, T_3; End of procedure, GA: General Anesthesia, RA: Regional Anesthesia

Table 4. Mean Arterial Pressures

Time	Mean Arterial Pressures (mmHg) (Mean ± std) Group RA (n=41)	Group GA (n=19)	p value
T_0	91.04 ± 11.82	94.42 ± 3.99	0.739
T_1	80.87 ± 8.92	96.84 ± 2.67	0.511
T_2	77.61 ± 6.95	97.05 ± 2.73	0.841
T_3	78.26 ± 7.25	96.42 ± 2.91	0.229

T_0; Before Anesthesia, T_1; After Anesthesia, T_2; perioperative 30th minute, T_3; End of procedure, GA: General Anesthesia, RA: Regional Anesthesia

Table 5. Peripheral Oxygen Saturation (SpO_2) values

Time	Peripheral Oxygen Saturation (Mean ± std) Group RA (n=41)	Group GA (n=19)	p value
T_0	93.12 ± 4.77	94.42 ± 3.99	0.307
T_1	95.68 ± 3.28	96.84 ± 2.67	0.185
T_2	95.87 ± 3.16	97.05 ± 2.73	0.169
T_3	95.90 ± 2.80	96.42 ± 2.91	0.512

T_0; Before Anesthesia, T_1; After Anesthesia, T_2; perioperative 30th minute, T_3; End of procedure, GA: General Anesthesia, RA: Regional Anesthesia

DISCUSSION

Hip fractures are skeletal injuries mostly seen in an elderly population with an average age of around 80 years. The majority of the hip fractures are treated surgically under anesthesia; thus hip fracture surgery represents one of the most common orthopaedic procedures. The present study has examined the results from 60 patients who underwent either regional or general anesthesia for hip fracture surgery. This retrospective study showed that complications related to tha anesthesia and surgery, duration of anesthesia and surgery, admission to the postoperative ICU, length of ICU and hospital, and also mortality in regional anesthesia were significantly lower in comparison with general anesthesia. Need for invasive arterial monitorization, central venous catheterization and nasogastric tube was significantly less in regional anesthesia. Total crystalloid consumption perioperative period in general anesthesia was significantly higher than regional anesthesia. On the other hand, total colloid consumption was similar for both groups. Also, there were no significant differences between groups in respect to heart rates, mean arterial pressures and peripheral oxygen saturations.

The most important factors that are related to mortality were having more than two comorbidities, blood transfusion requirement (11). Jin et al reported in restrospective study for elderly patients with hip fractures that the most common comorbidities were cardiovascular disease, diabetes, respiratory disease and stroke (12). Similarly, we observed that the most common preoperative comorbidities in this study were hypertension, diabete mellitus, coronary artery disease and cerebrovascular disease, respectively.

Different anesthetic methods are used for patients over 80 years old for hip fracture surgery. Matsuo et al reported that spinal anesthesia was more frequently performed in the oldest old group with hip fracture (13). Similarly, we found in our study that 68.3% percent of the patients had regional anesthesia.

Matsuo et al indicated that complication rates in elderly patients were significantly higher. (13). Bigler et al reported that patients received blood tranfusions were similar in regional or general anesthesia. In contrast, some studies reported that blood transfusion requirement in regional anesthesia was grerater than general anesthesia (14). Urwin et al reported that regional anesthesia did not reduce the risk of major thromboembolic complications following hip fracture surgery (15). In our study, there was no significant difference between regional and general anesthesia in respect of blood transfusions and complications such as perioperative hypotension and operative blood loss were significantly higher in general anesthesia. On the other hand, we could not evaluate the complications defined thromboembolic as the hospital data did not have sufficient records for the patients who had hip fracture surgery.

The anesthetic tecniques influence the clinical outcomes following hip fracture surgery. Specifically the return to postoperative daily life after anesthesia is important for elderly patients. Therefore, the preference of anesthetic technique is associated with the LOS for orthopedic

surgery such as hip fracture. Most of the studies found that there was no significant difference between regional and general anesthesia in respect to length of hospital stays (LOS) (16). In contrast, Neuman et al reported that regional anesthesia was associated with shorter LOS (17). We observed that the LOS for regional anesthesia (5.70±1.40 days) was significantly shorter than general anesthesia (8.15±1.74 days) (p=0.001). We thought that regional anesthesia made the LOS shortened in respect of postoperative mobilisation of the patients.

Urwin et al reported in meta-analysis of randomized trials that regional anesthesia was associated with a reduced early mortality in comparison with general anesthesia (15). Some studies did not support specific recommendation regarding the type of anesthetic tecnique and there was no significant difference between regional or general anesthesia (18). We observed in our retrospective study for hip fracture surgery that regional anesthesia was associated with a reduced hospital mortality. Hospital mortality of regional anesthesia (4.9%) was significantly lower than general anesthesia (26.3%).

Limitations

Our study has some limitations. This retrospective study was based on a data analysis that reviewed only anesthesia records. Indication bias may be a concern as the anesthesia type is operator dependent. All the patients were from a single center, and the sample size was relatively small. Patient data did not contain important information, such as pre-existing illness, postoperative mental state, use of vasopressor inotropes intraoperatively, and postoperative pain management. Moreover, not all results could be generalizable to other races and countries.

CONCLUSIONS

Having more than two comorbidities, anesthetic agent preferences, hemodynamic stability during the surgery, perioperative complications (specifically hypotension and operative blood loss), requirement of blood transfusion, duration of anesthesia and surgery, length of intensive care unit and hospital stay are a unique model for quantifying the impacts of patient risk factors on outcomes after hip fracture surgery.

The present retrospective cohort study has examined the results from 60 patients over 80 years old who underwent either regional or general anesthesia for hip fracture surgery and showed that perioperative complications, duration of anesthesia and surgery, admission to the postoperative ICU, length of ICU and hospital, and also mortality in regional anesthesia were significantly lower in comparison with general anesthesia. We therefore conclude that regional anesthesia can be used safely with patients during hip fracture surgery.

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REFERENCES

1. Konttinen N, Rosenberg PH. Outcome after anaesthesia and emergency surgery in patients over 100 years old. Acta Anaesthesiol Scand 2006;50:283-9.
2. Cheng SY, Levy AR, Lefaivre KA, et al. Geographic trends in incidence of hip fractures: a comprehensive literature review. Osteoporos Int 2011; 22:2575-86.
3. Melton LJ 3rd. Hip fractures: a worldwide problem today and tomorrow. Bone 1993;14:S1-8.
4. Parker MJ, Handoll HH, Griffiths R. Anaesthesia for hip fracture surgery in adults. Cochrane Database Syst Rev 2004;18: CD000521.
5. Oztürk I, Toker S, Ertürer E, et al. Analysis of risk factors affecting mortality in elderly patients (aged over 65 years) operated on for hip fractures. Acta Orthop Traumatol Turc 2008;42:16-21.
6. Bilsel K, Erdil M, Gulabi D, et al. Factors affecting mortality after hip fracture surgery: a retrospective analysis of 578 patients. Eur J Orthop Surg Traumatol 2013;23:895-900.
7. Modig J, Borg T, Bagge L, et al. Role of extradural and of general anaesthesia in fibrinolysis and coagulation after total hip replacement. British Journal of Anaesthesia 1983;55:625-9.
8. Winnie AP, Ramamurthy S, Durrani Z, et al. Plexus blocks for lower extremity surgery. Anesthesiology Reviews 1974;1:11-6.
9. Mansour NY. Reevaluating the sciatic nerve block: another landmark for consideration. Regional Anesthesia 1993;18:322-3.
10. Schulz KF, Altman DG, Moher D; CONSORT 2010 statement: updated guidelines for reporting parallel group randomised trials. Int J Surg 2011;9:672-7.
11. Ercin E, Bilgili MG, Sari C, et al. Risk factors for mortality in geriatric hip fractures: a compressional study of different surgical procedures in 785 consecutive patients.Eur J Orthop Surg Traumatol 2017;27:101-6.
12. Jin J, Wang G, Gong M, et al. Retrospective comparison of the effects of epidural anesthesia versus peripheral nerve block on postoperative outcomes in elderly Chinese patients with femoral neck fractures.Clin Interv Aging. Aug 2015;10:1223-31.
13. Matsuo M, Yamagami T, Higuchi A. Impact of age on postoperative complication rates among elderly patients with hip fracture: a retrospective matched study. J Anesth 2018;32:452-6.
14. Bigler D, Adelhøj B, Petring OU, et al. Mental function and morbidity after acute hip surgery during spinal and general anaesthesia. Anaesthesia 1985;40:672-6.
15. Urwin SC, Parker MJ, Griffiths R. General versus regional anaesthesia for hip fracture surgery: a meta-analysis of randomized trials. Br J Anaesth 2000;84:450-5.
16. Eger EI 2nd. General versus regional anaesthesia for hip fracture surgery. Br J Anaesth 2000;85:492.
17. Neuman MD, Rosenbaum PR, Ludwig JM, et al. Anesthesia technique, mortality, and length of stay after hip fracture surgery. JAMA 2014;311:2508-17.
18. Brox WT, Chan PH, Cafri G, et al. Similar mortality with general or regional anesthesia in elderly hip fracture patients. Acta Orthop 2016;87:152-7.