Impact of Epidural Versus General Anesthesia on Major Lumbar Surgery in Elderly Patients

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Study Design: This was a retrospective comparative study.

Objective: The main objective of this study was to investigate the effects of epidural anesthesia (EA) versus general anesthesia (GA) in elderly patients undergoing lower lumbar spine fusion surgeries.

Summary of Background Data: Lumbar spine surgery can be performed under GA or regional anesthesia. GA is more commonly used in lumbar spine surgery, which renders the patient motionless throughout the procedure and provides a secure airway. Although EA is associated with superior hemodynamic status, reduced duration of operation, less health care cost, and lower rate of surgical complications when compared with GA. Controversy still exists with regard to the optimum choice of anesthesia for major lumbar spine surgery, especially in elderly patients.

Materials and Methods: From September 2016 to August 2017, consecutive patients aged 70 years or older who underwent lower lumbar fusion surgery with EA or GA were enrolled in the study. Recorded data for all patients included: age, sex, medical conditions; surgical time, operation procedure, blood loss; intraoperative hypertension and tachycardia; occurrence of nausea, vomiting, delirium, or cardiopulmonary complications. Postoperative pain and satisfaction were also assessed.

Results: A total of 89 patients were included. Of these, 42 patients underwent GA and 47 patients underwent EA. The number of patients experiencing hypertension and tachycardia during anesthesia was significantly increased in the GA group when compared with EA. Patients with EA had significantly less delirium, nausea, and vomiting. The average Visual Analog Scale scores were significantly higher in the GA group at 0–8 hours after surgery. Patients underwent EA were more satisfied than patients with GA.

Conclusions: There was an association between those who received EA and superior perioperative outcomes. However, some concerns including airway security, operation duration, and obesity, must be carefully evaluated. In addition, it should be noted that this study was retrospective and selection bias may probably exist which may interfere with the results.

Key Words: epidural anesthesia, general anesthesia, major lumbar surgery, elderly patients, comparison study

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Lumbar spine surgery can be performed under anesthetic modalities, including general anesthesia (GA) or regional anesthesia (RA) (epidural, spinal, or a combination of these). Although GA is more commonly used in lumbar spine surgery, controversy still exists with regard to the optimum choice of anesthesia.[1–3] It has not yet been definitively established whether GA or RA is safer, more efficient, and less costly.[1] Consequently, the choice for GA or RA in spinal surgery differs based on the preferences and biases of the anesthesiologist, surgeon, and patient.

GA renders the patient motionless throughout the procedure and provides a secure airway, although it may lead to haemodynamic instability, greater intraoperative blood loss, and postoperative nausea and vomiting.[1–3] Recent studies have reported that the use of epidural anesthesia (EA) is associated with superior hemodynamic status, reduced duration of operation, less health care cost, and lower rate of surgical complications when compared with GA.[4–8] EA have been shown to be more effective for postoperative recovery with lesser side effects.[9] Moreover, studies have reported that EA in lumbar surgery may be more reliable than GA as it allows the surgeon to communicate with the patient during surgery.[6,8] Although the impact of GA versus EA on perioperative outcomes in lumbar spine surgery has been previously investigated, the results lack consistency.[6,8,10,11]

Specifically, elderly patients are at increased anesthetic risk due to their multiple health problems and lack of physiological reserve.[6,10,11] It has been shown that RA may reduce the incidence of postoperative delirium in the aging population compared with GA.[5] Recent studies have included patients 70 years or older, however, the

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impact of GA or EA on lower lumbar surgery in the elderly patients remains unclear.[6,10,11] The purpose of this retrospective study was to investigate the effects of GA versus EA in elderly patients undergoing lower lumbar spine fusion surgeries.

MATERIALS AND METHODS

Before initiating this study approval was obtained by the Institutional ethics committee of the First Affiliated Hospital of Sun Yat-sen University. All patients were treated consecutively between September 2016 and August 2017 by the same surgeon (H.L.). All the patients have met the following criteria: 70 years or older with degenerative lower lumbar diseases (including lumbar disc herniation, lumbar spinal stenosis, and lumbar spondylolisthesis); undergoing one-level posterior lumbar interbody fusion surgery at L4–L5 or L5–S1; under GA or EA; no previous history of spinal surgery. Patients were excluded from the study if they had evidence of coagulopathy, infection at the surgical site, a rheumatologic or demyelinated disease, a history of active illicit drug abuse, spine tumor, infection, or fracture. In the period of our study, there were 2 patients failed to EA due to obesity, who were not included in our study.

As per clinical policy, each patient was evaluated for both EA and GA. The final decision between the 2 was based on a combination of physical status, anatomic considerations, and ultimately a consensus decision between the patient, surgeon, and anesthesiologist.

Anesthesia Procedure

All patients were given 0.5 mg of atropine intramuscularly 30 minutes before the operation as a premedication. In addition, antibiotic prophylaxis was given using 2 g of cefazolin before skin incision.

Before induction in the GA group, 4–6 L/min oxygen (O_2) was given through a mask for preoxygenation. Induction was then conducted using 0.2–0.3 μg/kg sufentanil, 2–2.5 mg/kg propofol, and 0.2 mg/kg cisatracurium intravenously. After induction and oxygenation, intubation was performed with an endotracheal tube with a cuff. To maintain anesthesia, 0.15–0.2 μg/kg/min remifentanil, 1.5–2% sevoflurane, and 2 L/min fresh gas flow (50% O_2/50% air mix) were administered. After extubation, the patients were transferred to the postanesthesia care unit where an anesthetist and a nurse unaware of the study protocol observed the patients. Then the patient was sent to the ward after confirmation by an experienced anesthetist.

EA was administered in the operating room with the patient in a lateral position. Needle puncture and catheterization of the epidural space was performed 2–3 segments above the expected site of surgery. After local anesthesia with subcutaneous 1% lidocaine, an 18-G Tuohy needle was inserted into the epidural space. A 27-G Whitacre spinal needle was passed through the epidural needle into the subarachnoid space. Then, a 3 mL test dose of 1% lidocaine was administered through the catheter. Five minutes after the test dose, if there were no clinical signs of subarachnoid injection as evidenced by the ability of the patients to move their legs and the absence of hypotension, an epidural catheter was advanced 3 cm in the cranial direction into the epidural space. An additional 10 to 15 mL 0.5% isobaric ropivacaine and 5 μg sufentanil were injected. After 5–10 minutes in the recovery room in the postoperative period, they were moved to the ward.

Intraoperative hypertension was defined as a 25% increase from baseline for systolic arterial pressure and tachycardia was defined as a 25% increase from baseline for heart rate (HR). In both group, postoperative analgesia was performed with a nonsteroidal anti-inflammatory drug 3–5 days after surgery routinely. If the initial medications did not provide adequate analgesia, supplemental analgesic agents (Tramadol 100 mg intramuscularly) were administered at the patient's request.

Surgical Indication and Procedure

The approaches of lumbar fusions in our study included posterior lumbar interbody fusion and transforaminal lumbar interbody fusion. The indications of fusion procedures included: (1) symptomatic disc herniation or lumbar stenosis combined with segmental instability or spondylolisthesis; (2) extremely lateral disc herniation or foraminal stenosis requiring a facetectomy which may lead to iatrogenic instability; (3) symptomatic lumbar spondylolisthesis.

All the patients were operated in prone position. A one-level combined decompression and fusion procedure was performed posteriorly by a same surgeon (H.L.). Decompression consisted of total laminectomy, unilateral or bilateral semilaminectomy followed by discectomy, based on the stenotic pathology. All fusions received supplemental instrumentation using titanium 5.5-mm rods and bilateral pedicle screws. A posterior interbody fusion was performed for all patients after decompression using an interbody cage. The surgical implants were chosen from different companies based on the operative strategies and surgeon's preference (companies including Stryker Spine, MI and DePuy Synthes Spine, MA).

Postoperative Treatment

All the patients were monitored by the electrocardiographic monitoring system 6–8 hours after surgery. The drain was removed when the drainage was <50 mL (typically 2–3 d postoperatively). Patients were encouraged to do functional exercise of their legs during stay in bed. The patients were allowed for ground activity with custom-made brace 3–5 days after surgery.

Clinical Assessment

For all patients, the age, sex, height, weight, and American society of anesthesiologists physical status (ASA) were recorded. The HR, mean arterial blood pressure (MABP), oxygen saturation, and depth of anesthesia were monitored throughout the surgery. Blood loss was measured in routine manner by calculating the volume of blood suctioned from the surgical field and blood collected by sponges. Duration in the operation room, duration of the surgery, and time in hospital were documented.

A Visual Analog Scale (VAS) (0–10: 0 = no pain, 10 = the worst pain possible) was used to assess pain. VAS score was recorded at 0, 2, 4, 8, 24, 36, and 48 hours after

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surgery. If the initial medications did not provide adequate analgesic effect, supplemental analgesic agents (tramadol 100 mg intramuscularly) were administered at the patient's request. Each patient was also asked to provide a rating of his or her satisfaction with the postoperative pain management on the third day after surgery as follows: 4 = very satisfied, 3 = satisfied, 2 = neutral, 1 = dissatisfied, and 0 = very dissatisfied. Nausea was assessed by having patients respond yes or no when asked whether they were nauseous. Patients were considered to have postoperative nausea if they responded yes at least once during patients' hospital stay. Any complications such as nausea, vomiting, pneumonia, and delirium occurring in hospital were also recorded.

Statistical Analyses

Statistical analyses were performed using IBM SPSS 22.0 (SPSS Inc., Chicago, IL). All parametric values were presented as mean ± SD, or percentage as appropriate. Pairwise comparisons were analyzed using an analysis of variance (ANOVA) with a Tukey post hoc test. Kruskall-Wallis analysis was used to determine differences in the frequencies of nonparametric variables. The number needed to treat and number needed to harm were further calculated to better illustrate the results. $P < 0.05$ was considered statistically significant.

RESULTS

Patient Characteristics

Between September 2016 and August 2017, a total of 89 patients (aged 70–88 y) were included. Of these, 42 patients (47.2%) underwent GA and 47 patients (52.8%) underwent EA. Thirty-seven patients (41.6%) underwent unilateral semilaminectomy, 32 patients (36.0%) underwent bilateral semilaminectomy, and 20 patients (22.5%) underwent total laminectomy procedures. Demographic characteristics are summarized in Table 1. No statistically significant difference was detected between the 2 groups. No case required conversion to GA.

TABLE 1. Demographic Data

Variables	Group GA (N = 42)	Group EA (N = 47)
Sex (male/female)	20/22	23/24
Age (y)*	77.4 ± 4.7 (70–88)	76.2 ± 4.3 (70–84)
Weight (kg)*	57.7 ± 4.3 (42–86)	58.8 ± 4.8 (40–84)
Height (cm)*	163.2 ± 7.6 (148–179)	164.6 ± 7.5 (153–178)
ASA*	2.2 ± 0.3	2.3 ± 0.5
Medical conditions present†		
Cardiac disease	14 (33.3)	16 (34.0)
Respiratory disease	6 (14.3)	6 (12.8)
Diabetes	9 (21.4)	11 (23.4)
Operation†		
Unilateral semilaminectomy	18 (42.9)	19 (40.4)
Bilateral semilaminectomy	15 (35.7)	17 (36.2)
Total laminectomy	9 (21.4)	11 (23.4)

*Values are represented as mean ± SD (range).
†Values are represented as number (percentage).
ASA indicates American Society of Anesthesiologists physical status; EA, epidural anesthesia; GA, general anesthesia.

Intraoperative and Postoperative Outcomes

Intraoperative and postoperative characteristics are detailed in Table 2. The average duration in operation room was 214.5 minutes (185–246 min) for group GA and 158.3 minutes (130–172 min) for group EA ($P < 0.05$). However, no significant difference was detected between the 2 groups when comparing duration of surgery, hospital stay, or blood loss. No intraoperative cerebrospinal fluid leakage had occurred in all cases. The mean intraoperative HR and MABP was significantly higher in the GA group as compared with the EA group at the time point between 10 and 60 minutes ($P < 0.05$, Figs. 1A, B). The number of patients experiencing hypertension and tachycardia during anesthesia had significantly increased in the GA group when compared with EA group ($P < 0.05$).

During the postoperative period, nausea and vomiting were more frequent in group GA (n = 24, 57.1%) compared with those who underwent EA (n = 7, 14.9%) ($P < 0.05$). In addition, the incidence of delirium was significantly higher in the GA group (n = 4, 9.5%) compared with EA (0) ($P < 0.05$). In group GA, 3 patients displayed transient postoperative delirium lasting no longer than

TABLE 2. Intraoperative and Postoperative Characteristics

Variables	Group GA (N = 42)	Group EA (N = 47)	NNT/NNH
Duration of surgery (min)*	118.6 ± 6.7 (102–132)	116.2 ± 6.5 (98–128)	—
Duration in OR (min)*	214.5 ± 10.3 (185–246)	158.3 ± 9.3 (130–172)†	—
Total hospital stay (d)*	15.8 ± 4.8 (10–20)	14.3 ± 3.5 (10–19)	—
EBL (mL)*	198.4 ± 40.3 (120–450)	186.4 ± 42.8 (100–460)	—
Intraoperative hypertension‡	8 (19.0)	2 (4.3)†	6.8
Intraoperative tachycardia‡	9 (21.4)	2 (4.3)†	5.8
Intraoperative CSF leakage	0	0	—
Postoperative complications‡	28 (66.7)	10 (21.3)	2.2
Postoperative nausea and vomiting	24 (57.1)	7 (14.9)†	2.4
Pneumonia	3 (7.1)	3 (6.4)	142.9
Pulmonary embolism	0	0	—
Deep vein thrombosis	0	1 (2.1)	47.6§
Delirium	4 (9.5)	0†	10.5
Urine retention	4 (14.3)	1 (2.1)	8.2
Cardiac-cerebrovascular accident	2 (4.8)	0	20.9
Wound infection	2 (4.8)	1 (2.1)	37.0
Neurological injury/complication	0	0	—
Mortality in hospital	0	0	—
Satisfaction with pain management*	1.8 ± 0.2	3.2 ± 0.3†	—

*Values are represented as mean ± SD (range).
†$P < 0.05$ compared with group GA.
‡Values are represented as number (percentage).
§Indicates NNH, otherwise indicates NNT.
CSF indicates cerebrospinal fluid; EA, epidural anesthesia; EBL, estimated blood loss; GA, general anesthesia; NNH, number needed to harm; NNT, number needed to treat; OR, operation room.

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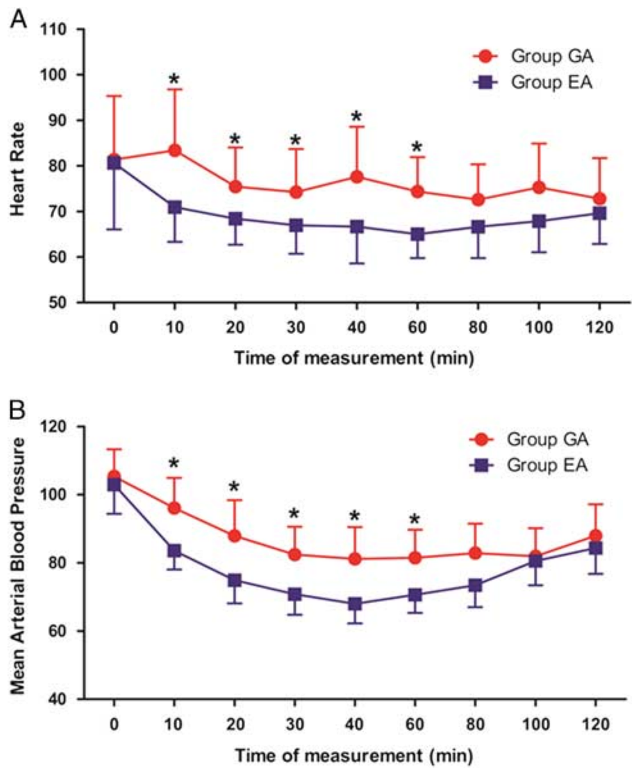

FIGURE 1. The mean intraoperative heart rate (A) and mean arterial blood pressure (B) was significantly higher in the GA group as compared with the EA group at the time point between 10 and 60 minutes. EA indicates epidural anesthesia; GA, general anesthesia. *$P<0.05$. full color online

24 hours; 1 patient displayed delirium lasting for 48 hours. However, there was no significant difference when compared with other complications including pneumonia, urine retention, or wound infection. No neurological complications were observed in the either groups. Mortality had not occurred during hospital stay.

Postoperative Pain Status

Postoperative pain levels are shown in Table 3 and Figure 2. The average VAS scores were significantly higher in the GA group as compared with the EA group at

TABLE 3. Comparison of Average Visual Analog Pain Scores at Postoperative Time Points

Postoperative Pain Intensity During 48 h (h)*	Group GA (N = 42)	Group EA (N = 47)
0	4.4 ± 1.1	0.8 ± 0.7†
2	3.9 ± 1.3	1.0 ± 0.8†
4	3.5 ± 0.8	0.9 ± 0.7†
8	3.1 ± 1.0	1.8 ± 0.8†
24	2.3 ± 1.0	1.6 ± 0.7
36	1.5 ± 0.8	1.1 ± 0.9
48	1.5 ± 1.0	1.6 ± 0.9

*Values are represented as mean ± SD.
†$P<0.05$ compared with group GA.
EA indicates epidural anesthesia; GA, general anesthesia.

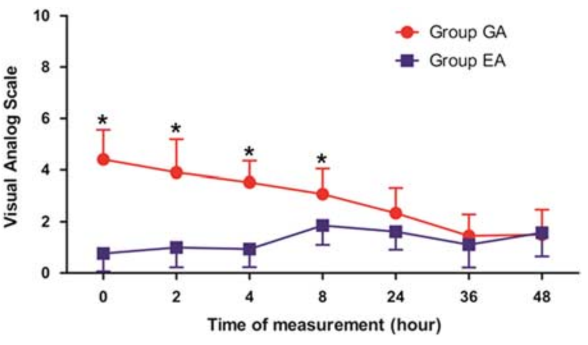

FIGURE 2. The average Visual Analog Scale scores were significantly higher in the GA group as compared with the EA group at the time point between 0 and 8 hours after surgery. EA indicates epidural anesthesia; GA, general anesthesia. *$P<0.05$. full color online

the time point between 0 and 8 hours after surgery ($P<0.05$). Patients in group EA were significantly more satisfied with their postoperative pain management than patients in group GA ($P<0.05$).

DISCUSSION

The results of this retrospective study found that EA provided lower HR and MABP, less delirium, nausea and vomiting, better pain control, and patients' satisfaction than GA in elderly patients undergoing lower lumbar spine fusion surgeries. This is the first study to evaluate EA versus GA for major lumbar surgery in an exclusively geriatric population from South China.

GA is the most commonly used technique for spine surgery, because of greater patient acceptance and the ability to perform operations of long duration in the prone position with a secured airway.[1–3] However, growing evidence has emerged supporting the use of RA (epidural, spinal, or a combination of these) over GA in patients undergoing lumbar spine operations.[7,8,11–14] A recent study including 700 patients showed that EA seems more advantageous for lumbar surgery since it does not have some intraoperative and postoperative risks that GA bears.[11] Although literatures of LDS with EA have shown feasibility and advantages over GA, these studies focused mainly on simple, relatively short lumbar spine operations (including lumbar microdiscectomy or decompression), and they did not evaluate the effect of EA in the exclusively elderly patients. On the basis of the perioperative outcome of this study, we for the first time documented that EA was superior than GA in major lumbar spine surgeries (fusion surgeries) in patients older than 70 years of age.

Previous studies have stated that MABP and HR values with EA were stable without hypertensive and tachycardia attacks in contrast to GA.[1,13,15] Mergeay et al[13] found that EA was superior to GA in causing fewer episodes of hypertension and tachycardia. In accordance with previous studies, our data suggested that intraoperative MABP and HR values were more stable with lower occurrence of hypertensive and tachycardia for the elderly

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patients who underwent EA. This may be explained by different pharmacological sympatholysis, profound surgical analgesia, reduced stress response, and the avoidance of endotracheal instrumentation.[1,13,15]

Decreased blood loss during lumbar spine surgery has been observed with EA when compared with GA.[13,16] It is a possible result of more stable intraoperative hemodynamics, sympathetic blockage–induced vasodilatation and hypotension.[13,16] In the current series, the mean blood loss for GA and EA were 198.4 and 186.4 mL, respectively. However, no significant difference was detected between the 2 groups, probably due to the relatively small sample size.

The major advantages of RA are the excellent postoperative analgesia along with reduced nausea and vomiting.[14–16] Mergeay et al[13] suggested that postoperative vomiting was more frequent among patients recovering from GA compared with EA. To explain this difference, it has been demonstrated that GA may inhibit gastric emptying leading to increased nausea and vomiting, while this phenomenon may be virtually absent with EA.[14,17] In addition, the use of anesthetic or N_2O in GA has been associated with an increased incidence of postoperative vomiting.[14]

Postoperative delirium is common in elderly patients following LDS.[10] Delirium is associated with high mortality and morbidity, poor long-term functional outcomes, increased social and economic burden.[10] Previous studies have shown EA or spinal anesthesia may reduce the incidence of postoperative delirium in elderly population compared with GA.[5,10] In a randomized controlled trial, Sieber found that a reduced depth of anesthesia decreased the incidence of postoperative delirium.[18] In the current study, the incidence of delirium was significantly higher in the GA group (n = 4, 9.5%) compared with EA (0). In group GA, 3 patients displayed transient postoperative delirium lasting no longer than 24 hours; 1 patient displayed delirium lasting for 48 hours. The incidences of other postoperative complications including urine retention, pneumonia, and wound infection did not differ between the 2 groups.

Previous studies have demonstrated decreased postoperative pain scores and/or narcotic requirement for the RA compared with GA group.[7,15,19] The present study also showed improved postoperative (0–8 h) pain and patients' satisfaction in the EA group. The existence of a residual sensory blockade after EA might be an explanation for less postoperative pain in the EA group.[15,19] In addition, decreased pain scores in the EA group might be due to RA's more selective inhibition of afferent nociceptive sensitization pathways.[19,20]

GA is by far more frequently used anesthetic technique than EA for common spinal surgical procedures. Compared with EA, the advantages of GA include greater acceptance by patients, the ability to easily extend the duration of an operation using GA, and/or anesthesiologist preference for GA because of a more secure airway establishment. Anesthesiologists may favor securing the airway with endotracheal intubation in these operations, as prone positioning of the patient increases the risk of airway compromise. Recently, researchers have also stated that increased body mass index might be associated with increased technical difficulty, failure of neuraxial analgesia and the risk of high spinal block during EA.[21,22] In addition, limited usage of muscle relaxant during EA may further increase the difficulty in posterior approach especially in obese patients. Thus, obesity is a specific consideration for anesthesia technique which needs to be carefully evaluated before surgery. The impact of EA and GA on dural repair and EMG monitoring remains unclear by our study, as dural rupture had not occurred, and EMG monitoring was not applied in this series.

There are some limitations to this study. First, this study is a retrospective research of a selected cohort. Second, the overall patient number is small and may limit the power of this study, thus, number needed to treat and number needed to harm were further calculated to evaluate relative benefits and harms. The power of this study is also limited by the selection of patients at a single institution and within a restricted time period.

CONCLUSIONS

On the basis of our observation, there was an association between those who received EA and superior perioperative outcomes, including lower intraoperative HR and MABP, improved delirium, nausea and patients' satisfaction. However, some concerns including airway security, operation duration and obesity, must be carefully evaluated between different anesthesia techniques. In addition, it should be noted that this study was retrospective and selection bias may probably exist which may interfere with the results.

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