Joint Diseases and Related Surgery

Jt Dis Relat Surg
2024;35(3):562-573

ORIGINAL ARTICLE

Application of combined anesthesia with spontaneous breathing in the surgery of intertrochanteric fracture of femur in elderly patients

Lu Zou, MD, Xiao-yan Pan, MD, Xu-dong Xu, MD, Yuan-yuan Qu, MD

Department of Anesthesiology, Changzhou Hospital of Traditional Chinese Medicine, Changzhou, China

The majority of the elderly are grievously afflicted with severe osteoporosis, and relevant data show that 70% of elderly patients have had intertrochanteric fracture of femur, and most of them have received surgical treatment.[1,2] Intertrochanteric fracture of femur, also known as intertrochanteric fracture, refers to the fracture from the base of femoral trochanter neck to above the level of lesser trochanter, which belongs to the category of hip fracture.[3] Internal fixation surgery is the preferred treatment for patients with intertrochanteric fracture of femur, who are mostly complicated with chronic diseases (such as coronary heart disease, diabetes, hypertension) due to age and other factors. In this regard, such patients are less tolerant of surgery.[4] Therefore, a scientific, safe and efficient anesthesia scheme should be adopted to ensure smooth operation and good prognosis.[5,6] Spinal block anesthesia is a common

Received: December 13, 2023
Accepted: July 09, 2024
Published online: August 14, 2024

Correspondence: Yuan-yuan Qu, MD. Department of Anesthesiology, Changzhou Hospital of Traditional Chinese Medicine, Changzhou 213003, China.

E-mail: yuanyy2025qu@126.com

Doi: 10.52312/jdrs.2024.1571

Citation: Zou L, Pan XY, Xu XD, Qu YY. Application of combined anesthesia with spontaneous breathing in the surgery of intertrochanteric fracture of femur in elderly patients. Jt Dis Relat Surg 2024;35(3):562-573. doi: 10.52312/jdrs.2024.1571.

ABSTRACT

Objectives: This study aims to investigate the feasibility and safety of combined anesthesia with spontaneous breathing in the operation of intertrochanteric fracture of femur in the elderly.

Patients and methods: Between January 2020 and January 2023, a total of 141 elderly patients (45 males, 96 females; mean age: 72.5±6.8 years; range, 65 to 87 years) who underwent proximal femoral nail anti-rotation (PFNA) surgery for intertrochanteric fracture of femur were included in this single-blind, prospective, randomized-controlled study. The patients were randomly divided into three groups. Group A (experimental group) was a general anesthesia with laryngeal mask airway (LMA) group preserving spontaneous breathing, Group B (control group 1) was a general anesthesia with LMA group for mechanical ventilation, and Group C (control group 2) was a tracheal intubation anesthesia group for mechanical ventilation. The differences of related indexes among the three groups were compared.

Results: The mean onset time of anesthesia (6.23±1.45 *vs*. 12.78±2.78 *vs*. 13.73±2.43 min), postoperative recovery time of consciousness (8.13±0.83 *vs*. 11.34±0.89 *vs*. 12.45±0.86 min), and postoperative complete awakening time (10.45±2.34 *vs*. 18.87±2.56 *vs*. 19.62±2.93 min) were significantly shorter in Group A than in Groups B and C ($p<0.05$). The duration of analgesic effect was longer in Group A than in Groups B and C ($p<0.05$). After anesthesia, the Ramsay Sedation Scale and Visual Analog Scale (VAS) scores were significantly lower in Group A than the other groups ($p<0.05$). The mean Mini-Mental State Examination (MMS) scores were significantly higher in Group A than in Groups B and C ($p<0.05$). Hemodynamic parameters showed that blood pressure, heart rate, cardiac output, and cardiac index (CI) levels were significantly higher in Group A than the other groups ($p<0.05$).

Conclusion: Our study results indicate that combined anesthesia preserving spontaneous breathing is safe and feasible in the operation of intertrochanteric fracture of femur in the elderly, with faster anesthesia recovery than the mechanical ventilation group.

Keywords: Anesthetics, elderly, intertrochanteric fractures, laryngeal mask, spontaneous respiration.

anesthesia scheme for fracture surgery. However, the elderly patients with intertrochanteric fracture of femur are more prone to physical and mental stress reaction, causing neurological disorder and cognitive dysfunction.[7]

Regional nerve block, a type of anesthesia with mild hemodynamic effects, boasts long duration of anesthetic and analgesic effects, and low incidence of postoperative complications such as nausea, vomiting, urinary retention, and hypotension.[8] This type of anesthesia has been shown in several studies to be superior to general anesthesia in certain surgeries and contributes to a lower risk of in-hospital mortality and postoperative lung complications.[9,10] A study also showed that, compared to the spinal anesthesia group, regional nerve block anesthesia had a good analgesic effect in intertrochanteric fracture surgery, which could reduce the negative nitrogen balance, shorten the length of hospital stay, reduce hospitalization costs, promote the recovery of self-care ability of patients, and accelerate the rehabilitation of patients.[11] However, due to the complexity and multiplicity of hip innervation, regional nerve block also has the problem of incomplete analgesic effect.[12] Therefore, regional nerve block also needs general anesthesia assistance. Currently, laryngeal mask airway (LMA) general anesthesia is widely used in auxiliary general anesthesia. This method is simple and convenient to use, easy to implant, high success rate and good hemodynamic stability during anesthesia induction and recovery.[13] Patients' spontaneous breathing through LMA can reduce airway irritation, improve airway patency, reduce the dosage of anesthetic and shorten the operation time, thereby achieving better analgesic effect. Studies have shown that regional nerve block combined with general anesthesia can reduce the stress response of patients undergoing tibiofibular fracture surgery, without damaging postoperative cognitive function and ensuring postoperative sleep quality.[14]

In the light of these data, we hypothesized that regional nerve block combined with general anesthesia could provide the possibility for elderly patients undergoing proximal femoral nail anti-rotation surgery (PFNA) to retain spontaneous breathing during operation. In this study, we, therefore, aimed to used anesthesia preserving spontaneous breathing for elderly patients undergoing PFNA surgery, and to investigate the feasibility of this anesthesia mode and its influence on patients' vital signs, postoperative anesthesia recovery and complications to provide clinical basis and reference for anesthesia of this type of surgery.

PATIENTS AND METHODS

Study design and study population

This single-center, single-blind, prospective, randomized-controlled clinical study was conducted at Changzhou Hospital of Traditional Chinese Medicine, Department of Anesthesiology between January 2020 and January 2023. Elderly patients who underwent PFNA surgery in our hospital were screened. All patients were informed before the operation about the anesthesia method to be used; however, they remained blind to the anesthesia methods of the other two groups. According to the preliminary experimental data, α=0.05 and β was 80%, with postoperative consciousness recovery time, postoperative recovery time and duration of analgesia as the main observation indicators, the difference in consciousness recovery time between the postoperative experimental group and the control group was about 6 min, using https://select-statistics.co.uk/calculators/sample-size-calculator-two-means/. The web site estimates the sample size, with a dropout rate set at 10% and a total calculated sample size of 129 cases. As the patients were divided equally into three groups and more study participants were required, the total sample size was estimated as 141. Inclusion criteria were as follows: elderly patients diagnosed with intertrochanteric fracture of femur by imaging examination and with indications for PFNA surgery; those older than 65 years and younger than 95 years and classified by the American Society of Anesthesiologists (ASA) as Grade 2-3; and those whose various chronic diseases were stable after medical treatment. Exclusion criteria were as follows: elderly patients with contraindications to LMA use; those with contraindications to nerve block; those who participated in other clinical trials within the past three months; and those with severe hearing, vision, mental or cognitive dysfunction that prevents them from communicating well. Finally, a total of 141 elderly patients (45 males, 96 females; mean age: 72.5±6.8 years; range, 65 to 87 years) who met the inclusion criteria and underwent PFNA surgery for intertrochanteric fracture of femur were recruited.

Grouping

The random number generator was used for random grouping. A total of 141 numbers were randomly divided. After sorting according to the

size, 1-47 were Group A (experimental group), 48-94 were Group B (control group 1), 95-141 were Group C (control group 2), 47 cases in each group. Group A (experimental group) was a general anesthesia with LMA group preserving spontaneous breathing, Group B (control group 1) was a general anesthesia with LMA group for mechanical ventilation, and Group C (control group 2) was a tracheal intubation anesthesia group for mechanical ventilation. All three groups underwent ultrasound-guided femoral nerve block (0.4% ropivacaine, 20 mL) and lateral femoral cutaneous nerve block (0.4% ropivacaine, 10 mL) before surgery.

Anesthesia and surgery

Nerve block

The patients were placed in the supine position, routinely disinfected and covered with towels. Two-dimensional portable ultrasound (FUJIFILM Sonosite, Inc., WA, USA) was used to place the probe on the surface of the femoral artery in the affected inguinal region. After revealing the short axis of the femoral artery, the probe was slid outwards and slightly tilted toward the head and feet to discover the femoral nerve. When the cross-sectional image of the femoral nerve was clearly displayed under ultrasound, the in-plane needle insertion technique was adopted, and the needle was inserted from the outside of the thigh to the skin at an angle of about 45°. Under the guidance of ultrasound, the femoral nerve was accurately located by puncture needle and 20 mL of 0.4% ropivacaine hydrochloride injection was slowly injected after blood withdrawal. Then, the ultrasound probe was moved outward along the groin to discover an "eye-like" structure composed of subcutaneous tissue, tensor fascia lata, sartorius muscle, or lateral femoral cutaneous nerve, and 10 mL of 0.4% ropivacaine hydrochloride injection was slowly injected to block the lateral femoral cutaneous nerve by using in-plane needle insertion technique. The temperature perception and tactile sensation of the corresponding innervation area were measured within 20 min after the block. If they were significantly lower than those of the corresponding area on the healthy side, it was decided that the block was effective and subsequent anesthesia was continued.

General anesthesia induction

In Group A, the patients were given propofol 0.5 to 1.5 mg/kg and sufentanil 0.15 ug/kg intravenously for induction. After the patients lost consciousness and were fully denitrogenous and oxygenated for 3 min, a laryngeal mask of appropriate size was placed, and spontaneous breathing was preserved during surgery. When the oxygen saturation (SpO_2) was lower than 95% and/or end-tidal carbon dioxide ($PetCO_2$) was above 50 mmHg, short-term manual assisted ventilation was performed.

In Group B, the patients were given cisatracurium besylate 0.15 mg/kg during induction on top of medication in Group A, and were given intermittent positive pressure ventilation (IPPV) mechanical ventilation after laryngeal mask implantation (tidal volume (VT): 6-8 mL/kg, respiratory rate (RR): 14 times/min, inspiratory: expiratory ratio (I:E)=1:1.5, positive end-expiratory pressure (PEEP): 4 cmH_2O).

In Group C, the patients were given propofol 0.5 to 1.5 mg/kg, sufentanil 0.2 to 0.3 μg/kg, and cisatracurium besylate 0.15 mg/kg. After the patients lost consciousness and were fully denitrogenous and oxygenated for 3 min, a reinforced endotracheal tube with appropriate size was inserted and connected to a ventilator for IPPV mechanical ventilation (VT: 6-8 mL/kg, RR: 14 times/min, I:E=1:1.5, PEEP: 4 cmH_2O).

All patients were given a mixture of air and oxygen at the oxygen concentration of 50%, and $PetCO_2$ was continuously monitored simultaneously. Depth of anesthesia in three groups was monitored intraoperatively using a Narcotrend monitor. During the operation, propofol (4 to 6 mg/kg/h) and small-dose dexmedetomidine (0.1 to 0.3 μg/kg/min) were injected by pump, and the depth of anesthesia was maintained at 40 to 60, and sufentanil 5.0 to 7.5 μg given as a single dose during the operation (if the increase in blood pressure [BP] or heart rate [HR] of the patients who had insufficient analgesia was more than 30% of the baseline value). The patients in Group B and Group C were given one-third of the first dose of myosin, if they recovered from respiration during the operation, and all drugs were discontinued at the time of suturing, and the laryngeal mask or endotracheal tube was withdrawn after reaching the indication of awake and extubation, and the patients were sent to the anesthesia recovery room for further monitoring (oxygen intake by nasal cannula at 3 L/min), and the blood gas analysis was detected at the time of discharge from the post-anesthesia care unit (PACU), and data were recorded. The Steward's score reached 6 before they were sent back to the ward.

Observation indicators

(1) Anesthesia effect: for anesthesia onset time, postoperative consciousness recovery time, the Glasgow Coma Scale (GCS) was used to evaluate the recovery of consciousness A GCS of ≥13 indicates the recovery of consciousness. Postoperative full awake time was evaluated (Steward score 6 indicates that the patient is awake). The analgesia effect maintenance time was also assessed.

(2) Sedative effect: Ramsay Sedation Scale (RSS)[15] was used to evaluate the sedative effect at 6, 12, and 24 h after the operation, with 1 point indicating restless and irritable, 2 points indicating quiet cooperation, 3 points indicating lethargy and being able to follow instructions, 4 points indicating sleep state but being able to wake up, 5 points indicating sleep state and being slow to respond, requiring stronger stimuli, and 6 points indicating no response to stimuli.

(3) Pain: Visual Analog Scale (VAS)[16] was used to assess the pain of patients at 6, 12, and 24 h after the operation, with a lower score indicating less pain.

(4) Cognitive status: The patients' cognitive function was assessed using the Mini-Mental State Examination (MMSE)[17] at 6, 12, and 24 h after the operation, with the higher the score, the better the patient's cognitive function (Supplementary Materials).

(5) Hemodynamic indicators before anesthesia and 1 h after anesthesia: including BP, HR, cardiac output (CO, cardiac output per minute assessed by echocardiography), cardiac index (CI, CI (L/min/m^2)=cardiac output per minute (L/min)/body surface area (m^2)).

(6) Adverse reactions: including lung infection, nausea and vomiting, dizziness occurred within one week after surgery. Pulmonary infection was assessed by combining clinical manifestations and computed tomography (CT) imaging results. The occurrence of symptoms such as nausea and vomiting, or dizziness were assessed by daily inquiry or patient self-report.

Statistical analysis

Statistical analysis was performed using the IBM SPSS version 26.0 software (IBM Corp., Armonk, NY, USA). Descriptive data were expressed in mean ± standard deviation (SD), median (min-max) or number and frequency, where applicable. One-way analysis of variance (ANOVA) was used for the comparison among the groups, and the least significant difference (LSD) method was used for pairwise comparison, while ANOVA for repeated measurements was used for the comparison within groups. The chi-square test (χ^2 test) was used for comparison among the groups, with a p value of <0.05 indicating a statistically significant difference. Under the condition that the sample size of 47 individuals in each of the three groups and the threshold of p=0.05, the statistical efficacy of each index comparison was set between 0.78 and 0.81 through the Group software: Ugrouping V1.0 (Beijing Unibiolabs Biotechnology Center, Beijing, China).

RESULTS

Comparison between clinical data and related indicators before anesthesia induction

No statistically significant differences were observed in terms of baseline data such as age, sex, body mass index (BMI), ASA class, and preoperative comorbidities among the three groups (p>0.05). Also, there were no statistically significant differences in mean arterial pressure (MAP), HR and SpO_2 among the three groups before baseline anesthesia induction (p>0.05). Group A, Group B, and Group C were comparable (Table I).

Comparison of anesthetic effects

There were significant differences in the anesthesia onset time, postoperative consciousness recovery time, postoperative complete awake time and analgesic effect among the three groups (p<0.05). In terms of anesthetic effect, the mean onset time of anesthesia (6.23±1.45 *vs.* 12.78±2.78 *vs.* 13.73±2.43 min, p=0.024), the mean postoperative recovery time of consciousness (8.13±0.83 *vs.* 11.34±0.89 *vs.* 12.45±0.86 min, p=0.016), and the mean postoperative full awake time (10.45±2.34 *vs.* 18.87±2.56 *vs.* 19.62±2.93 min, p=0.004) in Group A were shorter than those in Group B and Group C, with statistically significant differences (p<0.05). Moreover, the mean duration of analgesic effect (178.26±13.42 *vs.* 133.52±12.78 *vs.* 130.75±10.78 min, p=0.001) in Group A was longer than that in Group B and Group C, with a statistically significant difference (p<0.05) (Table II).

Correlation score of anesthesia effect at 6, 12, and 24 h after surgery

There were statistically significant differences in the mean RSS score, VAS score, and MMS score among the three groups (p<0.05).

In terms of RSS scores, the mean scores of Group A at 6 h (2.34±0.68 *vs.* 2.39±0.62 *vs.* 2.43±0.67,

TABLE I
Comparison between clinical data and related indicators before anesthesia induction

Indicator	Group A (n=47)			Group B (n=47)			Group C (n=47)			*p*
	n	%	Mean±SD	n	%	Mean±SD	n	%	Mean±SD	
Age (year)			73.5±6.8			74.2±6.4			72.9±6.7	0.753
Sex										0.783
Male	15	31.91		16	34.04		14	29.79		
Female	32	68.09		31	65.96		33	70.21		
BMI (kg/m^2)			21.86±2.82			22.21±3.64			22.31±3.46	0.531
ASA classification										0.684
Grade 2	7	14.89		8	17.02		7	14.89		
Grade 3	40	85.11		39	82.98		40	85.11		
Lung disease	17	36.17		15	31.91		16	34.04		0.639
Heart disease	10	21.28		9	19.15		11	23.40		0.892
Diabetes	13	27.66		12	25.53		14	29.79		0.573
Cerebral infarction	7	14.89		4	8.51		6	12.77		0.584
MAP (mmHg)			99.57±9.41			99.41±11.31			99.22±9.74	0.975
HR (bpm)			86.14±13.41			87.42±17.07			86.79±16.37	0.842
SpO2			92.78±5.48			93.27±4.52			93.73±4.63	0.663

SD: Standard deviation; BMI: Body mass index; ASA: American Society of Echocardiography; MAP: Mean arterial pressure; HR: Heart rate; SpO2: Blood oxygen saturation.

TABLE II
Comparison of anesthetic effects

Indicator	Group A (n=47)	Group B (n=47)	Group C (n=47)	*p*
	Mean±SD	Mean±SD	Mean±SD	
Onset time of anesthesia	6.23±1.45	12.78±2.78*	13.73±2.43#	0.024
Postoperative recovery time of consciousness	8.13±0.83	11.34±0.89*	12.45±0.86#	0.016
Postoperative full awake time	10.45±2.34	18.87±2.56*	19.62±2.93#	0.004
Duration of analgesic effect	178.26±13.42	133.52±12.78*	130.75±10.78#	0.001

SD: Standard deviation; * p<0.05 for A and B comparisons; # p<0.05 for A and C comparisons.

p=0.054), 12 h (2.55±0.52 *vs.* 2.69±0.73 *vs.* 2.76±0.72, p=0.034), and 24 h (2.29±0.47 *vs.* 2.43±0.64 *vs.* 2.47±0.89, p=0.021) after anesthesia were lower than those of Group B and Group C, with statistically significant differences among the three groups (p<0.05). However, this difference was not clinically evident.

The VAS scores of the three groups showed a gradually decreasing trend. The mean VAS scores of Group A at 6 h (2.40±0.74 *vs.* 2.51±0.78 *vs.* 2.57±0.77, p=0.042), 12 h (2.18±0.67 *vs.* 2.37±0.71 *vs.* 2.41±0.72, p=0.011), and 24 h (2.02±0.59 *vs.* 2.12±0.72 *vs.* 2.26±0.73, p=0.009) after anesthesia were lower than those of Group B and Group C, with statistically significant differences among the three groups (p<0.05). Similarly, this difference was almost imperceptible in clinical practice.

The MMS scores of the three groups showed a trend of decreasing first and, then, increasing. The mean MMS scores of Group A at 6 h (27.52±0.79 *vs.* 25.45±0.78 *vs.* 24.89±0.82, p=0.031), 12 h (25.58±0.71 *vs.* 24.14±0.72 *vs.* 23.73±0.57, p=0.014), and 24 h (30.37±1.03 *vs.* 27.79±0.97 *vs.* 26.83±0.93, p=0.001) after anesthesia were higher than those of Group B and Group C, with statistically significant differences among the three groups (p<0.05) (Table III).

TABLE III
Comparison of the anesthetic effects of the three groups of patients at 6 h, 12 h, and 24 h after surgery

Indicator	Time point	Group A (n=47) Mean±SD	Group B (n=47) Mean±SD	Group C (n=47) Mean±SD	*p*
VAS score	6 h after anesthesia	2.34±0.68	2.39±0.62	2.43±0.67	0.054
	12 h after anesthesia	2.55±0.52	2.69±0.73*	2.76±0.72#	0.034
	24 h after anesthesia	2.29±0.47	2.43±0.64*	2.47±0.89#	0.021
VAS score	6 h after anesthesia	2.40±0.74	2.51±0.78*	2.57±0.77#	0.042
	12 h after anesthesia	2.18±0.67	2.37±0.71*	2.41±0.72#	0.011
	24 h after anesthesia	2.02±0.59	2.12±0.72*	2.26±0.73#	0.009
MMS score	6 h after anesthesia	27.52±0.79	25.45±0.78*	24.89±0.82#	0.031
	12 h after anesthesia	25.58±0.71	24.14±0.72*	23.73±0.57#	0.014
	24 h after anesthesia	30.37±1.03	27.79±0.97*	26.83±0.93#	0.001

SD: Standard deviation; VAS: Visual Analog Scale; MMS: Mini-mental state examination; * p<0.05 for A and B comparisons; # p<0.05 for A and C comparisons.

TABLE IV
Comparison of hemodynamic indicators

Indicator	Time point	Group A (n=47) Mean±SD	Group B (n=47) Mean±SD	Group C (n=47) Mean±SD	*p*
BP (mmHg)	Before anesthesia	146.01±15.63	145.54±14.84	145.24±15.42	0.562
	1 h after anesthesia	127.32±11.17	114.85±12.14*	112.77±11.17*	0.003
HR (times/min)	Before anesthesia	84.65±11.42	84.52±10.78	84.44±11.27	0.613
	1 h after anesthesia	82.19±10.47	67.12±9.47*	64.57±9.62*	0.001
CI [L/(min.m^2)]	Before anesthesia	3.31±0.22	3.25±0.24	3.26±0.27	0.652
	1 h after anesthesia	3.43±0.32	3.02±0.42*	2.97±0.32*	0.014
CO (L/min)	Before anesthesia	5.42±0.64	5.19±0.55	5.27±0.63	0.538
	1 h after anesthesia	5.64±0.59	4.45±0.57*	4.04±0.63*	0.006

SD: Standard deviation; BP: Blood pressure; HR: Heart rate; CI: Cardiac index; CO: Cardiac output; * Compared with group A, the difference was statistically significant (p<0.05).

TABLE V
Comparison of adverse reactions

Indicator	Group A (n=47) n	%	Group B (n=47) n	%	Group C (n=47) n	%
Lung infection	1		1		3	
Nausea and vomiting	2		3		4	
Dizziness	2		4		5	
Total incidence of adverse reactions		10.64		17.02		25.53

Comparison of hemodynamic indicators

The results of single factor analysis showed that there were significant differences in BP, HR, CI, and CO levels among the three groups (p<0.05).

Before anesthesia, no statistically significant difference was observed in hemodynamic indicators among the three groups (p>0.05). However, 1 h after anesthesia, the levels of BP, HR, CI, and CO levels in

the three groups decreased. The mean levels of BP (127.32±11.17 *vs.* 114.85±12.14 *vs.* 112.77±11.17, p=0.003), HR (82.19±10.47 *vs.* 67.12±9.47 *vs.* 64.57±9.62, p=0.001), CI (3.43±0.32 *vs.* 3.02±0.42 vs. 2.97±0.32, p=0.014) and CO (5.64±0.59 *vs.* 4.45±0.57 *vs.* 4.04±0.63, p=0.006) in Group A were higher than those in Group B and Group C, with statistically significant differences (p<0.05) (Table IV).

Comparison of adverse reactions

In Group A, there was one case of lung infection, two cases of nausea and vomiting, and two cases of dizziness, with a total adverse reaction rate of 10.64%. In Group B, there was one case of lung infection, three cases of nausea and vomiting, and four cases of dizziness, with a total adverse reaction rate of 17.02%. In Group C, there was three cases of lung infection, four cases of nausea and vomiting, and five cases of dizziness, with a total adverse reaction rate of 25.53% (Table V).

DISCUSSION

In the present study, the combined anesthesia with spontaneous breathing was used for the anesthesia effect of PFNA surgery in elderly patients. Our study results showed that the combined anesthesia with spontaneous breathing could effectively maintain the effect of anesthesia, shorten the onset time of anesthesia, postoperative consciousness recovery time, postoperative complete awake time, and increase the maintenance time of analgesic effect.[18] However, it is important to note that although the difference in RSS and VAS scores were statistically significant, this difference was too small clinically, indicating that the difference may not be enough to make a real difference to patients. Therefore, these findings must be interpreted with caution. The clinical difference in RSS score may be smaller, as the patients were in anesthetic state, rather than pathological sleepy state, so the scores were between 2-3, which was reasonable. The reason for the small difference in the VAS score may be that elderly patients have higher pain after fracture and improved pain tolerance. The pain was relieved after anesthesia before surgery in our study; thus, the postoperative pain perception was low.

Elderly individuals are more prone to hip fractures due to degenerative changes in their bones, causing great physical and psychological pain. In addition, the elderly are often accompanied by several comorbidities as their organ functions deteriorate.[19] Therefore, an anesthesia mode with less physiological interference, comfort, and quick recovery needs to be proposed for such patients. General anesthesia with LMA combined with nerve block is an ideal compound anesthesia method for hip surgery in the elderly under the concept of comfortable medical care and rapid rehabilitation, boasts advantages than simple general anesthesia or intraspinal anesthesia.[20] In the respiratory management mode of combined anesthesia, mechanical ventilation is mainly performed using muscle relaxants to ensure intraoperative ventilation and oxygenation of elderly patients. However, with the development of ultrasound-guided nerve block and the maturity of LMA application, some surgeries with lower muscle relaxation requirements have also adopted the respiratory management method of preserving spontaneous breathing during surgery in recent years. Zhaowei et al.[21] achieved satisfactory results by preserving the patient's spontaneous breathing during surgery. Nonetheless, further research is needed to analyze whether different respiratory management approaches can produce a similar effect in elderly patients undergoing PFNA surgery.

In the current study, the onset time of anesthesia, postoperative recovery time of consciousness and postoperative full awake time in Group A were shorter than those in Group B and Group C, and the duration of analgesic effect was longer than those in Groups B and C. After anesthesia, the VAS scores in three groups showed a decreasing trend over time, and those in Group A were lower than those in Group B and Group C, indicating that LMA preserving spontaneous breathing has better anesthetic effect, faster onset of effect, quicker recovery of postoperative consciousness, and longer maintenance time of analgesic effect, which can effectively reduce the pain of patients. Tang et al.[22] reported that retaining the patient's spontaneous breathing anesthesia during the operation had a good effect in the hysteroscopy and could maintain the stability of hemodynamic parameters. In our study, 6 to 24 h after anesthesia, the MMS scores of the three groups were different over time and across the groups, and they all showed a trend of decreasing first and then increasing. The MMS scores of Group A were higher than those in Group B and Group C. Also, 1 h after anesthesia, the levels of BP, HR, CO, and CI in the three groups decreased, and those in Group A were higher than those in Group B and Group C, indicating that general anesthesia with LMA preserving spontaneous breathing has less damage to patients' cognitive function and less influence on patients' hemodynamics.

Moreover, the total incidence of adverse reactions in Group A is lower than that in Group B and Group C, indicating that general anesthesia with LMA preserving spontaneous breathing has fewer adverse reactions on patients and has a positive effect on their prognosis. Rossi et al.[23] also proposed that laryngeal mask anesthesia with spontaneous breathing should be popularized and applied in surgery in the published study on the safety of desflurane anesthesia and laryngeal mask ventilation. Preserving spontaneous breathing while maintaining stable volume and depth of anesthesia does not affect circulatory changes. This is because changes in intrathoracic pressure caused by changes in respiratory mechanics of natural physiological respiration are conducive to blood return.[24]

The impact of intraoperative spontaneous breathing on postoperative data may depend on many factors, including: type of surgery, anesthesia method, patient basic status and specific implementation methods of spontaneous breathing during surgery. Based on the anesthesia method in this study, some studies have shown that spontaneous breathing during surgery can improve postoperative lung function, such as increasing tidal volume, reducing airway resistance, and improving lung compliance. In addition, spontaneous breathing during surgery can reduce the incidence of postoperative complications, including pneumonia, atelectasis, or respiratory dependence time.[24] Preserving spontaneous breathing during surgery aims to maintain the normal natural physiological breathing of patients, ensure adequate oxygenation and ventilation, reduce mechanical ventilation against physiological respiratory mechanics, and avoid the use and residue of muscle relaxants.[25] This also helps to reduce the incidence of postoperative lung complications, thereby speeding up patients' recovery from anesthesia and their postoperative rehabilitation. Zheng et al.'s study[26] suggested that intraoperative spontaneous breathing might accelerate postoperative recovery and reduce postoperative VAS scores and complications in patients undergoing video-assisted thoracic surgery. Chen et al.[27] found that general LMA anesthesia using lumbar plexus sciatic nerve block provided more favorable outcomes and reduced complications and postoperative pain than general endotracheal intubation anesthesia in elderly patients undergoing hip surgery. Huaiying and Yue[28] observed the application effect of anesthesia with LMA in lung bullae resection, and concluded that the incidence of complications of this method was lower than that of the control group, which could shorten the recovery time of patients after operation and reduce the treatment cost. Additional studies by Gao[29] explored the effect of regional nerve block anesthesia in the operation of intertrochanteric fracture of femur, and showed that regional nerve block anesthesia could meet the needs of operation and keep the patients' signs stable, thereby reducing the use of anesthetic drugs. The method can shorten postoperative recovery time and is safer than combined spinal-epidural anesthesia. In our follow-up study, we plan to investigate the feasibility and safety of regional nerve block anesthesia in intertrochanteric fracture surgery in the elderly.

Nonetheless, there are still some limitations to this study. Due to time and manpower constraints, limited samples were included in this study, all of which were patients from our hospital, which may lead to results bias. Besides, the relevant observation indicators (such as long-term complications) and observation time limit of postoperative complications in this study were insufficient. Therefore, more samples will be included in subsequent studies to increase observation indicators and extend the observation time limit for more in-depth analysis.

In conclusion, combined anesthesia preserving spontaneous breathing is safe and feasible in the operation of intertrochanteric fracture of femur in the elderly. While relieving the pain of patients effectively, it can reduce the impact on cognitive function and hemodynamics of patients, achieving higher safety, which is worthy of widespread clinical use. During surgery, ventilation conditions should be closely monitored to avoid affecting the oxygenation of patients due to laryngeal mask displacement and respiratory depression.

Ethics Committee Approval: The study protocol was approved by the Changzhou Hospital of Traditional Chinese Medicine Ethics Committee (date: 11.05.2019, no: 2019-LL-008(L)). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patient Consent for Publication: A written informed consent was obtained from each patient.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Conceived of the study and its design: Z.L., P.X.Y.; Participated in its coordination and acquisition of data: X.X.D.; Helped to analyze the data: Q.Y.Y. All authors participated in drafting the manuscript. All authors read and approved the final manuscript.

Conflict of Interest: The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding: The authors received no financial support for the research and/or authorship of this article.

REFERENCES

1. Benes G, David J, Synowicz M, Betech A, Dasa V, Krause PC, et al. Race and age impact osteoporosis screening rates in women prior to hip fracture. Arch Osteoporos 2022;17:34. doi: 10.1007/s11657-022-01076-y.
2. Kassem E, Younan R, Abaskhron M, Abo-Elsoud M. Functional and radiological outcomes of dynamic hip screw with trochanteric stabilizing plate versus short proximal femoral nail in management of unstable trochanteric fractures: A randomized-controlled trial. Jt Dis Relat Surg 2022;33:531-7. doi: 10.52312/jdrs.2022.800.
3. Li XP, Zhang P, Zhu SW, Yang MH, Wu XB, Jiang XY. All-cause mortality risk in aged femoral intertrochanteric fracture patients. J Orthop Surg Res 2021;16:727. doi: 10.1186/s13018-021-02874-9.
4. Cheng YX, Sheng X. Optimal surgical methods to treat intertrochanteric fracture: A Bayesian network meta-analysis based on 36 randomized controlled trials. J Orthop Surg Res 2020;15:402. doi: 10.1186/s13018-020-01943-9.
5. Dai B, Huo Y. A subanesthetic dose of esketamine combined with hip peripheral nerve block has good sedative and analgesic effects in elderly patients undergoing total hip arthroplasty: A randomized-controlled trial. Jt Dis Relat Surg 2023;34:548-56. doi: 10.52312/jdrs.2023.997.
6. Song B, Zhou M, Zhu J. Necessity and importance of developing AI in anesthesia from the perspective of clinical safety and information security. Med Sci Monit 2023;29:e938835. doi: 10.12659/MSM.938835.
7. Ciudad P, Escandón JM, Manrique OJ, Escobar H, Pejerrey Mago B, Arredondo Malca A. Efficacy of combined spinal-epidural anesthesia for lower extremity microvascular reconstruction. J Surg Res 2023;291:700-10. doi: 10.1016/j.jss.2023.07.026.
8. Choi YM, Choi EJ, Ri HS, Park JY, You JA, Byeon GJ. The effect of dexmedetomidine and midazolam on combined spinal-epidural anesthesia in patients undergoing total knee arthroplasty. Anesth Pain Med (Seoul) 2020;15:111-9. doi: 10.17085/apm.2020.15.1.111.
9. Li T, Li J, Yuan L, Wu J, Jiang C, Daniels J, et al. Effect of regional vs general anesthesia on incidence of postoperative delirium in older patients undergoing hip fracture surgery: The RAGA randomized trial. JAMA 2022;327:50-8. doi: 10.1001/jama.2021.22647.
10. Mosaffa F, Taheri M, Manafi Rasi A, Samadpour H, Memary E, Mirkheshti A. Comparison of pericapsular nerve group (PENG) block with fascia iliaca compartment block (FICB) for pain control in hip fractures: A double-blind prospective randomized controlled clinical trial. Orthop Traumatol Surg Res 2022;108:103135. doi: 10.1016/j.otsr.2021.103135.
11. Zheng J, Chen J, Lin Z, Lin F, Zhou G, Han X. Application effect of regional nerve block anesthesia in the operation of intertrochanteric fracture. Journal Of Wezhou Medical University 2021;51:491-4.
12. Li WX, Luo RY, Chen C, Li X, Ao JS, Liu Y, et al. Effects of propofol, dexmedetomidine, and midazolam on postoperative cognitive dysfunction in elderly patients: A randomized controlled preliminary trial. Chin Med J (Engl) 2019;132:437-45. doi: 10.1097/CM9.0000000000000098.
13. Süzer MA, Özhan MÖ, Çaparlar CÖ, Eşkin MB, Atik B. Airway management in general anesthesia for endovascular treatment of cerebral arteriovenous malformation: a retrospective observational study. Braz J Anesthesiol 2022;72:359-64. doi: 10.1016/j.bjane.2021.12.004.
14. Lijun Z, Wei Z, Lu Z. Effect of regional nerve block combined with general anesthesia on stress response, cognitive function and sleep quality in patients undergoing tibio-fibular fracture surgery [J]. Journal of Zhengzhou University (Medical Edition) 2024;59:83-87. doi: 10.13705/j.issn.1671-6825.2023.03.024.
15. Rasheed AM, Amirah MF, Abdallah M, P J P, Issa M, Alharthy A. Ramsay sedation scale and Richmond agitation sedation scale: A cross-sectional study. Dimens Crit Care Nurs 2019;38:90-5. doi: 10.1097/DCC.0000000000000346.
16. Kuhlmann T, Dantlgraber M, Reips UD. Investigating measurement equivalence of visual analogue scales and Likert-type scales in Internet-based personality questionnaires. Behav Res Methods 2017;49:2173-81. doi: 10.3758/s13428-016-0850-x.
17. Jia X, Wang Z, Huang F, Su C, Du W, Jiang H, et al. A comparison of the Mini-Mental State Examination (MMSE) with the Montreal Cognitive Assessment (MoCA) for mild cognitive impairment screening in Chinese middle-aged and older population: A cross-sectional study. BMC Psychiatry 2021;21:485. doi: 10.1186/s12888-021-03495-6.
18. Atik OŞ. Writing for Joint Diseases and Related Surgery (JDRS): There is something new and interesting in this article! Jt Dis Relat Surg 2023;34:533. doi: 10.52312/jdrs.2023.57916.
19. Cui J, Shibata Y, Zhu T, Zhou J, Zhang J. Osteocytes in bone aging: Advances, challenges, and future perspectives. Ageing Res Rev 2022;77:101608. doi: 10.1016/j.arr.2022.101608.
20. Prince J, Goertzen C, Zanjir M, Wong M, Azarpazhooh A. Airway complications in intubated versus laryngeal mask airway-managed dentistry: A meta-analysis. Anesth Prog 2021;68:193-205. doi: 10.2344/anpr-68-04-02.
21. Zhaowei Z, Yuxia Z, Kai C. Effect of nerve block combined with LMA during gen-eral anesthesia in application of replantation of amputated finger surgery for children. Med J Chin PLA 2017;29:104-107. doi: 10.3969/j.issn.2095-140X.2017.07.028.
22. Tang S, Lu J, Xu C, Wei L, Mei S, Chen R, et al. Feasibility and safety of remazolam versus propofol when inserting laryngeal masks without muscle relaxants during hysteroscopy. Drug Des Devel Ther 2023;17:1313-22. doi: 10.2147/DDDT.S408584.
23. Rossi M, Corcione A, Esposito C, Micaglio M, Monzani R, Ori C. Safety aspects of desflurane anesthesia and laryngeal mask airway. Minerva Anestesiol 2017;83:1199-206. doi: 10.23736/S0375-9393.17.11930-9.
24. Zhibin L. Analysis of influencing factors on the stability of thoracoscopic surgery under spontaneous breathing anesthesia. Academic Journal of Guangzhou Medical University. Guangdong Province, China; 2019.

25. Shin SY, Kim MJ, Joo J. Oculocardiac reflex and oculorespiratory reflex during strabismus surgery under general anesthesia using the laryngeal mask airway with maintenance of spontaneous respiration: A retrospective study. J Int Med Res 2020;48:300060520945158. doi: 10.1177/0300060520945158.
26. Zheng YF, Jiang YS, Liu HT, Chen FZ, Shao AZ, Zhu JF, et al. Thoracic paravertebral nerve block combined laryngeal mask airway with preservation of spontaneous breathing can accelerate postoperative recovery. Eur Rev Med Pharmacol Sci 2023;27:10875-83. doi: 10.26355/eurrev_202311_34455.
27. Chen WQ, Guo N, Wang SS, Wang R, Huang F, Li SR. General laryngeal mask airway anesthesia with lumbar plexus and sciatic block provides better outcomes than general anesthesia and endotracheal intubation in elderly patients undergoing hip surgery. Arch Gerontol Geriatr 2018;78:227-32. doi: 10.1016/j.archger.2018.07.005.
28. Huaiying Z, Yue L. Application of anesthesia with LMA with spontaneous breathing un-der single-hole thoracoscopy in bullae resection. Youjiang Med J 2021;49:702-705. doi: 10.3969/j.issn.1003-1383.2021.09.013.
29. Jin G. Effect of regional nerve block anesthesia in the operation of intertrochanteric fracture. Med J Present Clin 2022;35:38-39. doi: 10.3969/j.issn.2095-9559.2022.05.20.

SUPPLEMENTARY MATERIALS

Mini-Mental State Examination (MMSE)

Name		Sex		Age		Educational level	
Outpatient No./Bed No.		Follow-up telephone		Examiner		Examination date	

[Score “1” point for each correct response within each question or activity, and “0” for errors, no answers or failure to answer]		Correct	Error
01. What is the year?			
02. What is the season?			
03. What is the month?			
04. What day of the week is it?			
05. What is today’s date?			
06. Which is the city (province)?			
07. What is the district (county)?			
08. What is the street (township)?			
09. What is this place?			
10. What floor are we on now?			
11. Now I’m going to name three things. After I said all three, please repeat them and remember them, for I’ll ask you later. [The examiner needs to clearly state the name of each thing] Ball. National flag. Trees. Please say these three things again. [The examiner scores according to the first repetition of the patient]	Ball		
	National flag		
	Trees		
12. Now please count backward from 100 by sevens, and then subtract 7 from the obtained number, and so on. Tell me every answer until I say “stop”. [If it is wrong, but the following answer is correct by subtracting 7 from the number of errors, then only the previous error will be recorded]	93		
	86		
	79		
	72		
	65		
13. Earlier I told you the names of three things. Can you tell me what those were?	Ball		
	National flag		
	Trees		
14. Can you tell me what is this? [The examiner shows the patient the wristwatch and pencil]	Wristwatch		
	Pencil		
15. Now I am going to say a, please repeat it clearly. The sentence is: forty-four stone lions. [The examiner can only say it once]			
16. I’ll give you a piece of paper, and please follow my instructions: Please take the paper in your right hand, fold it in half with both hands, and put it on your lap. [The examiner explains according to the above instructions and gives the subject a piece of paper the above instructions and give the patient a piece of paper. But the examiner should neither repeat the instructions nor demonstrate]	Take the paper in your right hand		
	Fold the paper in half		
	Put the paper on your lap		
17. Please read this sentence and do what it says. [The examiner shows the words “Close your eyes” on the back of the scale to the patient]			
18. Please make up and write a sentence about anything. [Requirements: The sentence must contain a subject and a predicate, which is meaningful] Writing place [ ]			
19. Please copy this picture. [The legend and drawing area are on the reverse side of the scale. The examiner gives the reverse side of the scale to the patient for drawing]		1	0
Total score		_____/30	

Instructions for Administration and Scoring of the Mini-Mental State Examination (MMSE)

The Mini-Mental State Examination (MMSE), originally compiled by Folstein in 1975, is one of the most influential screening tools for cognitive impairment.

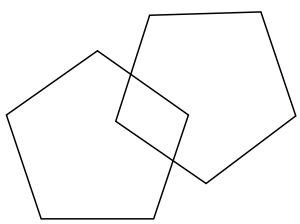
1 Item and examination criteria	2 Examination precautions
There are 19 items in the MMSE. Items 1-5 are time-oriented and items 6-10 are location-oriented. Item 11 contains three sub-items for immediate memory, and item 12 contains five sub-items for checking attention and calculation. Item 13 contains three sub-items for checking recall ability. Item 14 is contains five sub-items for naming objects. Item 15 is language retelling. Item 16 is language understanding and contains three sub-items. Item 17 is reading comprehension. Item 18 is to write a sentence. Item 19 is graphic drawing. There are 30 items in total. See the front of the scale for details. [Score "1" point for each correct response within each question or activity, and "0" for errors, no answers or failure to answer]	The examiner should ask the patient directly. Avoid interference from others during the examination. The elderly are easy to lose heart or give up, so they should be given appropriate encouragement. An examination takes 5-10 min. The examination and assessment methods of most items have been stated on the scale, and the following items need to be explained. 1. Item 11 only allows the examiner to speak once, and the patient is not required to answer in the order of items. If there are mistakes in the first pass, score first; Then, tell the patient where he/she is wrong and ask him/her to recall it until it is correct. But the patient can only "learn" five times at most. 2. Item 12 is a "continuous minus 7" test commonly used in clinic, and at the same time check the attention of the patient, so do not repeat the answer of the patient. The patient is not allowed to calculate with a pen. 3. Item 16 shall be operated in correct order.

Result analysis:

The total score of the scale is 30, and the higher the score, the better the cognitive function. Folsteini classified suspected dementia as MMSE <24-25 when designing the scale. But at present, international and domestic studies show that MMSE <24-25 is normal, 21-26 (≤22 for patients with primary school education) is mild dementia, 10-20 is moderate dementia, and <10 is severe dementia.

Close your eyes

[Graphic example] [Draw according to the graphic on the left]



Ramsay Sedation Scale

Score	Status	Description	Remarks
1	Sober	Anxiety, restlessness or irritability, or both	2-4 points indicate satisfactory sedation 5-6 points indicate excessive sedation
2		Quiet, cooperative and directional.	
3		Only respond to instructions	
4	Sleep	Agile response to eyebrow taps or loud auditory stimuli	
5		Slow response to eyebrow taps or loud auditory stimuli	
6		No response to eyebrow taps or loud auditory stimuli	

Visual analog scale (VAS)

A line with a length of 10 cm, on which a certain point can be assigned any point from 1 to 10 points

Painless +----+----+----+----+----+----+----+----+----+----+ Extremely painful

0 10

0 cm: 0 points, painless, without any pain feeling;

1-3 cm: 1-3 points, mild pain, not affecting work and life;

4-6 cm: 4-6 points, moderate pain, affecting work but not life;

7-10 cm: 7-10 points, severe pain, affecting work and life.