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Effects of Three Anesthesia Methods on Inflammation, Oxidative Stress, Analgesia and Cognition in Elderly Patients Receiving Hip Replacement

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ABSTRACT

The study aimed to investigate the effects of different anesthesia methods on the analgesia, inflammation and oxidative stress levels and cognitive function in elderly patients undergoing hip replacement. 100 elderly patients requiring hip replacement and admitted to Tianjin Hospital from March 2017 to March 2019 were enrolled and divided into group A (n=35, general anesthesia with endotracheal intubation), group B (n=35, epidural anesthesia) and group C (n=30, general anesthesia with endotracheal intubation + epidural anesthesia). The basic vital signs, inflammatory factors, stress response indicators and cognitive function changes were compared among three groups. Additionally, the effects of three different anesthesia methods were analyzed based on the differences in postoperative analgesic effect, extubation time and recovery time. The vital signs [systolic blood pressure (SBP), diastolic blood pressure (DBP) and heart rate (HR)] were lower in group C than those in group A and group B after surgery (p<0.05). The VAS score at 12 h and 24 h after surgery was lower than that at 3 h after surgery (p<0.05). Group A and B had increased levels of these inflammatory factors after surgery compared with those before surgery. Postoperative extubation time, eye-opening time upon calling and recovery time were significantly shorter in group C than those in groups A and B (p<0.05). The oxidative stress indexes in group C were remarkably lower than those in groups A and B (p<0.05). The MMSE score was decreased in groups A and B after surgery compared with that before surgery (p<0.05). General anesthesia combined with epidural anesthesia applied in elderly patients undergoing hip replacement achieves a good anesthetic effect and is able to stabilize the vital signs and stress levels of patients and improve postoperative analgesic effect and cognitive function, which is worthy of popularization in clinical practice.

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Introduction

For hip replacement in elderly patients, general anesthesia with endotracheal intubation and epidural anesthesia are mainly adopted in the clinic, but both general anesthesia alone and epidural anesthesia alone have certain shortcomings such as inducing unstable vital signs including strong stress response and elevated blood pressure (1, 2). Moreover, many elderly patients often suffer from chronic diseases of the cardiopulmonary system and have poor tolerance to hip replacement and intra-operative anesthesia, increasing the risk of anesthesia and surgery to a certain extent (3). Hip replacement, commonly used for joint diseases such as femoral head necrosis, arthritis and other skeletal retrograde injuries, is the best treatment option for elderly patients to improve prognosis and quality of life, but it requires a relatively long time and has a relatively high requirement for anesthesia methods due to patient age and surgical requirements (4, 5). Elderly patients have deteriorated systemic organ function due to advanced age and other factors, and thus suffer degenerated cognitive function and thinking to some extent (6). Given this, the effect of anesthesia on postoperative cognitive function in elderly patients must be taken into account (7). A study revealed that general anesthesia combined with epidural anesthesia applied has a relatively small impact on the respiratory and circulatory systems of elderly patients and fewer postoperative complications, which is conducive to improving the analgesic effect and postoperative cognitive function (8). However, the studies of combined anesthesia applied in hip surgeries for the elderly are rare. This study, therefore, explored the effects of different anesthesia methods on analgesia, oxidative stress and cognitive function in the elderly receiving hip replacement.

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Materials and methods

General data

One hundred elderly patients who were admitted to Tianjin Hospital from March 2017 to March 2019 and required hip replacement were selected and divided into group A (n=35, general anesthesia with endotracheal intubation), group B (n=35, epidural anesthesia) and group C (n=30, general anesthesia with endotracheal intubation + epidural anesthesia), including 53 males and 47 females aged 60-85 years old with a mean of (68.35±9.72) years old. This study was approved by the Ethics Committee of Tianjin Hospital and performed only after all patients enrolled signed the informed consent. Exclusion criteria: patients with a history of mental or neurological disease, those who could not undergo the operation due to severe chronic/acute disease of the respiratory or circulatory system, those with severely abnormal liver or kidney function, or those with abnormal blood system.

Methods

After the patients in three groups entered the operating room, ECG monitoring was used to closely monitor their blood pressure, blood oxygen, heart rate (HR) and other indicators. General anesthesia was adopted for the patients in group A: firstly, midazolam [Jiangsu Nhwa Pharmaceutical Co., Ltd., national medicine permission number (NMPN) H10980025, 2 mL: 2mg] and propofol (Sichuan Guorui Pharmaceutical Co., Ltd., NMPN H20040079, 20 mL: 0.2g) were intravenously infused at a dose of 0.03-0.04 mg/kg and 2.5 mg/kg, respectively, for induced anesthesia. After that, general anesthesia with endotracheal intubation was conducted, and anesthesia was maintained via mechanical ventilation. During anesthesia maintenance, halothane inhalation treatment was employed, and propofol was added at a dose of 1-2 mg/kg at intervals. Epidural anesthesia was applied to the patients in group B. The patients were in the lateral position with help. Then, the point of intersection of the anterior superior spine and the spine was selected as a puncture point. Next, local anesthesia was conducted with lidocaine, and then a puncture needle was inserted vertically. Finally, 0.5% ropivacaine injection (Jiangsu Nhwa Pharmaceutical Co., Ltd., NMPN H20052620) was injected from the vertical point, with 25-35 mL into the lumbar plexus nerve and 15-20 mL into the sciatic nerve. For the patients in group C, epidural anesthesia combined with general anesthesia was carried out. Epidural anesthesia was performed firstly according to the same procedures used in group B. Thereafter, general anesthesia with endotracheal intubation was performed based on the same procedures used in group A if there were no adverse reactions.

Detection of relevant indicators (inflammation indexes, stress indicators and two scores)

Fasting peripheral blood was collected from all patients before surgery and at 10 h after fasting for solids and liquids overnight after surgery, immunoturbidimetry was employed to measure the levels of [high-sensitivity C-reactive protein (hs-CRP), tumor necrosis factor-alpha (TNF-α), procalcitonin (PCT), interleukin-6 (IL-6), glucose (GLU) and cortisol (COR), and the changes in the vital signs before and after surgery were compared.

Evaluation of anesthetic effect: the anesthetic effect was graded as excellent (the analgesic effect was good, and the surgeon was satisfied with surgical procedures), fine (the traction reaction in patients was mild, and the requirement of surgical anesthesia was met), good (the traction reaction in patients was moderate, and analgesic drugs were applied several times to complete the surgery), and poor (the traction reaction in patients was severe, and there was a server impact on surgical procedures). The extubation time, eye-opening time and recovery time of patients in three groups were observed. Besides, the analgesic effect on patients was observed at different times after surgery, which was assessed using the visual analog scale (VAS) with a score range of 0-10 point (s). The lower the score is, the better the analgesic effect will be. Cognitive function was evaluated using the simple mini-mental status examination (MMSE)scale with a score range of 0-30 point (s). Score ≥26 points suggest normal cognitive function, and <26 points indicate different degrees of cognitive dysfunction.

Statistical methods

SPSS 19.0 software was used to process data. Data collected were expressed as ($\bar{\chi}\pm s$), and χ^2 test was employed to compare enumeration data. $p<0.05$ suggested that the difference was statistically significant.

Results and discussion

Comparisons of general clinical data among three groups

The general clinical data including age, gender, body mass index (BMI), history of smoking (n), hypertension (n) and surgical site exhibited no statistically significant differences among the three groups (p>0.05), which were comparable (Table 1).

2.2 Comparisons of vital signs before and after surgery among three groups

No statistically significant differences were found in the vital signs [systolic blood pressure (SBP), diastolic blood pressure (DBP) and HR] among the three groups before surgery. These indicators were increased in group A and B and exhibited no statistically significant differences in group C after surgery compared with those before surgery. In addition, the vital signs were overtly lower in group C than those in group A and B after surgery, showing statistically significant differences (p<0.05) (Table 2).

Comparison of VAS score among three groups at different time points after surgery

At 3 h after surgery, there was no difference in the VAS score among the three groups. At 12 h and 24 h after surgery, the VAS score declined compared with that at 3 h, and the decrease was more evident in the C group than that in group A and B, with a statistically significant difference (p<0.05) (Table 3).

Comparisons of inflammatory factor levels before and after surgery among three groups

The levels of inflammatory factors (hs-CRP, TNF-α and PCT) displayed no statistically significant differences among three groups before surgery. Compared with those before surgery, these levels were raised in group A and B and showed no statistically significant differences in group C after surgery. Besides, such levels were overtly lower in group C than those in group A and B after surgery, and differences were of statistical significance (p<0.05) (Table 4).

Comparisons of post-operative extubation time, eye-opening time upon calling and recovery time among three groups

No statistically significant differences were observed in the postoperative extubation time, eye-opening time upon calling and recovery time between group A and group B. Group C had distinctly shortened postoperative extubation time, eye-opening time upon calling and recovery time in comparison with group A and B, and the differences were statistically significant (p<0.05) (Table 5).

Comparisons of stress indicator levels before and after surgery among three groups

Before surgery, there were no statistically significant differences in the levels of stress indicators (IL-6, GLU and COR) among the three groups. These levels were elevated in group A and B and displayed no statistically significant differences in group C after surgery compared with those before surgery. Additionally, they were markedly lower in group C than those in group A and B after surgery, displaying statistically significant differences (p<0.05) (Table 6).

Comparison of MMSE score among three groups before surgery and at different time points after surgery

There was no difference in the MMSE score among the three groups before surgery, while it was lowered in group A and B after surgery and was not statistically different in group C compared with that before surgery (p<0.05) (Table 7).

Table 1. Comparisons of general clinical data among three groups

General data	Group A (n=35)	Group B (n=35)	Group C (n=30)
Age (years old)	69.57±10.04	67.93±7.86	70.09±8.53
Gender (male/female)	19/16	18/17	16/14
BMI (kg/m²)	20.71±3.59	22.03±2.65	20.65±3.59
History of smoking (n)	17	16	14
Hypertension (n)	20	19	16
Left (n)	18	20	16
Right (n)	17	15	14

Table 2. Comparisons of vital signs before and after surgery among three groups

Group	SBP (mmHg)		DBP (mmHg)		HR (beats/min)	
	Before surgery	After surgery	Before surgery	After surgery	Before surgery	After surgery
Group A	125.73± 10.13	139.51± 15.79	71.21± 7.89	79.91± 7.49	75.46± 7.25	98.96± 7.78
Group B	123.62± 11.90	135.76± 12.63	71.36± 7.75	80.03± 7.56	74.93± 7.41	96.57± 7.90
Group C	122.93± 11.57	120.85± 10.43	70.92± 6.68	71.18± 7.23	73.77± 7.47	75.65± 7.88
p	0.790	0.000	0.792	0.000	0.731	0.001

Table 3. Comparison of VAS score among three groups at different time points after surgery

Group	At 3 h after surgery	At 12 h after surgery	At 24 h after surgery
Group A	3.45±0.98	2.65±0.68	2.08±0.43
Group B	3.41±0.78	2.71±0.70	2.11±0.45
Group C	2.25±0.56	1.68±0.45	1.08±0.29

Table 4. Comparisons of inflammatory factor levels before and after surgery among three groups

Group	Hs-CRP (mg/L)		TNF-α (ng/mL)		PCT (μg/L)	
	Before surgery	After surgery	Before surgery	After surgery	Before surgery	After surgery
Group A	3.49±2.34	7.41±3.05	8.17±3.05	11.58±2.77	2.73±0.64	5.91±0.75
Group B	3.39±2.17	6.68±3.11	8.23±3.19	12.04±2.83	2.69±0.71	6.04±0.81
Group C	3.28±3.05	2.97±1.21	8.19±3.08	7.95±2.16	2.59±0.53	2.63±0.47
p	0.573	0.000	0.695	0.001	0.782	0.001

Table 5. Comparisons of extubation time, post-operative eye-opening time upon calling and recovery time among three groups (min)

Group	Extubation time	Post-operative eye-opening time upon calling	Recovery time
Group A	23.68±2.19	20.10±1.38	32.18±3.19
Group B	22.70±2.53	19.42±1.24	30.57±3.23
Group C	16.16±1.79	16.49±1.77	12.85±1.47

Table 6. Comparisons of stress indicator levels before and after surgery among three groups

Group	IL-6 (pg/mL)		GLU (mmol/L)		COR (mmHg)	
	Before surgery	After surgery	Before surgery	After surgery	Before surgery	After surgery
Group A	1.7±0.6	2.7±0.8	5.2±0.4	6.3±0.6	182.7±9.5	235.8±9.5
Group B	1.6±0.6	2.9±0.6	5.1±0.7	6.2±0.7	183.9±9.3	232.6±8.9
Group C	1.7±0.7	2.0±0.3	5.0±0.8	5.1±0.4	181.9±8.9	191.3±9.2
p	0.883	0.000	0.704	0.000	0.856	0.000

Table 7. Comparison of MMSE score among three groups before surgery and at different time points after surgery

Group	Before surgery	At 12 h after surgery	At 24 h after surgery
Group A	27.27±1.85	23.87±0.79	25.09±0.88
Group B	27.59±1.91	23.82±0.85	25.92±0.75
Group C	27.62±1.88	25.96±0.73	28.36±0.91

Joint necrosis, degeneration and inflammation severely affect the lives of elderly patients, and hip replacement is the most common treatment option for the above diseases, which can effectively prolong the life of patients and improve their postoperative quality of life (9). However, there is no unified anesthesia method in surgeries in clinical practice due to the age of elderly patients and the deterioration of their vital organs (10). As to the method and depth of anesthesia in surgeries, in addition to the requirements of the surgeon, the tolerance of patients shall be considered since the vital signs of patients are closely related to anesthesia methods (11). For elderly patients with abnormal cardiopulmonary function, inappropriate anesthesia methods may increase the risk of surgery and induce some common post-operative complications or even threaten lives at the same time (12,13). Currently, general anesthesia with endotracheal intubation is the most common anesthesia method used in hip replacement for the elderly in the clinic, which is featured by convenient patient ventilation and simple anesthesia management (14). However, it will affect the vital signs of patients to some extent, especially at intubation and extubation, and even result in myocardial ischemia in severe cases (15). To improve the safety and effectiveness of surgery and anesthesia, general anesthesia combined with epidural anesthesia is paid attention to (16). Moreover, appropriate anesthesia methods in surgeries are able to effectively reduce the incidence rate of postoperative cognitive dysfunction that, one of the common postoperative anesthesia complications of hip replacement for the elderly, reduces the self-care ability of patients to have a great impact on their livelihood, thus severely influencing the quality of life of patients (17). The depth of anesthesia required by general anesthesia will inhibit the breathing and circulatory system of patients to a certain extent. Epidural anesthesia requires a relatively accurate dose of anesthetic drugs, which complements the shortcomings of general anesthesia, has strong controllability and shortens the metabolism time of anesthetic drugs, effectively alleviating the effect of general anesthesia on the central nervous system (18). Therefore, general anesthesia combined with epidural anesthesia in hip replacement for the elderly attracts increasing attention. In this study, it was discovered that group C had effectively stabilized vital signs of patients, a reduced incidence rate of postoperative cognitive dysfunction and lowered postoperative stress indicator levels compared with group A and B, and the differences were statistically significant ($p<0.05$).

Besides, this study also found that group C exhibited effectively shortened extubation time, postoperative eye-opening time upon calling and

recovery time of patients. The MMSE score had no difference among the three groups before surgery, while it declined in group A and B and exhibited no difference in group C after surgery compared with that before surgery. This is because the anesthetic drug used in epidural anesthesia directly acts on the opioid receptor above the spinal cord and continuously blocks the upward painful impulsive behavior and the neural excitatory passage, which makes the nerve block function more comprehensive and perfect (19) and the general anesthesia relatively light and effectively tolerated for patients, thereby making the analgesic effect more obvious in surgeries (20). In conclusion, general anesthesia combined with epidural anesthesia brings a better surgical and postoperative environment for patients by effectively relieving the stimulation of hip replacement patients and reducing the adverse effects of drugs on the nervous system and providing relatively safe protection for the surgery and overall treatment of patients through maintaining the stable vital signs and tolerable stress status and decreasing postoperative adverse reactions.

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Availability of data and material

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Authors' contributions

JZwrote the manuscript. JZ and XS collected and analyzed general data of patients. YL and XG helped with the detection of relevant indicators.JZ and WR were responsible for statistical analysis. All authors read and approved the final manuscript.

Ethics approval and consent to participate

The study was approved by the ethics committee of Tianjin Hospital and informed consents were signed by the patients and/or guardians.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests

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