Application and Evaluation of Remifentanil in Conjunction with Sevoflurane in Elderly Total Hip Arthroplasty

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To observe the application and effects of remifentanil in conjunction with sevoflurane in elderly total hip arthroplasty. The research participants in this retrospective study consisted of 95 elderly patients who underwent total hip arthroplasty at our hospital during the period from October 2022 to October 2023. They were randomly allocated into either the control group (48 cases) or the observation group (47 cases). Intravenous administration of etomidate infusion (0.2 mg/kg), midazolam injection (0.02 mg/kg), sufentanil citrate injection (0.5 µg/kg), and cisatracurium besylate injection (0.1 mg/kg) were incorporated into the anesthesia induction protocol for the control group. Subsequent to tracheal intubation and initiation of mechanical ventilation, a continuous intravenous infusion of propofol emulsion at a rate of 4-6 mg/kg/h and remifentanil hydrochloride injection at a rate of 0.2 µg/kg/min was administered. The anesthesia induction protocol for the observation group involved the administration of 5 % sevoflurane inhalation, intravenous infusion of cisatracurium besylate injection at a dose of 0.1 mg/kg, midazolam injection at a dose of 0.02 mg/kg, remifentanil hydrochloride injection at a dose of 1 µg/kg, and etomidate injection at a dose of 0.1 mg/kg. Subsequent to tracheal intubation and initiation of mechanical ventilation, the patients were administered inhalation of sevoflurane at a concentration range of 1 % to 1.5 %, along with a continuous intravenous infusion of propofol emulsion at a dosage of 3-6 mg/kg/h and remifentanil hydrochloride injection at a dosage of 0.1 µg/kg/min. There was no substantial difference in the incidence of adverse reactions between the two groups (p>0.05). The application of remifentanil in conjunction with sevoflurane in elderly total hip arthroplasty has several advantages. By employing this combination, healthcare providers can achieve reduced durations of loss of consciousness, extubation, and awakening in patients, ensuring a significant analgesic effect and promoting a desirable state of postoperative sedation. Importantly, this approach exemplifies a robust safety profile.

Key words: Remifentanil, sevoflurane, arthroplasty, anesthesia, opioids

The global aging phenomenon has resulted in an increasing need for Total Hip Arthroplasty (THA) within the elderly community. THA represents a highly effective approach in the management of severe hip joint diseases, contributing to substantial improvements in patient's quality of life and functional outcomes[1,2]. The anesthesia management of elderly patients is confronted with various challenges owing to the coexistence of multiple underlying diseases, comorbidities, and medication treatments, thus rendering the anesthesia process more intricate[3]. Suboptimal anesthesia management during surgical interventions has the potential to elicit pronounced stress responses, which can impede the unhindered advancement of the procedure[4]. Additionally, it can impact the central nervous system, giving rise to brain and nerve injuries, consequently delaying the postoperative recovery processes[5]. Renowned for its swift onset, brief duration, and remarkable analgesic efficacy, remifentanil is a synthetic opioid analgesic of exceptional potency[6]. Its mechanism of action lies in its binding capability to mu (µ) receptors, ultimately hindering pain transmission and neuronal excitation, resulting in profound analgesic effects[7]. Widely utilized in general anesthesia management, including the elderly population, Sevoflurane serves as a popular general anesthetic due to its capacity for

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rapid anesthesia induction and accelerated recovery[8]. Extensive attention has been devoted to exploring the utilization of both remifentanil and sevoflurane as analgesic and anesthetic agents in THA. Nevertheless, there exists a paucity of research examining the specific application and evaluation of this particular combination in elderly patients undergoing the same surgical procedure. In order to optimize anesthesia management for elderly individuals undergoing THA, a meticulous assessment of the utilization and impacts of combining remifentanil and sevoflurane is essential. This study seeks to optimize the choice of anesthesia protocols, enhance pain management techniques during surgery, and augment postoperative patient satisfaction. By doing so, we aim to establish a more secure and efficient approach for THA in elderly individuals. A retrospective study was performed on a sample of 225 elderly patients who underwent THA at our hospital during the period from October 2020 to October 2023. This study employed the following criteria for participant inclusion, age ≥60 y; meeting the indications for primary THA and being a first-time THA recipient; ensuring informed consent was provided through signed documentation; classified as American Society of Anesthesiologists (ASA) physical status class II or III and undergone surgery performed by a consistent surgical team. Exclusion criteria encompassed the following, primary cardiac, cerebral, hepatic, renal, or other systemic diseases; detection of malignant tumors; prolonged usage of sedative medications; coagulation abnormalities; preoperative cognitive impairment and incomplete clinical data. Patients were allocated into two distinct cohorts, the observation group (n=47), which included individuals administered a combination of remifentanil and sevoflurane during surgery, and the control group (n=48), comprising patients exclusively receiving remifentanil. The control group exhibited an average age of 70.64±5.28 y, encompassing 27 males and 21 females. ASA grading revealed 17 cases classified as level III and 31 cases classified as level II within this group. Notably, the pathologies observed in the control group included 4 cases of old femoral neck fractures, 12 cases of hip degenerative osteoarthritis, 18 cases of avascular necrosis of the femoral head, and 14 cases of hip ankylosis. Within the observation group, the mean age was determined to be (70.07±5.06) y, comprising 29 males and 18 females. Analysis based on the ASA grading system revealed 19 cases classified as level III and 28 cases classified as level II. In terms of pathology, the observation group exhibited instances of old femoral neck fractures, avascular necrosis of the femoral head, degenerative osteoarthritis of the hip joint, and hip ankylosis, with respective occurrences of 4, 15, 17, and 11 cases. Evaluation of the general data unveiled no notable differences ($p>0.05$) between the two groups, denoting their comparability. Prior to the procedure, both groups complied with the established fasting protocol, observing an 8 h restriction on food intake and a 6 h abstinence from drinking. Upon entering the operating room, the patient's intravenous access was established, vital signs were closely monitored, and a 3 min pure oxygen therapy was initiated. Prior to the administration of anesthesia, the patient received an intravenous injection of hexobarbital hydrochloride injection (produced by Jinzhou Aohong Pharmaceutical Co., Ltd., Chengdu Tiantaishan) at a dosage of 0.01 mg/kg. The control group underwent anesthesia induction according to the following protocol, intravenous bolus injection of etomidate (Jiangsu Enhua, National Medical Products Approval Number H32022992, Specification: 10 ml: 20 mg) at a dosage of 0.2 mg/kg, followed by midazolam injection (Yichang Renfu, National Medical Products Approval Number H20067040, Specification: 2 ml:2 mg) at a dosage of 0.02 mg/kg, sufentanil citrate injection (Yichang Renfu, National Medical Products Approval Number H20024171, Specification: 1 ml:50 μg) at a dosage of 0.5 μg/kg, and cisatracurium besylate injection (Nanjing Jianyou, National Medical Products Approval Number H20203700, specification of 5 ml:10 mg) at a dosage of 0.1 mg/kg. Following tracheal intubation, the patient was mechanically ventilated. Continuous intravenous infusion of propofol emulsion (produced by Jiangsu Enhua, National Medical Products Approval Number H20123138, specification of 20 ml:0.2 g) was administered at a rate of 4-6 mg/kg/h. The patient also received an intravenous infusion of remifentanil hydrochloride (produced by Yichang Renfu, National Medical Products Approval Number H20030197, specificationof 1 mg) at a rate of 0.2 μg/kg/min. The anesthesia induction protocol employed in the observation group included both inhalational and intravenous techniques. Inhalation of sevoflurane at a concentration of 5 % (produced by Shanghai Hengrui, National Medical Products Approval Number H20070172, and specification of 120 ml) was utilized to maintain anesthesia. Furthermore,

intravenous administration comprised a bolus injection of cisatracurium besilate at a dosage of 0.1 mg/kg, midazolam injection at a dosage of 0.02 mg/kg, remifentanil hydrochloride injection at a dosage of 1 μg/kg, and etomidate injection at a dosage of 0.1 mg/kg. Following tracheal intubation, the patient underwent mechanical ventilation. Intravenous administration of sevoflurane inhalation was initiated at a concentration ranging from 1 % to 1.5 %. Additionally, continuous intravenous infusion of propofol emulsion at a rate of 3-6 mg/kg/h and remifentanil hydrochloride at a rate of 0.1 μg/kg/min were administered. The duration of loss of consciousness, extubation time, and awakening time were observed in both groups. Prior to the surgery and 12 h postoperatively, the patient's sedation and analgesia were carefully assessed. The level of sedation was determined using the Ramsay sedation scale[9], which assigns a score ranging from 1 to 6. A higher score indicates a deeper level of sedation. The scale categorizes levels as follows, 1 for anxious and agitated, 2 for calm and cooperative, 3 for drowsy but easily arousable, 4 for asleep and brisk response to stimulation, 5 for asleep and sluggish response to stimulation, and 6 for unarousable. Pain intensity was assessed using the Visual Analog Scale (VAS) [10], which ranges from 0 to 10, with higher scores indicating higher pain intensity. Comprehensive surveillance and documentation of adverse reactions were conducted during the perioperative period, followed by calculation of the incidence rate for these unfavorable events. Statistical Package for the Social Sciences (SPSS) 25.0 will be employed to perform the statistical analysis in this research. Continuous variables will be presented as means and standard deviations, and their analysis will be conducted using t-tests. Categorical variables, on the other hand, will be expressed as frequencies and percentages n (%) and assessed using Chi-square ($\chi 2$) tests. To establish statistical significance, a threshold of $p<0.05$ will be utilized. Remarkable differences were observed between the control and observation groups in terms of the durations of loss of consciousness, extubation, and awakening ($p<0.05$), with the observation group exhibiting shorter durations, as outlined in Table 1. Following 12 h of postoperative recovery, both groups exhibited an increase in VAS scores. However, the observation group demonstrated substantially lower scores compared to the control group at the same time point. Furthermore, while the Ramsay sedation scale scores decreased in both groups, the observation group displayed notably higher scores than the control group ($p<0.05$), as indicated in Table 2. The control group experienced 2 cases of pruritus, 4 cases of nausea and vomiting, 2 cases of drowsiness, and 3 cases of hypotension, yielding an incidence rate of adverse reactions of 22.92 %. Similarly, the observation group had 2 cases of pruritus, 2 cases of nausea and vomiting, 4 cases of drowsiness, and 2 cases of hypotension, resulting in an incidence rate of adverse reactions of 21.28 %. The comparison between the two groups revealed no significant difference in the incidence of adverse reactions ($p>0.05$), as displayed in Table 3. THA is a frequently employed therapeutic approach in the field of orthopedics. Progress in the realms of biomechanics, materials science, friction dynamics, and surgical techniques has contributed to a gradual enhancement in the success rate of this procedure, which in turn has resulted in heightened patient acceptance. The surgical technique discussed here is frequently employed in geriatric patients. Nonetheless, due to their advanced age and underlying comorbidities, along with the intricate nature of THA which involves femoral head resection, joint capsule manipulation, and prosthesis implantation, the procedure is associated with a notable degree of surgical and anesthetic risk[2]. Achieving optimal anesthesia effects and minimizing surgical risks for patients necessitates the meticulous selection of appropriate anesthetic drugs. Remifentanil demonstrates non-specific esterase hydrolysis, rapid onset and metabolism, and non-organ-dependent metabolism, which enhances patient tolerance to tracheal intubation, prevents severe cough reflex, and maintains stable hemodynamic parameters. Additionally, it facilitates precise control of the dosage when administered in clinical settings[11,12]. Sevoflurane, as an inhaled anesthetic, offers advantages such as rapid anesthesia induction, rapid emergence, and minimal impact on the cardiovascular and respiratory systems[13]. Furthermore, sevoflurane is less readily absorbed by blood and tissues, allowing for easier control of anesthesia depth[14]. Some studies have shown that the combination of sevoflurane and remifentanil can improve anesthesia effectiveness and help alleviate postoperative pain, thereby promoting patient recovery[15,16]. The aim of this study was to assess the utilization of the combined administration of remifentanil and sevoflurane in elderly patients who underwent THA. The study

results revealed that the observation group had markedly shorter durations of loss of consciousness, extubation, and emergence when compared to the control group. These findings demonstrate that the combined administration of remifentanil and sevoflurane facilitates swift anesthesia induction and recovery, thereby minimizing the overall duration of anesthesia during the surgical procedure. At the 12 h mark after surgery, both groups exhibited an increase in pain scores; however, the observation group reported lower levels of pain compared to the control group. These findings suggest that the combination of remifentanil and sevoflurane in the observation group yielded superior analgesic effects, effectively mitigating postoperative pain. The present findings are in line with prior research, substantiating the advantage of employing the combination of remifentanil and sevoflurane in effectively managing pain during hip arthroplasty procedures in older adults. Based on the sedation levels, the observation group had higher Ramsay sedation scale scores, indicating a deeper sedation state compared to the control group. The lower sedation scores in the control group may be attributed to the specific types and dosages of anesthetic drugs and sedatives used. This suggests that the combination of remifentanil and sevoflurane can provide better sedation effects, ensuring patients are in a more comfortable sedated state. Regarding adverse reactions, the incidence rates were similar between the two groups, showing no significant difference. Both groups encountered adverse reactions, such as pruritus, nausea and vomiting, drowsiness, and hypotension. Nevertheless, the cumulative incidence rates of these adverse events remained within an acceptable range. Notably, the administration of the remifentanil and sevoflurane combination to elderly patients did not heighten the likelihood of adverse reactions, underscoring its commendable safety profile. Collectively, the findings of this investigation highlight several advantages associated with administering the combination of remifentanil and sevoflurane in elderly patients undergoing THA. These advantages encompass shortened durations of loss of consciousness, extubation, and emergence, along with effective pain relief and desirable postoperative sedation. Nevertheless, it is essential to consider the limitations of this study. Specifically, it is worth noting that this investigation adopts a retrospective approach, thereby potentially influencing data collection and introducing biases. Furthermore, the sample size of this study was relatively small, implying the possibility of sample selection bias. Consequently, future research endeavors should employ larger sample sizes and incorporate multicenter designs to validate the robustness and generalizability of the obtained results. In conclusion, the utilization of the combination of remifentanil and sevoflurane in THA surgeries for elderly patients yields notable clinical benefits. Nevertheless, to establish the optimal application protocols and thoroughly assess its safety and potential side effects, larger-scale studies conducted across multiple centers are warranted. The results of this study will provide valuable insights for guiding clinical practice and elevating the standard of anesthesia management, thereby promoting higher levels of patient satisfaction during THA procedures in elderly patients.

TABLE 1: AWAKENING QUALITY (min, x±s)

Group (n)	Consciousness disappearance time	Awakening time	Extubation time
Observation (47)	3.81±0.82	16.40±1.42	22.91±2.71
Control (48)	5.15±0.92	20.85±2.53	28.10±3.65
t	7.445	10.545	7.862
p	0.000	0.000	0.000

TABLE 2: SEDATION AND ANALGESIA SCORES (POINTS, x±s)

Group (n)	VAS		Ramsay sedation score	
	Before	After	Before	After
Observation (47)	1.89±0.60	2.51±0.72*	2.34±0.48	1.64±0.64*
Control (48)	1.98±0.70	3.90±0.78*	2.42±0.50	1.38±0.53*
t	0.640	9.008	0.760	-2.184
p	0.524	0.000	0.449	0.031

TABLE 3: ADVERSE REACTIONS n (%)

Group (n)	Pruritus	Nausea and vomiting	Drowsiness	Hypotension	Overall incidence
Observation (47)	2 (4.26)	2 (4.26)	4 (8.51)	2 (4.26)	10 (21.28)
Control (48)	2 (3.08)	4 (5.38)	2 (6.15)	3 (3.85)	11 (22.92)
χ^2					0.037
p					0.847

Conflict of interests:

The authors declared no conflict of interests.

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