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Effectiveness and Safety of Low-flow Sevoflurane Combined with Remifentanil on Anaesthesia of Patients Undergoing Gynaecological Laparoscopic Surgery

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Abstract: *Objective:* To evaluate the advantages of sevoflurane (low-flow) + remifentanil for patients undergoing gynaecological laparoscopic surgery. *Methods:* 300 patients admitted for gynaecological laparoscopic surgery between July 2020 and July 2023 were selected and divided equally by random number table, 150 cases were counted in the observation group, and sevoflurane (low-flow) + remifentanil was chosen for maintenance anaesthesia; 150 cases were counted in the reference group, and anaesthesia was maintained only with remifentanil. The anaesthesia indexes, haemodynamics, stress reaction indexes, and adverse reaction rate of the two groups were compared. *Results:* The anaesthesia indexes of the observation group were better than those of the reference group ($P < 0.05$). Before 5 min of anaesthesia (T1), there was no difference between the haemodynamics and stress reaction indexes of the two groups ($P > 0.05$). After 30 min of pneumoperitoneum (T2) and immediately after the end of surgery (T3), the hemodynamic and stress indicators of the observation group were lower than those of the reference group ($P < 0.05$). The adverse reaction rate of the observation group was lower than that of the reference group ($P < 0.05$). *Conclusion:* Sevoflurane (low-flow) + remifentanil can improve the anaesthesia indexes of gynecological laparoscopic surgery patients, stabilize intraoperative haemodynamics, reduce the stress reaction, and the safety of medication is high.

Keywords: Low-flow; Sevoflurane; Remifentanil; Gynaecological laparoscopic surgery; Anaesthesia effects

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1. Introduction

Laparoscopic surgery is a more commonly used surgical procedure in clinical gynaecology, which has the advantages of minimal invasiveness, safety, and a high surgical success rate. However, the creation of an artificial pneumoperitoneum in laparoscopic surgery increases intrathoracic pressure, which decreases the

diastolic function of the heart and leads to intraoperative stress [1,2]. For this reason, attention needs to be paid to the induction and maintenance of anaesthesia for this procedure to ensure the effectiveness of anaesthesia while minimizing the negative effects on the circulatory system, so that the patient can complete the surgical treatment smoothly and safely. Currently, remifentanil is a commonly used anaesthetic drug for laparoscopic surgery, which can maintain haemodynamic stability. Combined with sevoflurane (low-flow) inhalation, anaesthesia can reduce the adverse stress caused by carbon dioxide pneumoperitoneum and enhance the analgesic effect [3]. For this reason, 300 gynaecological laparoscopic surgery patients were selected in this study to evaluate the anaesthetic effect of sevoflurane (low-flow) + remifentanil.

2. Information and methods

2.1. General information

The study period was from July 2020 to July 2023, and 300 laparoscopic surgery patients admitted to the gynaecology department were selected. Random number table grouping, observation group 150 cases, age in 24–68 years old, mean (44.28 ± 5.91) years old; body mass in 41–79 kg, mean (58.94 ± 6.37) kg; lesion site: uterus 41 cases, ovary 68 cases, fallopian tube 41 cases. In the reference group, there were 150 cases with ages ranging from 23 to 66 years, with a mean of (44.71 ± 5.67) years old; body mass ranging from 42 to 78 kg, with a mean of (58.60 ± 6.72) kg; and lesion sites: uterus in 38 cases, ovary in 72 cases, and fallopian tube in 40 cases. Compared with the basic data of the two groups, $P > 0.05$, that is, comparable.

Inclusion criteria: (1) meet the indications for laparoscopic surgery; (2) meet the indications for anaesthesia; (3) normal mental status; (4) normal communication and audio-visual ability; (5) complete clinical data.

Exclusion criteria: (1) combined with liver and kidney diseases; (2) accompanied by mental disorders; (3) combined with malignant tumours and other serious diseases; (4) allergic to the study drugs; (5) transit open surgery; and (6) withdrawing from the study in the middle of the study.

2.2. Methods

Both groups of patients were fasted and abstained from food and drink before surgery, and atropine was injected intramuscularly at a dose of 0.5 mg, 30 min before surgery, and intravenous access was created after admission to the room, and the patients were monitored for signs and treated with oxygen. The anaesthesia method was the same in both groups, which was general anaesthesia by tracheal intubation, and anaesthesia was induced by intravenous infusion of fentanyl (6 μg/kg) + atracurium (0.5 mg/kg) + midazolam (0.1 to 0.8 mg/kg) + etomidate (0.1 mg/kg). The ventilation frequency level of mechanical ventilation was maintained at 15–20 times per minute, and the respiratory parameters were reasonably adjusted in the light of the patient's specific situation. The pneumoperitoneal pressure level of carbon dioxide was 10–15 mmHg, and low-flow air intake treatment was also given.

The anaesthesia maintenance method of the reference group was: remifentanil micro-pumping, and its pumping volume was 0.5 mg/kg per minute, and it was continuously pumped until the pneumoperitoneum stopped. In the observation group, based on the reference group, sevoflurane was inhaled at a concentration between 1.5% and 3.0%, and the end-expiratory concentration was maintained at 2.0%. The depth of anaesthesia was moderately adjusted according to the patient's condition, and sevoflurane was discontinued

when the pneumoperitoneum stopped.

The two groups were given continuous oxygen therapy during the operation, with the oxygen flow rate set at 4.5–6.5 L/min, and atracurium was added intermittently according to the intraoperative situation, with an additional amount of 0.5 mg/kg.

2.3. Observation indexes

(1) Anaesthesia indexes: Observe the time of conscious wakefulness, the time of spontaneous respiratory resumption, the time of orientation resumption, the time of eye-opening and the time of extubation.

(2) Haemodynamics: Heart rate (HR), mean arterial pressure (MAP) and oxygen saturation (SpO2) data from cardiac monitor were recorded from T1 to T3 time points.

(3) Indicators of stress response: At T1 to T3 time points, levels of cortisol (COR), norepinephrine (NE) and epinephrine (E) were measured by radioimmunoassay.

(4) Adverse reactions: Observe the adverse reactions such as laryngospasm, hypotension, agitation with nausea and vomiting.

2.4. Statistical analysis

The data were processed by SPSS 28.0 software, and the measurement data were expressed as mean ± standard deviation (SD), using t value comparison and test, and the count data were expressed as (n/%), using χ^2 value comparison and test, and the statistical significance was $P < 0.05$.

3. Results

3.1. Comparison of anaesthesia indexes between the two groups

All anaesthesia indexes of the observation group were better than those of the reference group ($P < 0.05$) (**Table 1**).

Table 1. Comparison of anaesthesia indexes between the two groups (mean ± SD, min)

Grouping	Time to consciousness	Time to return to spontaneous respiration	Time to return to directional force	Eye opening time	Extubation time
Observation group (n = 150)	9.42 ± 1.82	4.60 ± 0.53	7.26 ± 1.63	6.65 ± 1.30	5.44 ± 0.64
Reference group (n = 150)	12.73 ± 1.95	5.38 ± 0.67	9.47 ± 1.68	8.42 ± 1.37	10.53 ± 1.49
t	15.198	11.182	11.563	11.478	38.442
P	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

3.2. Comparison of haemodynamic indexes between the two groups

At T1, there was no difference in the haemodynamics of the two groups ($P > 0.05$). At T2 and T3, the haemodynamics of the observation group was lower than that of the reference group ($P < 0.05$) (**Table 2**).

Table 2. Comparison of haemodynamic indexes between the two groups (mean ± SD)

Grouping	HR (cycles/min)			MAP (mmHg)			SpO_2 (%)		
	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3
Observation group (n = 150)	81.29 ± 7.61	84.25 ± 6.71	82.43 ±6 .50	64.15 ± 6.54	70.52 ± 8.91	66.27 ± 6.17	97.55 ± 1.53	96.74 ± 1.03	95.66 ± 1.12
Reference group (n = 150)	81.38 ± 7.50	90.33 ± 6.53	87.19 ± 6.37	65.02 ± 6.73	78.33 ± 8.19	73.02 ± 6.84	97.54 ± 1.46	94.03 ± 1.01	93.87 ± 1.15
t	0.103	7.953	6.406	1.135	7.904	8.975	0.058	23.008	13.657
P	0.918	< 0.001	< 0.001	0.257	< 0.001	< 0.001	0.954	< 0.001	< 0.001

3.3. Comparison of stress reaction indexes between the two groups

At T1, there was no difference in the stress reaction indexes of the two groups ($P > 0.05$). At T2 and T3, the stress reaction indexes of the observation group were lower than those of the reference group ($P < 0.05$) (**Table 3**).

Table 3. Comparison of stress reaction indexes of the two groups (mean ± SD, ng/L)

Group	COR			NE			E		
	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3
Observation group (n = 150)	127.54 ± 15.36	135.66 ± 18.92	130.57 ± 16.99	231.68 ± 24.61	255.83 ± 27.92	245.91 ± 22.05	187.64 ± 15.71	197.53 ± 20.30	190.55 ± 18.07
Reference group (n = 150)	126.92 ± 15.24	207.91 ± 19.82	183.67 ± 17.58	230.21 ± 23.94	340.72 ± 28.61	310.24 ± 23.17	188.77 ± 15.93	234.61 ± 24.63	207.15 ± 20.47
t	0.351	32.294	26.601	0.524	26.008	24.633	0.619	14.228	7.446
P	0.726	< 0.001	< 0.001	0.600	< 0.001	< 0.001	0.537	< 0.001	< 0.001

3.4. Comparison of adverse reaction rates between the two groups

The adverse reaction rate of the observation group was lower than that of the reference group ($P < 0.05$) (**Table 4**).

Table 4. Comparison of adverse reaction rates between the two groups (n/%)

Group	Laryngospasm	Hypotension	Agitation	Nausea and vomiting	Incidence
Observation group (n = 150)	0	1 (0.67)	0	1 (0.67)	1.33 (2/150)
Reference group (n = 150)	2 (1.33)	3 (2.00)	1 (0.67)	3 (2.00)	6.00 (9/150)
χ^2	-	-	-	-	4.624
P	-	-	-	-	0.032

4. Discussion

Gynaecological laparoscopic surgery is a minimally invasive procedure, which can reduce the patient's organic damage and shorten the postoperative recovery cycle [4,5]. However, the need to create an artificial pneumoperitoneum during surgery, coupled with the exogenous stimulation of special positions, laparoscopes

and other surgical instruments, can easily lead to intraoperative stress, which in turn affects the patient's nervous system as well as the circulatory system, and reduces their surgical tolerance. Previous studies have found that carbon dioxide artificial pneumoperitoneum will elevate the diaphragm due to the increase in abdominal pressure during the creation process, which will compress the lungs, reduce lung compliance, affect pulmonary ventilation, and then change the SpO2 level [6]. Laparoscopic surgery requires patients to maintain a head-down position, which is prone to hemodynamic fluctuations. In order to improve the smoothness of surgery, the anaesthesia protocol needs to be optimized [7].

Remifentanil is a short-duration anaesthetic drug, with a fast onset of action and a small distribution volume in the body, which is not easy to lead to drug accumulation reactions and basically has no respiratory depression [8,9]. In the anaesthesia process of laparoscopic surgery, the anaesthesia depth of remifentanil is controllable, and the target-controlled infusion can maintain a more ideal blood concentration and continuously exert anaesthesia effect. Combined with sevoflurane can enhance the anaesthetic effect, the drug's blood gas partition coefficient is small, inhalation anaesthesia does not stimulate the respiratory tract. The fast induction speed and postoperative wakefulness play a synergistic mechanism with remifentanil and thus improve the anaesthesia index [10]. In this study, the anaesthesia indexes of patients in the observation group were better than those of the reference group ($P < 0.05$).

Remifentanil can reasonably regulate the depth of anaesthesia during anaesthesia for laparoscopic surgery, and stabilize its blood concentration by target-controlled infusion so that it can continuously play an analgesic role and reduce intraoperative stress reactions. Remifentanil can achieve blood-brain equilibrium within 1 min of administration, and within 10 min of stopping the drug after surgery, patients can breathe on their own without significant interference in haemodynamics [11]. Sevoflurane is an inhaled drug, which has little negative impact on circulatory function, and the drug can be metabolized rapidly, relaxing muscles and exerting strong analgesic effects in a short time, so the intraoperative haemodynamics are more stable and the stress reaction is less. In addition, the drug component of sevoflurane is sevoflurane, which has a more aromatic odour and is highly accepted by patients [12]. Inhalation anaesthesia can flexibly control the depth of anaesthesia, maximize the advantages of the combination of drugs, and enable patients to successfully complete surgical treatment. In this study, the hemodynamic indexes of T2 to T3 in the observation group were lower than those of the reference group, and the stress response indexes were lower than those of the reference group ($P < 0.05$). The results were basically consistent with the findings of Han Menghe *et al.* (2021) [13].

Remifentanil basically does not affect the liver and kidney functions during metabolism, and its bioavailability is high [14]. While sevoflurane is administered by inhalation, it does not significantly affect circulatory function, can reasonably control the concentration of anaesthetic drugs. The drug metabolism rate is high with no drug accumulation, and it is not easy to lead to adverse reactions after using the drug. The combination of drugs can exert anaesthetic efficacy in multiple targets and mechanisms, increase the anaesthetic effectiveness of remifentanil, and reduce the specific dosage of remifentanil, so there are fewer side effects after anaesthesia [15]. In this study, the adverse reaction rate of the observation group was lower than that of the reference group ($P < 0.05$).

5. Conclusion

In conclusion, sevoflurane (low-flow) + remifentanil can be used as a common anaesthetic maintenance

regimen for gynaecological laparoscopic surgery, which can shorten the post-anaesthetic awakening time, restore the autonomic respiratory function and orienting force as soon as possible. It can stabilize intraoperative haemodynamics, prevent intraoperative stress reactions, and has high anaesthetic safety.

Disclosure statement

The authors declare no conflict of interest.

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