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Efficacy and safety of ciprofol in laparoscopic myomectomy anesthesia

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Abstract: **Objective** To study the efficacy and safety of ciprofol in laparoscopic myomectomy anesthesia, and provide a reference for the rational selection of anesthesia methods in clinical laparoscopic minimally invasive surgery. **Methods** Eighty patients who underwent laparoscopic myomectomy at Zhongshan Hospital Affiliated to Xiamen University from May 2022 to February 2024 were retrospectively grouped according to different anesthesia regimens. Thirty-two patients who received the propofol combined anesthesia regimen were the control group, and 48 patients who received the ciprofol combined anesthesia regimen were the study group. The perioperative indicators, and stress response indicators, hemodynamic indicators, cognitive functions at different time points as well as the occurrence of perioperative adverse reactions were compared between the two groups. **Results** The recovery time of the study group was shorter than that of the control group (P<0.05), and the Steward score of 30 min after recovery was higher than that of the control group (P<0.05), but there was no significant difference in the operation time between the two groups (P>0.05). Serum levels of adrenocorticotropic hormone (ACTH) and cortisol (Cor) gradually increased with prolonged surgery duration in both groups (P<0.05). ACTH and Cor levels in the study group were lower than those in the control group at 5 min after tracheal intubation (T_2), immediately after extubation (T_3), and at the end of operation (T_4) (P< 0.05). In terms of hemodynamic indicators, the levels of peripheral capillary oxygen saturation (SpO_2) at T_2 and T_3 in the study group were (97.05%±2.50%) and (97.80%±2.32%) , respectively, which were both higher than those in the control group [(94.01%±2.11%) and (95.75%±2.40%) (P<0.05); the mean arterial pressure (MAP) levels in the study group at T_2, T_3, and T_4 were (72.90 ± 4.58) mmHg, (71.65 ± 5.50) mmHg, and (72.60 ± 4.62) mmHg, respectively, which were lower than those of the control group [(78.50±6.21) mmHg, (76.25±5.72) mmHg, (77.50± 5.25) mmHg] (P<0.05). The postoperative mini-mental state examination (MMSE) scores of the two groups were lower than those before surgery (P<0.05), and the MMSE scores of the control group were lower than those of the study group 1 and 3 days after surgery (P<0.05). In addition, the incidence of perioperative adverse reactions in the study group was significantly lower than that in the control group, and the difference between two groups was statistically significant (6.25% *vs* 25.00%, χ^2=4.220, P<0.05). **Conclusion** The application of ciprofol in laparoscopic myomectomy can help shorten the postoperative recovery time and improve the recovery quality of patients, with minimal influence on the hemodynamics during anesthesia. It can also inhibit intraoperative stress response, reduce the risk of postoperative cognitive function damage, and provide high safety.

Keywords: Laparoscopic myomectomy; Ciprofol; Adrenocorticotropin; Cortisol; Security

Uterine fibroids are one of the most common benign tumors of the female reproductive system. They primarily occur in women over the age of 30, initially without obvious symptoms. As the condition progresses, symptoms such as urinary and bowel difficulties may appear. Surgical resection is currently the most effective and commonly used treatment for uterine fibroids [1-2]. Laparoscopic myomectomy is increasingly favored by patients and clinicians due to its characteristics of minimal trauma, low blood loss, and rapid recovery. However, in recent clinical practice, it has been found that processes such as skin incision and pneumoperitoneum during laparoscopic myomectomy can still induce certain stress responses and hemodynamic fluctuations in patients. Therefore, the reasonable selection of anesthetic drugs is of great significance in ensuring the success of the surgery and promoting postoperative recovery [3-4]. Ciprofol is a new intravenous anesthetic developed in recent years. It mainly promotes chloride ion influx and hyperpolarization of nerve cell membranes by activating γ-aminobutyric acid type A (GABAA) receptors, thereby further inhibiting the central nervous system to exert anesthetic or sedative effects. It has been applied in fields such as anesthesia induction and maintenance for adult surgery, fiberoptic bronchoscopy, and digestive endoscopy [5-7]. This study aimed to explore the efficacy and safety of ciprofol in anesthesia for laparoscopic myomectomy, in order to provide a reference for the rational selection of anesthesia methods in clinical laparoscopic minimally invasive surgery. The details are reported as follows.

1. Materials and methods

1.1 General information

A retrospective analysis was conducted on the clinical data of 80 patients who underwent laparoscopic myomectomy at the Zhongshan Hospital Affiliated to Xiamen University between May 2022 and February 2024. The patients were divided into two groups based on the anesthetic regimen: 32 patients in the control group who received propofol-based anesthesia and 48 patients in the

study group who received ciprofol-based anesthesia. Inclusion criteria: (1) American Society of Anesthesiologists (ASA) physical status [8] I–II; (2) indication for laparoscopic myomectomy and successful surgery. Exclusion criteria: (1) Preoperative assessment indicating coagulation disorders, allergy to anesthetic drugs, or difficult endotracheal intubation; (2) Preoperative medication that could affect hemodynamics or stress responses; (3) Presence of malignancy, severe liver or kidney dysfunction, autoimmune diseases, or psychiatric disorders; (4) Pregnant or lactating women. This study was approved by the Ethics Committee of Zhongshan Hospital Affiliated to Xiamen University (Approval number: xmzsyyky-2024-533).

1.2 Methods

Both groups underwent elective laparoscopic myomectomy with preoperative fasting for 8 hours and water restriction for 4 hours. Upon entering the operating room, the patients were monitored for electrocardiography and bispectral index (BIS). A venous access was established, followed by oxygen inhalation for 3 minutes, and then anesthesia induction was conducted. The control group received remifentanil [3 μg/(kg·h), Batch number: 30A09251, Manufacturer: Wuhan Renfu Pharmaceutical Co., Ltd.], propofol (2 mg/kg, Batch number: 5C231206, Manufacturer: Guangdong Jiabo Pharmaceutical Co., Ltd.), and rocuronium bromide (2.5 mL, Batch number: 220901-3, Manufacturer: Nanjing Hengdao Pharmaceutical Co., Ltd.). When the BIS reached 40–60, anesthesia induction was considered successful. If induction failed, additional doses of propofol (≤1 mg/kg) were given. The study group received remifentanil [3 μg/(kg·h)], ciprofol (0.4 mg/kg, Batch number: 20221006, Manufacturer: Liaoning Haishike Pharmaceutical Co., Ltd.), and rocuronium bromide (2.5 mL). When BIS reached 40-60, anesthesia induction was considered successful. If induction failed, additional doses of ciprofol (≤0.2 mg/kg) were administered. Surgery commenced after the disappearance of the eyelash reflex. In the control group, anesthesia maintenance was achieved with a propofol infusion of 4-6 mg/(kg·h), and in the study group, anesthesia was maintained with a ciprofol infusion of 1-1.5 mg/(kg·h). The depth of anesthesia was maintained at a BIS of 40-60. Ten minutes before the end of the surgery, infusion of propofol and ciprofol was stopped, and remifentanil was discontinued at the end of the surgery.

1.3 Observational indicators

(1) Perioperative indicators: Including surgery time, postoperative awakening time, and Steward score at 30 minutes after awakening [9]. The Steward score assesses the quality of awakening based on three dimensions: consciousness level, limb movement, and patency of respiration, with a higher score indicating better recovery.

(2) Stress response indicators: The levels of serum adrenocorticotropic hormone (ACTH) and cortisol (Cor) were recorded and compared at 10 minutes before anesthesia induction (T1), 5 minutes after tracheal intubation (T2), immediately after extubation (T3), and at the end of surgery (T4).

(3) Hemodynamic indicators: The percutaneous pulse oximeter oxygen saturation (SpO_2) and mean arterial pressure (MAP) were recorded and compared at T1, T2, T3, and T4.

(4) Cognitive function: The Mini-Mental State Examination (MMSE) [10] scores were recorded and compared between the two groups at 1 day before surgery, 1 day after surgery, and 3 days after surgery. The MMSE assesses cognitive function, with a higher score indicating better cognitive function.

(5) Perioperative adverse events: The incidence of adverse events such as nausea, vomiting, respiratory depression, and hypotension was recorded and compared between the two groups.

1.4 Statistical methods

Data were processed using SPSS 26.0 software. Normally distributed continuous variables were expressed as $\bar{x}\pm s$, and intergroup comparisons were made using independent sample *t*-tests. Repeated measures analysis of variance was used for comparisons across multiple time points. Categorical data were expressed as case (%) and compared using chi-square tests and corrected chi-square tests. A *P*-value < 0.05 was considered statistically significant.

2. Results

2.1 Comparison of general information between the two groups

The control group consisted of 32 patients, aged 28-42 years (35.50 ± 2.50), with a weight range of 48-75 kg (60.50 ± 8.20), including 15 patients with ASA grade I and 17 with ASA grade II. The study group included 48 patients, aged 28-45 years (36.00 ± 3.20), with a weight range of 49-74 kg (60.20 ± 8.15), including 24 patients with ASA grade I and 24 with ASA grade II. There were no significant differences between the two groups in terms of general data ($P > 0.05$).

2.2 Comparison of perioperative indicators between the two groups

The study group had a shorter postoperative awakening time and higher Steward scores at 30 minutes post-awakening compared to the control group, with significant differences ($P < 0.01$). However, there were no significant differences in surgery time between the two groups ($P > 0.05$). **See Table 1.**

Tab.1 Comparison of perioperative indexes between two groups ($\bar{x}\pm s$)

Group	*n*	Surgery time (min)	Postoperative awakening time (min)	Steward score at 30 minutes after awakening
Control group	32	87.62±10.20	12.25±2.25	4.82±0.35
Study group	48	85.90±10.05	9.20±1.80	5.45±0.28
t value		0.745	6.712	8.913
P value		0.458	＜0.001	＜0.001

2.3 Comparison of stress response indicators at Different Time Points

There was an interaction between the group and time points for ACTH and cortisol levels ($P < 0.01$). At T2, T3, and T4, the ACTH and Cor levels in the study group were lower than those in the control group ($P<0.05$). **See Table 2.**

2.4 Comparison of hemodynamic indicators at different time points

There was an interaction between the group and time points for SpO_2 and MAP ($P < 0.01$). At T2 and T3, the SpO_2 was higher in the study group compared to the control group ($P < 0.05$). At T2, T3, and T4, the MAP was lower in the study group ($P < 0.05$). See **Table 3.**

2.5 Comparison of cognitive function at different Time Points

There was an interaction between the group and time points for the MMSE score ($P < 0.01$). The MMSE scores on postoperative days 1 and 3 were lower in the control group than in the study group ($P < 0.05$). See **Table 4**.

2.6 Comparison of adverse events before discharge

The incidence of adverse events before discharge was lower in the study group (6.25%) compared to the control group (25.00%), with a significant difference ($P < 0.05$). See **Table 5.**

Tab.2 Comparison of stress response indexes between the two groups at different time points ($\bar{x}\pm s$)

Group	*n*	ACTH（pg/mL）				Cor（ng/L）			
		T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4
Control group	32	17.52±2.20	50.40±6.52[a]	72.58±9.50[ab]	63.85±8.20[abc]	130.55±15.25	158.85±16.57[a]	179.92±24.95[ab]	202.57±25.96[abc]
Study group	48	17.35±2.24	38.52±4.19[ad]	51.27±7.45[abd]	57.20±6.55[abcd]	130.08±15.20	142.52±17.52[ad]	160.58±20.25[abd]	182.25±23.30[abcd]
F/P_{group} value		52.648/P＜0.001				25.645/P＜0.001			
F/P_{time} value		68.527/P＜0.001				35.698/P＜0.001			
$F/P_{interaction}$ value		102.595/P＜0.001				55.582/P＜0.001			

Note: Compared with T1 in the same group, [a] $P < 0.05$; compared with T2 in the same group, [b] $P < 0.05$; compared with T3 in the same group, [c] $P < 0.05$; compared with the control group, [d] $P < 0.05$.

Tab.3 Comparison of hemodynamic indexes between the two groups at different time points ($\bar{x}\pm s$)

Group	*n*	SpO_2（%）				MAP（mmHg）			
		T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4
Control group	32	96.50±2.54	94.01±2.11[a]	95.75±2.40	95.07±2.35[a]	74.55±5.35	78.50±6.21[a]	76.25±5.72	77.50±5.25[a]
Study group	48	96.15±2.48	97.05±2.50[d]	97.80±2.32[ad]	95.90±2.20[bc]	74.20±5.42	72.90±4.58[d]	71.65±5.50[ad]	72.60±4.62[d]
F/P_{group} value		8.256/P＜0.001				21.528/P＜0.001			
F/P_{time} value		6.658/P＜0.001				32.529/P＜0.001			
$F/P_{interaction}$ value		12.542/P＜0.001				52.267/P＜0.001			

Note: Compared with T1 in the same group, [a] $P < 0.05$; compared with T2 in the same group, [b] $P < 0.05$; compared with T3 in the same group, [c] $P < 0.05$; compared with the control group, [d] $P < 0.05$.

Tab.4 Comparison of MMSE scores between the two groups at different time points (point，$\bar{x}\pm s$)

Group	*n*	1 d before surgery	1 d after surgery	3 d after surgery
Control group	32	29.19±0.60	25.00±1.25[a]	27.90±0.90[ab]
Study group	48	29.08±0.65	26.50±1.50[ac]	28.50±0.85[abc]
F/P_{group} value		2.250/P＜0.001		
F/P_{time} value		21.157/P＜0.001		
$F/P_{interaction}$ value		25.522/P＜0.001		

Note: Compared with 1 day before surgery in the same group, [a] $P < 0.05$; compared with 1 day after surgery in the same group, [b] $P < 0.05$; compared with the control group,[c] $P < 0.05$.

Tab.5 Comparison of adverse reactions between the two groups [case(%)]

Group	*n*	Nausea and vomiting	Respiratory depression	Hypotension	Total
Control group	32	4(12.50)	2(6.25)	2(6.25)	8(25.00)
Study group	48	2(4.17)	1(2.08)	0	3(6.25)
χ^2 value					4.220
P value					0.040

3. Discussion

With the continuous development of minimally invasive techniques, laparoscopic surgery has been widely applied in the treatment of gynecological diseases. Laparoscopic myomectomy has gradually replaced traditional open surgery as one of the main methods for treating uterine fibroids [11]. Relevant reports show that laparoscopic myomectomy has minimal impact on ovarian function, but it places higher demands on the effectiveness and safety of anesthesia. Postoperative rapid awakening, early mobilization, and smooth recovery are critical factors for the success of the surgery [12-13]. Therefore, the rational selection of anesthetic drugs during laparoscopic myomectomy is crucial.

Remifentanil is a first-line anesthetic drug known for

its rapid onset, lack of accumulation, and ability to achieve an ideal blood-brain balance quickly. However, recent studies have shown that the dosage of remifentanil alone is difficult to control in laparoscopic minimally invasive surgeries, which can increase the risk of anesthesia-related damage [14]. To improve anesthesia quality, combined anesthesia regimens are commonly used in clinical practice. Propofol and ciprofol are two commonly used anesthetics in laparoscopic minimally invasive surgery, but the anesthetic effects of different drug combinations vary. This study compared the application of propofol-based and ciprofol-based anesthesia regimens in laparoscopic myomectomy. The results showed that the study group had a shorter postoperative awakening time and higher Steward scores at 30 minutes post-awakening compared to the control group, indicating that ciprofol-based anesthesia allows for quicker recovery and significantly improves awakening quality. This may be related to the unique molecular structure of ciprofol. Ciprofol's molecular structure, which incorporates a cyclopropyl group into the propofol molecule, enhances its binding capacity to GABAA receptors, resulting in higher potency, greater lipid solubility, and faster metabolism. Liu Lu *et al.* [15] found that ciprofol combined with a small dose of dexmedetomidine can effectively alleviate postoperative pain following laparoscopic myomectomy. In the future, the application value of different ciprofol-combined anesthesia regimens in minimally invasive surgery can be further explored.

Compared with traditional surgery, laparoscopic minimally invasive surgery has minimized traumatic stimulation, but it is still an invasive procedure. Intraoperative procedures such as skin incision and pneumoperitoneum can still stimulate the hypothalamic-pituitary-adrenal axis and sympathetic nervous system of the body, inducing abnormal manifestations such as non-specific stress response and hemodynamic fluctuations during the perioperative period, which is not conducive to the smooth implementation of surgery [16-17]. Inhibiting perioperative sympathetic nerve excitation, reducing intraoperative stress response, and stabilizing hemodynamics are important topics that clinical anesthesiologists continue to study in depth. Further observation in this study found that both groups had stress responses and hemodynamic fluctuations during surgery, but the levels of ACTH and Cor in the study group at T2, T3, and T4 were lower than those in the control group, and the fluctuations of SpO_2 and MAP during surgery were smaller than those in the control group. This suggests that the ciprofol-combined anesthesia regimen has a smaller impact on the stress response and hemodynamics of patients during the anesthetic period. Scholars such as Wang *et al.* [18] believe that the affinity of ciprofol for GABAA receptors is approximately 5 times that of propofol, and it has higher selectivity for two competitive binding sites [tert-butylbicyclothiophosphate (TBPS) and tert-butylbicycloorthobenzoate (TBOB)] of GABAA receptor chloride channels. It is more likely to cross the blood-brain barrier, has a fast clearance rate, and the clearance rate has no dose-dependent trend, which is more conducive to stabilizing blood circulation. Therefore, it provides better anesthetic depth, less stimulation to the body, and higher safety. Epidemiological survey results show that the risk of postoperative cognitive dysfunction in elderly patients over 60 years old is much higher than that in young and middle-aged patients [19]; some reports also suggest that although the compensatory capacity of the central nervous system of young and middle-aged patients to anesthetic drugs is higher than that of elderly patients, some young and middle-aged patients still experience cognitive dysfunction of varying degrees after surgery [20]. The results of this study showed that the MMSE scores of both groups decreased to varying degrees after surgery compared with before surgery. Among them, the MMSE scores of the control group at 1 day and 3 days after surgery were lower than those of the study group, and the incidence of adverse reactions before discharge in the study group (6.25%) was significantly lower than that in the control group (25.00%). This suggests that anesthetic drugs have a certain impact on the central nervous system, but the ciprofol-combined anesthesia regimen causes less damage to cognitive function and has higher safety compared with the propofol-combined anesthesia regimen. In the future, the anesthesia regimen can be further optimized to reduce the damage to neurological function. This study confirmed the efficacy and safety of ciprofol in laparoscopic myomectomy, but the sample size selected was limited. In the next step, large-sample multicenter studies should be conducted to further improve the argumentation strength of the relevant conclusions of this study.

In conclusion, the use of ciprofol in laparoscopic myomectomy promotes quicker recovery and improved awakening quality, with less impact on hemodynamics during anesthesia. It also reduces intraoperative stress responses and lowers the risk of postoperative cognitive dysfunction, demonstrating a higher safety profile compared to propofol-based anesthesia.

Conflict of interest None

Reference

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·论 著·

环泊酚在腹腔镜子宫肌瘤剔除术麻醉中的有效性及安全性

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摘要：目的 研究环泊酚在腹腔镜子宫肌瘤剔除术麻醉中的有效性及安全性，为临床在腹腔镜下微创手术中合理选择麻醉方式提供参考。**方法** 回顾性地将2022年5月至2024年2月在厦门大学附属中山医院行腹腔镜子宫肌瘤剔除术的80例患者按不同麻醉方案分组。采用丙泊酚复合麻醉方案的32例患者为对照组，采用环泊酚复合麻醉方案的48例患者为研究组。比较两组围手术期指标和不同时刻应激反应指标、血流动力学指标、认知功能及围手术期不良反应发生情况。**结果** 研究组术后苏醒时间短于对照组，苏醒30 min Steward评分高于对照组（$P<0.05$），两组手术时间差异无统计学意义（$P>0.05$）。两组血清促肾上腺皮质激素（ACTH）、皮质醇（Cor）水平随手术时间延长而逐渐升高（$P<0.05$），其中研究组气管插管后5 min（T_2）、拔管即刻（T_3）、手术结束时（T_4）的ACTH、Cor水平低于对照组（$P<0.05$）。在血流动力学指标方面，研究组T_2、T_3时脉搏血氧饱和度（SpO_2）分别为（97.05%±2.50%）、（97.80%±2.32%），均高于对照组的（94.01%±2.11%）、（95.75%±2.40%）（$P<0.05$）；T_2、T_3、T_4时平均动脉压（MAP）分别为（72.90±4.58）mmHg、（71.65±5.50）mmHg、（72.60±4.62）mmHg，均低于对照组的（78.50±6.21）mmHg、（76.25±5.72）mmHg、（77.50±5.25）mmHg（$P<0.05$）。两组术后简易神经状态检查量表（MMSE）评分较术前均不同程度降低（$P<0.05$），且对照组术后1 d、3 d MMSE评分均低于研究组（$P<0.05$）。此外，研究组围手术期不良反应发生率低于对照组，差异有统计学意义（6.25% *vs* 25.00%，$\chi^2=4.220$，$P<0.05$）。**结论** 环泊酚应用于腹腔镜子宫肌瘤剔除术有助于缩短患者术后苏醒时间并提高苏醒质量，对麻醉期血流动力学的影响较小，也可抑制术中应激反应，降低术后认知功能损害风险，安全性较高。

关键词： 腹腔镜子宫肌瘤剔除术；环泊酚；促肾上腺皮质激素；皮质醇；安全性
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Abstract: Objective To study the efficacy and safety of ciprofol in laparoscopic myomectomy anesthesia, and provide a reference for the rational selection of anesthesia methods in clinical laparoscopic minimally invasive surgery. **Methods** Eighty patients who underwent laparoscopic myomectomy at Zhongshan Hospital Affiliated to Xiamen University from May 2022 to February 2024 were retrospectively grouped according to different anesthesia regimens. Thirty-two patients who received the propofol combined anesthesia regimen were the control group, and 48 patients who received the ciprofol combined anesthesia regimen were the study group. The perioperative indicators, and stress response indicators, hemodynamic indicators, cognitive functions at different time points as well as the occurrence of perioperative adverse reactions were compared between the two groups. **Results** The recovery time of the study group was shorter than that of the control group ($P<0.05$), and the Steward score of 30 min after recovery was higher than that of the control group ($P<0.05$), but there was no significant difference in the operation time between the two groups ($P>0.05$). Serum levels of adrenocorticotropic hormone (ACTH) and cortisol (Cor) gradually increased with prolonged

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surgery duration in both groups ($P < 0.05$). ACTH and Cor levels in the study group were lower than those in the control group at 5 min after tracheal intubation (T_2), immediately after extubation (T_3), and at the end of operation (T_4) ($P< 0.05$). In terms of hemodynamic indicators, the levels of peripheral capillary oxygen saturation (SpO_2) at T_2 and T_3 in the study group were (97.05%±2.50%) and (97.80%±2.32%), respectively, which were both higher than those in the control group [(94.01%±2.11%) and (95.75%±2.40%)] ($P<0.05$); the mean arterial pressure (MAP) levels in the study group at T_2, T_3, and T_4 were (72.90±4.58) mmHg, (71.65±5.50) mmHg, and (72.60±4.62) mmHg, respectively, which were lower than those of the control group [(78.50±6.21) mmHg, (76.25±5.72) mmHg, (77.50±5.25) mmHg] ($P<0.05$). The postoperative mini-mental state examination (MMSE) scores of the two groups were lower than those before surgery ($P<0.05$), and the MMSE scores of the control group were lower than those of the study group 1 and 3 days after surgery ($P<0.05$). In addition, the incidence of perioperative adverse reactions in the study group was significantly lower than that in the control group, and the difference between two groups was statistically significant (6.25% *vs* 25.00%, $\chi^2=4.220$, $P<0.05$). **Conclusion** The application of ciprofol in laparoscopic myomectomy can help shorten the postoperative recovery time and improve the recovery quality of patients, with minimal influence on the hemodynamics during anesthesia. It can also inhibit intraoperative stress response, reduce the risk of postoperative cognitive function damage, and provide high safety.

Keywords: Laparoscopic myomectomy; Ciprofol; Adrenocorticotropin; Cortisol; Safety

子宫肌瘤是女性生殖系统常见良性肿瘤之一，好发于30岁以上女性，初起无明显症状，随病情进展可出现排尿、排便困难等症状，手术切除是目前临床治疗子宫肌瘤最有效且最常用的方式[1-2]。腹腔镜子宫肌瘤剔除术因其创伤小、出血量少、康复速度快等特点日益受到患者及临床医师的青睐，但近年来实践中发现，腹腔镜子宫肌瘤剔除术切皮、气腹等过程依旧会导致患者一定程度应激反应、血流动力学波动，合理选择麻醉药物对保障手术实施及患者术后的恢复具有重要意义[3-4]。环泊酚是近年来研发的新型静脉麻醉药物，主要通过激活γ-氨基丁酸A型(GABAA)受体而促使氯离子内流及神经细胞膜超极化，进一步抑制中枢神经系统而发挥麻醉或镇静作用，其在成人手术麻醉诱导及维持、纤维支气管镜检查、消化内镜检查等领域均有应用[5-7]。本研究旨在探讨环泊酚在腹腔镜子宫肌瘤剔除术麻醉中的有效性及安全性，以期为临床在腹腔镜下微创手术中合理选择麻醉方式提供参考，现报道如下。

1 资料与方法

1.1 一般资料 回顾性地将2022年5月至2024年2月在厦门大学附属中山医院行腹腔镜子宫肌瘤剔除术的80例患者临床资料按不同麻醉方案分组，其中采用丙泊酚复合麻醉方案的32例患者为对照组，采用环泊酚复合麻醉方案的48例患者为研究组。纳入标准：(1) 美国麻醉医师协会(American Society of Anesthesiologists, ASA)分级[8] Ⅰ~Ⅱ级；(2) 符合腹腔镜子宫肌瘤剔除术手术指征且成功实施手术。排除标准：(1) 术前评估存在凝血功能障碍、相关麻醉药物过敏、气管插管困难等手术禁忌证；(2) 术前服用可能影响血流动力学、应激反应的药物；(3) 合并躯体恶性肿瘤、严重肝肾功能障碍、自身免疫系统疾病或精神系统疾病；(4) 妊娠期或哺乳期女性。本研究经厦门大学附属中山医院伦理委员会批准(审批号：xmzsyyky伦审第2024-533号)。

1.2 方法 两组患者均择期行腹腔镜子宫肌瘤剔除术，术前8 h禁食、4 h禁饮，入室后予以心电监护、脑电双频指数(BIS)监测，建立静脉通路后吸氧3 min，行麻醉诱导：对照组予以瑞芬太尼[3 μg/(kg·h)，生产批号：30A09251，生产厂家：武汉人福药业有限责任公司]、丙泊酚(2 mg/kg，生产批号：5C231206，生产厂家：广东嘉博制药有限公司)、罗库溴铵(2.5 mL，生产批号：220901-3，生产厂家：南京恒道医药有限公司)，BIS达到40~60时认为麻醉诱导成功，麻醉诱导不成功则追加丙泊酚(每次追加剂量≤1 mg/kg)；研究组予以瑞芬太尼[3 μg/(kg·h)]、环泊酚(0.4 mg/kg，生产批号：20221006，生产厂家：辽宁海思科制药有限公司)、罗库溴铵(2.5 mL)，BIS达到40~60时认为麻醉诱导成功，麻醉诱导不成功则追加环泊酚(每次追加剂量≤0.2 mg/kg)。患者睫毛反射消失后开始手术操作，其中对照组泵注丙泊酚4~6 mg/(kg·h)进行麻醉维持，研究组泵注环泊酚1~1.5 mg/(kg·h)进行麻醉维持，术中麻醉深度维持BIS 40~60，术毕前10 min停止注入丙泊酚、环泊酚，术毕停止注入瑞芬太尼。

1.3 观察指标 (1) 围手术期指标：包括手术时间、术后苏醒时间、苏醒30 min Steward评分[9]，其中Steward

评分从清醒程度、肢体活动、呼吸通畅情况三个维度评估，总分越高提示术后苏醒质量越高。(2) 应激反应指标：记录并比较两组麻醉诱导前10 min(T1)、气管插管后5 min(T2)、拔管即刻(T3)、手术结束时(T4)的血清促肾上腺皮质激素(ACTH)、皮质醇(Cor)水平。(3) 血流动力学指标：记录并比较两组T1、T2、T3、T4的经皮脉搏血氧饱和度(SpO_2)、平均动脉压(MAP)。(4) 认知功能：记录并比较两组术前1 d、术后1 d、术后3 d简易神经状态检查量表(MMSE)[10]评分，总分越高提示认知功能越好。(5) 围手术期不良反应发生情况：记录并比较两组围手术期恶心呕吐、呼吸抑制、低血压发生情况。

1.4 统计学方法 采用SPSS 26.0软件处理数据。符合正态分布的计量资料用$\bar{x}\pm s$表示，采用独立样本t检验进行两组间比较，重复测量方差分析进行两组多时间点比较；计数资料用例(%)表示，采用χ^2检验和校正χ^2检验比较。$P<0.05$为差异有统计学意义。

2 结 果

2.1 两组一般资料比较 对照组32例，年龄28~42(35.50±2.50)岁，体质量48~75(60.50±8.20)kg，ASA分级Ⅰ级15例、Ⅱ级17例。研究组48例，年龄28~45(36.00±3.20)岁，体质量49~74(60.20±8.15)kg，ASA分级Ⅰ级24例、Ⅱ级24例。两组一般资料差异无统计学意义($P>0.05$)。

2.2 两组围手术期指标比较 研究组术后苏醒时间短于对照组，苏醒30 min Steward评分高于对照组，差异有统计学意义($P<0.01$)，而两组手术时间差异无统计学意义($P>0.05$)。见表1。

2.3 两组不同时刻应激反应指标比较 不同组间、时点间ACTH、Cor水平存在交互作用($P<0.01$)。其中研究组T_2、T_3、T_4时ACTH、Cor水平均低于对照组($P<0.05$)。见表2。

2.4 两组不同时刻血流动力学指标比较 不同组间、时点间SpO_2、MAP存在交互作用($P<0.01$)。其中研究组T_2、T_3时SpO_2高于对照组($P<0.05$)，T_2、T_3、T_4时MAP低于对照组($P<0.05$)。见表3。

2.5 两组不同时刻认知功能比较 不同组间、时点间MMSE评分存在交互作用($P<0.01$)，且对照组术后1 d、3 d MMSE评分均低于研究组($P<0.05$)。见表4。

2.6 两组出院前不良反应发生情况比较 研究组出院前不良反应发生率低于对照组，差异有统计学意义($P<0.05$)。见表5。

表1 两组围手术期指标比较 ($\bar{x}\pm s$)

Tab.1 Comparison of perioperative indexes between the two groups ($\bar{x}\pm s$)

组别	例数	手术时间(min)	术后苏醒时间(min)	苏醒30 min Steward评分(分)
对照组	32	87.62±10.20	12.25±2.25	4.82±0.35
研究组	48	85.90±10.05	9.20±1.80	5.45±0.28
t值		0.745	6.712	8.913
P值		0.458	<0.001	<0.001

表2 两组不同时刻应激反应指标比较 ($\bar{x}\pm s$)

Tab.2 Comparison of stress response indexes between the two groups at different time points ($\bar{x}\pm s$)

组别	例数	ACTH(pg/mL)				Cor(ng/L)			
		T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4
对照组	32	17.52±2.20	50.40±6.52[a]	72.58±9.50[ab]	63.85±8.20[abc]	130.55±15.25	158.85±16.57[a]	179.92±24.95[ab]	202.57±25.96[abc]
研究组	48	17.35±2.24	38.52±4.19[ad]	51.27±7.45[abd]	57.20±6.55[abcd]	130.08±15.20	142.52±17.52[ad]	160.58±20.25[abd]	182.25±23.30[abcd]
$F/P_{组间}$值		52.648/<0.001				25.645/<0.001			
$F/P_{时间}$值		68.527/<0.001				35.698/<0.001			
$F/P_{交互}$值		102.595/<0.001				55.582/<0.001			

注：与同组T_1比较，[a]$P<0.05$；与同组T_2比较，[b]$P<0.05$；与同组T_3比较，[c]$P<0.05$；与对照组比较，[d]$P<0.05$。

表3 两组不同时刻血流动力学指标比较 ($\bar{x}\pm s$)

Tab.3 Comparison of hemodynamic indexes between the two groups at different time points ($\bar{x}\pm s$)

组别	例数	SpO_2(%)				MAP(mmHg)			
		T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4
对照组	32	96.50±2.54	94.01±2.11[a]	95.75±2.40	95.07±2.35[a]	74.55±5.35	78.50±6.21[a]	76.25±5.72	77.50±5.25[a]
研究组	48	96.15±2.48	97.05±2.50[d]	97.80±2.32[ad]	95.90±2.20[bc]	74.20±5.42	72.90±4.58[d]	71.65±5.50[ad]	72.60±4.62[d]
$F/P_{组间}$值		8.256/<0.001				21.528/<0.001			
$F/P_{时间}$值		6.658/<0.001				32.529/<0.001			
$F/P_{交互}$值		12.542/<0.001				52.267/<0.001			

注：与同组T_1比较，[a]$P<0.05$；与同组T_2比较，[b]$P<0.05$；与同组T_3比较，[c]$P<0.05$；与对照组比较，[d]$P<0.05$。

表4　两组不同时刻MMSE评分比较（分，$\bar{x}\pm s$）

Tab.4　Comparison of MMSE scores between the two groups at different time points （point，$\bar{x}\pm s$）

组别	例数	术前1 d	术后1 d	术后3 d
对照组	32	29.19±0.60	25.00±1.25[a]	27.90±0.90[ab]
研究组	48	29.08±0.65	26.50±1.50[ac]	28.50±0.85[abc]
$F/P_{组间}$值			2.250/<0.001	
$F/P_{时间}$值			21.157/<0.001	
$F/P_{交互}$值			25.522/<0.001	

注：与同组术前1 d比较，[a]$P<0.05$；与同组术后1 d比较，[b]$P<0.05$；与对照组比较，[c]$P<0.05$。

表5　两组不良反应发生情况比较　［例(%)］

Tab.5　Comparison of adverse reactions between the two groups ［case(%)］

组别	例数	恶心呕吐	呼吸抑制	低血压	总发生
对照组	32	4(12.50)	2(6.25)	2(6.25)	8(25.00)
研究组	48	2(4.17)	1(2.08)	0	3(6.25)
χ^2值					4.220
P值					0.040

3　讨　论

随着微创技术的不断发展，腹腔镜微创手术已广泛应用于妇科疾病治疗，其中腹腔镜子宫肌瘤剔除术已逐渐取代传统开腹手术成为治疗子宫肌瘤的主要手段之一[11]。相关报道显示，腹腔镜子宫肌瘤剔除术对患者卵巢功能影响较小，但该术式对手术麻醉的有效性、安全性要求相对较高，患者术后能否快速苏醒、尽早活动、顺利康复等是手术成功与否的重要环节[12-13]。因此，腹腔镜子宫肌瘤剔除术中合理选择麻醉药物至关重要。

瑞芬太尼是一线麻醉药物，具有起效快、无积蓄且可快速达到理想的血脑平衡等特点，近年来研究发现，瑞芬太尼单一应用于腹腔镜微创手术时的剂量不易控制，一定程度上增加麻醉损伤风险[14]。为提高麻醉质量，临床多采用复合麻醉方案，其中丙泊酚、环泊酚是腹腔镜微创手术中较常用的两种麻醉药物，但不同麻醉药物配伍的麻醉效果不尽相同。本研究比较丙泊酚复合麻醉方案、环泊酚复合麻醉方案在腹腔镜子宫肌瘤剔除术中的应用效果，结果显示研究组术后苏醒时间较对照组短，苏醒30 min Steward评分较对照组高，说明环泊酚复合麻醉方案可使患者术后更快苏醒，苏醒质量明显提高，这可能与环泊酚独特分子结构有关。环泊酚分子结构特点是在丙泊酚分子结构基础上引入环丙基，形成手性结构后增强与GABAA受体结合能力，其效价更高、脂溶性更高、代谢更快，刘璐[15]研究结果还发现，环泊酚与小剂量右美托咪定复合麻醉可有效缓解腹腔镜下子宫肌瘤切除术术后疼痛。后续可进一步探讨不同环泊酚复合麻醉方案在微创手术中的应用价值。

腹腔镜微创手术相较于传统手术已将创伤刺激降至最低，但其终究为有创操作，术中切皮、气腹等操作仍会刺激机体下丘脑-垂体-肾上腺轴交感神经系统，诱使围手术期出现非特异性应激反应、血流动力学波动等异常表现，不利于手术实施[16-17]，抑制围手术期交感神经兴奋、降低术中应激反应、稳定血流动力学是临床麻醉医师不断深耕的重要课题。本研究通过进一步观察，发现两组术中均存在应激反应、血流动力学波动的现象，但研究组T_2、T_3、T_4时ACTH、Cor水平均低于对照组，且术中SpO_2、MAP波动较对照组小，提示环泊酚复合麻醉方案对患者麻醉期应激反应、血流动力学的影响更小。Wang等[18]学者认为环泊酚与GABAA受体的亲和力约为丙泊酚的5倍，且对GABAA受体氯离子通道的2个竞争性结合靶点叔丁基二环硫代磷酸酯 (TBPS)、叔丁基二环原苯甲酸酯 (TBOB) 具有更高的选择性，更易透过血脑屏障，清除较快，且清除率无剂量依赖性趋势，更有助于稳定血液循环，故麻醉深度好、对机体刺激较小，安全性更高。流行病学调查结果显示，60岁以上老年患者术后并发认知功能障碍的风险远高于中青年患者[19]；也有报道认为，尽管中青年患者中枢神经系统对麻醉药物的代偿能力高于老年患者，但仍有部分中青年患者术后出现不同程度认知功能障碍[20]。本研究结果显示，两组术后MMSE评分较术前均不同程度降低，其中对照组术后1 d、3 d MMSE评分均低于研究组，且研究组出院前不良反应发生率(6.25%)明显低于对照组(25.00%)，提示麻醉药物对中枢神经系统存在一定影响，但环泊酚复合麻醉方案相较于丙泊酚复合麻醉方案对认知功能的损害较小，且安全性更高，后续可进一步优化麻醉方案以降低对神经功能的损害。本研究肯定了环泊酚在腹腔镜子宫肌瘤剔除术中的有效性及安全性，但选取样本量有限，下一步有待选取大样本量开展多中心研究进一步提高本研究相关结论论证强度。

综上所述，环泊酚应用于腹腔镜子宫肌瘤剔除术有助于患者术后更快苏醒并提高苏醒质量，对麻醉期血流动力学的影响较小，也可抑制术中应激反应，降低术后认知功能损害风险，安全性较高。

利益冲突　无

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