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Original Article

Hemodynamics and anesthetic effect of propofol combined with remifentanil in patients undergoing laparoscopic ovarian cystectomy under laryngeal mask airway anesthesia

Yanshu Xu[1*], Jiang Wu[2*], Jili Zhao[3], Haiping Zhang[4]

[1]Department of Anesthesiology, Fengcheng Hospital, Fengxian District, Shanghai 201411, China; [2]Department of Anesthesiology, Ninety-ninth Hospital of The Joint Support Unit, Zhangzhou 363000, Fujian Province, China; [3]Department of Anesthesiology, Zhangqiu District Maternal and Child Health Hospital, Jinan 250200, Shandong Province, China; [4]Department of Anesthesiology, Sichuan Provincial Maternity and Child Health Care Health Hospital, Chengdu 610045, Sichuan Province, China. [*]Equal contributors.

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Abstract: Objective: To study the effect of propofol combined with remifentanil on hemodynamics and anesthetic effect in patients undergoing laparoscopic ovarian cystectomy under laryngeal mask airway (LMA) anesthesia. Methods: From December 2018 to December 2019, gynecological patients who underwent laparoscopic ovarian cystectomy in our hospital were chosen and randomly separated into control group (group A) and combination group (group B). In the group B, patients were anesthetized with remifentanil combined with propofol. In the group A, patients were anesthetized with fentanyl combined with propofol. The anesthetic effect, hemodynamic changes, alertness-sedation score (OAAS), verbal depiction score (VRA), postoperative VAS score and adverse reactions were observed and compared in both groups. Results: The anesthesia induction time, recovery time of postoperative spontaneous respiration, time of opening eyes and time of removing laryngeal mask in the group B were shorter than those in the group A, and the difference was statistically significant ($P<0.05$). The OAAS scores at the time of recovery and 5 min after laryngeal mask removal in the group B were obviously lower than those in the group A. The mean arterial pressure and heart rate before and after 40 min pneumoperitoneum were more stable than those in the group A. The degree of postoperative pain in the group B was also significantly weaker than that in the group A. The incidence of postoperative adverse reactions was also lower than that of the group A, and the difference was statistically significant ($P<0.05$). Conclusion: Propofol combined with remifentanil and LMA anesthesia has better anesthetic effect, more stable condition and higher safety for patients undergoing laparoscopic ovarian cystectomy.

Keywords: Propofol combined with remifentanil, laryngeal mask airway, ovarian cystectomy, anesthetic effect, hemodynamics

Introduction

Ovarian cyst is a cystic mass on the ovary, which is a common gynecological disease in clinic [1], including pathological [2] and physiological [3] diseases. Ovarian cysts can be diagnosed by medical history and physical examination, and large cystic masses can be touched in the abdomen of patients [4]. Once the patient is diagnosed with an ovarian cyst, the nature of the cyst should be clarified first. Physiological ovarian cyst can be resolved by itself, and pathological ovarian cyst is mostly treated by surgery [5]. With the change of people's life style, the incidence of ovarian cyst is gradually increasing, which brings very negative influence to the normal life of childbearing age women [6]. Ovarian cyst patients generally show obvious intra-abdominal mass, which has certain mobility characteristics. It can often move to the abdominal cavity with the pelvic cavity of the patient [6]. When malignant or inflammatory lesions develop in the abdomen of the patient, the mass activity is significantly limited, and patients who press the mass will feel pain. In severe cases, some clinical manifesta-

tions such as peritoneal irritation and ascites will develop, which will reduce the quality of life and affect the recovery effect of the patient [8]. Laparoscopic surgery [9] is the main way to treat ovarian cyst, but some patients are easily affected by the establishment of pneumoperitoneum and other factors during the operation, resulting in stress response, which leads to obvious changes in vital signs such as blood pressure and heart rate and affects the operation process [10]. Therefore, laparoscopic ovarian cystectomy has higher requirements for anesthesia, and it is especially important to choose reasonable anesthetic drugs.

Tracheal intubation general anesthesia and LMA general anesthesia are widely used in laparoscopic surgery, and both have achieved better results [11]. Tracheal intubation ventilation anesthesia is a common type of anesthesia in clinic. Although it can effectively control intra-abdominal pressure, the incidence of postoperative complications is high, which limits its application [12]. Laryngeal mask [13] is a new type of anesthesia device which integrates the advantages of mask and endotracheal intubation to maintain the airway. Because of its many unique advantages, many studies have been carried out on its application in the medical field at home and abroad. This study was designed to evaluate the application of propofol combined with remifentanil and LMA in laparoscopic ovarian cystectomy.

Materials and methods

Research objects

From December 2018 to December 2019, there were 97 gynecological patients undergoing laparoscopic ovarian cystectomy in Fengcheng Hospital, all of whom met the standards of the American Society of Anesthesiologists (ASA). They were randomly divided into group A and group B. There were 42 cases in group A, aged 31.97±3.82 years. There were 55 cases in the group B, aged 32.25±3.46 years. Inclusion criteria: (1) All patients met the clinical diagnostic criteria of ovarian cyst; (2) none of the patients were contraindicated in operation and anesthetic use. Exclusion criteria were as follows: (1) Patients with severe organic diseases such as heart, liver and kidney; (2) patients with malignant tumor diseases and mental diseases. There was no obvious difference in general data in both groups, which was comparable. In this study, the informed consent was signed by patients or their families and the test was ratified by the ethics committee of our hospital.

Methods

In both groups, patients received laparoscopic surgery. All patients were fasted for 4-6 hours before operation and injected with atropine (0.01 mg/kg) intramuscularly 30 minutes before operation. After entering the operating room, the venous channel was opened, and the blood pressure, electrocardiogram, respiration and blood oxygen saturation were routinely monitored. After oxygen inhalation for 3 minutes, patients were injected intravenously with 2-4 μg/kg of remifentanil (group B) or 3-5 μg/kg of fentanyl (group A), 1.5-2 mg/kg of propofol and 0.1 mg/kg of vecuronium to induce anesthesia. According to the patient's body weight and mouth size, the laryngeal mask size was selected. After placing the laryngeal mask, the anesthesia machine was connected for IPPV mode ventilation. The 0.1-0.3 μg/(kg·min) of remifentanil (group B) or 0.03 μg/(kg·min) of fentanyl (group A) + 50-100 μg/(kg·min) of propofol were continuously pumped by micropump to maintain anesthesia. After the operation, the laryngeal mask/extubation was removed at the time of recovery.

Outcome measures

(1) The anesthetic effects, recovery time of spontaneous respiration, time of opening eyes, anesthesia induction time and time of removing laryngeal mask were compared in the two groups.

(2) Hemodynamic changes: The blood pressure, heart rate, blood oxygen saturation and mean arterial pressure were recorded before anesthesia, before pneumoperitoneum and after pneumoperitoneum for 40 min.

(3) OAAS score: OAAS score at the time of recovery and after removing laryngeal mask for 5 min. 0 point: the patient did not respond to intense stimulation; 1 point: the patient was unresponsive and lethargic by tapping; 2 points: the patient responded by tapping but could not distinguish speech; 3 points: the patient responded by waking up repeatedly and

Table 1. Baseline data

	group A (n=42)	EEN group (n=55)	χ^2/t	P
Age	31.97±3.82	32.25±3.46	0.3775	0.7066
Weight (kg)	55.19±3.26	54.75±3.52	0.6296	0.5304
ASA grading			0.8692	0.3512
Grade I	22	34		
Grade II	20	21		
Cyst diameter (cm)	6.15±1.56	6.03±1.68	0.3594	0.7200
Operation time (min)	93.4±21.3	89.2±23.5	0.9078	0.3663
Blood loss (mL)	150.3±38.6	143.5±41.3	0.8264	0.4107
Alcoholism history			0.0494	0.8241
Yes	4 (57.5)	6 (56.1)		
No	38 (42.5)	49 (43.9)		
Smoking history			0.0137	0.9068
Yes	8 (65)	11 (61.4)		
No	34 (35)	44 (38.6)		

loudly but with blurred speech; 4 points: the patient was unresponsive by waking up with a normal voice and spoke slowly; 5 points: the patient responded quickly by waking up with a normal voice and she was fully awake.

(4) VAR score: VRA score at 15 min and 30 min after removing the laryngeal mask. A score of zero meant no pain; A score of 1-3 meant mild pain-slight pain when not moving, coughing or turning over; A score of 4-6 meant medium pain-pain that was noticeable but tolerable when not moving; A score of 7-9 meant serious pain-acute pain at any time.

(5) VAS score: The pain degree was assessed in the two groups at 6, 12, 24 and 48 hours after operation, with 0 points (no pain), 1-3 points (mild pain), 4-6 points (medium pain), 7-9 points (serious pain) and 10 points (acute pain).

(6) Adverse reactions: The adverse reactions of patients were observed in the two groups after medication.

Statistical analysis

SPSS20.0 was applied for statistical analysis. The measurement data were represented as the mean number ± standard deviation from at least three independent experiments. The t test was applied. The counting data was represented as (n, %). Chi-square test was used. ANOVA was used to analyze data in multiple groups. The difference was statistically significant with P<0.05. GraphPad Prism 6 was applied for analysis and mapping.

Results

Baseline data

There was no significant difference in baseline data between the two groups (P<0.05), which was comparable (**Table 1**).

Anesthesia effect and OAAS score of patients

The anesthesia induction time, recovery time of postoperative spontaneous respiration, time of opening eyes and time of removing laryngeal mask in the group B were shorter than those in the group A, and the difference was statistically significant (P<0.05). The OAAS scores at the time of recovery and 5 min after laryngeal mask removal in the group B were obviously lower than those in the group A (P<0.05) (**Table 2**).

Comparison of hemodynamic changes in both groups

Before anesthesia, there was no obvious difference in HR, MAP, SpO_2, DBP and SBP levels between the two groups (P<0.05). Before pneumoperitoneum, the HR, MAP, SBP and DBP in the two groups increased in different degrees, while SpO_2 decreased in different degrees, but the differences in the group B were significant compared with the group A. After pneumoperitoneum for 40 min, all indexes changed in different degrees, but the indexes in the group B were obviously better than those in the group A (P<0.05) (**Figure 1**).

VRA score in the two groups after removing laryngeal mask

After removing the laryngeal mask for 15 min and 30 min, the number of patients with low scores (VRA score) in the group B was obviously higher than that in the group A, while the number of patients with high scores was obviously lower than that in the group A (P< 0.05) (**Table 3**).

Table 2. Comparison of anesthetic effect and OAAS score between the two groups

	Anesthesia effect				OAAS score	
	Anesthesia induction time (min)	Recovery time of spontaneous respiration (min)	Time of opening eyes (min)	Removing the laryngeal mask (min)	The time of recovery	Removing the laryngeal mask for 5 min
Group A (n=42)	6.13±1.31	8.38±3.06	10.32±3.94	13.94±4.21	2.09±0.71	4.01±0.91
Group B (n=55)	4.10±1.38	6.84±3.10	8.21±4.02	11.03±4.35	2.72±0.93	4.63±0.66
χ^2/t	7.3368	2.4378	2.5835	3.3101	3.6507	3.8899
P	<0.0001	0.0166	0.0113	0.0013	0.0004	0.0001

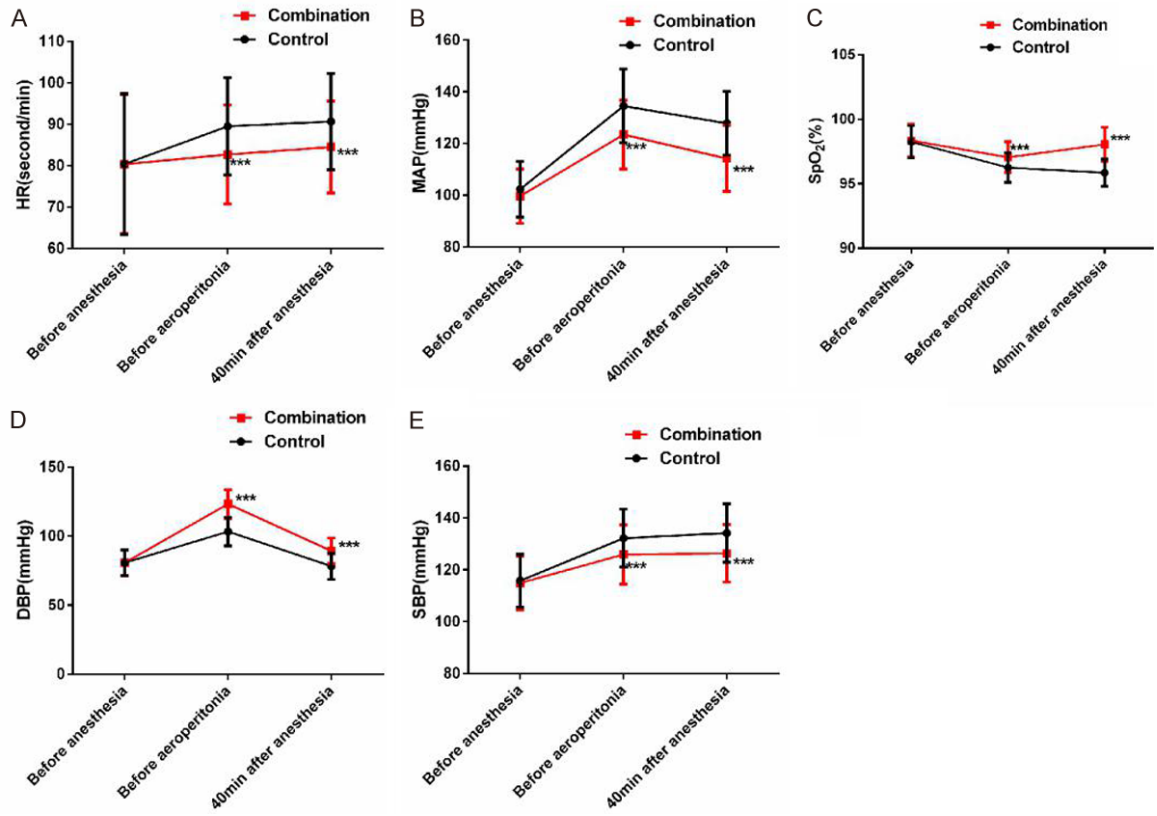

Figure 1. Hemodynamic changes of patients in the two groups. A: Heart rate changes of patients in the two groups; B: MAP changes of patients in the two groups; C: SpO_2 changes of patients in the two groups; D: DBP changes of patients in the two groups; E: SBP changes of patients in the two groups; *** means the comparison with the group A, P<0.001.

Postoperative VAS score

After operation for 6 h, 12 h, 24 h and 48 h, the VAS scores in the group B were lower than those in the group A, and the difference was statistically significant (P<0.05) (**Table 4**).

Incidence of adverse reactions in both groups

The incidence of postoperative adverse reactions in the group B (3.62%) was obviously lower than that in the group A (16.7%), and the difference was statistically significant (P< 0.05) (**Table 5**).

Discussion

Laparoscopic ovarian cystectomy has the advantages of minimally invasive, less bleeding during operation and quick recovery after operation, which is recognized by the majority of patients and physicians. However, it is necessary to create artificial pneumoperitoneum

Table 3. VRA score in the two groups after removing laryngeal mask

	After removing the laryngeal mask for 15 min			After removing the laryngeal mask for 30 min		
	0 points	1-3	≥4 points	0 points	1-3	≥4 points
Group A (n=42)	5 (11.90)	20 (47.62)	17 (40.48)	20 (47.62)	10 (23.81)	12 (28.57)
Group B (n=55)	19 (34.55)	29 (52.73)	7 (12.72)	39 (70.91)	14 (25.45)	2 (3.64)
χ^2/t	6.5561	0.2486	9.8481	5.4211	0.0346	11.9910
P	0.0105	0.6181	0.0017	0.0199	0.8524	0.0005

Table 4. VAS scores of patients in the two groups after operation

	After operation for 6 hours	After operation for 12 hours	After operation for 24 hours	After operation for 48 hours
Group A (n=42)	5.01±1.12	5.36±0.85	5.49±1.02	5.35±0.52
Group B (n=55)	2.23±1.03	2.38±0.71	2.48±0.82	2.35±0.47
χ^2/t	2.4608	6.5100	5.7972	5.7567
P	0.0157	<0.0001	<0.0001	<0.0001

Table 5. Incidence of adverse reactions in the two groups

	Pruritus	Abdominal pain	Nausea and vomiting	Pharyngodynia	Overall incidence
Group A (n=42)	2 (4.76)	2 (4.76)	3 (7.14)	0 (0)	7 (16.7)
Group B (n=55)	0 (0)	1 (1.81)	1 (1.81)	0 (0)	2 (3.62)
χ^2/t					4.8041
P					0.0284

and dilate uterus during operation, which easily affects the respiratory and circulatory system of patients, resulting in obvious changes in hemodynamics of patients, so it is not conducive to the operation. Therefore, it is particularly important to perform effective anesthesia during operation [14]. Propofol is an anesthetic with fast onset and strong calming effect [15]. In the surgical treatment process, the propofol combined with remifentanil can effectively avoid the disadvantages of the traditional anesthetic fentanyl, such as slow onset and long induction time. In addition, remifentanil is a μ-type receptor agonist, which has better controllability. It has very low influence on the hemodynamics of patients during operation, and it is conducive to shorten the time of eye opening after operation, which has positive significance for improving the prognosis of patients after operation [16].

This research was designed to compare the effect of remifentanil combined with propofol and fentanyl combined with propofol and LMA in laparoscopic ovarian cystectomy. The results showed that the anesthesia induction time, recovery time of postoperative spontaneous respiration, time of opening eyes and time of removing laryngeal mask in remifentanil combined with propofol group were significantly shorter than those in fentanyl combined with propofol group. At the time of recovery and after removing laryngeal mask for 5 min, the OAAS scores in remifentanil combined with propofol group were significantly lower than those in fentanyl combined with propofol group. Remifentanil, as an anesthetic and analgesic, is a potent opioid receptor agonist with typical opioid pharmacological effects, which has the characteristics of rapid onset and rapid disappearance, and does not need drug reversal, so it can effectively avoid adverse reactions in postoperative recovery period, such as respiratory depression [17]. Propofol is a quick and short-acting general anesthetic, which is mainly used to induce and maintain general anesthesia [15]. In the body, propofol can enhance the transfer function of the chloride ion and inhibit the activation of central nervous system [18]. Propofol has better controllability, but it can inhibit the respiratory and circulatory system to some extent. When remifentanil is combined

with propofol, the drug can be distributed to all parts of the body after administration for 1 minute, and the effect lasts for more than 10 minutes. The above results are consistent with the results of this study: Propofol combined with remifentanil can shorten the induction time of anesthesia and shorten the awakening time of patients. Before and after pneumoperitoneum for 40 min, the mean arterial pressure and heart rate in remifentanil combined with propofol group were more stable than those in fentanyl combined with propofol group. Propofol is a potent general anesthetic of alkylphenols, which has the advantages of quick onset, short action time, quick recovery from anesthesia, less toxic and side effects, etc. It can activate γ-GABA receptor and desensitize γ-GABA receptor [19]. The application of propofol in laparoscopic ovarian cystectomy can inhibit cardiovascular reactions such as elevated blood pressure and increased heart rate caused by carbon dioxide pneumoperitoneum [20]. However, the analgesic effect of propofol is relatively weak, so it is often used in combination with opioid analgesics in clinic. Remifentanil has the characteristics of no accumulation after long-term continuous infusion, and it is a μ type receptor agonist [21], so the postoperative recovery is not affected by induction or maintenance of anesthesia with large doses of remifentanil. Micro-pump injection can maintain induction, maintain stability, inhibit the stress reaction of neuroendocrine system caused by carbon dioxide pneumoperitoneum and reduce the secretion of cortisol [22, 23]. At the same time, it directly acts on blood vessels and promotes the release of prostacyclin and nitric oxide from vascular endothelial cells, thus leading to endothelium-dependent vasodilation and hypotension [24]. In addition, propofol coordinated by remifentanil has multiple effects such as reducing peripheral vascular resistance and venous tension, and the combination of the two drugs is helpful to keep the hemodynamic stability of patients [25]. The postoperative pain degree in the remifentanil combined with propofol group was also significantly weaker than that in the fentanyl combined with propofol group. Fentanyl is an opioid narcotic analgesics by stimulating μ receptor in central nervous system, and its analgesic potency is 100-180 times of morphine [26]. Remifentanil is a derivative of fentanyl, and its analgesic efficacy is 1.5-3 times of fentanyl. Remifentanil has the advantages of strong anesthetic analgesic efficacy, short duration of action, rapid elimination in vivo, low toxic and side effects and stable hemodynamics [27]. The incidence of postoperative adverse reactions in remifentanil combined with propofol group is relatively low. Compared with endotracheal intubation, LMA is easier to tolerate. It has less cardiovascular reaction, and patients do not need to expose glottis, and it can be quickly placed. After laryngeal mask airway surgery, the majority of patients are relatively quiet, without severe agitation and coughing, which is conducive to early recovery of patients and has less postoperative complications such as pharyngodynia [28]. The deficiency of this study is that the clinical sample size is relatively small, so it is necessary to increase the sample size to obtain more reliable data, and the stress response caused by LMA anesthesia will be less severe. However, it is necessary to pay attention to the use time limit of LMA anesthesia, and the best use time is 2-7 h, which may increase the incidence of complications if used for a long time. If the sample size is increased, the use time of anesthesia should be considered.

To sum up, the remifentanil combined with propofol and LMA is more safe and effective, with stable intraoperative hemodynamics and fewer complications, so it is suitable for laparoscopic ovarian cystectomy.

Disclosure of conflict of interest

None.

Address correspondence to: Haiping Zhang, Department of Anesthesiology, Sichuan Provincial Maternity and Child Health Care Health Hospital, 290th Shayan Second Street, Jinyang Road, Wuhou District, Chengdu 610045, Sichuan Province, China. Tel: +86-13258220005; E-mail: haipingz55@163.com

References

[1] Hitzerd E, van Hamont D and Pijnenborg JM. Mesenteric lymphangioma mimicking a cystic ovarian mass on imaging. BMJ Case Rep 2016; 2016: bcr2015213727.

[2] Abduljabbar HS, Bukhari YA, Al Hachim EG, Alshour GS, Amer AA, Shaikhoon MM and Khojah MI. Review of 244 cases of ovarian cysts. Saudi Med J 2015; 36: 834-838.

[3] Schallert EK, Abbas PI, Mehollin-Ray AR, Price MC, Dietrich JE and Orth RC. Physiologic ovarian cysts versus other ovarian and adnexal pathologic changes in the preadolescent and adolescent population: us and surgical follow-up. Radiology 2019; 292: 172-178.
[4] Marko J, Marko KI, Pachigolla SL, Crothers BA, Mattu R and Wolfman DJ. Mucinous neoplasms of the ovary: radiologic-pathologic correlation. Radiographics 2019; 39: 982-997.
[5] Nowak-Psiorz I, Ciecwiez SM, Brodowska A and Starczewski A. Treatment of ovarian endometrial cysts in the context of recurrence and fertility. Adv Clin Exp Med 2019; 28: 407-413.
[6] Legendre G, Catala L, Moriniere C, Lacoeuille C, Boussion F, Sentilhes L and Descamps P. Relationship between ovarian cysts and infertility: what surgery and when? Fertil Steril 2014; 101: 608-614.
[7] Asfour V, Varma R and Menon P. Clinical risk factors for ovarian torsion. J Obstet Gynaecol 2015; 35: 721-725.
[8] Lin CS, Huang C, Li PC, Hsu YH and Ding DC. Huge ovarian mature cystic teratoma with gliomatosis peritonei and massive ascites in a postmenopausal woman. Ci Ji Yi Xue Za Zhi 2019; 31: 289-291.
[9] Li T, Tan J and Cohen P. A novel surgical technique for the large ovarian cystic mass - combined mini-laparotomy and laparoscopy. Eur J Gynaecol Oncol 2016; 37: 766-770.
[10] Kaistha S, Kumar A, Gangavatiker R, Br S and Sisodiya N. Laparoscopic access: direct trocar insertion versus open technique. J Laparoendosc Adv Surg Tech A 2019; 29: 489-494.
[11] Vilos GA, Ternamian A, Dempster J and Laberge PY. No. 193-laparoscopic entry: a review of techniques, technologies, and complications. J Obstet Gynaecol Can 2017; 39: e69-e84.
[12] Rosero EB, Ozayar E, Eslava-Schmalbach J, Minhajuddin A and Joshi GP. Effects of increasing airway pressures on the pressure of the endotracheal tube cuff during pelvic laparoscopic surgery. Anesth Analg 2018; 127: 120-125.
[13] Boroda N, Malesinska M, Kars MS and Smith LP. The use of laryngeal mask airway for adenoidectomy. Int J Pediatr Otorhinolaryngol 2018; 107: 42-44.
[14] Alammari R, Lightfoot M and Hur HC. Impact of cystectomy on ovarian reserve: review of the literature. J Minim Invasive Gynecol 2017; 24: 247-257.
[15] O'Connor S, Zhang YL, Christians U, Morrison JE Jr and Friesen RH. Remifentanil and propofol undergo separation and layering when mixed in the same syringe for total intravenous anesthesia. Paediatr Anaesth 2016; 26: 703-709.
[16] Burkle H, Dunbar S and Van Aken H. Remifentanil: a novel, short-acting, mu-opioid. Anesth Analg 1996; 83: 646-651.
[17] Zhu Y, Wang Y, Du B and Xi X. Could remifentanil reduce duration of mechanical ventilation in comparison with other opioids for mechanically ventilated patients? A systematic review and meta-analysis. Crit Care 2017; 21: 206.
[18] Sun X, Zhang J, Li H, Zhang Z, Yang J, Cui M, Zeng B, Xu T, Cao J and Xu L. Propofol effects on excitatory synaptic efficacy in the CA1 region of the developing hippocampus. Brain Res Dev Brain Res 2005; 157: 1-7.
[19] Luo L, Zhang X, Xiang T, Yuan JL, Tang JY and Yu Q. Propofol inhibited the excitability of pyramidal neurons in the orbitofrontal cortex by influencing the delayed rectifier K+ channels and gamma-aminobutyric acid type A receptors. Neuroreport 2019; 30: 102-107.
[20] Xu Q, Zhang H, Zhu YM and Shi NJ. Effects of combined general/epidural anesthesia on hemodynamics, respiratory function, and stress hormone levels in patients with ovarian neoplasm undergoing laparoscopy. Med Sci Monit 2016; 22: 4238-4246.
[21] Wagner KJ, Valet M, Kochs EF, Kriner M, Tolle TR and Sprenger T. The mu-opioid receptor agonist remifentanil induces acute dysphoria irrespective of its analgesic properties. J Psychopharmacol 2010; 24: 355-361.
[22] Windpassinger M, Plattner O, Gemeiner J, Bohler K, Luntzer R, Klimscha W, Yang D, Mascha EJ and Sessler DI. Opioid use after propofol or sevoflurane anesthesia: a randomized trial. Can J Anaesth 2016; 63: 1258-1265.
[23] Aceto P, Dello Russo C, Lai C, Perilli V, Fucci N, De Giovanni N, Piras A, Navarra P and Sollazzi L. Relationship between blood remifentanil concentration and stress hormone levels during pneumoperitoneum in patients undergoing laparoscopic cholecystectomy. Eur Rev Med Pharmacol Sci 2017; 21: 4419-4422.
[24] Cantarella G, La Camera G, Di Marco P, Grasso DC and Lanzafame B. Controlled hypotension during middle ear surgery: hemodynamic effects of remifentanil vs nitroglycerin. Ann Ital Chir 2018; 89: 283-286.
[25] Hino H, Matsuura T, Kihara Y, Tsujikawa S, Mori T and Nishikawa K. Comparison between hemodynamic effects of propofol and thiopental during general anesthesia induction with remifentanil infusion: a double-blind, age-stratified, randomized study. J Anesth 2019; 33: 509-515.
[26] Rab E, Flanagan RJ and Hudson S. Detection of fentanyl and fentanyl analogues in biological samples using liquid chromatography-high

resolution mass spectrometry. Forensic Sci Int 2019; 300: 13-18.
[27] Ziesenitz VC, Vaughns JD, Koch G, Mikus G and van den Anker JN. Pharmacokinetics of fentanyl and its derivatives in children: a comprehensive review. Clin Pharmacokinet 2018; 57: 125-149.
[28] Dumas GA, Bryant AS, Ibey J, Long JA, Vicinanzo MG and Boyd GL. Safety comparison of laryngeal mask use with endotracheal intubation in patients undergoing dacryocystorhinostomy surgery. Ophthalmic Plast Reconstr Surg 2018; 34: 324-328.