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ORIGINAL ARTICLE

A Comparison of Two Proportions of Remifentanil–Propofol Mixture Administered with Target-Controlled Infusion for Patients Undergoing Colonoscopy

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Background: Previous studies have demonstrated the feasibility of a remifentanil–propofol (RP) mixture use in sedation for medical examinations. However, delivery of an RP mixture by target-controlled infusion (TCI) for colonoscopy has not been described. Here, we investigate the appropriate proportion of RP mixed regimens, prepared in two different ratios for colonoscopy. **Methods:** A retrospective study including patients who received a colonoscopy between May 2018 and January 2019 was conducted. Group 1 and Group 2 were, respectively, administered a mixture of RP at concentrations of 2.5 μg/mL-10 mg/mL and 5.0 μg/mL-10 mg/mL by adjusting a TCI pump with Schneider model to keep the Observer's Assessment of Alertness/Sedation scale between 1 and 2. The primary outcome was to determine the appropriate proportion of RP for the procedure in terms of hemodynamic conditions and adverse events. The secondary endpoints included the total dosage of anesthetics and total times of TCI pump adjustments. **Results:** A total of 120 patients in Group 1 and 116 patients in Group 2 were eligible for analysis. Several parameters were significantly different between Group 1 and Group 2, with Group 1 having a higher respiratory rate, a lower end-tidal carbon dioxide pressure, fewer patients with hypotension (mean arterial pressure <60 mmHg; 1 vs. 7, $P = 0.033$) or apnea with desaturation (peripheral oxygen saturation < 90%; 1 vs. 12, $P = 0.001$), more propofol consumption (162.4 ± 49.6 mg vs. 130.3 ± 48.8 mg, $P < 0.001$), less remifentanil consumption (40.6 ± 12.3 μg vs. 65.1 ± 24.4 μg, $P < 0.001$), and fewer total times of TCI pump adjustment (1 [0–1] vs. 1 [1–2], $P < 0.001$), as compared to Group 2. **Conclusions:** In colonoscopy, TCI with an RP mixed regimen prepared in the proportion of 2.5 μg/mL-10 mg/mL with propofol Schneider model target 2.5–3.0 μg/mL provided appropriate hemodynamic conditions, sufficient sedation and analgesia, and less adverse events.

Key words: Remifentanil, propofol, target-controlled infusion, colonoscopy

INTRODUCTION

Colonoscopy, the gold standard of detecting neoplastic changes and pathologies in the lower gastrointestinal system, is a painful process.[1] Pain and anxiety extend the timeframe of the procedure and increase the possibility of complications for patients. Thus, sedation and analgesia are recommended.[2] Besides providing effective sedation and analgesia to reduce pain and anxiety, it is necessary to maintain stable hemodynamic and respiratory conditions during an interventional endoscopic operation.[3,4]

For its unique properties, including rapid onset, precise intraoperative control, and a fast recovery profile, remifentanil is preferable to other opioids when combined with propofol administration in a target-controlled infusion (TCI) pump.[5,6] Propofol and remifentanil are often administered with two TCI pumps to, respectively, provide hypnotic and analgesic effects, which together are considered to be an ideal anesthetic

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technique.[7] In addition to a two-fold increase in the number of TCI supplies used (including pumps, syringes, and extension tubes), it takes time to set the TCI model for propofol and remifentanil if they are infused separately. Remifentanil–propofol (RP) mixtures delivered in the same syringe for monitored anesthesia care (MAC) are reported to be safe and effective in spontaneously breathing pediatric patients undergoing either magnetic resonance imaging (MRI) or flexible fiberoptic bronchoscopy at a RP concentration of 10–20 μg/mL-10 mg/mL.[8,9] Moreover, Stewart *et al*.[10] reported that remifentanil can be mixed with propofol in small concentrations (5 μg/mL) in polypropylene syringes, with a remaining concentration of 91.9% after an hour. In general, the duration of colonoscopy is less than half an hour, which is accordant with the limited duration of the RP mixture. Thus, this study investigated the appropriate proportion of an RP mixture prepared in two different regimens for a colonoscopy procedure.

METHODS

Study design and setting

This retrospective study was conducted at Tri-Service General Hospital (TSGH), Taipei, Taiwan, Republic of China.

Participants and data sources

The ethics committee of TSGH approved this retrospective study and due to the nature of the study, the need for informed consent was waived (TSGH institutional review board No. 2-108-05-116). The relevant patient information was retrieved from the medical records and the electronic database of TSGH.

From May 2018 to January 2019, 236 patients who were >20 years of age, with an American Society of Anesthesiologists score of I–III and undergoing elective colonoscopy (including polypectomy) with MAC in an RP mixture prepared in the proportion of 2.5 μg/mL-10 mg/mL (Group 1, n = 120) or 5.0 μg/mL-10 mg/mL (Group 2, n = 116), were included without any difference in enrollment time. The proportion of RP mixture was determined according to the anesthesiologist's preference (n = 2). Patients who were pregnant or had anticipated airway difficulties; those who had active gastrointestinal system bleeding, severe cardiac and respiratory insufficiencies, an increase in intracranial pressure, a history of allergy to remifentanil or propofol, alcohol and drug addiction, psychiatric disorders; and those patients that were undergoing combined procedures leading to extended procedural times over 1 h were excluded from the study.

Mixture preparation

For Group 1, 2 mg remifentanil powder was reconstituted with 4 mL of 5% dextrose and water to a concentration of 0.5 mg/mL solution for injection. The reconstituted remifentanil solution (0.1 mL; 50 μg) was mixed in the bottle of propofol (Fresofol 1% medium-chain triglyceride/long-chain triglyceride 20 mL, Fresenius Kabi; Graz, Austria) and aspirated in a 20-mL polypropylene syringe, to final concentrations of remifentanil and propofol at 2.5 μg/mL and 10 mg/mL, respectively.

For Group 2, 2 mg remifentanil powder was reconstituted with 2 mL of 5% dextrose and water to a concentration of 1 mg/mL solution for injection. The reconstituted remifentanil solution (0.1 mL; 100 μg) was mixed in the bottle of propofol (Fresofol 1% medium-chain triglyceride/long-chain triglyceride 20 mL, Fresenius Kabi; Graz, Austria) and aspirated in a 20-mL polypropylene syringe, to final concentrations of remifentanil and propofol 5 μg/mL and 10 mg/mL, respectively.

Each medication mixture was visually inspected with prudence before anesthesia induction to ensure that there was no evidence of layering or separation for either group.

Anesthesia and monitoring

All patients were fasted overnight before the procedure, and no medications were allowed before the induction of anesthesia. Standard monitoring, such as noninvasive arterial blood pressure, electrocardiography (lead II), pulse oximetry, and end-tidal carbon dioxide pressure ($EtCO_2$), were applied for each patient. The participants were preoxygenated and adequately maintained with 100% oxygen at 6 L/min via a facial mask during the entire procedure.

During anesthesia induction, continuous infusion of RP mixed regimens were delivered using propofol Schneider's kinetic model of TCI (Fresenius Orchestra Primea; Fresenius Kabi AG, Bad Homburg, Germany) with the effect-site concentration (Ce) of 2.5–3.0 μg/mL in Group 1 and 2.0–2.5 μg/mL in Group 2, based on patients' medical conditions. In both groups, maintenance of the Ce of propofol was adjusted upward and downward by 0.5 μg/mL to keep the Observer's Assessment of Alertness/Sedation (OAA/S) scale between 1 and 2 and mean arterial pressure (MAP) and heart rate (HR) at baseline levels ±30%.[1] As soon as the scopy instrument reached the cecum valve, the RP mixed regimens were discontinued, except in those patients indicated for further polypectomy. After each patient regained consciousness by name, the patient was sent to the postoperative anesthesia care unit for further care. Patients were monitored for MAP, HR, peripheral oxygen saturation (SpO_2), respiratory rate (RR), $EtCO_2$, Ce of propofol, and OAA/S scale at the initial setting (T1),

5 min (T2), 10 min (T3), 15 min (T4), 20 min (T5), and 25 min (T6) after RP mixed regimen infusion.

Outcomes

The primary outcome was to determine the appropriate proportion of RP for colonoscopy in terms of hemodynamic conditions (such as MAP, HR, $EtCO_2$, SpO_2, and RR) and adverse events (such as patient movements affecting the procedure, hypotension [MAP <60 mmHg], ephedrine requirements [systolic blood pressure <80 mmHg], and apnea with desaturation [SpO_2 <90%]). The secondary endpoints included total dosage of anesthetics and total times of TCI pump adjustments during the procedure. Each adjustment of TCI pump was recorded, and once the Ce was adjusted, it was counted in the number of adjustments. We also recorded total times of upward or downward adjustment of the TCI pump.

Statistical analysis

Data were expressed as means ± standard deviations or as medians with the range or percentage counts, unless otherwise indicated. The demographic and perioperative variables were compared using Student's *t*-test or Mann–Whitney test if the data were not normally distributed. Categorical variables were compared using Chi-square or Fisher's exact test if needed. We also applied ANOVA for multiple comparison analyses. Statistical significance was accepted for two-tailed $P < 0.05$, and statistics were performed by using SigmaStat version 3.5 for Windows (Systat Software, Inc, San Jose, CA, USA).

RESULTS

A total of 236 patients undergoing colonoscopy with MAC were enrolled. The demographic data for the two groups are shown in Table 1. The two groups showed similar patient characteristics.

Table 2 shows the results of anesthetic management analysis for the two groups. There was no significant difference between Group 1 and Group 2 in terms of anesthesia time (18.2 ± 5.6 min vs. 18.6 ± 5.7 min, $P = 0.590$) or procedural time (15.5 ± 5.1 min vs. 15.7 ± 6.5 min, $P = 0.792$). Propofol consumption during the procedure was 162.4 ± 49.6 mg in Group 1 and 130.3 ± 48.8 mg in Group 2 ($P < 0.001$). Remifentanil consumption during the procedure was 40.6 ± 12.3 μg in Group 1 and 65.1 ± 24.4 μg in Group 2 ($P < 0.001$). The median of upward adjustments was 0 (0–1) in Group 1 and 0 (0–1) in Group 2 ($P = 0.760$), and the median of downward adjustments was 1 (0–1) in Group 1 and 1 (1–2) in Group 2 ($P < 0.001$). The total number of TCI pump adjustments was higher in Group 2 than in Group 1 overall (1 [1–2] vs. 1 [0–1], respectively, $P < 0.001$) [Table 2].

Table 1: Patient characteristics

	Group 1 (*n*=120)	Group 2 (*n*=116)	*P*
ASA I/II/III	12/102/6	16/91/9	
Sex (male/female)	60/60	57/59	0.897
Age (year)	54.7±13.0	56.2±14.7	0.420
Height (cm)	164.2±8.3	163.7±8.6	0.652
Weight (kg)	65.3±11.9	65.2±13.6	0.944
BMI	24.1±3.2	24.1±3.8	0.878

Data are shown as mean±SD or number. Group 1=Remifentanil–propofol: 2.5 μg/mL–10 mg/mL; Group 2=Remifentanil–propofol: 5.0 μg/mL–10 mg/mL; ASA=American Society of Anesthesiologists; BMI=Body mass index; SD=Standard deviation

Table 2: Results of anesthetic management analysis

	Group 1 (*n*=120)	Group 2 (*n*=116)	*P*
Anesthesia time (min)	18.2±5.6	18.6±5.7	0.590
Procedural time (min)	15.5±5.1	15.7±6.5	0.792
Propofol consumption (mg)	162.4±49.6	130.3±48.8	<0.001
Remifentanil consumption (μg)	40.6±12.3	65.1±24.4	<0.001
Total times of TCI pump adjustment (*n*)	1 (0–1)	1 (1–2)	<0.001
Upward (*n*)	0 (0–1)	0 (0–1)	0.760
Downward (*n*)	1 (0-1)	1 (1–2)	<0.001

Data are shown as mean±SD or median (range) or *n* (%). Group 1=Remifentanil–propofol: 2.5 μg/mL–10 mg/mL; Group 2=Remifentanil–propofol: 5.0 μg/mL–10 mg/mL; TCI=Target-controlled infusion; SD=Standard deviation

There was no significant difference in MAP between the two groups at each time point [Figure 1a]. There was also no significant difference in HR between the two groups at each time point (except T3). At T3, the HR in Group 1 was significantly higher (67.0 bpm ± 9.7 bpm) than that in Group 2 [64.4 bpm ± 7.9 bpm; $P < 0.05$; Figure 1a].

The RR in Group 1 was generally higher than that in Group 2 [Figure 1b]; at T2, 12.4 ± 1.7 times/min versus 11.8 ± 2.1 times/min ($P < 0.05$); at T3, 13.3 ± 1.4 times/min versus 12.8 ± 1.4 times/min ($P < 0.05$); at T5, 14.4 ± 1.1 times/min versus 13.7 ± 1.8 times/min ($P < 0.05$); and at T6, 14.8 ± 1.3 times/min versus 13.6 ± 1.9 times/min ($P < 0.05$). There was no significant difference in RR between the two groups at T1 or T4 [Figure 1b].

The $EtCO_2$ pressure values in Group 1 were generally lower than that in Group 2, [Figure 1b]; at T2, 43.9 ± 3.4 mmHg versus 45.6 ± 4.7 mmHg ($P < 0.05$); at T3, 41.8 ± 2.8 mmHg versus 43.8 ± 3.6 mmHg ($P < 0.001$); at T4, 41.5 ± 2.6 mmHg versus

43.1 ± 3.6 mmHg ($P < 0.001$); at T5, 40.5 ± 1.8 mmHg versus 43.1 ± 3.8 mmHg ($P < 0.001$); and at T6, 40.6 ± 2.0 mmHg versus 43.2 ± 4.1 mmHg ($P < 0.05$). There was no significant difference in $EtCO_2$ between the two groups at T1 [Figure 1b].

The SpO_2 in Group 1 varied significantly from Group 2 at T2–T4 [Figure 1b]; at T2, 99.2 ± 1.4% versus 98.1 ± 3.5% ($P < 0.05$); at T3, 99.6 ± 0.6% versus 99.3 ± 1.2% ($P < 0.05$); and at T4, 99.7 ± 0.5% versus 99.5 ± 0.7% ($P < 0.05$). There were no significant differences in SpO_2 between the two groups at T1, T5, and T6 [Figure 1b]. There were statistically significant differences in hemodynamics and respiratory parameters, but no clinically significant differences were observed.

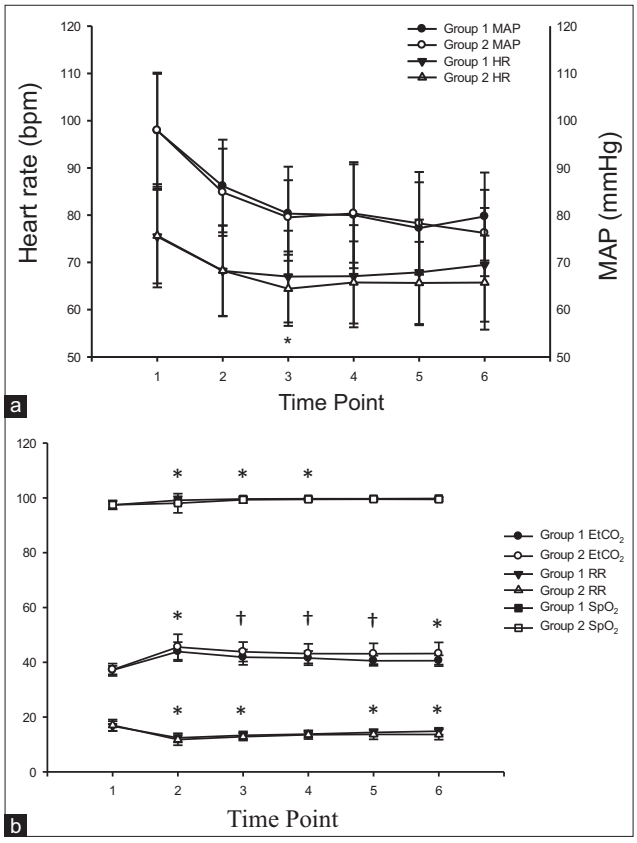

Figure 1: Changes of MAP and HR (a); RR (times/min), $EtCO_2$ (mmHg), and SpO_2 (%) (b) During every step of colonoscopy. Time point: (1) in the initial setting (n = 120 in Group 1, n = 116 in Group 2), (2) 5 min after RP infusion (n = 120 in Group 1, n = 116 in Group 2), (3) 10 min after RP infusion (n = 120 in Group 1, n = 116 in Group 2), (4) 15 min after RP infusion (both n = 89), (5) 20 min after RP infusion (n = 47 in Group 1, n = 41 in Group 2), and (6) 25 min after RP infusion (n = 18 in Group 1, n = 22 in Group 2). Data were presented as mean ± SD *$P < 0.05$ compared with Group 1 at each time point measurement; †$P < 0.001$ compared with Group 1 at each time point measurement. Ce = Effect-site concentration; RP = Remifentanil–propofol; bpm: Beats per minute; $EtCO_2$ = End-tidal carbon dioxide pressure; HR: Heart rate; MAP: Mean arterial pressure; OAA/S scale = Observer's Assessment of Alertness/Sedation Scale; RR = Spontaneous respiratory rate; SpO_2 = Peripheral oxygen saturation; SD = Standard deviation

Table 3 indicates adverse events that occurred during the procedure for the two groups. Seven patients (5.8%) in Group 1 and two patients (1.7%) in Group 2 moved during colonoscopy, affecting the procedure [P = 0.172; Table 3]. After judicious adjustment of the Ce, the procedures were completed without incidents. The number of occurrences of hypotension (MAP <60 mmHg) was one event (0.8%) in Group 1 and seven episodes (6.0%) in Group 2 (P = 0.033). There were no patients requiring ephedrine administration due to systolic blood pressure <80 mmHg in either group. There were no patients with postoperative nausea and vomiting (PONV) in the two groups. One patient (0.8%) developed apnea with desaturation (SpO_2 < 90%) in Group 1 and two patients (1.8%) developed apnea with desaturation in Group 2 (P = 0.001; [Table 3]. The SpO_2 returned to normal range immediately after sufficient supplementary oxygen, jaw elevation, and reduced Ce.

Table 4 compares the Ce of propofol during colonoscopy between the groups. There were significant differences in the propofol Ce between the two groups at each time point. At T1, the Ce of propofol was 2.82 ± 0.24 μg/mL in Group 1 (n = 120) and 2.35 ± 0.23 μg/mL in Group 2 (n = 116; $P < 0.001$); at T2, 5 min after RP mixed regimen infusion, the Ce of propofol was 2.91 ± 0.51 μg/mL in Group 1 (n = 120) and 2.59 ± 0.52 μg/mL in Group 2 (n = 116; $P < 0.001$); at T3, 10 min after RP mixed regimen infusion, the Ce of propofol was 2.65 ± 0.51 μg/mL in Group 1 (n = 120) and 2.19 ± 0.51 μg/mL in Group 2 (n = 116; $P < 0.001$); at T4, 15 min after RP mixed regimen infusion, the Ce of propofol was 2.52 ± 0.55 μg/mL in Group 1 (n = 89) and 1.92 ± 0.54 μg/mL in Group 2 (n = 89; $P < 0.001$); at T5, 20 min after RP mixed regimen infusion, the Ce of propofol was 2.52 ± 0.53 μg/mL in Group 1 (n = 47) and 1.76 ± 0.50 μg/mL in Group 2 (n = 41; $P < 0.001$); and at T6, 20 min after RP mixed

Table 3: Adverse events during the procedure

	Group 1 (n=120)	Group 2 (n=116)	P
Patient movements affecting the procedure	7 (5.8)	2 (1.7)	0.172
Hypotension (mean arterial pressure <60 mmHg)	1 (0.8)	7 (6.0)	0.033
Patients requiring ephedrine (systolic blood pressure <80 mmHg)	0 (0)	0 (0)	1.000
Apnea with desaturation (SpO_2 <90%)	1 (0.8)	12 (10.3)	0.001
Postoperative nausea and vomiting	0 (0)	0 (0)	1.000

Data are shown as n (%). Group 1=Remifentanil–propofol: 2.5 μg/mL–10 mg/mL; Group 2=Remifentanil–propofol: 5.0 μg/mL–10 mg/mL; SpO_2=Peripheral oxygen saturation

Table 4: Ce of propofol during the procedure

	T1	T2	T3	T4	T5	T6
Group 1	2.82±0.24 (*n*=120)	2.91±0.51 (*n*=120)	2.65±0.51 (*n*=120)	2.52±0.55 (*n*=89)	2.52±0.53 (*n*=47)	2.31±0.57 (*n*=18)
Group 2	2.35±0.23† (*n*=116)	2.59±0.52† (*n*=116)	2.19±0.51† (*n*=116)	1.92±0.54† (*n*=89)	1.76±0.50† (*n*=41)	1.73±0.43† (*n*=22)

†*P*<0.001 compared with Group 1 at each time point measurement. Data are shown as mean±SD. Group 1= Remifentanil–propofol: 2.5 μg/mL–10 mg/mL; Group 2=Remifentanil–propofol: 5.0 μg/mL–10 mg/mL; T1=In the initial setting; T2=5 min after RP infusion; T3=10 min after RP infusion; T4=15 min after RP infusion; T5=20 min after RP infusion; T6=25 min after RP infusion; Ce=Effect-site concentration; RP=Remifentanil–propofol; SD=Standard deviation

regimen infusion, the Ce of propofol was 2.31 ± 0.57 μg/mL in Group 1 (n = 18) and 1.73 ± 0.43 μg/mL in Group 2 (n = 22; P < 0.001) [Table 4].

DISCUSSION

Previous research indicates that use of the combination of remifentanil and propofol has been limited in light sedation of spontaneously breathing patients during procedures such as MRI and bronchoscope examination.[8,9] In light of this, we investigated this drug combination during colonoscopy procedures. The major findings of this study revealed that the RP mixture prepared in the proportion of 2.5 μg/mL-10 mg/mL with TCI pump provided appropriate hemodynamic conditions, sufficient sedation and analgesia, less adverse events (such as hypotension and apnea with desaturation), and a lower total number of TCI pump adjustments during elective colonoscopy.

The TCI of propofol is an ideal anesthetic technique with advantages of less PONV and a rapid awakening profile, and provides a guarantee against malignant hyperthermia.[7,11] Combination of propofol with other anesthetic drugs is a common practice for delivering total intravenous anesthesia (TIVA), with most administered simultaneously with separate TCI systems. Under certain circumstances where multiple TCI systems are unavailable or are time- and cost-consuming, mixing multiple drugs, including propofol with ketamine (known as "ketofol"); propofol with alfentanil; or even a 3-in-1 regimen containing propofol, alfentanil, and mivacurium, in a single syringe, is a feasible and well-established alternative.[12-16] However, this limited clinical use is largely attributed to the previous reports of instability of an RP mixture.[10,17] O'Connor *et al*.[17] studied the interaction between propofol and remifentanil when mixed in the same syringe and suggested that the drugs undergo separation and layering, resulting in an increased size of oil globules, which leads a "theoretical" risk of fat embolism. They concluded that TIVA should always be delivered with drugs using separate TCI devices. However, Bagshaw[18] tested three concentrations of remifentanil at 25, 50, and 100 μg/mL in propofol, which is significantly greater than that of our clinical use in this study. Such a gradient or aggregation effect might be concentration dependent and could be only observed at very high concentrations. Moreover, O'Connor *et al*.[17] demonstrated study results by mixing these two compounds in a syringe in a vertical direction, which is against procedures in a clinical setting as well. In the present study, the remifentanil concentration (2.5 or 5 μg/mL) in the mixture was much lower compared with those concentrations in the O'Connor study, whereas the TCI pump was placed horizontally during administration. As for the safety concerns, however, there are currently no clinical case reports of fat embolism caused by RP mixture delivery to date. In other words, the risk of fat embolism when combining these two drugs remains a physical rather than a physiological property. In addition, according to the drug information found in the electronic Medicines Compendium, remifentanil is compatible with propofol when administered together.

This is a retrospective study based on the results of Stewart *et al*.,[10] which reported that remifentanil can be mixed with propofol in low concentrations (5 μg/mL) in polypropylene syringes, with a remaining remifentanil concentration of 91.9% after 1 h. Considering the possible decay of remifentanil in the mixture, the regimen used in the present study was prepared just before anesthetic induction to minimize diminution of the drug. Ultimately, the true mixed regimen delivery period was within 30 min for all patients in this study. In addition, to make our findings more clinically feasible, all participant parameters such as MAP and HR were kept at baseline levels ±30%,[1] and an OAA/S scale between 1 and 2 by adjusting the Ce of propofol during the procedure, allowing adjustment of the anesthetic concentration in an easier way similar to our daily hospital practice.

The total frequency of TCI adjustment in Group 1 was significantly lower than that in Group 2. The 2.5 μg/mL concentration of remifentanil provided adequate analgesia, and the increased dose of propofol might have improved sedation while concurrently decreasing the risk of respiratory depression. Finally, there was only one patient in Group 1 that suffered from apnea with desaturation, but 12 patients in Group 2 experienced apnea with desaturation.

The possible adverse effects of remifentanil include respiratory depression, muscle rigidity, bradycardia, and nausea

and vomiting.[19] Although there were statistically significant changes in RR, SpO_2, and $EtCO_2$ in the present study, we believe that these effects were not of clinical significance or concern. Previous studies have reported a respiratory depressant effect of propofol TIVA, which, theoretically, would increase with the addition of a μ-opioid receptor agonist.[20-22] The occurrence of PONV was also a concern of the anesthetists, but none of the patients experienced nausea and vomiting subsequent to discharge during follow-up. Because both remifentanil and propofol can potentially cause severe respiratory depression, we suggest that this technique should only be performed by trained anesthesiologists.

There were some limitations in this study. First, our drug administration technique, in which both agents were mixed in fixed concentrations, eliminated the ability to selectively control the use of each agent. Given that individual patients often respond to individual drugs differently, it could be argued that it would be more appropriate to use separate infusions of propofol and remifentanil, rather than mixing them together. Second, we did not apply Bispectral Index (BIS) and Analgesia Nociception Index (ANI) monitoring as commonly practiced for colonoscopy with MAC. The BIS index, which correlates well with hypnotic state and can reduce the incidence of intraoperative awareness by approximately 80%, is certified as a measurement to monitor anesthetic depth by the US Food and Drug Administration. [23-26] However, because the duration of the procedure was short, the economic effect is required for further evaluation. Furthermore, Funcke *et al*. [27] reported that ANI is superior in detecting painful stimuli under sedation compared to clinical signs such as HR and MAP. However, to the best of our knowledge, most anesthetists do not use BIS and ANI during minor procedures of this type. Finally, in this study, the ratios of 5 μg/mL-10 mg/mL and 2.5 μg/mL-10 mg/mL for the RP mixed regimen that we chose was based on our clinical experience, and further investigation is required to determine optimal RP proportions.

CONCLUSIONS

In elective colonoscopy, a RP mixture at proportions of 2.5 μg/mL-10 mg/mL by TCI Schneider model with propofol Ce 2.5–3.0 μg/mL provides suitable hemodynamic conditions and effective sedation and analgesia. The major advantage of this modality is its convenience (less time-consuming for both drug preparation and setting TCI devices) and cost-saving (less equipment consumption of pumps, tubing, and syringes). It is of value in providing an alternative for procedures <1 h, especially when only one TCI pump is available.

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Conflicts of interest

There are no conflicts of interest.

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