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Sedoanalgesia with dexmedetomidine in daily anesthesia practices: a prospective randomized controlled trial

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Abstract

Background Patient safety is important in daily anesthesia practices, and providing deep anesthesia is difficult. Current debates on the optimal anesthetic agents highlight the need for safer alternatives. This study was justified by the need for safer and more effective anesthetic protocols for outpatient hysteroscopic procedures, particularly those conducted outside the operating room. Propofol, while widely used, has significant limitations, including respiratory depression, hemodynamic instability, and delayed recovery when higher doses are required for adequate sedation. The addition of opioids to propofol, though beneficial for analgesia, introduces risks such as hypoxemia and hypotension. These challenges necessitate exploring alternative combinations that balance sedation depth with fewer side effects.

Objective To assess the efficacy and safety of deep sedoanalgesia achieved with dexmedetomidine-propofol versus remifentanil-propofol combinations in daily anesthesia practices.

Design Prospective randomized clinical study.

Settings This study was carried out at Dursun Odabaş Medical Center.

Patients Eighty ASA I–II patients, aged 18–65, scheduled for elective hysteroscopic interventions under sedoanalgesia were included in the study.

Main outcome measures The primary aim of our study was to identify an anesthetic agent combination capable of delivering effective and safe deep sedation, with sedation depth assessed via the Ramsey Sedation Score (RSS) and respiratory safety evaluated through desaturation rates. Secondary endpoints included Visual Analogue Scale (VAS) scores, oxygen saturation (SpO2), patient, surgeon, and anesthesiologist satisfaction scores, hemodynamic parameters, the time to achieve an RSS > 4, the time to reach a Modified Aldrete Score (MAS) > 9, and the requirement for mask ventilation and jaw thrust maneuvers.

Interventions Patients were randomized into two groups ($n = 40$ each):

- Group DP (Dexmedetomidine–Propofol): A bolus of 1 mg/kg IV propofol and 1 mcg/kg IV dexmedetomidine over 10 min, followed by a continuous infusion of 0.2–1.4 mcg/kg/hour.

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- Group RP (Remifentanil–Propofol): A bolus of 1 mg/kg IV propofol and 0.25 mcg/kg IV remifentanil, followed by a continuous infusion of 0.025–0.1 mcg/kg/minute.

Results Patients in the DP group exhibited significantly lower VAS scores and desaturation rates ($p = 0.003$) compared to the RP group. Satisfaction scores (patient, surgeon, anesthesiologist) and integrated pulmonary index (IPI) values were significantly higher in the DP group ($p < 0.05$).

Conclusion The dexmedetomidine-propofol combination is an effective and safe anesthetic regimen for deep sedation in outpatient hysteroscopic procedures, offering adequate sedation and superior preservation of respiratory function. Additionally, the dexmedetomidine-propofol combination ensures more stable hemodynamics, with a lower incidence of hypoxia, and results in higher satisfaction rates among patients, surgeons, and anesthesiologists.

Trial registration Clinical Trials ID is NCT05674201 Date 2022.12.07.

Key points

- Dexmedetomidine combined with propofol provides adequate depth of anesthesia and analgesia for hysteroscopic procedures.
- The combination of dexmedetomidine and propofol affects respiratory function less, and hypoxemia is less common in patients.
- When nonoperating rooms administer dexmedetomidine, one should be prepared for cardiovascular complications, especially bradycardia.

Keywords Anesthesia, General, Deep sedation, Anesthesia recovery period, Dexmedetomidine, Hysteroscopy, Remifentanil, Propofol, Capnography

Introduction

Hysteroscopy is regarded as the gold standard for diagnosing and treating intrauterine pathologies [1, 2]. Advancements in hysteroscopic technology, such as smaller instruments and refined surgical techniques, have allowed many procedures to transition from operating rooms to outpatient clinics [3–5]. This shift in hysteroscopic technology offers advantages such as improved visualization of the uterine cavity, higher patient acceptance, and minimal complication rates. However, pain and anxiety remain the leading causes of incomplete procedures in outpatient settings [6]. Consequently, a well-structured anesthetic protocol is essential to ensure patient comfort, enhance procedural success rates, and maintain a positive doctor-patient relationship [7].

Propofol, a short-acting intravenous anesthetic with strong sedative properties, is frequently employed in hysteroscopy due to its rapid onset and short recovery time [8–10]. However, as propofol lacks intrinsic analgesic properties, patients may experience movement or discomfort due to pain, necessitating higher doses to achieve adequate sedation. Unfortunately, increased propofol dosages can lead to significant side effects, including respiratory depression, circulatory instability, and delayed recovery [11, 12]. To address these challenges, opioids are often combined with propofol to enhance analgesia and reduce the required dose of propofol, thereby minimizing its adverse effects. Despite these advantages, opioid-propofol combinations can still cause notable respiratory and hemodynamic compromise, including hypoxemia and hypotension. These limitations underscore the need for safer anesthetic regimens that balance sedation depth with minimal side effects.

Dexmedetomidine, a highly selective α-2 adrenoceptor agonist, has gained prominence as an anesthetic adjuvant due to its unique properties [13, 14]. It provides sedative, analgesic, sympatholytic, and amnesic effects without causing respiratory depression [15]. Approved for short-term (< 24 h) sedation in intensive care units and during surgical procedures, dexmedetomidine offers "conscious sedation" and is increasingly utilized for outpatient and operating room procedures due to its favorable pharmacological profile [16].

This study aimed to assess the perioperative effects of dexmedetomidine-propofol versus remifentanil-propofol combinations in achieving deep sedation for outpatient hysteroscopic procedures performed outside the operating room. By evaluating Ramsey Sedation Scores (RSS), Visual Analogue Scale (VAS) scores, oxygen saturation (SpO2) levels, hemodynamic parameters, recovery times (time to achieve RSS > 4 and MAS > 9), the need for mask ventilation or jaw thrust maneuvers, and satisfaction levels of patients, surgeons, and anesthesiologists, the study seeks to determine the most effective and safe anesthetic protocol for outpatient settings.

Method

The research adhered to the CONSORT guidelines. The study was conducted with the approval of the Van Yüzüncü Yıl University Clinical Research Ethics Committee (approval dated 22.06.2021, No. 07). It was registered with the Clinical Trials Registry (NCT05674201) on 07.12.2022. Patient enrollment began after trial

registration, and both verbal and written informed consent were obtained from all participants prior to their inclusion in the study. The study was completed on 06.01.2023.

Study design and participants

This was a prospective, randomized clinical trial conducted at Dursun Odabaş Medical Center. Eighty patients aged 18–65 years with ASA physical status I–II, scheduled for elective hysteroscopic interventions under sedoanalgesia, were included. The exclusion criteria for the study were defined as follows: patients younger than 18 years or older than 65 years; those with severe systemic diseases, including cardiac (e.g., heart failure, coronary artery disease), renal (e.g., chronic kidney disease, renal failure), hepatic (e.g., liver cirrhosis, hepatic insufficiency), or respiratory conditions (e.g., severe asthma, chronic obstructive pulmonary disease); patients with known hypersensitivity or allergies to any of the medications used in the study; individuals with psychomotor dysfunction that could impair their ability to cooperate or respond to sedation protocols; and patients anticipated to require intubation post-procedure due to respiratory or procedural complications. The study was conducted in full adherence to the prescribed procedure, without any exclusions related to the procedure.

Randomization

The 80 patients were randomized into Group DP or Group RP using a computerized random number generator. To ensure allocation concealment and minimize selection bias, the group assignments were secured in sealed, sequentially numbered envelopes, which were only opened at the time of patient inclusion. The anesthesiologist who recorded the data throughout the study did not know which sedation protocol was applied to which patient.

Preoperative preparation

Patients underwent preoperative evaluations at least 24 h prior to the procedure in the Anesthesiology and Reanimation Clinic. A perioperative fasting protocol was implemented for all patients; clear liquids were allowed up to 2 h, non-clear liquids up to 4 h, and light meals up to 6 h prior to sedation. The study was conducted in a Non-Operating Room Anesthesia (NORA) setting. An intravenous (IV) catheter (20G) was inserted into the right antecubital vein, and a 1000 mL isotonic saline (10 ml/kg/h) infusion was initiated. Patients were placed in the supine position on a gynecological table and premedicated with 0.025 mg/kg IV midazolam. Standard ASA monitoring was applied, including electrocardiography (ECG), peripheral oxygen saturation (SpO2), heart rate (HR), blood pressure (systolic, diastolic, mean), end-tidal carbon dioxide (ETCO2), and respiratory rate. All patients received 2 L/min of oxygen via a nasal cannula, and integrated pulmonary index (IPI) values were recorded using a Medtronic Capnostream 35 Capnography device.A 1 mg/kg bolus of propofol (Propofol® Lipuro 1% (10 mg/ml), Braun, Indonesia) was administered to the patients in the DP group during the procedure.

Interventions

Group DP (Dexmedetomidine-Propofol)

- A bolus of 1 mg/kg IV propofol (Propofol® Lipuro 1%, B. Braun) was administered at the start of the procedure.
- A 4 mcg/mL isotonic dexmedetomidine solution (Sedadomid® 200 µg/2 mL, KOÇAK FARMA) was prepared. A 1 mcg/kg IV bolus was infused over 10 min, followed by a continuous infusion of 0.2–1.4 mcg/kg/hour [15].

Group RP (Remifentanil-Propofol)

- A bolus of 1 mg/kg IV propofol (Propofol® Lipuro 1%, B. Braun) was administered at the start of the procedure.
- A 20 mcg/mL isotonic remifentanil solution (Ultiva®, GlaxoSmithKline) was prepared. A 0.25 mcg/kg IV bolus was administered, followed by a continuous infusion of 0.025–0.1 mcg/kg/min [15].

Measurements

The depth of sedation was assessed using the Ramsey Sedation Scale (RSS), and recovery was evaluated using the Modified Aldrete Score (MAS). Pain levels were measured using the Visual Analogue Scale (VAS). (VAS). The depth of anesthesia was ensured so that the Ramsey Sedation Scale score of the patients was greater than four. Patients with an RSS < 4 with additional propofol administration were excluded from the study. SpO2 levels below 90% for more than 10 s were classified as desaturation and managed with 6 L/min oxygen flow. Mask ventilation was initiated if necessary. Bradycardia was defined as a 20% decrease in HR from baseline and treated with atropine if required. Hypotension and hypertension were similarly defined as 20% deviations in mean arterial pressure from baseline and were managed with vasoactive agents if required. The duration of hysteroscopy, duration of the procedure, sedoanalgesia end time, recovery time and several possible complications (nausea and vomiting, desaturation and jaw thrust maneuver, bradycardia) were also recorded. For postprocedural recovery assessment, the time to a modified Aldrete score (MAS) above 8 was recorded. All records were made by an anesthesiologist who was not familiar with the sedation protocol

administered during the procedure. In both groups, physician satisfaction was evaluated at the end of the operation, and patient satisfaction was evaluated when the MAS score was above 8. Anesthesiologist, surgeon and patient satisfaction were evaluated on a 10-point scale (0: totally dissatisfied; 10: excellent).

Statistical analysis

The required sample size was calculated using G-Power software (version 3.1.9.4; University of Kiel, Kiel, Germany). The effect size was derived from the data of a previous study by Haspolat et al., considering Ramsey Sedation Scores (RSS) [Group I: mean 4.43 ± 1.87, Group II: mean 3.28 ± 1.51]. With a 5% margin of error and 80% statistical power, the effect size was determined to be 0.67. Based on these calculations, a minimum of 35 patients per group was required. To account for potential data collection errors or exclusions, 5 additional cases were added as reserves for each group. Consequently, patient recruitment began with 40 patients in each group.

During the study, four patients from the DP group were excluded: two due to hypertension detected on the morning of the procedure and two because the prolonged surgical procedure necessitated a transition to general anesthesia. Similarly, three patients from the RP group were excluded: two required intubation due to apnea, and one withdrew consent. The study was completed with 36 patients in the DP group and 37 patients in the RP group.

Data analysis was conducted using SPSS software (version 28.0). Numerical data were presented as mean ± standard deviation or median, while categorical data were expressed as frequencies and percentages. The Kolmogorov-Smirnov test was used to assess the normality of numerical data distribution. For data with normal distribution, independent sample t-tests were applied. For non-normally distributed data, the non-parametric Mann-Whitney U test was used. Categorical variables were compared using Chi-square or Fisher's exact tests. A p-value of <0.05 was considered statistically significant. In this study, an Intention-to-Treat (ITT) analysis was performed to assess the impact of the intervention on desaturation risk.

Results

The study initially recruited 80 patients. After the commencement of the study, four patients in the DP group were excluded. Two patients were excluded due to hypertension detected on the morning of the procedure, While the other two were excluded because the prolonged surgical procedure made the transition to general anesthesia unavoidable. Similarly, three patients from the RP group were excluded: two required intubation due to apnea, and one withdrew consent. The study was completed with 36 patients in the DP group and 37 patients in the RP group (Fig. 1). There were no reported violations of the study protocol throughout the study, and no data on primary and secondary outcomes were omitted during the study (See Table 1).

Baseline characteristics

The baseline demographic and clinical characteristics, including age, height, weight, BMI, and ASA classifications, were comparable between the RP and DP groups, with no statistically significant differences observed ($p>0.05$, Table 2).

Primary outcome

Ramsey Sedation Score (RSS) did not differ significantly between the two groups ($p>0.05$), with the RP group having a 95% CI of [5.139, 5.461] and the DP group having a 95% CI of [5.238, 5.562]. However, significant differences were noted in other primary outcomes. The VAS scores were significantly lower in the DP group compared to the RP group ($p=0.003$), with the RP group showing a 95% CI of [0.635, 1.525] and the DP group showing a 95% CI of [0.051, 0.509]. The incidence of desaturation was also significantly lower in the DP group ($p<0.001$), with the RP group having a 95% CI of [0.7202, 0.9554] and the DP group showing a 95% CI of [0.1072, 0.3928]. (Table 3).

Secondary outcomes

The duration of hysteroscopy and the requirement for mask ventilation did not differ significantly between the RP and DP groups ($p>0.05$, Table 3).

The incidence of the need for the Jaw Thrust maneuver was significantly lower in the DP group compared to the RP group ($p<0.05$, Table 3).

Time to achieve RSS > 4, time to achieve MAS > 9, and the rate of bradycardia were significantly higher in the DP group compared to the RP group ($p<0.05$, Table 3).

Anesthesiologist satisfaction scores, patient satisfaction scores, and surgeon satisfaction scores were significantly higher in the DP group compared to the RP group ($p<0.05$, Table 4).

Baseline heart rate (HR) and baseline respiratory rate did not differ significantly between the RP and DP groups ($p>0.05$, Figs. 2 and 3). However, the HR variability (HRV) was significantly lower in the DP group at the 1st, 5th, 10th minute, last measurement, and postoperative periods ($p<0.05$, Fig. 2). The respiratory rate at the 1st, 5th, 10th minute, last measurement, and postoperative periods was significantly higher in the DP group compared to the RP group ($p<0.05$, Fig. 3).

Baseline and postoperative systolic, diastolic, and mean blood pressure values did not show significant differences between the groups ($p>0.05$, Table 5). However, at the 1st, 5th, and 10th minutes, the systolic, diastolic, and mean blood pressure values were significantly higher

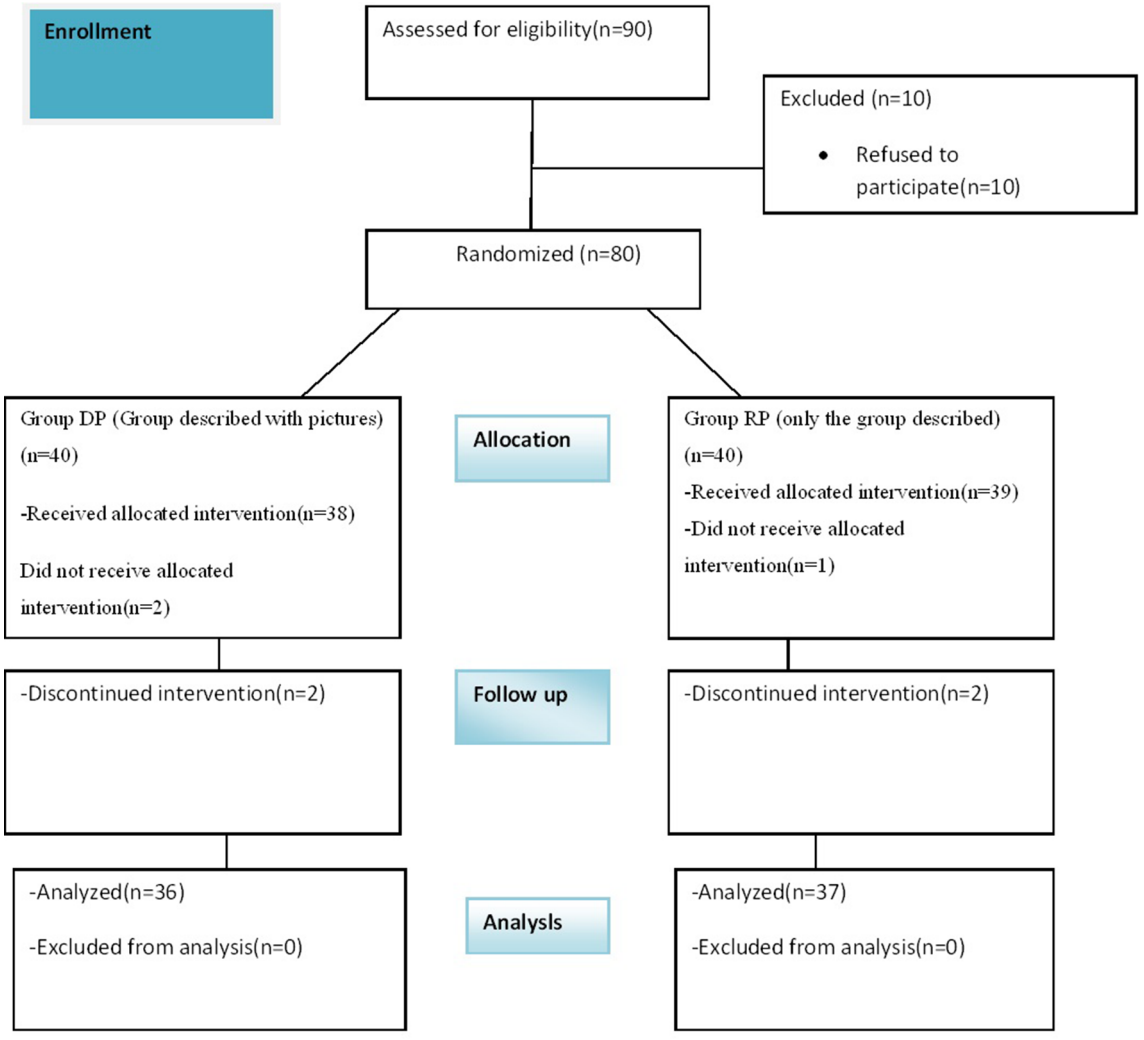

Fig. 1 Recruitment and flow of patients

Table 1 The standard table aimed to highlight power power analysis [17]

We performed the POWER analysis:	Before starting
On the primary outcome:	Ramsey sedation score (RSS)
Based on the two-tailed statistical test:	Two-tailed
And accepting the cutoff for significance (α):	0.05
and a power (1-β) of:	0.80
The variability of the primary outcome was:	In the study by Haspolat et al., RSS scores were taken into account (group I mean 4.43 ± 1.87, group II mean 3.28 ± 1.51) [18]
We considered as clinically relevant a difference (or a different effect, please specify) of:	1
Consequently, the effect size was:	0.67
The total sample size needed was:	72

in the DP group compared to the RP group ($p < 0.05$, Table 5).

Postoperative SPO2 levels did not differ significantly between the RP and DP groups ($p > 0.05$, Fig. 4). However, the baseline, 1st, 5th, 10th minute, and last measurement SPO2 values were significantly greater in the DP group compared to the RP group ($p < 0.05$, Fig. 4).

Baseline, 5th minute, 10th minute, last measurement, and postoperative ETCO2 values were similar between the RP and DP groups ($p > 0.05$, Fig. 5). However, the 1st

Table 2 Demographic data

		Min-Max			Median	med ± sd/*n*%			*p*	
Age		19	-	55	34.0	34.5	±	8.0	0.455	t
Height		150	-	178	163.0	162.6	±	5.4	0.823	t
Weight		50	-	95	70.0	68.5	±	10.7	0.136	t
BMI		18	-	34	25.7	25.9	±	3.6	0.062	t
ASA	I					35		48%	0.903	X^2
	II					38		52%		

[t] Independent sample test / [m] Mann-whitney u test / [X^2] Chi-square test(Fischer test)

Table 3 Anesthetic agent use, depth of sedation and adverse events

		Group RP				Group DP				*p*	
		Mean ± SD/*n*-%			Median	Mean ± SD /*n*-%			Median		
Total Remifentanil (mcg)		122.8	±	51.7	120.0	78.2	±	11.1	79.5	***0.000***	t
Total time (min)		19.1	±	4.5	17.0	17.8	±	3.1	16.5	0.161	t
VAS Score		1.08	±	1.382	0.00	0.28	±	0.70	0.00	***0.003***	t
RSS		5.3	±	0.5	5.0	5.4	±	0.5	5.0	0.298	t
RSS > 4 time (min)		2.11	±	0.46	2.00	5.28	±	0.66	5.00	***0.000***	t
MAS > 9 time (min)		1.81	±	0.84	2.00	19.03	±	2.16	19.00	***0.000***	t
Desaturation	(-)	6		16,2%		27		75.0%		***0.000***	X^2
	(+)	31		83.8%		9		25.0%			
JAWS TRAC	(-)	6		16.2%		30		83.3%		***0.000***	X^2
	(+)	31		83.8%		6		16.7%			
Mask Ventilation	(-)	33		89.2%		36		100.0%		0.115	X^2
	(+)	4		10.8%		0		0.0%			
Bradycardia	(-)	34		91.9%		16		44.4%		***0.000***	X^2
	(+)	3		8.1%		20		55.6%			

[t] Independent sample test / [m] Mann-whitney u test / [X^2] Chi-square test (Fischer test)

Table 4 Satisfaction score

	Group RP				Group DP				*p*	
	Mean ± SD			Median	Mean ± SD			Median		
Anesthesiologist Satisfaction	7.6	±	1.2	8.0	9.2	±	1,0	9.5	***0.000***	t
Patient satisfaction	8.9	±	1.1	9.0	9.4	±	0.9	10.0	***0.014***	t
Surgeon satisfaction	8.8	±	1.0	9.0	9.5	±	0,7	10.0	***0.001***	t

[t] Independent sample test

minute ETCO2 value was significantly higher in the DP group compared to the RP group ($p < 0.05$, Fig. 5).

The baseline, 1st minute, 5th minute, 10th minute, last measurement, and postoperative IPI values were all significantly higher in the DP group compared to the RP group ($p < 0.05$, Fig. 6).

In this study, Intention-to-Treat (ITT) analysis was applied to both groups. For the RP (Remifentanil-Propofol) group, the desaturation rate was 83.8% (31/37), with a Risk Ratio (RR) of 1.00 (95% CI: 0.71, 1.40), indicating no significant difference. The Per-Protocol (PP) analysis for the RP group showed a similar desaturation rate of 86.1% (31/36). On the other hand, for the DP (Dexmedetomidine-Propofol) group, the ITT analysis revealed a desaturation rate of 25% (9/36), with an RR of 0.30 (95% CI: 0.28, 0.32), which was statistically significant. The PP analysis for the DP group also showed a desaturation rate of 25% (9/36), confirming the significant reduction in desaturation risk. Overall, the results indicate that DP group had a significantly lower risk of desaturation compared to the RP group, both in the ITT and PP analyses.

Discussion

Numerous studies investigating the role of dexmedetomidine as an anesthetic adjuvant have suggested several advantages of dexmedetomidine over propofol or remifentanil, including better hemodynamic stability, less respiratory depression, and prolonged postoperative analgesic effects [19–21]. Similarly, Tekeli et al. reported that the dexmedetomidine–propofol combination is an effective and reliable option for sedation in endoscopic procedures [22].

Riachy et al., in a randomized double-blind study, highlighted that dexmedetomidine may cause hypotension and bradycardia, but in some cases, it can also lead to hypertension [23]. In contrast, a prospective randomized

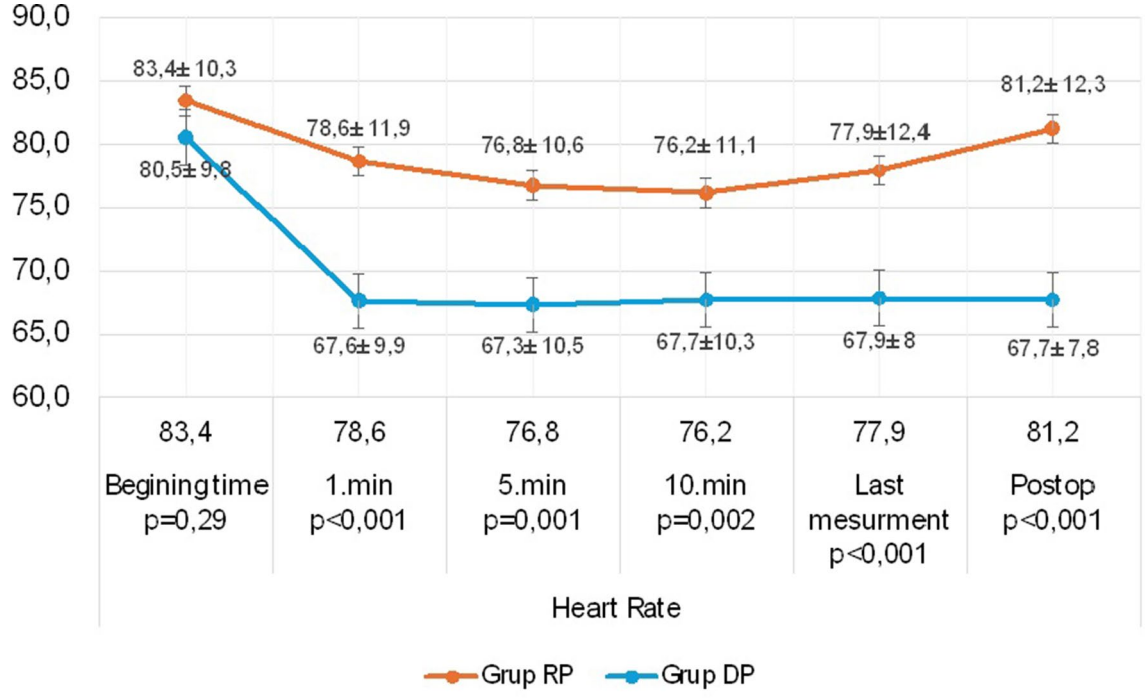

Fig. 2 Heart rate changes between groups

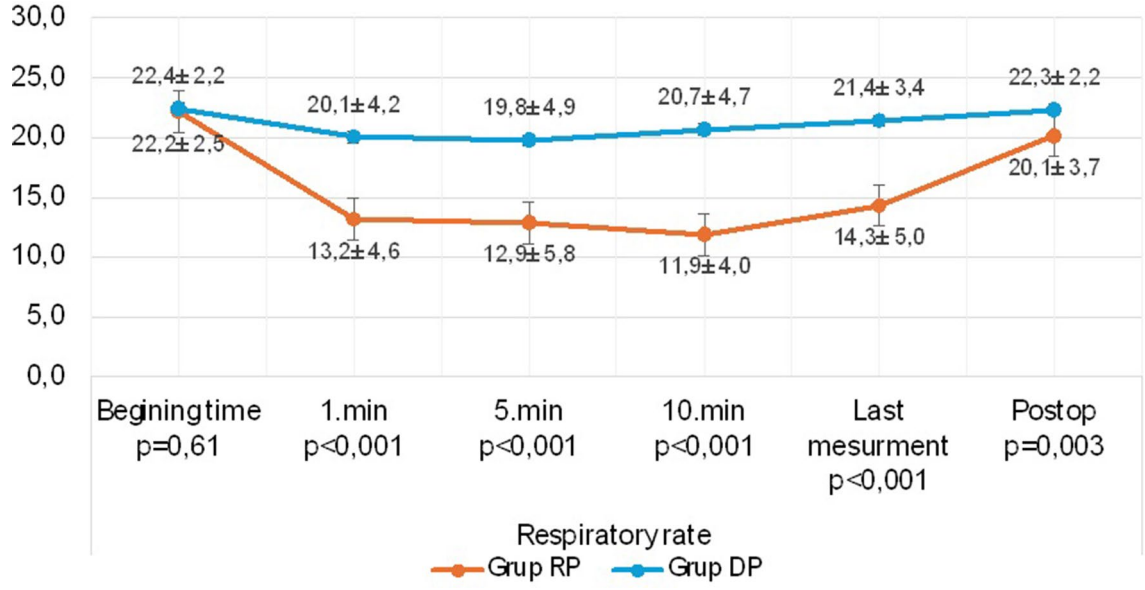

Fig. 3 Respiratory rate changes between groups

study conducted by Ömür et al. in 2016, titled *"Endoskopik Retrograd Kolanjio Pankreato Grafi İşleminde Monitorize Anestezi Bakımında Deksmedetomidin-Propofol ve Remifentanil-Propofol Protokollerinin Karşılaştırılması"* reported that hemodynamic parameters were unstable in the group receiving dexmedetomidine [24]. In our study, the hemodynamic effects of dexmedetomidine were more consistent with the findings of Riachy et al. We observed that patients treated with dexmedetomidine had a more stable pattern of systolic and diastolic arterial pressures compared to the findings reported by Ömür et al. Specifically, in the dexmedetomidine–propofol group, blood pressure initially increased but later decreased to normal levels or slightly below baseline. Conversely, in the remifentanil–propofol group, systolic and diastolic pressures remained consistently low throughout the procedure. These results suggest that the

Table 5 Systolic, diastolic, and mean blood pressure values changes between groups

	Grup RP				Grup DP				*p*	
	Mean ± SD			Median	Mean ± SD			Median		
Systolic blood pressure										
Beginning	130.6	±	13.8	129.0	130.4	±	14.9	129.0	0.899	m
1.Min	116.9	±	16.0	117.0	131.5	±	15.3	130.0	***0.000***	m
5. Min	116.1	±	13.6	113.0	140.4	±	19.3	137.0	***0.000***	m
10. Min	117.1	±	15.4	114.0	136.9	±	18.9	134.5	***0.000***	m
Last measurement	115.3	±	16.5	115.0	128.3	±	16.8	126.0	***0.002***	m
Postop	120.1	±	16.5	117.0	121.4	±	17.9	115.0	0.736	m
Diastolic blood pressure										
Beginning	73.9	±	10.1	74.0	75.1	±	10.4	73.0	0.761	m
1. Min	65.9	±	10.6	66.0	76.5	±	10.9	74.5	***0.000***	m
5. Min	66.8	±	11.8	64.0	79.0	±	12.9	79.5	***0.000***	m
10. Min	68.7	±	11.6	69.0	79.4	±	11.1	77.0	***0.001***	m
Last measurement	67.2	±	12.5	68.0	73.6	±	11.2	72.0	***0.049***	m
Postop	70.6	±	13.4	71.0	68.4	±	10.6	67.5	0.362	m
Mean blood pressure										
Beginning	95.8	±	10.4	98.0	97.0	±	11.0	95.0	0.812	m
1. Min	86.5	±	11.1	85.0	98.4	±	12.1	97.5	***0.000***	m
5. Min	87.4	±	11.6	86.0	104.2	±	14.4	103.5	***0.000***	m
10. Min	88.4	±	11.9	88.0	102.1	±	12.0	99.0	***0.000***	m
Last measurement	86.8	±	12.4	89.0	95.6	±	11.4	92.5	***0.008***	m
Postop	90.7	±	12.4	92.0	89.5	±	11.6	87.5	0.389	m

[m]Mann-whitney u test

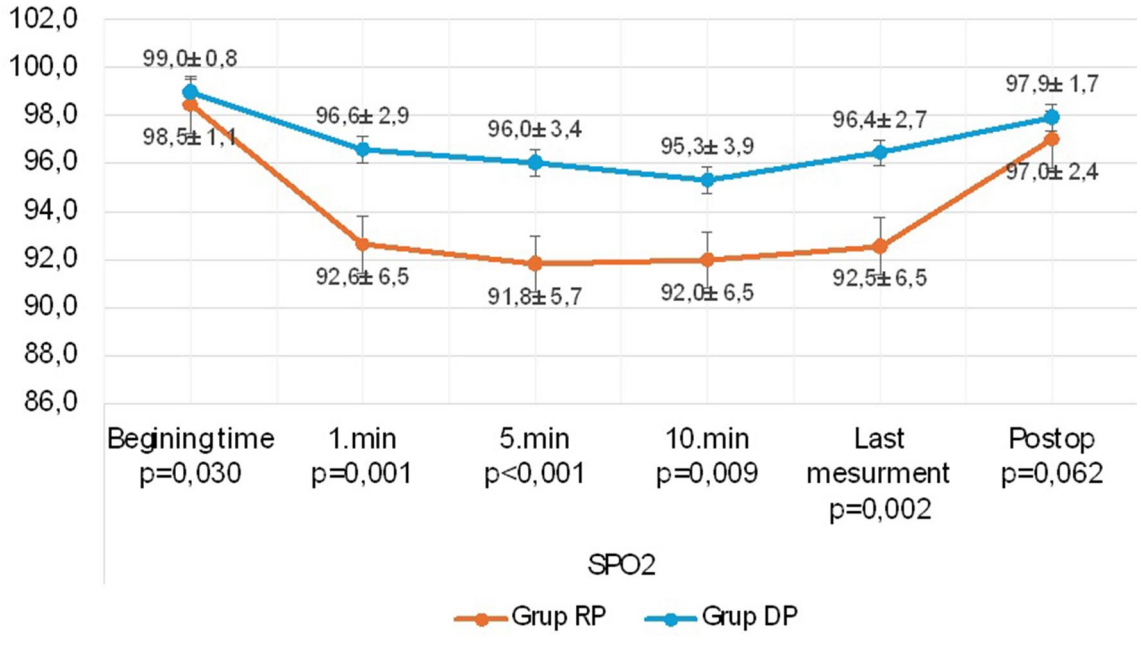

Fig. 4 SpO2 changes between groups

dexmedetomidine–propofol combination may offer better hemodynamic stability under the conditions of our study.

To determine adequate anesthesia depth, we utilized the Ramsey Sedation Scale (RSS). In a study conducted by Consales et al. involving intensive care patients, the depth of anesthesia was assessed in 40 sedated patients using both the bispectral index (BIS) and RSS, demonstrating a strong correlation between the Ramsay score and BIS values. The same study reported that different BIS values indicating deep levels of anesthesia corresponded to a Ramsay score of 6 [25]. In our study, the

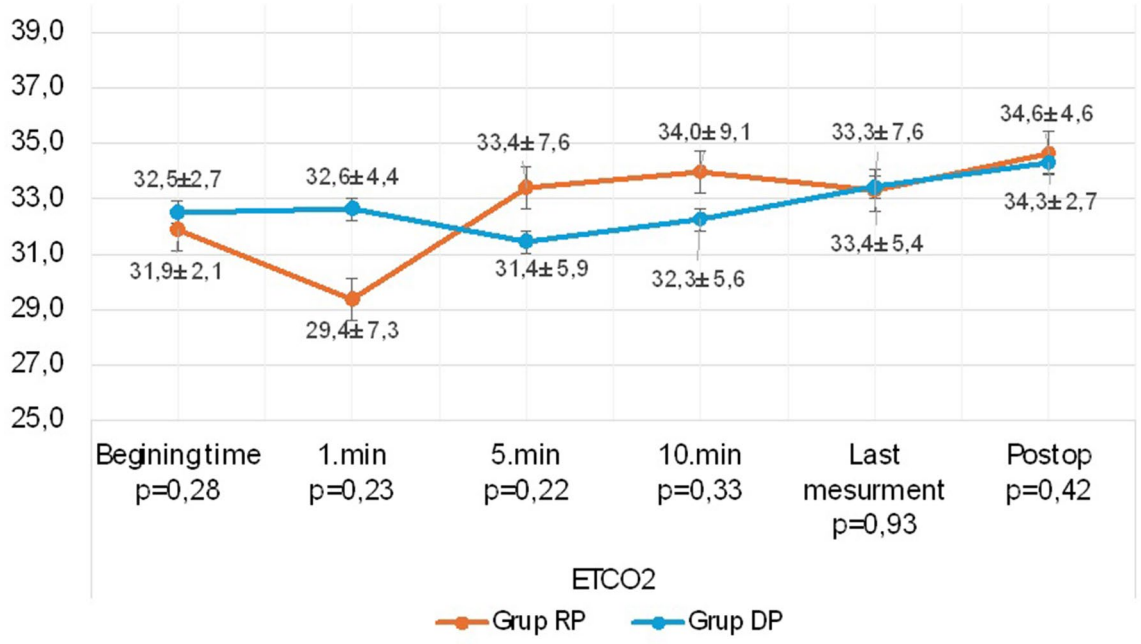

Fig. 5 EtCO2 changes between groups

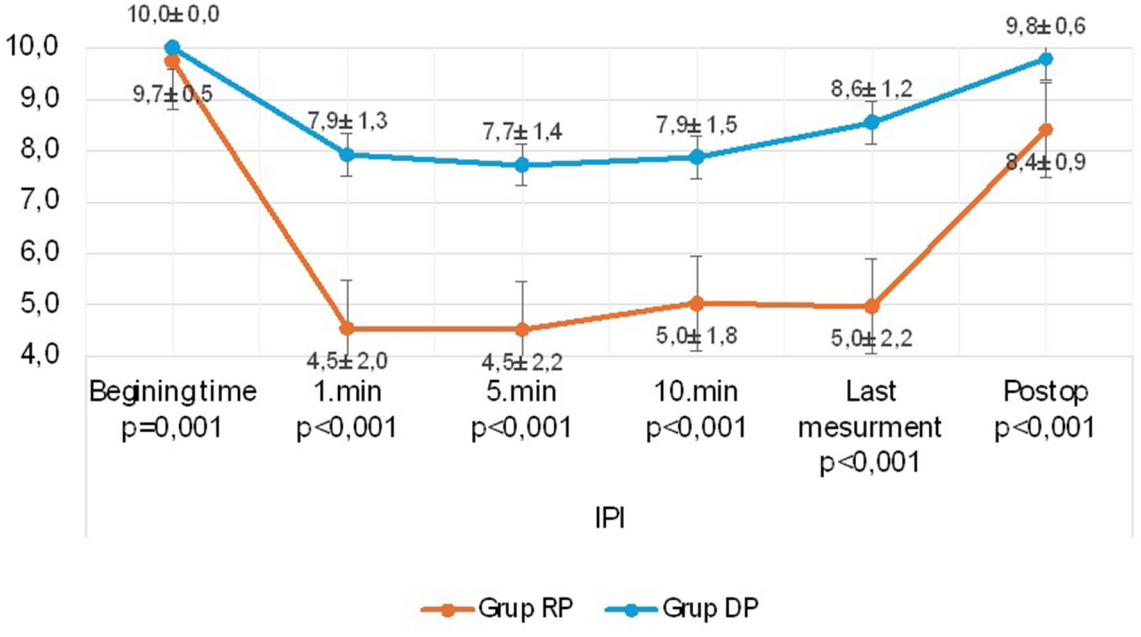

Fig. 6 IPI changes between groups

target value for adequate anesthesia depth was RSS > 4. Both groups achieved the targeted RSS without a significant difference between them. However, the time to reach adequate sedation depth (RSS > 4) was significantly shorter in the RP group. Nonetheless, the dexmedetomidine–propofol combination maintained sufficient sedation depth throughout the hysteroscopy procedure and resulted in better oxygen saturation values compared to the remifentanil–propofol combination.

In previous studies, desaturation has been defined as a decrease in SpO2 levels below 90% [26]. In the study conducted by Peveling-Oberhag et al., oxygen support was increased when SpO2 levels remained below 90% for more than 15 s [27]. In our study adopted a more stringent criterion due to its outpatient setting and on patient safety. Specifically, desaturation was defined as SpO2 levels remaining below 90% for more than 10 s. In our study the desaturation rate in patients treated with

dexmedetomidine and propofol was significantly lower than in those treated with remifentanil and propofol. Additionally, the rates of mask ventilation and Jaw Thrust maneuvers were notably lower in the DP group compared to the RP group, highlighting improved respiratory stability with dexmedetomidine.

In our study, we used the integrated pulmonary index (IPI) algorithm to assess pulmonary function and hypoxia in patients throughout the procedure. The IPI is an algorithm-based monitoring parameter that combines oxygenation, measured via pulse oximetry, and ventilation, measured via capnography. The effectiveness of the IPI has been demonstrated in previous studies. By integrating oxygenation parameters (saturation and heart rate) with ventilation parameters (respiratory rate, apnea > 10 s, and partial pressure of end-tidal carbon dioxide), the IPI provides rapid and convenient insights into a patient's respiratory status. It generates a score ranging from 1 to 10, allowing the medical team to assess respiratory function by referring to a single parameter. Scores between 7 and 10 indicate stable respiratory conditions, while scores below 7 warrant attention. The monitor alerts the sedation team to potential suppression of spontaneous respiration with a flashing signal around the IPI value and an audible alarm [26, 27]. The findings of our study revealed that the dexmedetomidine–propofol combination had a lesser impact on physiological respiratory function and resulted in significantly less hypoxemia compared to the remifentanil–propofol combination. Furthermore, the IPI scores of patients treated with dexmedetomidine and propofol were significantly higher than those of patients treated with remifentanil and propofol, indicating superior respiratory stability in the dexmedetomidine group.

The satisfaction scores in our study were based on subjective assessments by patients, surgeons, and anesthesiologists, measured using a 10-point scale. While this approach offers a simple and practical method for gauging perceptions, it inherently reduces a multifaceted qualitative experience to a single quantitative value. For example, patient satisfaction may encompass comfort, pain relief, and recovery speed, while surgeon satisfaction may depend on procedural conditions, such as patient stability and the ease of maintaining optimal sedation. Similarly, anesthesiologist satisfaction likely reflects factors such as the ease of managing sedation and hemodynamic stability.

The findings of our study indicate that the combination of dexmedetomidine and propofol resulted in significantly higher satisfaction levels among surgeons, patients, and anesthesiologists compared to the remifentanil–propofol combination. This enhanced satisfaction was reflected in both the satisfaction scores and the lower Visual Analog Scale (VAS) scores observed in the dexmedetomidine–propofol group. Similar results have been reported in previous studies, such as those by Tekeli et al., which demonstrated the superior sedative and analgesic properties of dexmedetomidine, contributing to improved procedural experiences for patients and clinicians [22]. The higher satisfaction scores among anesthesiologists may be attributed to the respiratory stability associated with dexmedetomidine, as evidenced by reduced desaturation rates in our study, aligning with findings from Peveling-Oberhag et al. regarding the importance of maintaining oxygenation during sedation [26]. Surgeon satisfaction is likely tied to the stable hemodynamic profile of dexmedetomidine, which facilitates uninterrupted procedural conditions. Patient satisfaction, reflected in lower VAS scores, is consistent with the analgesic effects of dexmedetomidine, as noted in studies by Gurbet et al., who highlighted its efficacy in reducing perioperative pain [21]. However, the cardiovascular effects of dexmedetomidine, particularly its propensity to cause bradycardia, remain a concern. This is consistent with prior studies by Riachy et al., which emphasize the need for close cardiovascular monitoring when using dexmedetomidine in clinical practice [23]. Although these side effects can be effectively managed with atropine or vasoactive agents, their occurrence underscores the importance of tailoring dexmedetomidine use to patient-specific factors. Future studies should explore strategies to mitigate these cardiovascular effects while retaining the respiratory and analgesic benefits of this combination. Despite its advantages, the cardiovascular effects of dexmedetomidine warrant careful consideration. Its known propensity to cause bradycardia requires close monitoring, though these side effects can be effectively managed with atropine or vasoactive agents [28, 29]. In our study, the incidence of bradycardia was significantly higher in the dexmedetomidine–propofol group compared to the remifentanil–propofol group. While this may present a clinical challenge, it is worth noting that the hemodynamic stability achieved with dexmedetomidine largely offsets these risks, making it a viable and effective sedative option.

Another important finding of our study was the determination of awakening times in patients whose recovery durations were measured. In a study conducted by Hu et al. in 2012, dexmedetomidine was associated with faster recovery compared to remifentanil [30]. However, our study yielded different results. To evaluate postoperative recovery times in both groups, we used the Modified Aldrete Score (MAS) and calculated the time for patients to reach MAS > 9. Our findings revealed that patients receiving the dexmedetomidine–propofol combination required significantly longer times to achieve a Modified Aldrete Score (MAS) > 9 compared to those treated with the remifentanil–propofol combination. These results highlight a notable delay in recovery with

dexmedetomidine, suggesting that its effects on recovery dynamics may vary depending on the sedative protocol and clinical context.

In conclusion, when combined with propofol, dexmedetomidine provides adequate anesthesia and analgesia for performing routine procedures such as hysteroscopy under office conditions. Furthermore, it offers more stable hemodynamics compared to the remifentanil–propofol combination, while having a lesser impact on respiratory function and reducing the incidence of hypoxemia. Based on these findings and the results of similar studies, we believe that dexmedetomidine offers more comfortable and reliable sedoanalgesia for outpatient procedures in office settings, and its use is likely to increase rapidly.

Limitations

This study has several limitations. While partial blinding was achieved, complete blinding was not possible as the anesthesiologist administering sedation also assessed their own satisfaction, potentially introducing bias. Satisfaction scores were subjective and lacked validated, specific tools for measurement. The findings are limited to female patients undergoing hysteroscopy, making their applicability to male patients or other procedures uncertain. Similarly, the use of a fixed 2 L/min nasal cannula for oxygenation raises questions about whether alternative oxygenation methods or longer procedure durations would yield different results for SpO2 or IPI values. Additionally, the study focused on remifentanil and did not evaluate other opioids, which may have different effects on respiratory and satisfaction outcomes. Finally, geriatric patients and those with significant comorbidities were excluded, limiting generalizability to these higher-risk populations. Future studies should address these gaps by including diverse populations, exploring alternative methods, and employing validated satisfaction assessment tools.

Abbreviations

ASA	American Society of Anesthesiologists
IPI	Integrated Pulmonary Index
DP	dexmedetomidine-propofol
RP	Remifentanil-Propofol
ICU	Intensive Care Unit
RSS	Ramsey Sedation Score
MAS	Modified Aldrete score

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Author contributions

All the authors contributed to the study's conception and design. The first draft of the manuscript was written by AKO and CS, and all the authors commented on previous versions of the manuscript. Material preparation: AKO and NY. Data collection: AKO, CS and YET. Analysis was performed by AKO and AET. Review and editing: AKO, CS, and AET. All the authors read and approved the final manuscript.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

This study was initiated after approval was obtained from the Ethics Committee of Van Yüzüncü Yıl University Clinical Research Ethics Committee, dated 22.06.2021 and numbered 07. Written and verbal informed consent for participation was obtained from all participants in the study.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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