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The efficacy and safety of ciprofol versus propofol in patients undergoing painless hysteroscopy: a randomized, double-blind, controlled trial

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Abstract

Background Studies have reported that ciprofol has the advantage of reducing injection pain compared to propofol during gastroscopy, colonoscopy, and fiberoptic bronchoscopy. The effect of ciprofol on the injection pain in painless hysteroscopy needs to further explore.

Methods A double-blind randomized controlled trial (RCT) was designed, and patients were recruited from the First Central Hospital of Baoding from March 2024 to June 2024. The eligible participants were allocated into ciprofol group (ciprofol combined with alfentanil) and propofol group (propofol combined with alfentanil) at 1:1 ratio. The primary outcome was injection pain. The secondary outcomes included sedation success rate, anesthesia success rate, adverse events, patient satisfaction, and comparison of vital signs before and after administration.

Results A total of 217 participants were included for analysis, with 109 participants in the ciprofol group and 108 participants in the propofol group. The injection pain rate of ciprofol group (18.35%) was significantly lower than the propofol group (40.74%). Both the ciprofol group and propofol group had 100% of the sedation success rate. The anesthesia success rate between the two groups was comparable ($P > 0.05$). The rate of adverse events was lower (27.52% vs. 45.37%) and patient satisfaction was higher (9.84 ± 0.45 vs. 9.65 ± 0.85) in the ciprofol group than the propofol group. In addition, values of systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP) in propofol group were significantly lower than those in ciprofol group at the time of cervical dilation and consciousness recovery.

Conclusions Ciprofol exhibits comparable efficacy to that of propofol, and is associated with less injection pain rate, fewer adverse events, higher patient satisfaction, and more stable hemodynamics when used for general anesthesia during the painless hysteroscopy.

Clinical trial number NCT06413862.

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Keywords ciprofol, propofol, painless hysteroscopy, injection pain, hemodynamics

Introduction

Hysteroscopy has become the gold standard for the diagnosis and treatment of intrauterine diseases; however, some procedures during the hysteroscopy, such as cervical dilation and endometrial curettage, often cause severe pain [1, 2]. The development of painless hysteroscopy has greatly improved patients' comfort and examination success rate, and has been widely used in the clinic [3]. Currently, propofol combined with opioid intravenous anesthesia is used to achieve the effect of painless diagnosis and treatment under hysteroscopy [4]. Propofol has a good sedative effect, but there are adverse reactions such as injection pain, decreased blood pressure, and hemodynamic instability [5, 6]. The incidence of propofol injection pain ranges from 28 to 90% in adults, which seriously affects the examination success rate and patients' satisfaction [7]. Therefore, the pain caused by propofol injection is a problem that cannot be ignored.

Ciprofol is a new type of intravenous anesthetic, with a chemical structure similar to propofol and relatively improved pharmacokinetics [8]. Some studies have reported that compared to propofol, ciprofol has the advantage of reducing injection pain during the endoscopic examinations [9, 10]. A multicenter randomized controlled trial (RCT) showed that ciprofol had a similar deep sedation effect to propofol during gastroscopy or colonoscopy, but the incidence of injection pain in the group treated with ciprofol was significantly lower than that in the group treated with propofol (4.9% vs. 52.4%) [9]. A double-blind RCT displayed that patients' satisfaction was significantly higher in the ciprofol group than the propofol group during fiberoptic bronchoscopy, and ciprofol group had more stable hemodynamics and fewer number of patients experiencing injection pain [10]. Chen et al. found that the anesthesia induction efficacy of ciprofol was comparable to propofol in gynecological surgery, and the incidence of injection pain and adverse events in the ciprofol group was significantly lower than those in the propofol group [11]. One study compared the efficacy and safety of ciprofol and propofol for sedation during hysteroscopy, and found that the success rate of hysteroscopy in each group was 100%, and the incidence of adverse events in ciprofol group was much lower than the propofol group [12].

Considering that there are few studies reporting the application of ciprofol in painless hysteroscopy, and the injection pain needed to further research. Therefore, we aimed to perform a RCT to further compare the efficacy and safety between ciprofol and propofol during painless hysteroscopy, especially for injection pain.

Methods

Study design

This was a double-blind RCT, and patients were recruited from the First Central Hospital of Baoding from May 10, 2024 to June 9, 2024. This trial was performed according to the Declaration of Helsinki, and registered in the ClinicalTrials.gov (https://www.clinicaltrials.gov/) (identifier: NCT06413862). This trial has been approved by the Ethics Committee of the First Central Hospital of Baoding (approval No. 2022-066), and all patients have signed the informed consent. All methods were performed in accordance with the relevant guidelines and regulations.

Study population

Inclusion criteria

1. age ≥ 18 years old;
2. undergoing hysteroscopy examination and requiring intravenous anesthesia;
3. American Society of Anesthesiologists (ASA) physical status I to II;
4. without communication difficulties, and able to cooperate with intervention implementation;
5. participating in this trial voluntarily, and signing an informed consent form;

Exclusion criteria

1. with severe cardiac insufficiency, liver and kidney dysfunction, and other major diseases;
2. with a history of uterine surgery within the past three months;
3. body temperature above 37.5 ℃ before the anesthesia;
4. long-term use of sedative or analgesic drugs.

Sample size calculation

The sample size was calculated based on the incidence of injection pain. According to the previous study [13], the incidence of injection pain of ciprofol and propofol in the induction of general anesthesia was 6.8% and 20.5%, respectively. α was 0.05, and β was 0.2. The required sample size calculated using PASS 11.0 software (NCSS, Kaysville, Utah, USA) was 188 cases. In each group, 94 cases were needed. Considering a dropout rate of 10%, 105 patients were needed in each group. A total of 210 patients were at least needed.

Randomization and blinding

Randomization was generated by computers, with sequential numbering hidden through opaque sealed envelopes for allocation. The treatment allocations corresponding to the patients with serial numbers 001-218 were listed (random code table). The random code table was kept by the designated personnel. After the patients were selected, researchers notified the random coding table keeper of the patients' numbers. The random coding table keeper gave instructions based on the random coding table for the patients to enter the ciprofol group or propofol group. After receiving the instructions, researchers recorded the instructions and implemented the corresponding allocation following the instructions. A professional anesthesiologist was designated to evaluate and collect data on various observation indicators of all patients. This anesthesiologist and the patients were blinded to the group allocation, and they were unblinded during the statistical analysis after the study was completed.

Intervention

Patients fasted for at least 6 h before hysteroscopy. After arriving in the operating room, a venous channel was immediately established for the patient. The various vital signs of the patient were monitored through electrocardiogram, respiratory rate, pulse oxygen saturation, bispectral index (BIS), and continuous non-invasive arterial blood pressure (CNAP), and wore a mask for oxygen inhalation (3 L/min). The emergency medication and anesthesia machine were prepared.

The 18-gauge venous cannula was inserted into the patient's right opisthenar vein, and patients in each group were intravenously transfuse alfentanil at a slow rate (5ug/kg, Yichang Renfu Pharmaceutical Co., Ltd., Yichang, China, batch number 33S110312) for general anesthesia induction. The administration time was 30 s. After 30 s, the experimental group was slowly injected with ciprofol for 30 s (0.4 mg/kg, Haisike Pharmaceutical Co., Ltd., Liaoning, China, batch number 20220911). The control group was slowly injected with propofol for 30 s (2 mg/kg, Guorui Pharmaceutical Co., Ltd., Sichuan, China, batch number 22102914). The injection speed was relatively slow (about 0.5mL/s) throughout the entire injection process.

The sedation level of the subjects was assessed using the Modified Observer's Assessment of Alertness/Sedation (MOAA/S) scale. The hysteroscope was inserted when the MOAA/S score ≤ 1. During the sedation induction, anesthesiologist evaluated the MOAA/S score every 30 s. If the MOAA/S score was still > 1 after 2 min of initial administration, 1/4 of the initial dose (experimental group: 0.1 mg/kg of propofol, control group: 0.5 mg/kg of propofol) was injected within 10 s as a supplementary dose. During the hysteroscopy, if the patient appeared restlessness or lack of sedation (such as coughing or body movement), a supplementary dose was given and repeated every 2 min as needed. If more than 5 supplementary doses were required within 15 min, sedation was considered unsuccessful. During the surgery, ephedrine (6 mg) was administered when patient's blood pressure dropped by 30% of the baseline, and atropine (0.3 mg) was administered when the heart rate was below 50 beats/minute. After the examination, all medications were stopped, and the patient was transferred to the postanesthesia care unit (PACU).

Outcomes

Primary outcome

The primary outcome was injection pain. The injection pain was defined as the pain reported verbally by patients during the first injection of the investigational drugs (ciprofol or propofol) [14]. The Numerical Rating Scale (NRS) was used to evaluate the pain level. The anesthesiologist asks the patient during the first injection of the investigational drug (ciprofol or propofol), "Do you feel arm pain from the injection? Patients who answered "yes" was asked to describe the level of the pain (a score of 0 to 10 indicated "painless" to "unbearable pain") [11]. The pain level was divided into painless (0 points), mild pain (1–3 points), and moderate to severe pain (4–10 points) [15].

Secondary outcomes

The secondary outcomes were sedation success rate, anesthesia success rate, time for successful anesthesia induction, recovery time, use of rescue drugs (ephedrine, atropine), times of supplementing ciprofol or propofol, adverse events, severity level of adverse events, patient satisfaction, comparison of vital signs before and after administration.

The sedation success was defined as no more than 5 supplementary doses within 15 min.

The anesthesia success was defined as the absence of any alternative sedatives/anesthetic drugs after the initial administration of the investigational drugs.

Time for successful anesthesia induction was defined as the time from starting the administration of investigational drugs to the MOAA/S score ≤ 1.

Recovery time was defined as the time from the last administration of investigational drugs to awaken.

The adverse events included nausea, vomiting, hypoxemia (blood oxygen saturation < 90% and lasting > 30 s), bradycardia (heart rate < 55 beats/minute), hypotension (systolic blood pressure reduced by 20% compared to baseline), body movement (patient's unconscious limb movements) during the examination [16].

The severity level of adverse events was graded based the National Cancer Institute Common Terminology

Criteria for the Classification of Adverse Events (CTCAE) version 5.0, and divided into grade 1 (mild), grade 2 (moderate), grade 3 (severe or medically significant but not immediately life threatening), grade 4 (events with life-threatening consequences needing urgent intervention), grade 5 (death related to the adverse events) [10].

Patient satisfaction was assessed using a 10-point scale, with 1 point indicating extreme dissatisfaction and 10 points indicating very satisfied.

Vital signs: The systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), blood oxygen saturation (SPO_2), and heart rate (HR) were recorded before anesthesia induction (T0), after anesthesia induction (T1), at cervical dilation (T2), and at consciousness recovery (T3).

Statistical analysis

The continuous data conforming to a normal distribution were described as mean±standard deviation (Mean±SD), and t-test were used to compare the differences between the two groups. The counting data were described as number (n) and percentage (%), and chi-square test or Fisher's exact test were used to compare the differences between the two groups. R version 4.2.3 (R Foundation for Statistical Computing, Vienna, Austria) was used statistical analysis. All statistical analyses were conducted using a two-sided test, and $P \leq 0.05$ was considered statistically significant difference.

Results

Patients' selection and baseline information

A total of 218 eligible participants were included in this study. After randomization, 109 participants were allocated to the ciprofol group, and 109 participants were allocated to the propofol group. In the propofol group, 1 participant with difficulty in cervical dilation were excluded. Therefore, 109 participants in the ciprofol group and 108 participants in the propofol group were included for analysis (Fig. 1).

The baseline information of the included participants was shown in Table 1. The mean age of ciprofol group and propofol group was 38.95±10.30 years and 37.31±10.71 years, respectively. There was no significant difference in age, height, weight, body mass index (BMI), ASA grade, comorbidities, and history of drug use ($P>0.05$).

Comparison of primary outcome between ciprofol group and propofol group

The injection pain rate was 18.35% in the ciprofol group and 40.74% in the propofol group, and the difference was statistically significant ($P=0.001$). The participants with moderate to severe pain in the ciprofol group was also less than the propofol group (2.75% vs. 19.44%) (Table 2). Figure 2 shows that the percentage of participants with 1 point, 3 points, and 5 points in the ciprofol group were 6.42%, 4.59%, and 0.92%, respectively, while those in the propofol group were 0%, 16.67%, and 11.11%, respectively. There was a statistical difference between ciprofol group and propofol group in terms of the comparison of painless and mild pain, mild pain and moderate to severe pain (Table 3).

Comparison of secondary outcomes between ciprofol group and propofol group

The sedation success rate was 100% in both the ciprofol group and propofol group (Table 4). In the ciprofol group, there were 22 participants with once supplementary dose and 5 participants with twice supplementary doses. In the propofol group, there were 24 participants with once supplementary dose and 5 participants with twice supplementary doses. The anesthesia success rate (79.82% vs. 87.96%) was comparable between the two groups ($P>0.05$). Time for successful anesthesia induction (44.44±12.47s vs. 40.48±10.24) was higher in the

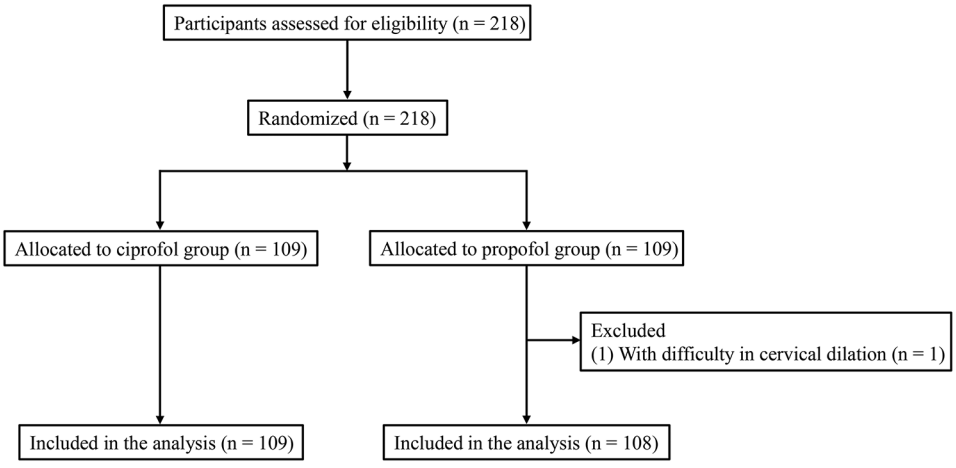

Fig. 1 The flowchart of participants selection

Table 1 Baseline information of included participants

Variables	Total ($n=217$)	Ciprofol ($n=109$)	Propofol ($n=108$)	Statistics	*P*
Age, years, Mean ± SD	38.13 ± 10.51	38.95 ± 10.30	37.31 ± 10.71	t = 1.156	0.249
Height, cm, Mean ± SD	161.06 ± 5.22	160.78 ± 5.41	161.34 ± 5.03	t = -0.793	0.428
Weight, kg, Mean ± SD	62.38 ± 9.03	62.96 ± 8.95	61.79 ± 9.11	t = 0.960	0.338
BMI, n (%)				$\chi^2 = 1.349$	0.509
Underweight & normal	108 (49.77)	50 (45.87)	58 (53.7)		
Overweight	77 (35.48)	42 (38.53)	35 (32.41)		
Obesity	32 (14.75)	17 (15.6)	15 (13.89)		
ASA, n (%)				$\chi^2 = 1.368$	0.242
I	121 (55.76)	56 (51.38)	65 (60.19)		
II	96 (44.24)	53 (48.62)	43 (39.81)		
Comorbidities, n (%)				$\chi^2 = 0.050$	0.823
No	187 (86.18)	95 (87.16)	92 (85.19)		
Yes	30 (13.82)	14 (12.84)	16 (14.81)		
History of drug use, n (%)				$\chi^2 = 0.058$	0.810
No	201 (92.63)	100 (91.74)	101 (93.52)		
Yes	16 (7.37)	9 (8.26)	7 (6.48)		

Abbreviation BMI, body mass index; ASA, American Society of Anesthesiologists; Mean ± SD, mean ± standard deviation

Note: t, t-test; χ^2, chi-square test; Comorbidities: hypertension and anemia; drug use: Antihypertensive drugs, iron supplements

Table 2 Comparing the primary outcome between ciprofol group and propofol group

Variables	Ciprofol group ($n=109$)	Propofol group ($n=108$)	Statistics	*P*
Injection pain, n (%)			$\chi^2 = 12.026$	0.001
No	89 (81.65)	64 (59.26)		
Yes	20 (18.35)	44 (40.74)		
Pain level, n (%)			$\chi^2 = 18.481$	< 0.001
Painless	89 (81.65)	64 (59.26)		
Mild pain	17 (15.6)	23 (21.3)		
Moderate to severe pain	3 (2.75)	21 (19.44)		

Note χ^2, chi-square test

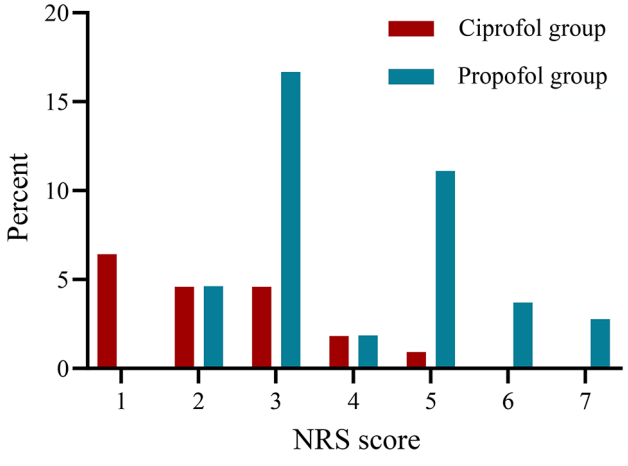

Fig. 2 The percentage of participants at each point of Numerical Rating Scale (NRS) score in the ciprofol group and propofol group

Table 3 Comparing the pain level between ciprofol group and propofol group

	Statistics	*P*
Painless vs. mild pain	$\chi^{2'} = 4.880$	0.035
Painless vs. moderate to severe pain	-	0.744
Mild pain vs. moderate to severe pain	-	0.044

Note $\chi^{2'}$, chi-square test with simulated *p* value; -, Fisher's exact test

ciprofol group. The percentage of participants with adverse events (27.52% vs. 45.37%), nausea and vomiting (0% vs. 7.41%), body movement during the examination (9.17% vs. 19.44%) was lower in the ciprofol group than the propofol group ($P<0.05$), and the ciprofol group had lower severity level of adverse events ($P=0.049$). There was no significant difference in the recovery time, use of rescue drugs, hypoxemia, bradycardia, hypotension ($P>0.05$). Patient satisfaction was significantly higher in the ciprofol group compared to the propofol group ($P=0.035$) (Table 4).

Comparison of vital signs between ciprofol group and propofol group

SBP, DBP, MAP, HR, and SPO_2 values at each time point were shown in Fig. 3. SBP, DBP, HR, and SPO_2 were comparable between the two groups before anesthesia induction (T0). After anesthesia induction (T1), SBP value was lower in propofol group than the ciprofol group ($P=0.040$). In addition, we found that SBP, DBP, and MAP values in propofol group were significantly lower than those in ciprofol group at the time of cervical dilation (T2) and at the time of consciousness recovery (T3). HR and SPO_2 values were comparable at all time points in both groups. SBP, DBP, and MAP reached a nadir after anesthesia induction (T1), and then showed a

Table 4 Comparing the secondary outcomes between ciprofol group and propofol group

Variables	Ciprofol group (*n* = 109)	Propofol group (*n* = 108)	Statistics	*P*
Anesthesia success, n (%)			$\chi^2 = 2.093$	0.148
No	22 (20.18)	13 (12.04)		
Yes	87 (79.82)	95 (87.96)		
Time for successful anesthesia induction, s, Mean ± SD	44.44 ± 12.47	40.48 ± 10.24	t'= 2.557	0.011
Recovery time, min, Mean ± SD	7.37 ± 2.38	6.74 ± 2.78	t = 1.782	0.076
Use of rescue drugs, n (%)			$\chi^2 = 0.034$	0.854
No	95 (87.16)	96 (88.89)		
Yes	14 (12.84)	12 (11.11)		
Sedation success	100%	100%		
Adverse events, n (%)			$\chi^2 = 6.713$	0.010
No	79 (72.48)	59 (54.63)		
Yes	30 (27.52)	49 (45.37)		
Nausea and vomiting, n (%)			-	0.003
No	109 (100)	100 (92.59)		
Yes	0 (0)	8 (7.41)		
Hypoxemia, n (%)			$\chi^2 = 3.067$	0.080
No	98 (89.91)	87 (80.56)		
Yes	11 (10.09)	21 (19.44)		
Bradycardia, n (%)			-	0.369
No	105 (96.33)	107 (99.07)		
Yes	4 (3.67)	1 (0.93)		
Hypotension, n (%)			$\chi^2 = 0.061$	0.804
No	99 (90.83)	96 (88.89)		
Yes	10 (9.17)	12 (11.11)		
Body movement during the examination, n (%)			$\chi^2 = 3.872$	0.049
No	99 (90.83)	87 (80.56)		
Yes	10 (9.17)	21 (19.44)		
Severity level of adverse events, n (%)			W = 825	0.049
I	0 (0)	6(5.56)		
II	30 (27.52)	43 (39.81)		
Patient satisfaction, Mean ± SD	9.84 ± 0.45	9.65 ± 0.85	t = 2.121	0.035

Abbreviation Mean ± SD, mean ± standard deviation

Note t, Student's t test; t', Satterthwaite t test; χ^2, Chi-square test; -: Fisher's exact test; W, Wilcoxon rank sum test

small increase in both groups. The results were shown in Table 5.

Discussion

In this study, we found that sedation success rate was 100% in both ciprofol group and propofol group during the painless hysteroscopy. The incidence rate of injection pain and the intensity of pain in the ciprofol group were significantly lower than the propofol group. Also, the ciprofol group had lower incidence rate and severity level of adverse events and higher patient satisfaction. In addition, SBP, DBP, and MAP values in propofol group were found to be significantly lower than those in ciprofol group at the time of cervical dilation and of consciousness recovery.

Injection pain was one of the most common adverse reactions of propofol administration [7]. The incidence of injection pain of propofol may be related to its concentration in the outer aqueous phase of the injection emulsion [17]. During the injection process, the contact between propofol in the outer aqueous phase and the venous endothelium may cause injection pain, and the pain level was related to the increase of propofol concentration in the aqueous phase [17]. Some researchers have pointed out that reducing the concentration of propofol in the outer aqueous phase of the injection emulsion by increasing its concentration in the inner lipid phase may alleviate the injection pain, but this process was difficult to implement in clinical practice [18]. The chemical structure of ciprofol was similar to that of propofol, and had relatively improved pharmacokinetics [8]. The pharmacological study had found that compared to the same concentration and dose of propofol injection emulsions, ciprofol had higher liposolubility and lower concentration in the outer aqueous phase of injection emulsion, which may reduce the injection pain [19]. Previous studies have reported that ciprofol had a lower incidence rate of injection pain and a similar deep sedation effect

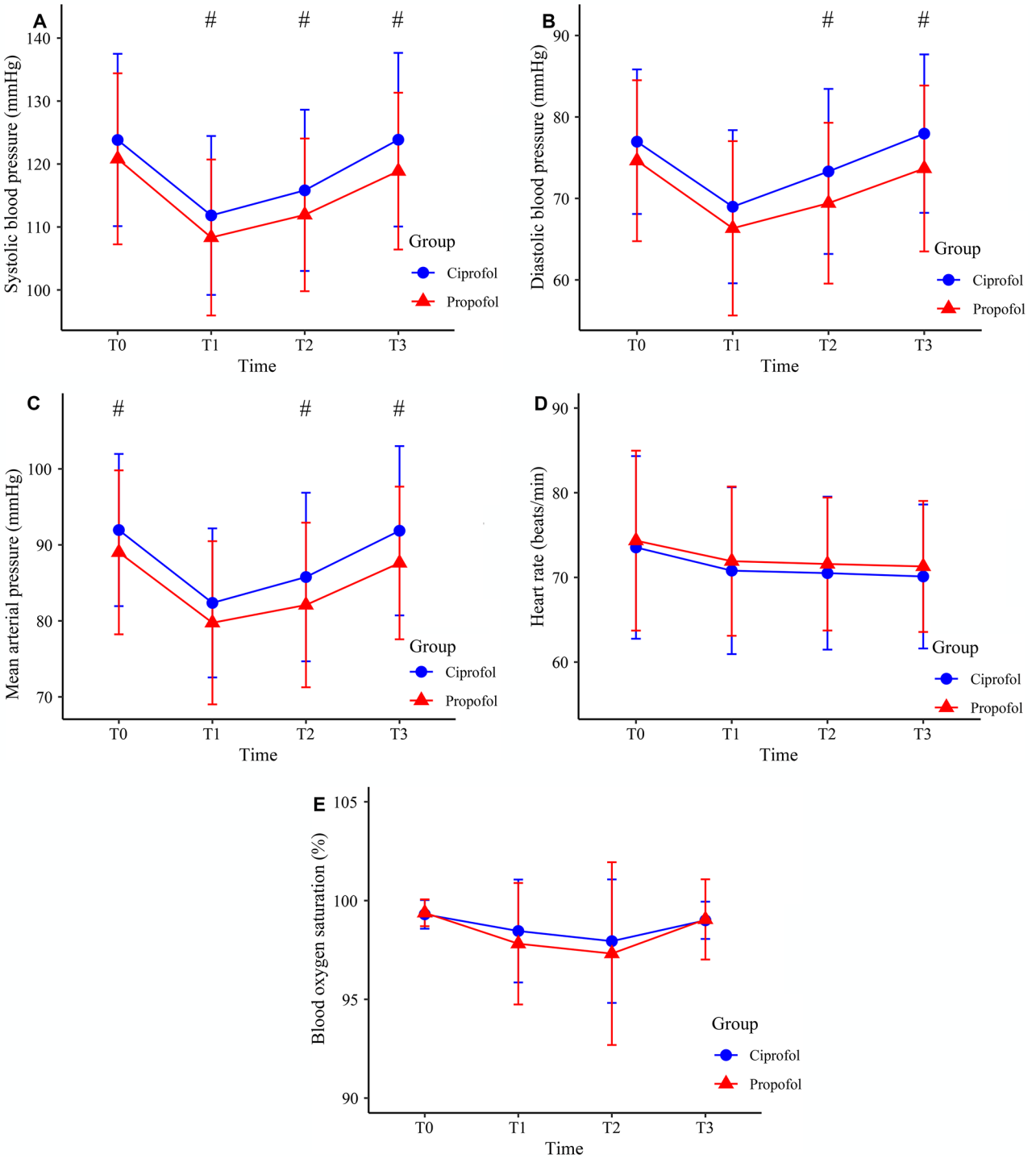

Fig. 3 Comparisons of systolic blood pressure (SBP) (**A**), diastolic blood pressure (DBP) (**B**), mean arterial pressure (MAP) (**C**), heart rate (HR) (**D**), and blood oxygen saturation (SPO_2) (**E**) between ciprofol group and propofol group

compared to the propofol in the endoscopic examinations, such as gastroscopy, colonoscopy, and fiberoptic bronchoscopy [9, 10]. Similarly, in this study, we found that incidence rate of injection pain in ciprofol group was lower than the propofol group (18.35% vs. 40.74%), and the sedation effect was similar between the two groups (100% vs. 100%) in hysteroscopy. In addition, the pain intensity of ciprofol group was lower than the propofol group.

Some adverse events have been reported after ciprofol or propofol, including nausea, vomiting, hypoxemia, bradycardia, hypotension, body movement [20, 21]. In this

Table 5 Comparing vital signs between ciprofol group and propofol group

Variables	Ciprofol group ($n=109$)	Propofol group ($n=108$)	Statistics	*P*
DBP				
T0, Mean ± SD	76.96 ± 8.87	74.63 ± 9.88	t = 1.831	0.068
T1, Mean ± SD	68.98 ± 9.40	66.33 ± 10.70	t = 1.938	0.054
T2, Mean ± SD	73.31 ± 10.13	69.42 ± 9.87	t = 2.869	0.005
T3, Mean ± SD	77.95 ± 9.72	73.68 ± 10.18	t = 3.166	0.002
SBP				
T0, Mean ± SD	123.82 ± 13.68	120.82 ± 13.58	t = 1.617	0.107
T1, Mean ± SD	111.83 ± 12.62	108.33 ± 12.39	t = 2.063	0.040
T2, Mean ± SD	115.82 ± 12.80	111.93 ± 12.12	t = 2.298	0.023
T3, Mean ± SD	123.86 ± 13.79	118.87 ± 12.45	t = 2.798	0.006
MAP				
T0, Mean ± SD	91.95 ± 10.01	89.02 ± 10.79	t = 2.078	0.039
T1, Mean ± SD	82.37 ± 9.81	79.75 ± 10.74	t = 1.875	0.062
T2, Mean ± SD	85.77 ± 11.09	82.09 ± 10.83	t = 2.471	0.014
T3, Mean ± SD	91.86 ± 11.14	87.62 ± 10.04	t = 2.946	0.004
HR				
T0, Mean ± SD	73.54 ± 10.79	74.34 ± 10.62	t = -0.551	0.582
T1, Mean ± SD	70.80 ± 9.86	71.92 ± 8.81	t = -0.881	0.379
T2, Mean ± SD	70.50 ± 9.03	71.58 ± 7.86	t = -0.938	0.349
T3, Mean ± SD	70.11 ± 8.50	71.30 ± 7.74	t = -1.074	0.284
SPO_2				
T0, Mean ± SD	99.30 ± 0.73	99.38 ± 0.68	t = -0.805	0.422
T1, Mean ± SD	98.46 ± 2.61	97.81 ± 3.08	t = 1.665	0.097
T2, Mean ± SD	97.94 ± 3.13	97.31 ± 4.63	t = 1.177	0.241
T3, Mean ± SD	99.00 ± 0.94	99.05 ± 2.03	t = -0.216	0.829

Abbreviation DBP, diastolic blood pressure; SBP, systolic blood pressure; MAP, mean arterial pressure; SPO_2, blood oxygen saturation; HR, heart rate; Mean ± SD, mean ± standard deviation

Note T0, before anesthesia induction; T1, after anesthesia induction; T2, at cervical dilation; T3, at consciousness recovery; t, Student's t test

study, we found that there was no significant difference in hypoxemia, bradycardia, and hypotension between the two groups. The incidence of nausea and vomiting and body movement was significantly lower in ciprofol group than the propofol group. The injection pain may cause body movement during the endoscopic examinations [11]. The incidence rate and severity level of adverse events were lower in the ciprofol group than the propofol group, indicating that ciprofol may have a higher safety than propofol. In addition, injection pain alleviation and low adverse reactions may improve patient satisfaction [7, 22]. In this study, patient satisfaction of the ciprofol group was significantly higher than that of the propofol group.

Previous studies have reported the hemodynamic instability of propofol during the induction [9, 23]. In this study, we found that SBP value was lower in propofol group than the ciprofol group after anesthesia induction, and SBP, DBP, and MAP values were all lower in propofol group than those in ciprofol group at the time of cervical dilation and consciousness recovery. This finding indicated that ciprofol had a smaller impact on blood pressure than propofol, resulting in a more stable hemodynamic changes during the anesthesia.

This study further compares the efficacy and safety between ciprofol and propofol, especially for injection pain, and found the better efficacy and safety and lower incidence injection pain of ciprofol, which may provide evidence for the clinical practice of ciprofol during hysteroscopy. There are some limitations in this study. First, this is a single-center clinical study, multi-center clinical studies are needed to further validate the application of ciprofol in painless hysteroscopy. Second, this study was performed in ASA I-II patients. Whether our findings can be extrapolated to ASA III or IV patients requires further studies. Third, the sedation level is assessed using a subjective scale. Combining subjective and objective indicators may provide more accurate assessment of sedation level for patients undergoing hysteroscopy examination. Fourth, both propofol and propofol are intermittently injected. Continuous intravenous infusion may be more beneficial for patients undergoing hysteroscopy.

Conclusion

In conclusion, this study showed that ciprofol exhibited less incidence and level of injection pain, lower incidence and severity level of adverse events, higher patient satisfaction, and more stable hemodynamics during the

painless hysteroscopy than propofol. Our results indicated that ciprofol may be a promising sedative with advantages in hysteroscopy.

Abbreviations

ASA	American Society of Anesthesiologists
BIS	Bispectral index
CNAP	Continuous non-invasive arterial blood pressure
MOAA	Modified Observer's Assessment of Alertness
NRS	Numerical Rating Scale
CTCAE	Classification of Adverse Events
SBP	Systolic blood pressure
DBP	Diastolic blood pressure
MAP	Mean arterial pressure
SPO_2	Blood oxygen saturation
HR	Heart rate

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Author contributions
AJL, NL, and LZ designed the study. AJL and NL wrote the manuscript. ZGX, YFW, JJL, and GRZ collected, analyzed and interpreted the data. LZ critically reviewed, and edited the manuscript. All authors read and approved the final manuscript.

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Data availability
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
This trial has been approved by the Ethics Committee of the First Central Hospital of Baoding (approval No. 2022-066), and all patients have signed the informed consent. All methods were performed in accordance with the relevant guidelines and regulations.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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