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Early oral hydration on demand in postanesthesia care unit effectively relieves postoperative thirst in patients after gynecological laparoscopy: a prospective randomized controlled trial

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Abstract

Background Postoperative thirst is one of the most intense, common and easily ignored subjective discomforts in patients after gynecological surgery. This study aimed to investigate whether early oral hydration on demand in the postanesthesia care unit (PACU) after gynecological laparoscopy under general anesthesia can appease postoperative thirst and increase patient comfort.

Methods Participants were randomized into the intervention and control groups. Patients in the intervention group were allowed to achieve early oral hydration on demand in the PACU if they were evaluated as fully conscious, with stable vital signs, grade 5 muscle strength, and well-recovered cough and swallowing reflex. However, the total amount of water intake throughout the entire study should not exceed 0.5mL/kg. During the study, the frequency of water intake, the total amount of water intake and adverse events were accurately recorded. The control group was managed according to the routine procedures and began to drink water 2 h after anesthesia. The intensity of thirst and subjective comfort in patients were assessed using the visual analog scale (VAS) when they entered and left the PACU.

Results No statistically significant differences were identified in age, height, weight, body mass index, preoperative fasting time, duration of surgery, intraoperative fluid intake, intraoperative blood loss, intraoperative urine volume, and thirst intensity and subjective comfort scores between the groups before intervention ($P > 0.05$). After intervention, the VAS score for thirst intensity in the intervention group significantly decreased ($P < 0.05$), and the VAS score for subjective comfort in the intervention group significantly increased ($P < 0.05$). No adverse events were detected in both groups during the entire study.

Conclusion Early oral hydration on demand in the PACU can safely and effectively relieve postoperative thirst in patients, and improve patient comfort after gynecological laparoscopy.

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Trial registration This single-center, prospective, randomized controlled trial was registered at the Chinese Clinical Trial Center on April 27, 2023. The registration number of this study is ChiCTR2300070985.

Keywords Gynecological laparoscopy, Gynaecologic surgery, General anesthesia, Postoperative thirst, Postanesthesia care unit, Oral intake

Introduction

Postoperative thirst is a subjective experience which refers to the desire to ingest water for restoration of homeostasis of body fluids after surgery [1]. Lee et al. reported that the incidence of postoperative thirst in patients can be as high as 79.6% and the incidence of the moderate-to-severe form is 53.2–69.8% [2]. However, after several years of clinical observation, we found that the incidence rate of postoperative thirst in patients may even be higher than reported in previous studies. It is one of the most intense, common and easily ignored subjective discomforts in perioperative patients [3].

Laparoscopy, which involves a minimally invasive approach, wide visual field, minimal bleeding, less postoperative pain, earlier return of normal bowel function, low complication rate, and earlier recovery, has become the major treatment option in gynecological surgery [4]. For patients undergoing gynecological laparoscopy, due to risk factors such as the establishment of artificial pneumoperitoneum with carbon dioxide and the surgical position (lithotomy position with low head and high hip), gastric reflux and aspiration are more likely to occur [5]. Therefore, they are obliged to strictly follow the requirements of pre-operative fasting period. However, compared to men, women continued to have higher thirst distress over time under fluid restriction [6]. In addition, pain sensitivity in female patients can significantly increase after 24 h of fluid restriction [7], which can make female patients who are already prone to anxiety more anxious. Anxiety can further trigger hormonal responses, reduce saliva secretion, and exacerbate thirst intensity [8, 9]. Therefore, it is necessary to relieve postoperative thirst in patients undergoing gynecological laparoscopy with general anesthesia.

Compared with other complications after surgery, such as bleeding and pain, medical staff members generally do not pay sufficient attention to postoperative thirst in patients, especially when the patients are in the PACU [10]. Nowadays, the concept of enhanced recovery after surgery (ERAS) has attracted widespread attention, early oral hydration is an important ERAS procedure [11]. As reported in ESPEN practical guideline: oral feeding should be reestablished as early as possible after surgery [12]. Although previous studies have shown that early oral hydration can be carried out in patients in the PACU, it is mostly performed by spraying water into the mouth or setting intervals for water intake (such as every 15 min) [10, 13, 14]. Studies on early oral hydration in patients after gynecological laparoscopy are rare. The Practice Guidelines for Postanesthetic Care also reported: the consultants and American Society of Anesthesiologists (ASA) members agree that routine perioperative assessment of patients' hydration status reduces adverse outcomes and improves patient comfort and satisfaction. But the literature continues to be insufficient to evaluate the benefits of assessing the hydration status of patients in the PACU [15]. Is perioperative oral intake safe and how to convince anesthesiologists? This issue still remains a major challenge for the implementation of ERAS in gynecological surgery [16].

Based on previous studies [2, 17–21], we hypothesized that early oral hydration can be safely initiated immediately after recovery from general anesthesia for patients undergoing gynecological laparoscopic surgery. In our study, patients in the intervention group were allowed to drink water on demand, and intervals for drinking were not set. This study aimed to investigate if early oral hydration on demand in the PACU after gynecological laparoscopy under general anesthesia is safe, if it can appease postoperative thirst, and increase patient comfort.

Methods

Study design

We conducted a prospective randomized controlled trial to examine the feasibility and safety of early oral hydration and to determine if such intervention would relieve thirst in patients after gynecological laparoscopic surgery with general anesthesia.

Study setting and participants

There were 20 beds in our PACU. At the PACU of our hospital, during November 1, 2022 to November 1, 2023, patients who had undergone selective laparoscopic gynecological surgery in our hospital were screened after being transferred within 5 min upon completion of surgery.

Inclusion criteria were as follows: ① Aged 18 years or over; ② Underwent selective laparoscopic gynecological surgery; ③ General endotracheal anesthesia was performed in the patient; ④ At the ASA physical status classes I-II; ⑤ Duration of surgical procedures was ≤3 h; ⑥ When extubating after surgery, the patient had returned to a conscious state, and the Steward score was ≥5 points; ⑦ Patient voluntarily participated in the study and signed an informed consent letter.

Exclusion criteria were as follows: ① Had a history of facial, oropharyngeal, digestive or laryngeal surgery; ② Had swallowing dysfunction; ③ Had delayed time for gastric emptying and pre-existing gastrointestinal diseases, such as peptic ulcer, hiatus hernia, irritable bowel syndrome, esophagitis, or received a gastrointestinal surgery; ④ Had abnormal cognitive function, and unable to communicate fluently.

Sample size calculation

Previous studies have shown that approximately 79.6% of patients feel thirst in the PACU [2]. The thirst relief rate in the patients admitted to the PACU was selected as a key indicator for sample size calculation. The preset thirst relief rates were 85% in the intervention group and 60% in the control group, respectively. The statistical power was 0.90 and the method of analysis was the rates of independent two groups sample [20]. Considering that the rate of loss to follow-up was approximately 20%, 156 participants (78 in each group) were required in this study. To enhance the representativeness and reliability of the study, a total of 180 participants were recruited, with 90 in each group (Fig. 1).

Randomization and allocation

Participants were randomly assigned 1:1 to either the intervention group or the control group. A research assistant not involved in patient management prepared the opaque envelopes, which contained a randomization code generated using SPSS version 20 (IBM Corp), corresponding to the intervention group or control group. According to the surgical application list, a study coordinator not involved in the follow-up study would screen patients who met the inclusion criteria, as potential participants. After informing the participants of the study's purpose and specific process, interested patients were asked to sign an informed consent letter. The order of signing the informed consent letter was marked as the participant's number (1-180). When a participant entered the PACU, the researcher opened the envelope marked with the same number according to the participant's to obtain grouping information. A blinded study evaluator not directly involved in patient management in the PACU collected all postoperative data when the patient entered and left the PACU. The study evaluator was also blinded to group allocation. Due to different water drinking schemes, the researchers and participants were unblinded to grouping.

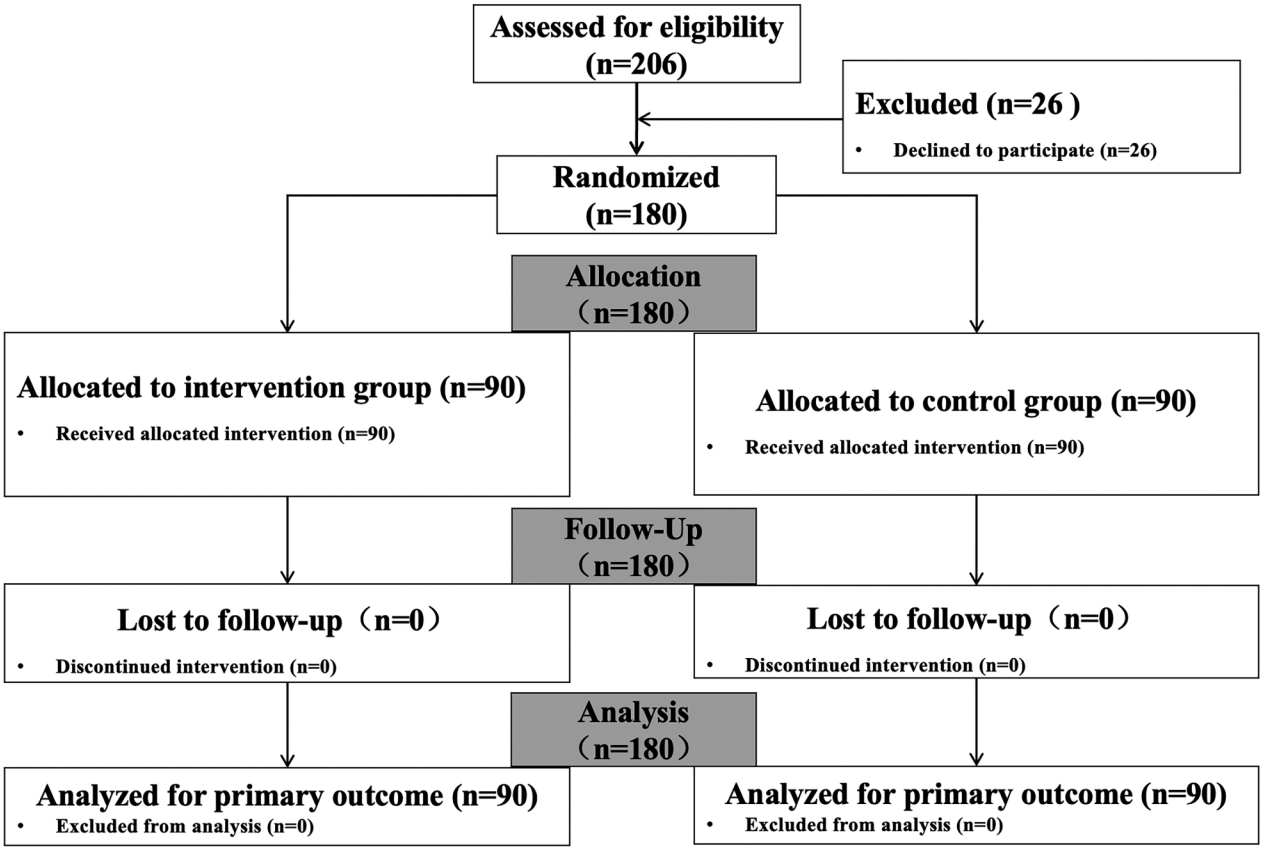

Fig. 1 Flow diagram for determining the participants

Study protocol

To ensure patient safety, anesthesia machines, oxygen tubes, rescue medications, negative pressure suction tubes and sputum suction tubes were prepared daily in advance by the PACU anesthesiologists and nurses. A pulse oximeter, noninvasive blood pressure monitoring, and electrocardiogram were applied in patients until they left the PACU. Patients in the intervention group were allowed to achieve early oral hydration on demand after being admitted to the PACU if they were evaluated as fully conscious (patient was able to speak out their own name and patient number correctly), with stable vital signs, grade 5 muscle strength, and well-recovered cough and swallowing reflex [22]. Water intake was no more than 10mL in the first instance. It was after the first intake of water that patients were allowed to drink water according to their demands. To reduce the incidence of potential adverse events, such as regurgitation and aspiration, we referred to the research of Yin et al. who suggested that the total amount of water intake throughout the entire study should not exceed 0.5mL/kg [21]. Hence, when participants in the intervention group entered the PACU, the anesthesiologist provided them with water (0.5mL/kg) poured into a graduated cup and the total amount of water intake was recorded when they left the PACU. The total amount of water intake=the volume of water in the cup when the patient entered the PACU - the volume of water in the cup when the patient left the PACU. Patients drank water using straws. Patients in the control group were given water 2 h after anesthesia ended, according to the routine procedures. If the patient developed bucking, they would be asked to stop drinking and lie on their side immediately, then cough hard with the help of gentle pats on their back by a medical staff member. If regurgitation and aspiration occurred, the anesthesiologist should be called immediately, and a negative pressure suction device should be used if necessary to remove oral and pharyngeal secretions. A doctor's advice to oxygen administration and medications, such as glucocorticoids and antibiotics, should be followed. If the patient vomited, granisetron (3 mg) should be administered intravenously.

Measurements

The VAS was used to rate the participants' intensity of postoperative thirst and patient comfort. The primary outcome was thirst relief, and the secondary outcome was subjective comfort. The following data was collected when each participant entered and left the PACU: ① A VAS score for thirst intensity, ranged from 0 (no thirst) to 10 (worst thirst); ② A VAS score for patient comfort, ranged from 0 (uncomfortable) to 10 (very comfort). During the whole study, attention was paid to adverse reactions such as bucking, regurgitation and aspiration.

Statistical analysis

SPSS 22.0 was used for data analyses. The Kolmogorov-Smirnov test was used to evaluate the normality of data distribution. Continuous data were compared using Student's t-tests and ANOVAs, and classification values were compared using the Chi-squared and Fisher's tests. A statistically significant difference was identified by a *P*-value of <0.05.

Results

Baseline characteristics

Out of the 180 patients enrolled in the study, no participants withdrew. The baseline characteristics of the participants are shown in Table 1. The intervention and control groups were compared at baseline. No statistically significant differences were identified in age, height, weight, body mass index, pre-operative fasting time, duration of surgery, intraoperative fluid intake, intraoperative blood loss and intraoperative urine volume between the two groups ($P>0.05$).

Medications used in anesthesia

No statistically significant differences were identified in the doses of perioperative anesthetic medications between the two groups (Table 2).

Table 1 Comparison of baseline characteristics between the two groups

Characteristics	Intervention group ($n=90$) Mean ± standard deviation	Control group ($n=90$) Mean ± standard deviation	*P* value
Age (years)	32.330 ± 6.448	31.660 ± 6.502	0.483
Height (cm)	159.789 ± 5.146	159.924 ± 5.366	0.863
Weight (kg)	56.161 ± 8.939	54.462 ± 9.053	0.207
Body mass index (kg/m^2)	22.000 ± 3.377	21.290 ± 3.383	0.161
Pre-operative fasting time (h)	13.130 ± 2.695	13.820 ± 2.890	0.100
Duration of surgery (min)	102.330 ± 40.112	108.870 ± 45.945	0.311
Intraoperative fluid intake (mL)	1222.220 ± 281.560	1286.110 ± 419.940	0.232
Intraoperative blood loss (mL)	32.270 ± 55.378	47.760 ± 124.765	0.283
Intraoperative urine volume (mL)	125.000 ± 83.212	130.560 ± 97.926	0.682

Table 2 Comparison of doses of anesthetic medications between the two groups

Medications	Intervention group ($n=90$) Mean ± standard deviation	Control group ($n=90$) Mean ± standard deviation	*P* value
Sufentanil (mg)	21.617 ± 4.057	21.667 ± 4.387	0.937
Propofol (mg)	132.698 ± 99.152	139.963 ± 141.706	0.691
	n (%)	*n* (%)	*P* value
Midazolam	89 (98.9%)	87 (96.7%)	0.312
Cisatracurium	89 (98.9%)	87 (96.7%)	0.312
Sevoflurane	87 (96.7%)	87 (96.7%)	1
Remifentanil	4 (4.4%)	2 (2.2%)	0.406
Dexmedetomidine	0 (0.0%)	1 (1.1%)	0.291
Atropine	47 (52.2%)	43 (47.8%)	0.551
Lidocaine	2 (2.2%)	3 (3.3%)	0.650
Granisetron	11 (12.2%)	14 (15.6%)	0.518
Paspertin	72 (80.0%)	66 (73.3%)	0.290
Dexamethasone	32 (35.6%)	25 (27.8%)	0.262
Tramadol	19 (21.1%)	15 (16.7%)	0.446
Neostigmine	22 (24.4%)	19 (21.1%)	0.594
Antihypertensive	0 (0.0%)	1 (1.1%)	0.316
Ephedrine	9 (10.0%)	8 (8.9%)	0.799
Lornoxicam	56 (62.2%)	48 (53.3%)	0.227
Succinylcholine	3 (3.3%)	2 (2.2%)	0.650
Aminophylline	1 (1.1%)	0 (0.0%)	0.316

Table 3 Comparison of the length of stay in the PACU, thirst rates, and the VAS scores for thirst intensity between the two groups

Items	Intervention group	Control Group	*P* value
Patients' length of stay in the PACU	47.13 ± 16.257	45.13 ± 16.087	0.408
Thirst rate (*n*, %)			
Pre-intervention	84 (93.3%)	86 (95.6%)	0.515
Post-intervention	33 (36.7%)	84 (93.3%)	< 0.001
VAS scores for thirst intensity (Mean ± stand deviation)			
Pre-intervention ($n=90$)	5.19 ± 1.937	5.08 ± 1.843	0.694
Post-intervention ($n=90$)	0.72 ± 1.028	5.90 ± 2.682	< 0.001

Notes: Pre-intervention refers to the occasion on which a participant entered the PACU; post-intervention refers to the occasion on which a participant left the PACU

Primary outcome

No statistically significant differences were identified in patients' length of stay in the PACU between the two groups. In our study, 170 (94.4%) felt thirsty when they entered the PACU. Among them, 84 (93.3%) were from the intervention group and 86 (95.6%) were from the control group. No statistically significant differences were identified in thirst intensity between the two groups before intervention ($P=0.515$). However, after intervention with early oral hydration on demand, the thirst rate among patients in the intervention group decreased to 36.7% when they left the PACU, while the control group remained as high as 93.3%, with a statistically significant difference between the two groups ($P<0.001$). Consistent with the thirst rate, no statistically significant differences were identified in the VAS scores for thirst intensity between the two groups when participants entered the PACU (5.19±1.937 versus 5.08±1.843; 95% CI, -0.445–0.667, $P=0.694$). When participants left the PACU, the VAS score for thirst intensity in patients in the intervention group decreased from (5.19±1.937) to (0.72±1.028), significantly lower than the control group, with a statistically significant difference (0.72±1.028 versus 5.90±2.682; 95% CI, -5.775 - -4.580, $P<0.001$). These results have shown that early oral hydration on demand can effectively appease thirst (Table 3).

To clarify the reason why 33 (36.7%) patients in the intervention group still had a VAS score for thirst intensity greater than 0 after the interventions, this study labeled the patients with a VAS score for thirst intensity of 0 at the time of leaving the PACU in the intervention group as group A, and the remaining of the patients in the intervention group as group B. The results showed that before interventions, group A received a significantly lower score for thirst intensity than group B (4.53±1.947 versus 6.33±1.291; 95% CI, -2.562 - -1.052, $P<0.001$). A statistically significant difference was identified in the total water intake in the PACU between group A and group B (0.220±0.106 mL/kg vs. 0.170±0.078 mL/kg; 95% CI, 0.008–0.092, $P=0.021$), but no statistically significant differences were identified in the total drinking frequency in the PACU between group A and group B (1.98±0.551 versus 1.88±0.696; 95% CI, -0.160 - -0.368, $P=0.438$). Therefore, 33 (36.7%) patients in the intervention group still felt thirsty when leaving the PACU, which was at least partly due to their greater thirst when

Table 4 Comparison of the difference of thirst scores (pre-intervention) and water intake between the patients of group A and group B

Items	Group A ($n=57$) Mean ± standard deviation	Group B ($n=33$) Mean ± standard deviation	*P* value
VAS scores for thirst intensity (pre-intervention)	4.53 ± 1.947	6.33 ± 1.291	< 0.001
Total water intake / body weight (mL/kg)	0.220 ± 0.106	0.170 ± 0.078	0.021
Total drinking frequency	1.98 ± 0.551	1.88 ± 0.696	0.438

Notes: Pre-intervention refers to the occasion on which a participant entered the PACU. Group A refers to the patients with a VAS score of 0 for thirst intensity after intervention in the intervention group. Group B refers to the patients with a VAS score > 0 for thirst intensity after intervention in the intervention group

Table 5 Comparison of the VAS scores for patient comfort between the two groups

VAS scores for patient comfort	Intervention group ($n=90$) Mean ± standard deviation	Control Group ($n=90$) Mean ± standard deviation	*P* value
Pre-intervention	2.62 ± 1.259	2.88 ± 0.922	0.122
Post-intervention	6.57 ± 1.152	2.83 ± 1.084	< 0.001

Note: Pre-intervention refers to the occasion on which a participant entered the PACU; post-intervention refers to the occasion on which a participant left the PACU

entering the PACU and insufficient total water intake (Table 4).

Secondary outcome

VAS score for patient comfort

No statistically significant differences were identified in the VAS scores for patient comfort between the two groups when participants entered the PACU (2.62 ± 1.259 versus 2.88 ± 0.922; 95% CI, -0.580–0.069, $P=0.122$). After the interventions of early oral hydration on demand, the VAS score for patient comfort in the intervention group increased to (6.57 ± 1.152), which was significantly higher than that in the control group (2.83 ± 1.084), with a statistically significant difference (95% CI, 3.404–4.062, $P<0.001$). These results indicate that early oral hydration on demand can significantly improve patient comfort (Table 5).

Serious adverse events

No observable adverse events, such as bucking, regurgitation and aspiration, were detected during the intervention period.

Discussion

This study was the first to allow early oral hydration on demand in patients in the PACU after a gynecological laparoscopy under general anesthesia. The findings of this randomized study show that this practice was not only safe and effective in relieving postoperative thirst in patient but could also significantly increase patient comfort. This study added clinical practice evidence on early oral hydration on demand in patients in the PACU.

In our study, the prevalence of thirst in patients in the PACU was as high as 94.4%, significantly higher than the results reported by Lee et al. [2]. The main reasons are as follows: ① The average preoperative fasting time was approximately 13 h, much longer than the specified period, which was consistent with the previous report by Wu et al. [17]. ② Atropine was used in 90 (50%) patients in the course of surgery to prevent severe bradycardia or combined with neostigmine to antagonize the residual muscle relaxation after general anesthesia, thereby improving the safety and subsequent recovery in patients. The application of atropine inhibited glandular secretion and increased postoperative thirst. ③ The main focus of our study were female patients. Female patients with insufficient water intake generally feel more pain and anxiety [5]. This can further increase their thirst intensity [6, 7]. Therefore, it is necessary to relieve postoperative thirst in patients undergoing gynecological laparoscopy with general anesthesia.

As reported by Yin et al. [14, 16], early oral hydration (0.5mL/kg) after general anesthesia is safe and effective in relieving thirst in adults and children undergoing non-gastrointestinal surgery. In our study, the total water intake volume was also restricted to 0.5mL/kg. However, we only required patients to drink no more than 10mL for the first intake after the surgery. If such a volume did not result in any adverse events, such as coughing, then patients were permitted to drink the remaining volume of water on their demand without setting a drinking interval. The results of our study are consistent with that of Yin et al. [14, 16] who reported that early oral hydration can effectively relieve postoperative thirst. After interventions, the thirst rate of the intervention group decreased from 93.3 to 36.7%, and the VAS score for thirst intensity decreased from 5.19 ± 1.937 to 0.72 ± 1.028, which was significantly lower than that of the control group (Table 3). Patients' subjective comfort also significantly improved after their postoperative thirst was relieved (Table 5). Beyond thirst relief, the potential mechanism for improved comfort scores may be that when the postoperative thirst was actively intervened and effectively relieved, the anxiety caused by thirst may be less. In addition, timely meeting of patients' postoperative needs may increase patients' trust and satisfaction

with medical staff, thereby further enhancing patients' subjective comfort level. To further clarify the reason why 33 patients in the intervention group still felt thirst when they left the PACU, we analyzed their VAS scores for thirst intensity when they entered the PACU and the total water intake volume and drinking frequency. It was discovered that patients with incomplete relief of thirst had a higher VAS score for thirst intensity when they entered the PACU but had a lower total water intake in the PACU (Table 4). It is possibly because patients' traditional Chinese concepts affect their drinking behavior. Patients might be afraid to drink water after surgery, fearing that drinking too much water might cause damage to the body. However, it can be confirmed that, under the restriction of water intake volume, early oral hydration on demand can effectively relieve postoperative thirst and improve patient comfort.

During the study, no adverse events were detected by anesthesiologists and nurses. For patients undergoing gynecological laparoscopy with general anesthesia, early oral hydration on demand after the surgery was safe in the patients in the PACU if they were evaluated as fully conscious, with stable vital signs, grade 5 muscle strength, and well-recovered cough and swallowing reflex.

There were several limitations in this study. First, for patients undergoing gynecological laparoscopy, the establishment of artificial pneumoperitoneum with carbon dioxide and the surgical position (lithotomy position with low head and high hip), gastric reflux and aspiration are more likely to occur in the patients [4]. Therefore, they were asked not to eat fried food, fatty food or meat for at least 8 h before surgery in our study. However, due to the unpredictable start time of each surgery (except for the first one) and operation time, most patients prepared for fasting according to the first operation. The pre-operative fasting time referred to pre-operative solid food intake, not pre-operative liquid intake. For clear liquids, the minimum fasting period is 2 h. Due to the high compliance of patients in our hospital and the influence of traditional Chinese concepts, they generally do not eat through the mouth after eating solid food the night before the operation, fearing that it will bring extra burden to the body. Therefore, the time of pre-operative liquid intake has been ignored in our study. Second, the fasting and drinking requirements were the same for all patients in our study. We only evaluated patients' thirst intensity when they entered the PACU but did not evaluate the intensity and frequency of thirst before surgery. Studies on the intensity and frequency of thirst before surgery would make our research more rigorous. Third, due to different water drinking schemes, the patients and care providers were unblinded to grouping. To prevent adverse events such as reflux aspiration, care providers may unconsciously pay more attention to the vital signs and safety of the patients in intervention group. Although the two groups of patients were placed in separate areas within the PACU (on both sides of the bed curtain), the bed curtain was not soundproof. Assessment of patients in the intervention group and water intervention may still be heard by the control group. Whether this has a definite effect on patients' subjective comfort is not clear. Fourth, this study was conducted with patients undergoing gynecological laparoscopy with general anesthesia, so the results of this study may not be applicable to patients undergoing other types of surgeries, especially gastrointestinal surgery. We would need to expand the scope of our research subjects and sample size to confirm our results and improve the comfort and treatment experience in perioperative patients based on ethical approval and patients' informed consent. Fifth, to ensure the comfort and minimizing irritation to patients, we chose warm water for interventions. However, the studies of da Silva et al. [23] and Tsai et al. [14] suggest that cold oral stimuli may bring better results. Further studies on optimal water temperature are needed to improve the patient experience.

In summary, this clinical practice provides new scientific evidence for early oral hydration on demand in PACU. For patients undergoing gynecological laparoscopy with general anesthesia, early oral hydration on demand can be performed in PACU as long as the patients were evaluated as fully conscious, with stable vital signs, grade 5 muscle strength, and well-recovered cough and swallowing reflex. Based on the scientific practice, PACU medical staff can be more proactive in intervening in postoperative thirst rather than ignoring this painful medical experience. At the same time, the result also provides a new idea for postoperative thirst management during PACU in other non-gastrointestinal laparoscopic surgery patients.

Conclusion

The prospective randomized trial showed scientific evidence that early oral hydration on demand starting immediately after recovery from general anesthesia is safe and effective in patients undergoing gynecological laparoscopic. It can improve patient comfort. From a practical standpoint, the supply of room temperature water is a simple and safe means that may be easily implemented in the PACU.

Abbreviations

ERAS	Enhanced Recovery After Surgery
PACU	Postanesthesia care unit
VAS	Visual Analogue Scale
ASA	American Society of Anesthesiologists

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Author contributions
Jianying Song contributed to the conception and design of the study, manuscript writing and final approval of the manuscript. Min Qin contributed to the design of the study, with emphasis on the data collection, statistical analysis and sample size analyses. Wanli Tian, Wenwen Liu, Cheng Liao and Jing Luo contributed to the design of the study, statistics analysis and manuscript writing. All authors have 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 reviewed and approved by the Research Ethics Committee of West China Second University Hospital, Sichuan University (Chengdu, China) and adhered to the CONSORT guidelines. Written informed consent about the study protocol was obtained from each patient preoperatively.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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