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Prevention of propofol injection-related pain using pretreatment transcutaneous electrical acupoint stimulation

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Background/aim: This study aimed to study the effect of pretreatment transcutaneous electrical acupoint stimulation (TEAS) in preventing propofol injection-related pain.

Materials and methods: A total of 360 patients who were to undergo elective hysteroscopy surgery were randomly divided into the following three groups of 120 patients each: control (Group C), sham TEAS (Group F), and TEAS (Group T). Patients in Group C did not undergo any treatment before surgery; 30 min before the induction of anesthesia, patients in Groups F and T underwent electrical stimulation of the bilateral LI4-PC6 acupoint. Patients in Group F were subjected to "feeling flow", while those in Group T were subjected to "tolerance flow." The stimulation frequency was 2/100 Hz and the duration of stimulation was 30 min. After the induction of anesthesia, propofol injection-related pain scores, hemodynamic parameters, and adverse reactions were recorded.

Results: Of the 360 patients, 324 completed the study. There were significant differences among the groups in terms of the incidence of moderate-to-severe pain. In terms of the four-point scaling method, the end of the radial vein, the cubital vein, and the "back of the hand" vein differed significantly among the three groups (P = 0.05). Finally, using a numerical rating scale, a significant difference was observed among the three groups in terms of the pain scores in the different veins.

Conclusions: Pretreatment TEAS effectively reduces the incidence and severity of propofol injection-related pain, the incidence of postoperative nausea and vomiting, and patient postoperative pain scores.

Key words: Transcutaneous electrical stimulation, propofol, injection pain

1. Introduction

Propofol has the advantages of rapid onset, short duration of action, rapid recovery, and few side effects. For these reasons, it is among the most widely used clinical intravenous anesthetics. However, propofol injection-related pain ranked third among the 33 most common anesthesia-related surgical complications in outpatients (1,2), corresponding to an incidence of 28% to 90% (3). In 2011, a metaanalysis showed that more than 60% of patients experience propofol injection-related pain, some of which is severe or even unbearable (4). Both foreign and domestic investigators have suggested many methods of preventing or mitigating propofol injection-related pain, including use of a thicker vein, slow injection speed, and addition of lidocaine. Although many of these methods are relatively effective, no single reliable and effective method is widely used.

Transcutaneous electrical acupoint stimulation (TEAS) represents a combination of transcutaneous electrical nerve stimulation and traditional acupuncture (5). The technique directs a specific, low-frequency pulse current into the body via the skin, producing an antiinflammatory, analgesic effect. Research has shown that it can also facilitate sedation (6), promote recovery of the gastrointestinal tract, regulate the immune system, and facilitate organ protection. Due to its noninvasive nature, TEAS has been widely used in clinical practice.

The present study evaluated whether TEAS pretreatment can reduce the incidence and/or degree of propofol injection-related pain.

2. Materials and methods

2.1. General information

A total of 360 women were included in the present study. All were aged 18–65 years and had a body mass index

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ranging from of 18–31 kg/m^2, as well as an American Anesthesiologists Society (ASA) grade of I or II. Furthermore, all had provided written, informed consent for elective hysteroscopy or surgical treatment. Patients with a history of chronic pain syndrome, thrombophlebitis, neurological disease, forearm or thrombophlebitis syndrome with acute and chronic pain, severe mental disease, language barrier, or gastrointestinal ulcers were excluded from the study, as were patients allergic to lipid medications, propofol, and/or general anesthetic drugs. Furthermore, patients with history of abuse of analgesic and/or sedative substances were also excluded, as were patients with a surgical incision, surgical scar, or skin infection at the LI4-PC6 acupoint; a nerve injury in the upper extremities; or a history of spinal surgery. Patients were randomly divided into the following three groups of 120 subjects each: control (C), sham TEAS (F), and TEAS (T).

2.2. Patient treatment

Patients underwent routine preoperative fasting and were not given any premedication. Thirty minutes before the induction of anesthesia, during anesthesia preparation, two of the three groups were given TEAS by an anesthesiologist who was not involved in the anesthesia itself or the pain efficacy evaluation. The patients in the control group were not given any treatment, and a 22-gauge trocar was used to open their secondary upper main vein. The patients' blood pressure was measured noninvasively, and they were monitored using an electrocardiogram (ECG) and pulse oximetry after entering the operating room. They were also given oxygen (5 L/min) via a nasal cannula. After their infusion channel had been connected to the extension tube, 500 mL of lactated Ringer's was infused (20 mL/min) through the channel. After a 30-min pretreatment, the anesthesiologist instructed the gynecologist to proceed with preoperative preparation; anesthesia induction was initiated at the same time. The three groups of patients received sufentanil (5 μg from the infusion channel) via a 30-s fast injection using a micropump (speed: 1200 mL/h). After 1% propofol (2 mg/kg) had been injected, the patients were enquired about their pain every 5 s until they lost consciousness; pain scores were recorded at each point. The surgical operation then commenced. Anesthesia was maintained using a continuous infusion of propofol (4 mg/kg per hour) and remifentanil (0.1 μg/kg per minute) via a micropump. If the patient physically responded to the surgical procedures, an additional single intravenous injection of propofol (0.5 mg/kg) was administered. If the heart rate (HR) fell to below 60 bpm during surgery, the patient received intravenous atropine (0.5 mg). If the mean arterial pressure (MAP) dropped below 60 mmHg, intravenous ephedrine (5–10 mg) was administered. Finally, mask pressure oxygen was provided if the oxygen saturation (SPO_2) fell below 90% (Figure 1).

2.3. TEAS (Figure 2)

Patients in the sham TEAS group (Group F) were positioned comfortably; an electrode tab was then pasted onto their bilateral LI4-PC6 acupoint (1) and connected to an acupoint nerve stimulator (manufactured in South Korea). The stimulation strength of the density wave (2/100 Hz) was increased until the patient could feel it. A similar protocol was applied in the TEAS group (Group T): the stimulation intensity of the density wave (2/100 Hz) was increased, and the current flow was gradually increased until the patients felt uncomfortable.

2.4. Four-point verbal rating scale

The verbal rating scale (VRS) was as follows: 0—no pain, 1—mild pain, 2—moderate pain, 3—severe pain. The VRS score was determined to be 2 or 3 according to the patient's limb response. If there was no obvious physical reaction, the patient was asked whether she felt pain; she was then assigned a score of 0 or 1. The four-stage VRS evaluation method has been widely used to assess propofol injection-related pain.

2.5. Dysmenorrhea severity level

The severity of dysmenorrhea was graded as follows: 0—no dysmenorrhea, 1—mild, 2—moderate, 3—severe.

2.6. Curative effect observation

The main outcome measures were verbal response, facial expressions, arm withdrawal during propofol injection, and highest pain score recorded. The secondary outcome measures were the hemodynamic measurements (blood pressure, heart rate, pulse oximetry before induction of anesthesia, and pulse oximetry 1 min after the injection of propofol). Also recorded were the total amounts of propofol and remifentanil used, duration of surgery, recovery time to discontinuation, body movements, respiratory depression (SPO_2 less than 90%), and occurrence of postoperative nausea, vomiting, and other adverse reactions. The patient's pain score was recorded and evaluated after she had been awake for 30 min. Loss of the eyelash reflex was regarded as an indicator of unconsciousness during anesthesia, while opening of the eyes was regarded as the standard of return to consciousness after surgery.

2.7. Statistical analysis

In 30 preliminary experiments, the incidence of moderate-to-severe propofol injection-related pain was reduced from 80% in the control group to 58% in the TEAS group. With an α-value of 0.05 and a power of 0.8, each group's sample size was 36. Considering that different veins would be chosen (veins on the hand, radial vein, cubital vein), and that a small part of the access may drop, we set each group size as 120 people. All data were analyzed using SPSS 19.0 (IBM Corp., USA). Data with normal distribution and homogeneity of variance between the two groups (according to mean ± standard deviation) were

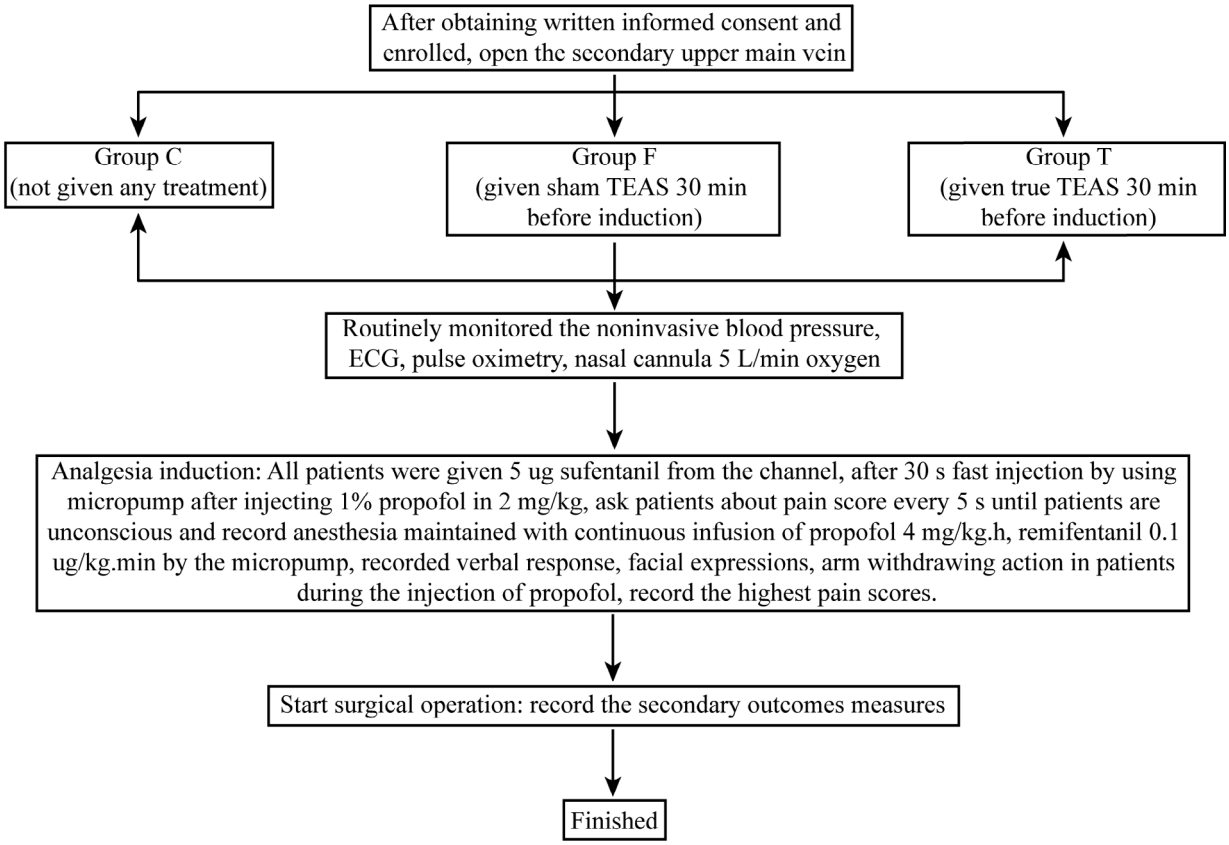

Figure 1. Study flow diagram.

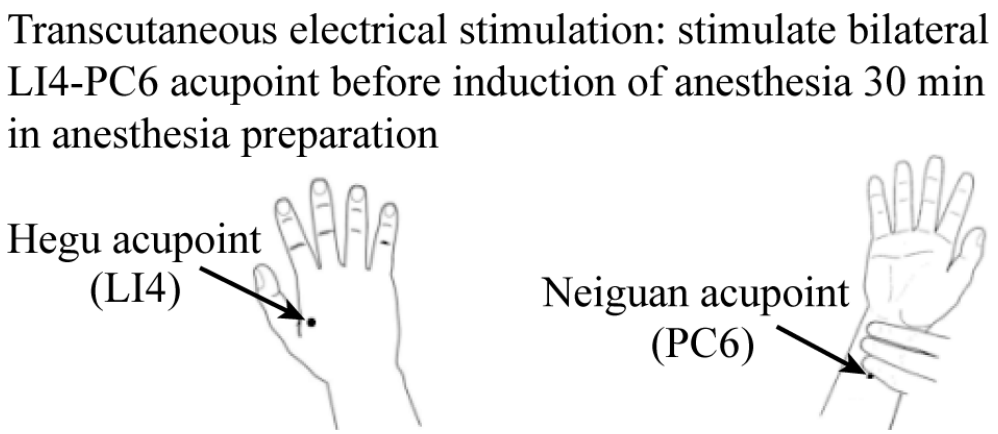

Figure 2. Illustration of the LI4-PC6 acupoint.

compared using analysis of variance (ANOVA); the overall difference was statistically significant data. A pairwise least significant difference (LSD) comparison method was used to analyze the data. Data that were not normally distributed were presented as medians (interquartile range), and the Kruskal–Wallis H test was used instead. For overall data that had statistically significant differences among the groups, a rank pairwise comparison was performed using the LSD method. Countable data were compared using either the chi-square test (continuity correction of χ^2) or Fisher's exact test according to the frequency of the sample size and the theory of variable number of categories; pairwise comparison was used for data that had an overall statistically significant difference. Ratings data were analyzed using the Kruskal–Wallis H test as well as by LSD pairwise comparison of rank. Other than in the chi-square

test, where a pairwise comparison test level of 0.017 was considered to be statistically significant, $P < 0.05$ was set as the significance level.

3. Results

Among the 360 patients, 33 were excluded, including 26 who exhibited abnormal blood pressure as they entered the surgical theater. These patients had no history of hypertension, but in the operating room they had a systolic blood pressure (SBP) greater than 180 mmHg that showed no improvement after 5 min. The remaining seven patients who were excluded had refused to participate in subsequent trials after pretreatment (Figure 3).

In patients with venous access, there were no statistically significant differences among the three groups of patients in terms of age, height, weight, ASA classification, degree of dysmenorrhea, and number of operations (Table 1).

Hemodynamic parameters were compared among patients, who were divided into three subgroups on the basis of venous access. In the hand vein subgroup, diastolic blood pressure (DBP) was significantly different among the groups after 1 min ($P < 0.05$); pairwise comparison results showed that there were significant differences in DBP between Group C and Group F after 1 min ($P = 0.018$). Similarly, SPO_2 differed significantly among the groups after 1 min ($P = 0.02$); pairwise comparison showed that the difference between Group C and Group F was significant ($P = 0.018$). There was no statistically significant difference in the remaining variables among the groups.

In the "end of radial vein" subgroup, there were significant differences in heart rate among the groups after 1 min. Pairwise comparison showed that heart rate differed significantly between Group C and Group T after 1 min ($P = 0.015$). The remaining variables demonstrated no significant difference among the groups.

In the cubital vein subgroup, there were statistically significant differences in SBP among the groups after 1 min ($P = 0.006$); pairwise comparison showed that the SBP differed significantly between Group C and Group F after 1 min ($P < 0.05$). SPO_2 also differed significantly among the groups after 1 min ($P = 0.004$); pairwise comparison showed a significant difference between Group 1 and Group 2 ($P = 0.003$). The remaining variables showed no statistically significant difference among the groups (Table 2).

The three groups were also compared in terms of basic anesthetic conditions. In the hand vein subgroup, there were significant differences among the groups in terms of remifentanil dosage ($P < 0.05$); pairwise comparison showed significant differences in remifentanil dosage between Group C and Group F ($P = 0.018$). None of the remaining variables were significantly different among the groups.

In the "end of radial vein" group, there were significant differences among the groups in terms of propofol dosage ($P < 0.05$); pairwise comparison showed that propofol dosage differed significantly between Group F and Group T ($P = 0.017$). None of the remaining variables showed any significant difference among the groups.

In the cubital vein subgroup, no significant differences were found among the groups (Table 3).

The three groups were also compared in terms of restlessness, dysphoria, dizziness, nausea, and vomiting after surgery. In the hand vein subgroup, there was a significant difference in the incidence of dysphoria among

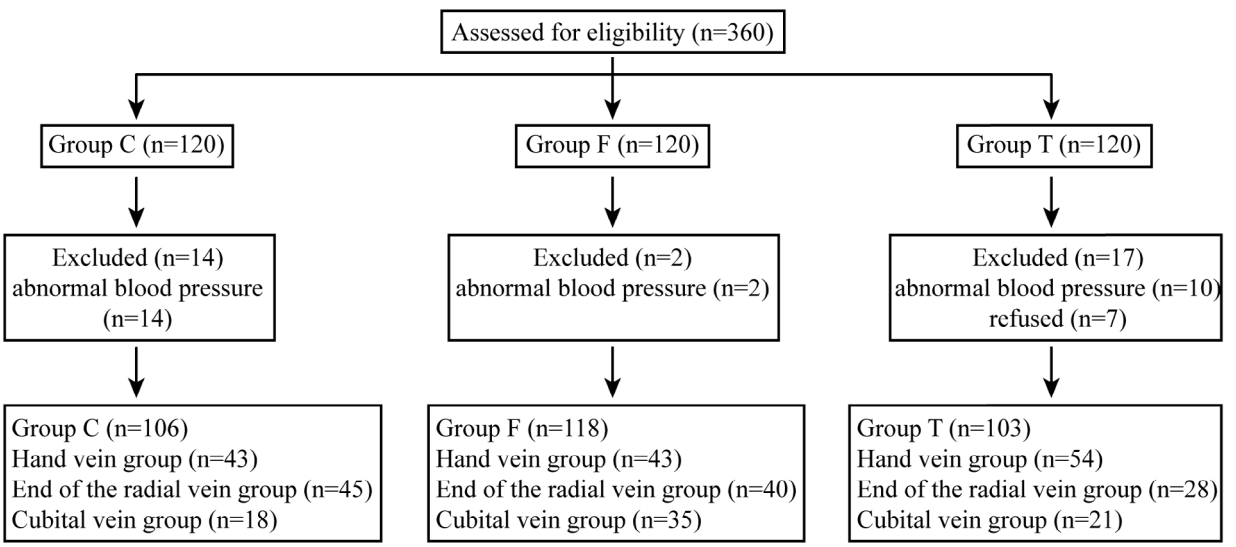

Figure 3. Flow of participants through a randomized, double-blind study investigating the efficacy of pretreatment with transcutaneous electrical acupoint stimulation in the prevention of propofol injection-associated pain.

Table 1. Three groups of patients with different intravenous general information.

	Hand vein group				End of the radial vein group				Cubital vein group			
	Group C	Group F	Group T	P	Group C	Group F	Group T	P	Group C	Group F	Group T	P
N	43	43	54		45	40	28		18	35	21	
Age (years)	34.02 ± 6.79	35.14 ± 8.28	32.52 ± 6.30	0.336	33.87 ± 7.03	34.95 ± 7.59	33.75 ± 7.86	0.742	37.89 ± 7.19	40.14 ± 14.34	35.33 ± 8.50	0.459
Height (cm)	158.86 ± 3.09	159.33 ± 4.54	158.02 ± 4.52	0.289	159.64 ± 6.13	159.35 ± 5.11	159.18 ± 4.64	0.933	158.67 ± 4.26	159.39 ± 4.35	159.33 ± 4.83	0.846
Weight (kg)	55.70 ± 7.87	55.19 ± 8.95	53.78 ± 6.94	0.458	55.38 ± 8.22	53.83 ± 7.56	54.82 ± 6.49	0.640	55.67 ± 6.68	56.21 ± 8.08	53.40 ± 5.05	0.342
ASA I / II	21 / 22	20 / 23	25 / 29	0.965	22 / 23	20 / 20	13 / 15	0.959	9 / 9	17 / 18	10 / 11	0.989
Degree of dysmenorrhea	19 / 23 / 1 / 0	21 / 18 / 4 / 0	37 / 11 / 4 / 2	0.138	27 / 17 / 1 / 0	28 / 11 / 1 / 0	21 / 5 / 1 / 1	0.473	9 / 8 / 1 / 0	16 / 13 / 5 / 1	14 / 5 / 2 / 0	0.304
Number of operations	0 / 1 / 0 / 2	0 / 1 / 0 / 3	0 / 1 / 0 / 4	0.547	0 / 1 / 0 / 2	0 / 1 / 0 / 2	0 / 1 / 0 / 2	0.591	0 / 2 / 0 / 3	0 / 1 / 0 / 2	0 / 1 / 0 / 4	0.977

Table 2. The comparison between hemodynamics of different patients whose venous accesses are divided into three groups.

	Hand vein group				End of the radial vein group				Cubital vein group			
	Group C	Group F	Group T	P	Group C	Group F	Group T	P	Group C	Group F	Group T	P
N	43	43	54		45	40	28		18	35	21	
SBP	135.70 ± 14.24	134.00 ± 15.15	133.83 ± 11.47	0.758	135.49 ± 11.69	133.90 ± 12.73	136.18 ± 14.76	0.747	136.61 ± 9.28	135.31 ± 13.99	135.76 ± 13.26	0.824
DBP	80.07 ± 9.70	78.12 ± 9.81	79.19 ± 7.67	0.603	76.67 ± 9.80	77.80 ± 9.20	78.04 ± 10.11	0.800	77.06 ± 11.47	79.94 ± 10.15	76.71 ± 10.72	0.465
SPO_2	99.00 / 2.00	99.00 / 1.00	99.00 / 1.00	0.082	99.00 / 2.00	99.00 / 3.00	98.50 / 2.00	0.074	99.00 / 2.00	99.00 / 2.00	98.00 / 1.00	0.120
HR	87.42 ± 17.59	83.42 ± 13.83	83.00 ± 13.89	0.311	87.38 ± 13.64	82.15 ± 13.28	80.39 ± 12.85	0.062	83.44 ± 15.91	82.31 ± 11.40	84.48 ± 16.76	0.998
1-min SBP	113.79 ± 15.18	108.86 ± 12.61	111.02 ± 9.74	0.189	113.87 ± 10.84	111.83 ± 11.45	111.93 ± 11.36	0.650	115.00 ± 8.92	109.80 ± 9.19	105.38 ± 9.10	0.006
1-min DBP	66.72 ± 10.29	61.91 ± 9.28	65.39 ± 8.46	0.048	64.40 ± 8.29	63.78 ± 9.13	63.71 ± 7.72	0.923	64.11 ± 8.78	62.74 ± 7.70	59.76 ± 6.82	0.194
1-min SPO_2	100.00 / 0.00	99.00 / 2.00	100.00 / 1.00	0.020	100.00 / 2.00	99.00 / 2.00	99.00 / 2.00	0.266	100.00 / 1.00	99.00 / 2.00	100.00 / 2.00	0.004
1-min HR	77.02 ± 10.24	75.30 ± 11.93	75.30 ± 11.10	0.699	80.18 ± 11.56	76.88 ± 11.43	73.46 ± 10.50	0.048	75.06 ± 10.64	74.26 ± 9.93	75.19 ± 16.31	0.954
Δ SBP	21.91 ± 15.82	25.14 ± 12.44	22.81 ± 12.76	0.526	21.62 ± 11.26	22.08 ± 12.15	24.25 ± 13.54	0.652	21.61 ± 12.44	25.51 ± 11.02	30.38 ± 9.75	0.051
Δ DBP	13.35 ± 11.34	16.21 ± 8.80	13.80 ± 8.29	0.317	12.27 ± 10.35	14.03 ± 8.29	14.32 ± 9.50	0.582	12.94 ± 11.57	17.20 ± 7.13	16.95 ± 11.70	0.294
Δ HR	10.40 ± 14.93	8.12 ± 9.69	7.70 ± 10.21	0.500	7.20 ± 10.29	5.28 ± 8.70	6.93 ± 11.58	0.654	8.39 ± 11.34	8.06 ± 8.68	9.29 ± 9.93	0.900

Table 3. Three groups of patients with different intravenous general information.

	Hand vein group				End of the radial vein group				Cubital vein group			
	Group C	Group F	Group T	P	Group C	Group F	Group T	P	Group C	Group F	Group T	P
N	43	43	54		45	40	28		18	35	21	
Propofol (mg)	186.86 ± 39.62	181.00 ± 55.14	183.41 ± 43.80	0.841	184.24 ± 55.19	196.68 ± 56.77	161.96 ± 28.62	0.019	178.67 ± 31.94	185.20 ± 55.71	166.95 ± 41.09	0.376
Remifentanil (μg)	79.95 ± 31.60	62.25 ± 31.27	69.87 ± 27.80	0.026	77.42 ± 33.62	67.00 ± 34.27	70.00 ± 27.42	0.319	76.33 ± 31.33	70.80 ± 30.60	57.43 ± 17.13	0.088
Duration of surgery (min)	14.91 ± 6.50	13.40 ± 5.86	13.50 ± 5.04	0.390	15.64 ± 6.26	14.28 ± 6.23	13.46 ± 4.76	0.283	14.50 ± 5.70	14.31 ± 4.88	11.71 ± 3.69	0.105
Recovery time to discontinuation (min)	2.00 / 2.00	2.00 / 2.00	2.00 / 2.00	0.582	2.05 ± 1.49	3.00 ± 2.32	2.14 ± 1.27	0.543	2.06 ± 1.26	2.09 ± 1.49	1.83 ± 1.20	0.805
Respiratory depression (SPO_2 less than 90%) Body movement	16 / 15 / 8 / 1 / 2 / 1 23 / 4 / 11 / 3 / 2	13 / 16 / 7 / 3 / 1 / 2 25 / 11 / 4 / 2 / 1	10 / 27 / 12 / 3 / 2 / 0 32 / 5 / 9 / 4 / 4	0.418 0.602	12 / 21 / 8 / 2 / 0 / 2 23 / 8 / 8 / 5 / 1	10 / 18 / 8 / 1 / 2 / 1 23 / 9 / 6 / 0 / 2	2 / 19 / 6 / 1 / 0 / 0 19 / 9 / 0 / 0 / 0	0.677 0.097	7 / 6 / 1 / 4 / 0 / 0 9 / 6 / 2 / 1 / 0	6 / 16 / 9 / 3 / 0 / 1 16 / 15 / 3 / 1 / 0	4 / 9 / 6 / 2 / 0 / 0 11 / 4 / 3 / 2 / 1	0.554 0.945

the groups (P = 0.001); pairwise comparison showed that the incidence of dysphoria differed significantly between Group C and Group T (χ^2 = 8.629; P = 0.003 [<0.017]), but that the remainder of the groups were not significantly different in this regard (P > 0.017). The incidence of nausea and vomiting differed significantly among the groups (P < 0.001); pairwise comparison showed that the incidence of nausea and vomiting differed significantly between Group C and Group T (P = 0.001 [<0.017]), as well as between Group F and Group T (P = 0.000 [<0.017]), but that the remainder of the groups showed no statistically significant differences in this regard (P > 0.017).

In the "end of radial vein" subgroup, the incidence of nausea and vomiting differed significantly among the groups (P < 0.001); pairwise comparison showed significant differences between Group C and Group T (P = 0.016 [<0.017]). The difference between Group F and Group T was also significant (P = 0.004 [<0.017]); however, there was not a significant difference between Group C and Group F in this regard (P = 0.535 > 0.017). In the remaining variables, there were no significant differences among the groups (Table 4).

Intravenous injection of additional propofol was compared among the three groups using the four-point scale, as well as incidence. In the hand vein subgroup, the four-point scale did not differ significantly among the groups (P = 0.050). The incidence of moderate-to-severe pain did differ significantly (P = 0.003), as did the 1-h postoperative visual analog scale (VAS) score (P = 0.003). Pairwise comparison showed that Group C and Group T differed significantly in this regard (P = 0.013), as did Group F and Group T (P = 0.009).

In the "end of radial vein" subgroup, there were significant differences among the groups in terms of the four-point scale (P = 0.048). Pairwise comparison revealed that Group T differed significantly from both Group C and Group F (P = 0.037 and 0.021, respectively); Group C and Group F did not differ significantly in this regard (P = 0.764). With regard to the incidence of moderate-to-severe pain, there was a significant difference among the groups (P = 0.012); pairwise comparison showed differences in incidence between Group C and Group T (P = 0.007 < 0.017), as well as between Group F and Group T (P = 0.005 [<0.017]). Group C did not differ significantly from Group F in this regard (P > 0.017). The 1-h postoperative VAS score also differed significantly among the groups (P < 0.001); pairwise comparison demonstrated that Group T differed significantly from both Group C and Group F in this regard (P = 0.012 and P < 0.001, respectively). However, the difference between Group C and Group T was not significant (P = 0.612), and there were no significant differences in the other groups (P > 0.05).

In the cubital vein subgroup, there were significant differences among the groups in terms of the four-point scale (P < 0.05); pairwise comparison showed that the four-point scale differed significantly between Group C and both Group T and Group F (P = 0.016 and P = 0.001, respectively). The incidences of pain and of moderate-to-severe pain difference differed significantly among the groups (P < 0.05); pairwise comparison showed significant differences between Group C and Group T (P = 0.005 [<0.017]). However, there was no significant difference between Group C and Group T in this regard (P = 0.026 [>0.017]). There were no significant differences in the rest of the group. The 1-h postoperative VAS scores differed significantly among the groups (P = 0.013 [<0.05]); pairwise comparison showed that it differed significantly between Group F and Group T (P = 0.012 < 0.05). However, the remaining variables showed no significant differences in any group (Table 5).

4. Discussion

Propofol injection-related pain is associated with the components of the formulation itself (7). Much preliminary research has investigated the methods used to prevent or relieve propofol injection-related pain; these methods include nondrug approaches such as choosing a thicker vein (8), slowing injection speed (9), dilution (10,11), microfiltration (12), cooling the propofol (13), and topical EMLA use (14), as well as drug interventions, such as the use of lidocaine (15), opioids (16), sedatives (17,18), muscle relaxants (19), and nonsteroidal antiinflammatories (20,21), among others. A metaanalysis published in 2011 indicated that the most effective methods are selection of a thicker vein and prophylactic preinjection of lidocaine combined with vein occlusion (4). Selection of cubital intravenous access can reduce the incidence of propofol injection-related pain by 14%; however, this approach is not the first clinical choice. Although other methods, such as simple preinjection of lidocaine (22), have some effect, no method or agent can completely prevent propofol injection-related pain. Consequently, and for various other reasons, the use of these methods is limited in clinical practice. Although the mechanism of propofol injection-related pain remains unclear, one emerging hypothesis is that contact between the propofol aqueous phase and the vascular endothelium induces bradykinin release from the kininase system, resulting in pain (23).

During TEAS, sparse waves induce encephalin and endorphin release; they also act on δ receptors. In contrast, density waves induce the release of a dimorphic response, which acts on K receptors and causes an analgesic effect (24). Not only does TEAS cause an analgesic effect, it also reduces postoperative nausea and vomiting, as well as other adverse reactions; these effects are related to the different

Table 4. The comparison of restlessness, dysphoria, dizziness, nausea, and vomiting after surgery among three groups of patients.

	Hand vein group				End of the radial vein group				Cubital vein group			
	Group C	Group F	Group T	P	Group C	Group F	Group T	P	Group C	Group F	Group T	P
N	43	43	54		45	40	28		18	35	21	
Restlessness, dysphoria	8 / 43	4 / 43	0 / 54	0.001	6 / 45	4 / 40	0 / 28	0.129	2 / 18	6 / 35	0 / 21	0.124
Dizziness	2 / 43	6 / 43	5 / 54	0.314	2 / 45	3 / 40	5 / 28	0.155	1 / 18	2 / 35	4 / 21	0.255
Nausea and vomiting	10 / 43	15 / 43	1 / 54	<0..001	14 / 45	15 / 40	2 / 28	0.017	5 / 18	8 / 35	0 / 21	0.019

Table 5. The comparison of the intravenous injection of propofol by four-point method and incidence in three groups of patients.

	Hand vein group				End of the radial vein group				Cubital vein group			
	Group C	Group F	Group T	P	Group C	Group F	Group T	P	Group C	Group F	Group T	P
N	43	43	54		45	40	28		18	35	21	
The four-point (VRS) (0 / 1 / 2 / 3)	3 / 19 / 17 / 5	1 / 22 / 16 / 4	5 / 34 / 12 / 3	0.050	4 / 23 / 14 / 4	4 / 19 / 11 / 6	2 / 23 / 3 / 0	0.048	0 / 11 / 7 / 0	10 / 20 / 5 / 0	9 / 11 / 1 / 0	0.001
0 / 1–3	3 / 40	2 / 41	0 / 54	0.123	4 / 41	4 / 36	2 / 26	1.000	0 / 18	10 / 25	9 / 12	0.008
0–1 / 2–3	22 / 21	24 / 19	44 / 10	0.003	27 / 18	23 / 17	25 / 3	0.012	11 / 7	30 / 5	20 / 1	0.027
VAS after 30 min (VAS: 0 / 1 / 2)	19 / 19 / 5	17 / 24 / 2	39 / 13 / 2	0.003	19 / 23 / 3	11 / 26 / 3	22 / 5 / 1	<0.001	9 / 8 / 1	15 / 16 / 3	18 / 2 / 1	0.013

points selected. The present research selected one effective analgesic acupuncture point—LI4-PC6—which has been proven by both traditional acupuncture theory and clinical experience of professional acupuncturists. Furthermore, much research has been devoted to analgesic pain relief (5,25), and PC6 acupuncture can significantly reduce the incidence of postoperative nausea and vomiting. Some research has specifically investigated the application of TEAS in obstetrics and gynecology patients, and the results have shown that not only can TEAS increase the success rate of embryo transfer in infertile women (26), it can also reduce the incidence of postoperative nausea and vomiting after abdominal cavity laparoscopic cholecystectomy procedures (27). In the present study, the subjects were treated or examined with hysteroscopy.

On a different note, not only can the stimulation of the LI4-PC6 acupoint achieve a certain analgesic effect, it can also effectively improve postoperative nausea and vomiting due to opioid use, hysteroscopy procedures, and other causes. The results of the present study corroborated this assertion.

Previous studies investigating propofol injection-related pain, other than research examining different vein choice, have selected the largest hand vein as the infusion channel. The present study examined three veins: the back of the hand's largest vein, the radial vein, and the elbow vein. We chose this design because clinicians do not always use a single hand as the maximum intravenous infusion channel. In this regard, if the other two subgroups had yielded similar results, our conclusion would have been more convincing, as well as more suitable in the clinic. When an indwelling intravenous needle was required, the decision to use one was made by a nurse who was unaware of the research. The patients were selected according to the most appropriate intravenous approach in their specific cases. The priority order was as follows: back of hand vein, radial vein, cubital vein. Therefore, the sample sizes of the three subgroups were not identical; the cubital vein group was the smallest. Therefore, during the preliminary study design, we accounted for the small sample size of a selected group (statistical analysis cannot meet the condition); a later sample was then added to increase the total sample size and obviate problems related to small sample size.

In previous studies investigating the effects of drugs on propofol injection-related pain, researchers did not administer any sedatives or opioid analgesics other than the test drug. In the present study, after 30 min of TEAS pretreatment and before propofol injection, the patients were routinely given 5 μg of sufentanil. The timing of medication is very important in gynecological operations; in this regard, pretrial test results showed that the incidence of pain upon injection of propofol was not affected by the administration of 5 μg of sufentanil 30 s before propofol injection.

In the present study, the incidence of propofol injection-related pain was higher than that usually reported: 95.4% in the hand vein subgroup, 91.2% in the radial vein subgroup, and as high as 100% in the cubital vein subgroup. One reason for this phenomenon was that the subjects in the present study were young women. Studies have shown that young women exhibit factors that affect the incidence of propofol injection-related pain (8,28). Conversely, according to our hospital's clinical habits, the present study used 22-G intravenous catheters, while other studies have used smaller sizes (18 G or 20 G). Propofol was first administered through a 1-m-long extension tube before reaching the body; in other studies, a Y-type direct injection catheter has been used. Specifically, a study by Wu et al. (29) examining the extension tube's influence in propofol injection-related pain reported that extending the length of the propofol tube increases the concentration of di-(2-ethylhexyl) phthalate in the patient's body, as well as the free propofol concentration, thereby increasing propofol injection-related pain (29).

In conclusion, this study compared the incidence of moderate-to-severe pain among three groups, indicating that TEAS can effectively reduce the severity of propofol injection-related pain. TEAS pretreatment can effectively reduce the severity of propofol injection-related pain, and, to a certain extent, it can reduce the incidence of pain on injection. TEAS can also effectively reduce the incidence of postoperative nausea and vomiting, as well as postoperative pain scores.

A limitation of this study is that no other combination of drugs and methods was used in to investigate better ways of reducing the severity and the incidence of injection-related pain. However, TEAS is a combination of traditional and modern medicine. Not only can it effectively reduce the severity and incidence of propofol injection-related pain to some extent, it can also effectively reduce the incidence of postoperative nausea and vomiting, as well as postoperative pain scores. We hope that research investigating the adjunctive use of TEAS leads to better methods of reducing the incidence of injection-related pain, and that it improves comfort during the entire perioperative period.

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