



# The effectiveness of electro-acupuncture combined with dyclonine hydrochloride in relieving the side effects of gastroscopy: a controlled trial

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**Background:** The present study aimed to explore the effectiveness of electro-acupuncture (EA) in combination with a local anesthetic used in Western medicine in preventing the side effects of gastroscopy.

**Methods:** A sample group of 150 patients were divided into three groups based on treatment methods: an EA group, a dyclonine hydrochloride mucilage group, and a combined treatment group. In the EA group, EA stimulation was given at the Hegu, Neiguan, and Zusanli acupoints; in the dyclonine hydrochloride mucilage group, patients took 10 mL of dyclonine hydrochloride mucilage orally; in the combined treatment group, prevention of side effects was attempted by administration of both acupuncture and oral local anesthetic. The incidences of nausea, emesis, salivation, cough, restlessness, and breath holding during gastroscopy were observed and recorded for the three groups. Mean arterial pressure, heart rate, and oxygen saturation were recorded before the examination, and changes in these measures were recorded as the gastroscope passed through the pylorus and after the examination. The visual analogue scale (VAS) values of nausea and emesis, the rate of successful first-pass intubation, and the time of gastroscopy were also recorded. Statistical analysis was performed using R-3.5.3 software.

**Results:** Incidences of side effects (e.g., nausea, emesis, salivation, restlessness, and breath holding) during the examination were lower in the combined treatment group than in the EA group and the dyclonine hydrochloride mucilage group ( $P < 0.05$  and  $P < 0.01$ , respectively). Furthermore, the changes in heart rate and oxygen saturation when the gastroscope passed through the pylorus and after the examination were better in the combined treatment group than in the EA group and dyclonine hydrochloride mucilage group ( $P < 0.01$ ). The VAS values of nausea and emesis, the first-pass success rate, and examination duration were also better for the combined treatment group than for the other two groups ( $P < 0.05$  and  $P < 0.01$ ).

**Conclusions:** EA combined with local anesthesia with dyclonine hydrochloride mucilage can alleviate side effects during gastroscopy, reduce patient pain, and improve the efficiency of the procedure.

**Keywords:** Side effects of gastroscopy; electro-acupuncture (EA); dyclonine hydrochloride mucilage; combined medication; preventive effect

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## Introduction

Digestive endoscopy is a common method used in the diagnosis and treatment of digestive tract diseases (1) and for the early detection and treatment of organic lesions of the gastroesophageal mucosa. However, gastroscopy is often accompanied by physiological and psychological response and damage, for example, nausea (2,3), emesis (2,3), abdominal distension, abdominal pain, palpitation, tension, anxiety, dizziness, sore throat, elevated blood pressure, and even syncope; researchers refer to these effects collectively as “the side effects of gastroscopy” (4-6). The emergence of these side effects has brought difficulties to the operation and treatment of gastroscopy. A current intervention to relieve stress in clinic is psychological support; pharyngeal anesthesia (e.g., lidocaine) and sedation (e.g., diazepam, midazolam, or propofol) are also used. These can effectively reduce discomfort during a gastroscopy (7-10). However, the use of additional drugs increases the cost of surgery and may lead to nausea during induction of anesthesia (2). Furthermore, sedatives have associated risks of respiratory and cardiovascular inhibition, hypotension, and even coma (11,12). The search for solutions to reduce side effects during examination and treatment is therefore a burning issue in the medical field. For a long time, traditional Chinese medicine has used acupuncture and moxibustion to relieve pain. In recent years, there have been many reports on the use of acupuncture, ear acupuncture, and electroacupuncture (EA) in anesthesia before gastroscopy (13-16), and good curative effects have been achieved.

The present study aimed to explore the effectiveness of EA in combination with a local anesthetic used in Western medicine in preventing the side effects of gastroscopy. We present the following article in accordance with the STRICTA reporting checklist (available at <http://dx.doi.org/10.21037/apm-20-831>).

## Methods

### *Study design and patients*

This prospective cohort study was carried out at the Outpatient Department of Gastroenterology, The 81th Group Army Hospital of the Chinese People's Liberation Army. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the ethics committee of the 81th Group Army Hospital of the Chinese People's Liberation Army (No.: 2016JL03-013-01) and informed consent was taken from all the patients.

### *Inclusion and exclusion criteria*

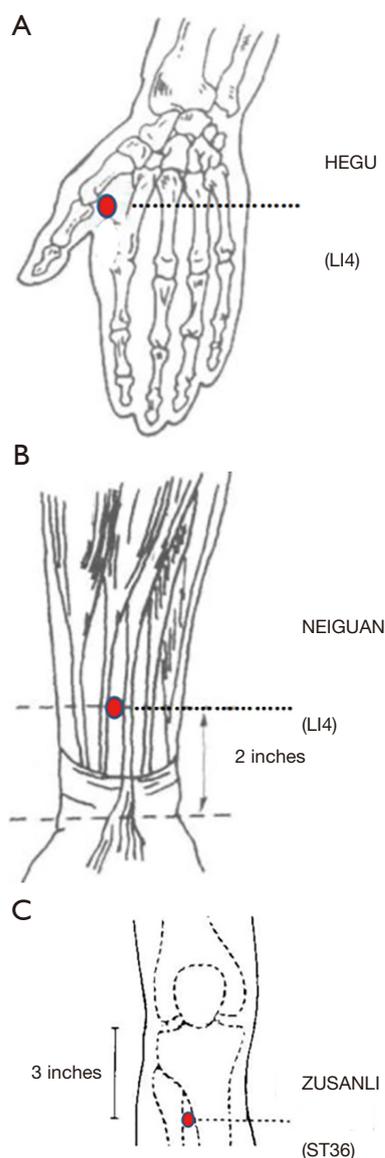
- (I) Inclusion criteria: (i) patients between the ages of 20 and 50, inclusive; (ii) patients with indications for electronic gastroscopy; and (iii) patients who volunteered to participate in the present study and provided informed consent.
- (II) Exclusion criteria: (i) patients whose ages fell beyond the scope of the study (i.e., younger than 20 or older than 50); (ii) patients with clear contraindications to gastroscopy; (iii) patients with neuropsychiatric disorders, severe anxiety and depression, or incapable of civil conduct; (iv) patients with serious or underlying diseases, such as diseases of the heart, brain, kidney, hematopoietic system, and respiratory system, which may induce abnormally related indicators during the gastroscopy process; (v) patients who could not accept acupuncture and EA, and are not allergic to acupuncture and moxibustion; and (vi) women who were pregnant or lactating.

### *Intervention methods*

Patients were assigned to one of three groups—EA, dyclonine hydrochloride mucilage (D), or combined treatment (EA+D)—based on their already existent treatment.

Before the gastroscopy, all patients were required to undergo fasting and water deprivation for more than eight hours [Olympus Medical Company, National Food and Drug Supervision Instrument (Import) No. 32707, 2011]. Before the examination, all patients were given sufficient psychological reassurance to enable them to relax in body and mind and to avoid anxiety.

- (I) EA group: at 20 minutes before the examination, patients in the EA group were asked to lie down, and routine local skin disinfection was performed at the patient's bilateral Hegu (LI4), Neiguan (PC6), and Zusanli (ST36) acupoints. Acupuncture needles (Huatuo Acupuncture and Moxibustion Needles, Suzhou Medical Supplies Factory Co., Ltd.; specifications:  $\phi 0.30 \times 25$  mm and  $0.30 \times 40$  mm) were used for direct percutaneous needling. After insertion, needles were stopped when a patient experienced soreness; it was important that the stimulation intensity could be tolerated by the patient. The stocks of the acupuncture needles at the bilateral Hegu and Zusanli acupoints were



**Figure 1** Anatomical location of acupoints: (A) Hegu; (B) Neiguan; (C) Zusanli.

connected with a Han stimulator [Nanjing Jisheng Medical Technology Co., Ltd., Jiangsu Food and Drug Supervision Instrument (Approval) No. 2260357, 2007]. Wires were connected to the ipsilateral acupoints, and a dilatational electrical wave (frequency: 2/15 Hz) was induced and maintained within a tolerable range for patients (the current was within 2–3 mA). The needles were retained in place until the end of gastroscopy; then, the electrical stimulation was stopped, and

the needles were removed. The acupuncture was carried out by a practitioner with at least five years' experience.

Standard positioning (17):

Hegu (LI4): This acupoint is on the back of the hand at the midpoint of the radial side of the second metacarpal bone, between the first and second metacarpal bones (Figure 1A).

Neiguan (PC6): This acupoint is on the palm-side of the forearm between the long palmar muscle tendon and radial flexor muscle tendon of the wrist, two inches above the transverse crease of the wrist, at the connecting line of Quze and Daling (Figure 1B).

Zusanli (ST36): This acupoint is on the anterolateral calf at one finger width from the anterior margin of the tibia, three inches below acupoint Dubi (Figure 1C).

(II) D group: Before the gastroscopy, patients in the D group received 10 mL of oral dyclonine hydrochloride mucilage (Yangzijiang Pharmaceutical Group Co., Ltd., 10 mL/bottle; National drug approval: No. H20041523), swallowing it over the course of 15 minutes.

(III) EA+D group: Patients in the EA+D group were treated according to the two treatment methods in the EA group and the D group.

### Observation indexes

- (I) The incidences of nausea, emesis, salivation, cough, restlessness, and breath holding in the three groups during gastroscopy were observed and recorded.
- (II) The rate of successful first-pass intubation was recorded.
- (III) The time of gastroscopy was recorded; this was measured using a stopwatch (unit: minutes).
- (IV) The mean arterial pressure (MAP), blood oxygen saturation (SpO<sub>2</sub>), and heart rate (HR) were recorded before the examination, as the gastroscope passed through the pylorus, and after the examination.
- (V) The visual analogue scale (VAS) scores for nausea and emesis were recorded after the gastroscopy (18). A 10-cm ruler was used as a scale plate: "0" was considered as indicating no nausea or emesis, while "10" indicated extremely serious nausea and emesis. This assessment was made by the patients immediately after the end of the gastroscopy; patients gave scores according to their individual feelings: the higher the score, the more serious their nausea and emesis. All VAS scores were evaluated by the same researcher, who had ten years of

experience. This researcher was blinded to the group assignments.

### **Recording and treatment of adverse reactions**

- (I) Recording and observation of adverse reactions: clinical manifestations of adverse reactions, such as expression, complexion, nausea, emesis, salivation, cough, restlessness, and breath holding, were observed. Body temperature, rhythm, HR, blood pressure, respiratory rate, and SpO<sub>2</sub> were recorded during the operation.
- (II) Treatment of adverse reactions: if unforeseen events (e.g., patient fainting during acupuncture treatment, needle sticking, bending, or breaking, or hematoma) occurred during the acupuncture treatment, the patient either received specific treatment or was withdrawn from the study, according to the individual patient's symptoms and condition.

### **Statistical analysis**

Data were statistically analyzed using R-3.5.3 software. The baseline data of the EA and D groups and of the EA+D group were evaluated using a Chi-squared test. A Chi-squared test was also used to analyze the side effects observed in patients during the examination. Intragroup paired samples comparison and intergroup independent samples comparison, before and after treatment, were conducted using *t*-tests. A nonparametric rank sum test was used to evaluate the overall curative effect between each pair of groups after treatment. Data were expressed as mean  $\pm$  standard deviation ( $\bar{x}\pm SD$ ).

## **Results**

### **General characteristics**

A total of 150 patients who were examined by gastroscopy in the Outpatient Department of Beijing Hospital of Traditional Chinese Medicine from June 2016 to December 2016 were enrolled in the present study. These patients were divided into three groups based on treatment methods: an EA group (n=50), a dyclonine hydrochloride mucilage (D) group (n=50), and a combined treatment (EA+D) group (n=50). The differences in gender, age, and weight, and past history of hypertension, diabetes, coronary heart disease, arrhythmia, gastrointestinal perforation, obstruction, acute and chronic liver diseases, acute and chronic biliary

diseases, and acute and chronic pancreatic diseases were not statistically significant (inter-group comparison using a Chi-squared test,  $P>0.05$ , baseline alignment; see *Table 1*). There was no participant dropout during the study.

### **Side effects in patients during gastroscopy**

The analysis reveals that incidences of most side effects after the gastroscopy, including nausea, emesis, salivation, restlessness, and breath holding, were lower in the EA+D group than in the EA and D groups, and the differences were statistically significant ( $P<0.05$  and  $P<0.01$ , respectively). Although the frequency of cough was also lower in the EA+D group than in both the EA and D groups, the difference yielded in the intergroup comparison was not statistically significant ( $P>0.05$ ). Comparing the two single-treatment groups, the incidence of side effects was lower in the EA group than in the D group; however, the difference between these two groups was not statistically significant ( $P>0.05$ ). This indicates that, to some extent that, EA was better than dyclonine hydrochloride mucilage in preventing side effects in patients. Therefore, in the future, EA may be an alternative to drugs to alleviate the side effects of gastroscopy (*Figure 2A,B,C,D,E,F*).

### **Comparison of MAP, HR and SpO<sub>2</sub>**

#### **MAP, HR and SpO<sub>2</sub> before the examination**

Before the examination, the differences in MAP, SpO<sub>2</sub>, and HR between the three groups were not statistically significant ( $P>0.05$ ; *Figure 3*).

#### **MAP, HR and SpO<sub>2</sub> during the examination**

As the gastroscope passed through the pylorus (i.e., during examination), MAP increased in the EA, D, and EA+D groups. Although MAP was lower in the EA+D group than in the EA and D groups, the difference was not statistically significant ( $P>0.05$ ). This result suggests that MAP was similarly elevated in all patients during the gastroscopy, and that none of the three treatment measures (EA, dyclonine hydrochloride mucilage, and a combination of the two) could effectively control its increase (*Figure 4A*).

SpO<sub>2</sub> was increased in the EA, D, and EA+D groups as the gastroscope passed through the pylorus (i.e., during examination). While SpO<sub>2</sub> decreased to a certain extent in the EA+D group after the gastroscope had passed through the pylorus, the level in this group remained significantly higher than the levels in the EA and D groups ( $P<0.01$ ).

**Table 1** The general data of the three groups

Items	Groups			P
	EA group	D group	EA+D group	
n	50	50	50	>0.05
Gender				
Male	26	24	28	>0.05
Female	24	26	22	
Age	30.24±7.01	29.40±7.02	29.52±7.01	>0.05
Weight	66.86±6.02	66.74±5.61	66.11±5.92	>0.05
Past medical history				
Hypertension	4	4	2	>0.05
Diabetes	4	3	2	>0.05
Coronary heart disease	2	3	5	>0.05
Arrhythmia	5	5	4	>0.05
Gastrointestinal perforation	2	0	1	>0.05
Gastrointestinal obstruction	0	0	0	>0.05
Acute and chronic liver diseases	8	10	7	>0.05
Acute and chronic biliary diseases	6	7	8	>0.05
Acute and chronic pancreatic diseases	2	3	2	>0.05

This suggests that, by preventing or retarding SpO<sub>2</sub> depletion, the combined use of EA and orally administered dyclonine hydrochloride mucilage can better prevent the above-mentioned side effects in patients during examination than the use of EA or dyclonine hydrochloride mucilage alone (*Figure 4B*).

HR increased significantly in the EA, D, and EA+D groups as the gastroscope passed through the pylorus (i.e., during the examination). However, the changed HR was significantly lower in the EA+D group than in the EA and D groups ( $P<0.01$ ). This suggests that the combined use of EA and orally administered dyclonine hydrochloride mucilage, by preventing or retarding the acceleration of HR in patients, can better prevent side effects during examination than the use of either treatment alone (*Figure 4C*).

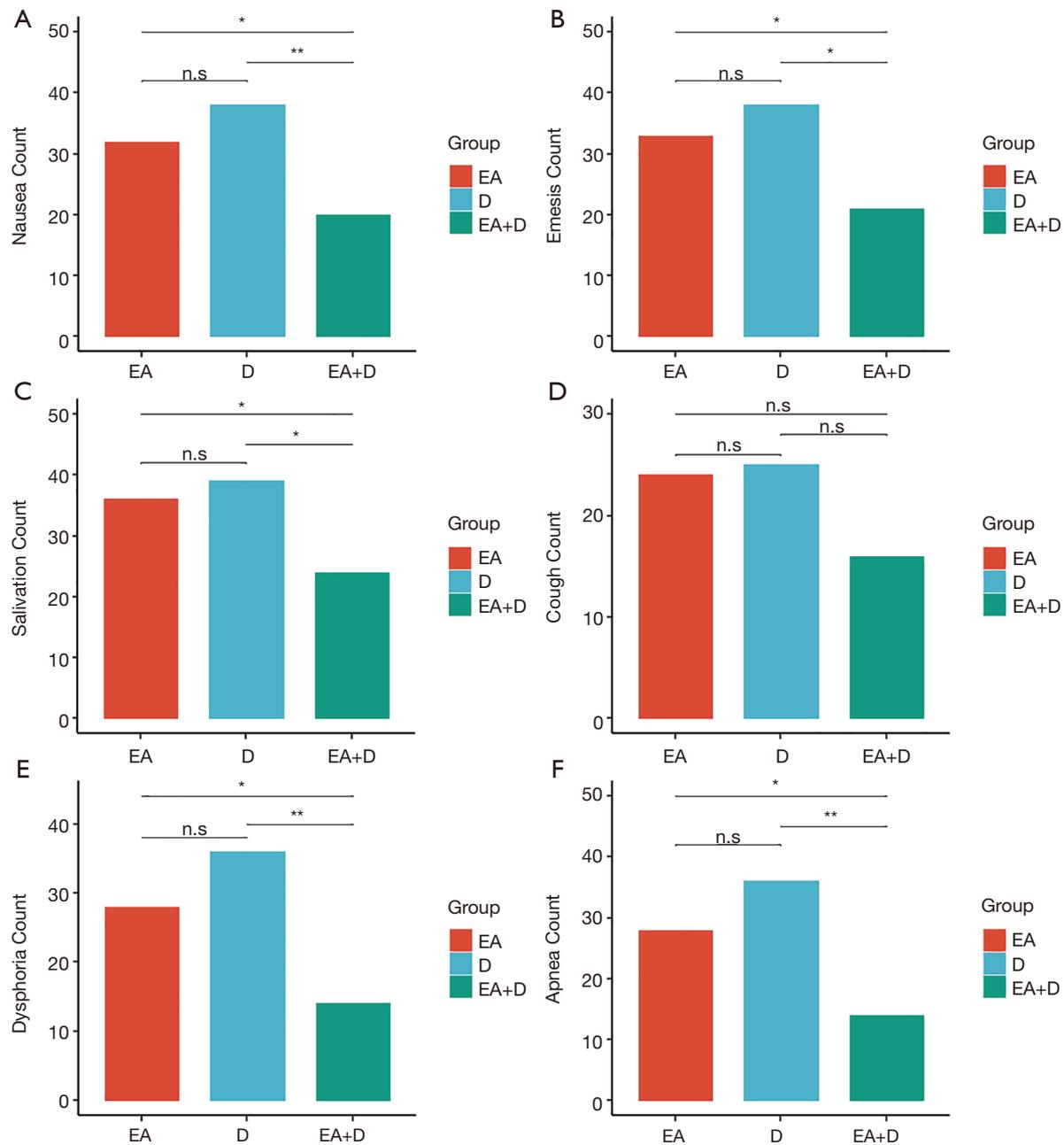
#### MAP, HR and SpO<sub>2</sub> at the end of the examination

At the end of the examination (i.e., gastroscope extraction), MAP increased in the EA, D, and EA+D groups. Although MAP was lower in the EA+D group than in the EA and D groups, the difference was not statistically significant ( $P>0.05$ ). This suggests that MAP increased similarly in all

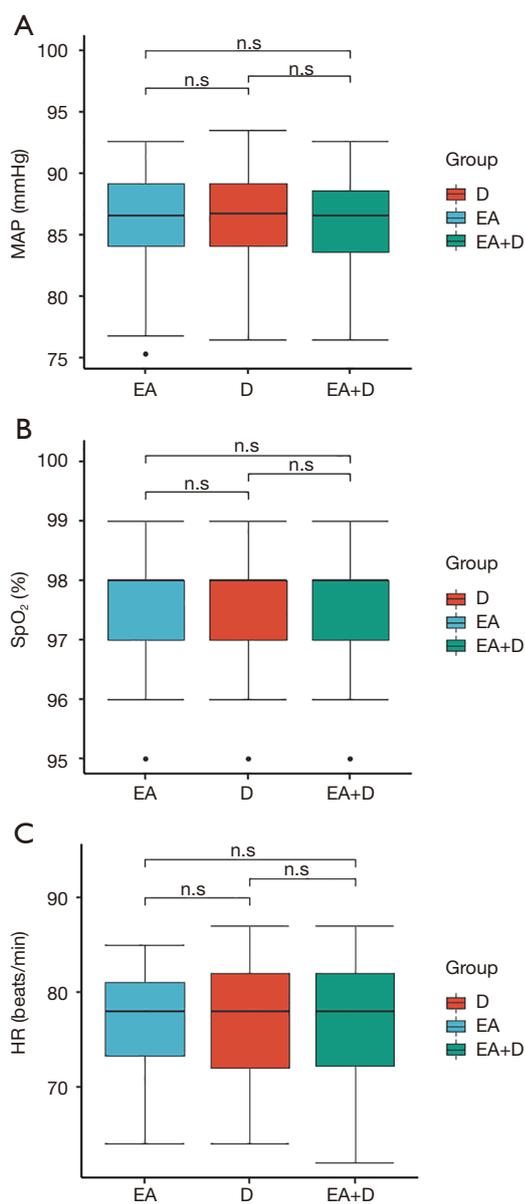
patients upon gastroscope extraction after the end of the gastroscopy, and that none of the three treatment measures (EA, dyclonine hydrochloride mucilage, and a combination of the two) was able to effectively control this increase (*Figure 5A*).

SpO<sub>2</sub> increased in the EA, D, and EA+D groups at the end of the examination (i.e., gastroscope extraction). Although SpO<sub>2</sub> decreased to a certain extent in the EA+D group at gastroscope extraction, the level in this group remained significantly higher than the levels in the EA and D groups ( $P<0.01$ ). This suggests that, by preventing or retarding the decrease in SpO<sub>2</sub>, EA combined with orally administered dyclonine hydrochloride mucilage may better prevent the above-mentioned side effects in patients during an examination than either treatment alone (*Figure 5B*).

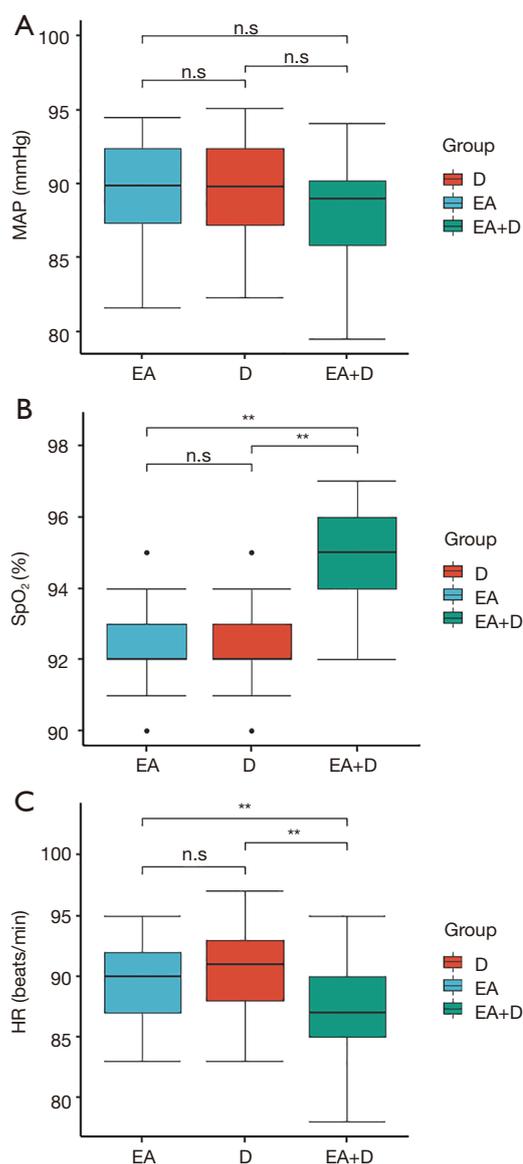
HR significantly increased in all three groups at the end of the examination (i.e., gastroscope extraction); however, HR was significantly lower in the EA+D group at gastroscope extraction than in the EA and D groups ( $P<0.01$ ). This suggests that EA combined with orally administered dyclonine hydrochloride mucilage, by preventing or retarding the acceleration of HR in patients, may better



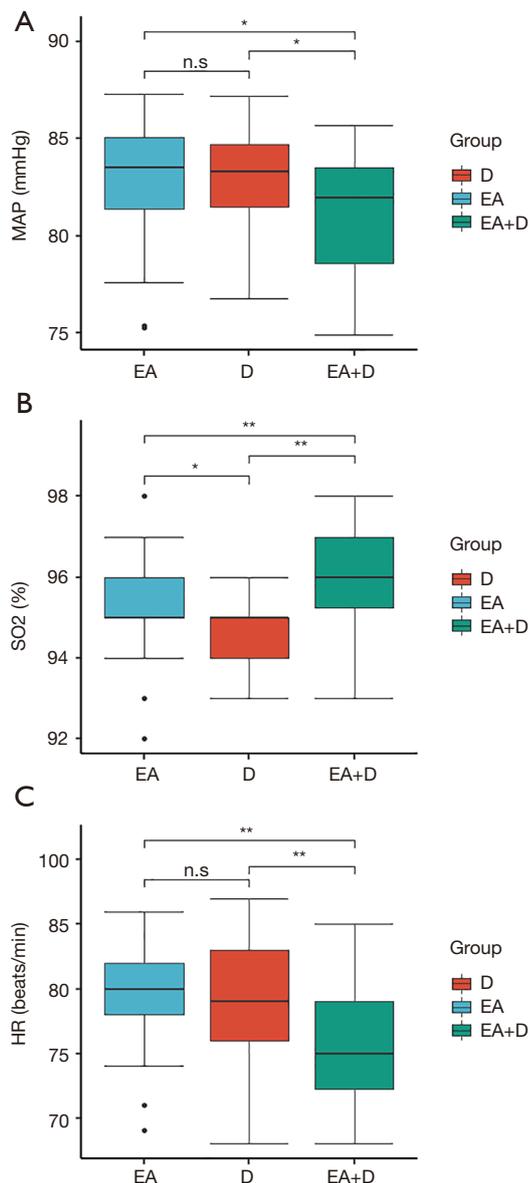
**Figure 2** Comparison of incidences of side effects of gastroscopy among the three groups [n (number of patients)]: (A) Nausea, PD:EA=0.53200, PD: EA+D=0.00702, PEA:EA+D=0.04150; (B) emesis, PD:EA=0.6810, PD:EA+D=0.0133, PEA:EA+D=0.0410; (C) salivation, PD:EA=1.000, PD:EA+D=0.037, PEA: EA+D=0.037; (D) cough, PD:EA=1.000, PD:EA+D=0.256, PEA:EA+D=0.256; (E) restlessness, PD:EA=0.297000, PD:EA+D=0.000348, PEA:EA+D=0.012700; (F) breath holding, PD:EA=0.297000, PD:EA+D=0.000348, PEA:EA+D=0.012700. These six values were expressed as n (patients). Among these, for the analysis of “nausea”, “emesis”, “salivation”, “restlessness” and “breath holding”: comparison of the EA+D group with the EA and D groups: \*P<0.05, \*\*P<0.01; comparison of the EA and D groups: n.s. P>0.05; analysis of “cough”: comparison of the EA+D group with the EA and D groups: n.s. P>0.05.



**Figure 3** Changes in MAP, HR and SpO<sub>2</sub> before the gastroscopy: (A) MAP (mmHg),  $P=0.9011$ ; (B) SpO<sub>2</sub> (%),  $P=0.6871$ ; (C) HR (sub/min),  $P=0.939$ . All data were obtained using an ECG monitor, and all data results were expressed as mean  $\pm$  standard deviation ( $\bar{x}\pm SD$ ). Comparison among the three groups: n.s.  $P>0.05$ .



**Figure 4** Changes in MAP, HR and SpO<sub>2</sub> when the gastroscope passed through the pylorus (i.e., during gastroscopy): (A) MAP (mmHg),  $P=0.05571$ ; (B) SpO<sub>2</sub> (%),  $PEA-D=0.54$ ,  $PEA+D-D=1.4e-13$ ,  $PEA+D-EA=4.9e-14$ ;  $P=0.6871$ ; (C) HR (sub/min),  $PEA-D=0.2958392$ ,  $PEA D-D=0.0000007$ ,  $PEA D-EA=0.0004984$ . All data were obtained using an ECG monitor, and all data results were expressed as mean  $\pm$  standard deviation ( $\bar{x}\pm SD$ ). Comparison of MAP (mmHg) among the three groups: n.s.  $P>0.05$ . Analysis of HR (sub/min) and SpO<sub>2</sub> (%): comparison of the EA+D group with the EA and D groups: \*\* $P<0.01$ ; comparison of the EA and D groups: n.s.  $P>0.05$ .



**Figure 5** Changes in MAP, HR and SpO<sub>2</sub> at the end of gastroscopy (i.e., gastroscope extraction): (A) MAP (mmHg), PEA-D=0.784, PEA+D-D=0.012, PEA+D-EA=0.012; (B) SpO<sub>2</sub> (%), PEA-D=0.01, PEA+D-D=3.2e-11, PEA+D-EA=3.5e-06; (C) HR (sub/min), PEA-D=0.56691, PEA+D-D=0.00015, PEA+D-EA=2.1e-06. All data were obtained using an ECG monitor, and all data results were expressed as mean  $\pm$  standard deviation ( $\bar{x}\pm$ SD). Comparison of MAP (mmHg) among the three groups: comparison of the EA+D group with the EA and D groups: n.s. P>0.05. Analysis of HR (sub/min) and SpO<sub>2</sub> (%): comparison of the EA+D group with the EA and D groups: \*P<0.01; comparison of the EA+D group with the EA and D groups: n.s. P>0.05.

prevent side effects during examination (Figure 5C).

#### Comparison of VAS scores of nausea and emesis among the three groups

##### VAS scores of nausea and emesis after the examination

The results of comparison between the three groups reveal that the VAS scores were lower in the EA+D group than in the EA and D groups (P<0.01), but that there was no statistical difference between the D and EA groups (P>0.05; Figure 6).

#### Comparison of the successful number of one-stop intubations among the three groups

For 45 patients in the EA+D group, the gastroscopy was completed at the first pass: a success rate superior to those of the EA group (31 patients) and the D group (36 patients) (P<0.05). These results suggest that the combined treatment intervention can improve patients' tolerance of and compliance with gastroscopy (Figure 7).

#### Comparison of duration of gastroscopy among the three groups

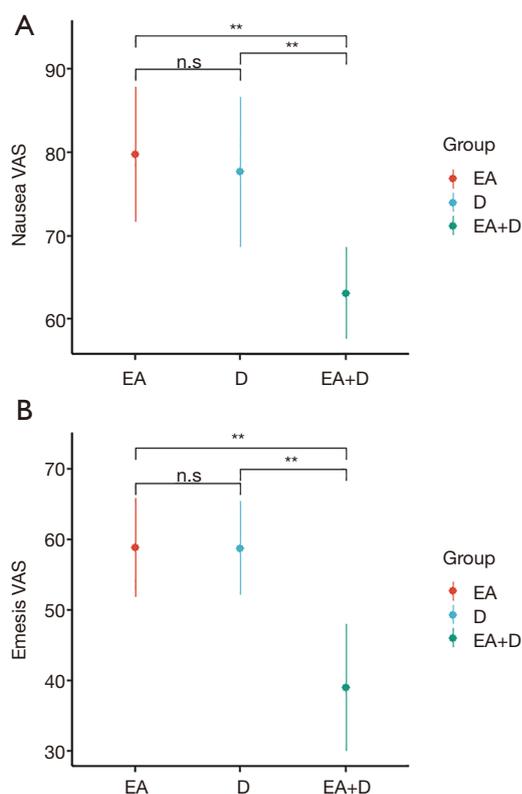
Gastroscopy duration was shorter in the EA+D group than in the EA and D groups (P<0.01). This suggests that the combined treatment intervention of EA and dyclonine hydrochloride mucilage may not only improve patients' tolerance to gastroscopy and reduce the side effects, but also help in shortening the duration of the procedure (Figure 8).

#### Adverse events

No adverse events and no events necessitating termination of the study (syncope, gastrointestinal bleeding, cardio-cerebrovascular complications, perforation, or death) were observed in any of the three groups, and no patients withdrew from the study. No adverse events were related to the intervention.

#### Discussion

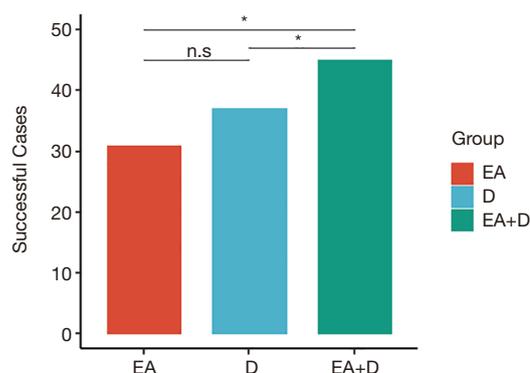
The first side effects of gastroscopy have their source in somatic stress, in which the physical stimulation of the inner wall of the throat and of the upper gastrointestinal tract causes pharyngeal and tension reflex, resulting in nausea and emesis. This also leads to psychological stress



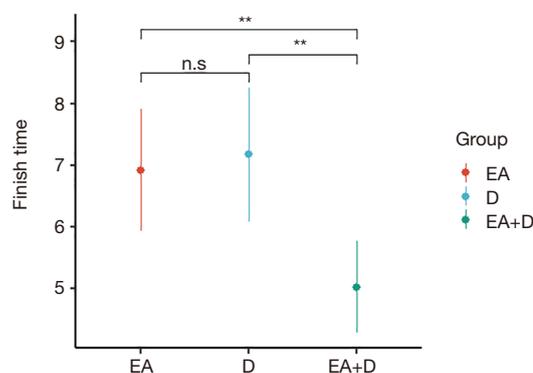
**Figure 6** VAS scores of nausea and emesis at the end of gastroscopy among groups: (A) VAS score of nausea, PEA-D=0.18, PEA+D-D=4.1e-13, PEA+D-EA=7.1e-14; (B) VAS score of emesis, PEA-D=0.99, PEA+D-D=9.9e-15, PEA+D-EA=2.0e-14. The VAS scale was used to immediately evaluate the two indicators after gastroscopy, and all data results were expressed as mean  $\pm$  standard deviation ( $\bar{x}\pm SD$ ). Comparison of the EA+D group with the EA and D groups: \*\* $P<0.01$ ; comparison of the EA and D groups: n.s.  $P>0.05$ .

and a series of psychological and physiological reactions and damage through the endocrine pathways, including abnormal gastric motility, changes in gastric electrical activity, mucosal damage, and changes in gastric acid and gastrointestinal hormones, and accordingly causes a series of clinical symptoms (2). Extensive clinical literature and numerous reports consider that acupuncture, moxibustion, and EA can alleviate the side effects of gastroscopy (13-16). Furthermore, the results of meta-analyses of the literature reveal that acupuncture can alleviate the side effects of gastroscopy to a certain extent (13,19).

EA combines traditional Chinese medicine and modern treatment. First, a needle is inserted into an acupoint to



**Figure 7** Comparison of the number of successful cases of one-stop intubation in gastroscopy in all groups. The data of “the number of successful cases of one-stop intubation” were expressed as n (patients). PD:EA=0.297000, PD: EA+D=0.000348, PEA:EA+D=0.012700. Comparison of the EA+D group with the EA and D groups: \* $P<0.05$ ; comparison of the EA and D groups: n.s.  $P>0.05$ .



**Figure 8** Comparison of duration of gastroscopy among the three groups. The duration of gastroscopy (min) was measured using a stopwatch. The results were rounded, and the data units were calculated in approximate minutes. PEA-D=0.12, PEA+D-D=5.4e-14, PEA+D-EA=8.3e-14; All data results were expressed as mean  $\pm$  standard deviation ( $\bar{x}\pm SD$ ). Comparison of the EA+D group with the EA and D groups: \*\* $P<0.01$ ; comparison of the EA and D groups: n.s.  $P>0.05$ .

bring about the desired sensation. Then, the needle is connected with a microcurrent close to the bioelectricity of the human body. Thus, this method is a combination of needling and electric stimulation; it has the potential to prevent and treat diseases (20,21). To date, the literature reports that EA can adjust human physiological functions (22), relieve pain (23), sedate (24), promote

blood circulation (25), and adjust muscle tension (26). The applicability of EA is essentially the same as that of acupuncture needling; it therefore has a wide range of treatment applications. In clinic, it is often used in pain syndromes (23,27); arthralgia syndrome (28); dysfunction of the stomach, intestine, and other organs (29,30); mania (31); muscle (26), ligament (23), and joint (28) damage; and for acupuncture anesthesia (32). However, there is no straightforward research data related to the use of EA for the prevention of side effects in gastroscopy. Hence, there is a need to systematically and scientifically investigate the application of EA in the prevention and treatment of side effects of gastroscopy, enteroscopy, duodenoscopy, and ERCP, and to explore the relevant mechanisms. Furthermore, it will be of great significance to scientifically understand the role and mechanism of EA in preventing gastroscopy and colonoscopy side effects.

Based on existing literature and clinical experience, and with the consent and support of the Ethics Committee of our hospital, the researchers in the present study designed a clinical trial to investigate the effectiveness of EA combined with dyclonine hydrochloride mucilage in preventing the side effects of gastroscopy. The results of the present study reveal that incidences of side effects (such as nausea, emesis, salivation, restlessness, and breath holding) were lower in patients in the treatment group (the EA+D group, who received the combined treatment) than in patients receiving only one of the two treatments (in the EA group and the D group) ( $P<0.05$  and  $P<0.01$ , respectively). Furthermore, as the gastroscope passed through the pylorus and after the examination, the changes in HR and SpO<sub>2</sub> were better in the EA+D group than in the EA group and the D group ( $P<0.05$  and  $P<0.01$ , respectively), and the VAS scores for nausea and emesis, the first-pass success rate, and examination duration were better for the EA+D patients than for those in the EA group and the D group ( $P<0.05$  and  $P<0.01$ , respectively). This series of results suggests that EA+D can alleviate the above-mentioned nerve, heart, and gastrointestinal stress responses induced by gastroscopy. Furthermore, the results of the present study are basically in agreement with those in the literature, where it is reported (13,19) that acupuncture at Zusanli before gastroscopy can relieve nausea and emesis during the procedure. Researchers who have reviewed and analyzed the application of therapies of traditional Chinese medicine (such as acupuncture, EA, moxibustion, and acupoint injection) in upper gastrointestinal endoscopy conclude that acupuncture (including EA, acupoint massage, and moxibustion) can

alleviate anxiety and adverse gastrointestinal reactions by regulating nervous and gastrointestinal electrical activity. They also found that the treatments of traditional Chinese medicine supported reductions in the dosage of anesthetics given to patients and promoted a shorter awakening time from anesthesia (14–16).

Among the literature related to the mechanism of EA and acupuncture in preventing the side effects of gastroscopy and colonoscopy, one previous study reports that acupuncture relieved a series of uncomfortable symptoms or sign changes caused by gastroscopy, and mitigated changes in mechanisms, pathways, signals, and transmitters. Studies have also revealed that acupuncture and moxibustion can regulate vegetative nerve and gastrointestinal function, protect gastric mucosa, promote resistance to anxiety, and reduce the concentration of 5-HT in blood (33); it follows that acupuncture and moxibustion can reduce emesis as a side effect during gastroscopy. Similar mechanisms can be found for other side effects. Acupuncture and moxibustion can influence the biological factors of anatomy and physiology. The mechanism of EA in preventing the side effects of gastroscopy is correlated to this. However, the stimulation intensity of EA is greater than that of simple acupuncture, and further clinical and animal studies are needed to verify whether there are other mechanisms involved, or whether the regulatory effect of EA on the secretion of neurosubstances is stronger than that of acupuncture alone.

One study involving an animal experiment reveals that the mechanism of the regulatory effect of EA on the gastrointestinal tract may be correlated to the inhibition of stimulation of the limbic system. For example, when EA was given at Zusanli and other acupoints, electrophysiological activities and blood flow and velocity increased in the gastrointestinal tract tissues of the experimental animals (26,27). In another experimental study (on dogs) (28), changes in the upper gastrointestinal tract of dogs after EA treatment at the Zusanli were characterized by a decrease in total pressure, basal pressure, and contraction frequency of the pyloric sphincter. The expression of calcitonin and related genes in plasma and the gastric mucosa of dogs was also detected, and the results reveal that the concentrations of these were higher in the treatment group than in the control group, whereas the concentration of endothelin was significantly lower. The preliminary results of the present study reveal that EA can regulate ghrelin to a certain extent, thereby regulating the gastrointestinal-neurophysiological reflex function.

The limitations of the present study should be mentioned. This was a small-scale study involving a small sample. There is no previous similar study to support our sample size calculation; this is therefore an exploratory study. The data obtained in this study will support the sample size calculations of future multi-center and large-scale clinical trials. Based on clinical trials, the present study aimed to determine the pathway of action of acupuncture and the changes in the corresponding indicator transmitters. It is only through this approach that powerful evidence-based medical evidence can be obtained. Because our study was a small-sample, prospective cohort study, there is the potential for bias (e.g., selection bias, performance bias, and measurement bias). In the future, multi-center and large-scale clinical trials are needed to eliminate such bias.

## Conclusions

On the basis of the present study and the literature, the researchers consider that acupuncture can alleviate the side effects induced by endoscopy. The associated advantages are the simplicity, convenience, and economy of acupuncture, and the potential to reduce the side effects of drugs; furthermore, the treatment has strong operability in clinic and can therefore be easily accepted by patients.

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## Footnote

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*Ethical Statement:* The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the ethics committee of the 81th Group Army Hospital of the Chinese People's Liberation Army (No.: 2016JL03-013-01) and informed consent was taken from all the patients.

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