

Review article: therapeutic roles of acupuncture in functional gastrointestinal disorders

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SUMMARY

Acupuncture has been practiced empirically in China for several millennia, and is being increasingly accepted by practitioners and patients worldwide. Functional gastrointestinal disorders are common in clinical gastroenterology. The prevalence of one or more functional gastrointestinal disorders is estimated to be as high as 70% in general population using Rome diagnostic criteria. Since functional gastrointestinal disorders are diagnosed based on symptoms and the exact aetiologies for most of functional gastrointestinal disorders are not completely known, it is not unusual that the treatment for these disorders is unsatisfactory and alternative

therapies are attractive to both patients and practitioners. During the latest decades, a considerable number of studies have been performed on acupuncture for the treatment of functional gastrointestinal disorders and underlying mechanisms. In this article, we reviewed available data in the literature on the applications and mechanisms of acupuncture for the treatment of functional gastrointestinal disorders, including functional oesophageal disorders, nausea and vomiting, functional dyspepsia, irritable bowel syndrome, constipation, etc. A summary is provided based on the quality and quantity of published studies regarding the efficacy of acupuncture in treating these various disorders. In addition, the methodology of acupuncture is also introduced.

INTRODUCTION

Acupuncture has been practiced empirically in China for several millennia. The existence of acupuncture is believed to have been at least 4000 years, although its precise origin is not clear. The 'sharp stone needle', the earliest form of acupuncture needle made in stone, was discovered in the New Stone Age ruins in China.¹ The systemic theory of acupuncture and meridian was established about 2000 years ago in Huang Di Nei Jing (Yellow Emperor's Inner Classic, a medical textbook).^{2, 3}

Acupuncture has then served as one of major medical resources in China and some other Asian countries.

Acupuncture is being increasingly accepted by practitioners and patients worldwide, including United States, especially during the last three decades.^{4–9} During the last decade, a considerable number of studies were performed to examine the efficacy of acupuncture for the treatment of functional gastrointestinal disorders (FGIDs).¹⁰ Human and animal studies were conducted to explore the effects of acupuncture on gastrointestinal secretion, sensation, motility and myoelectrical activity.^{11, 12} The aim of this paper is to provide principal information about acupuncture and a critical review on the therapeutic roles of acupuncture for FGIDs or gastrointestinal motility disorders.

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THEORY AND METHOD OF ACUPUNCTURE

Meridians

Acupuncture is one of major components of traditional Chinese medicine (TCM), which is a distinctive heritage of Chinese culture-related medicine when compared with the conventional Western medicine. In TCM, the human body is considered as a dynamic organism composed of internal and external organs, connected with channels called meridians, through which 'qi' (a kind of air) is circulating.¹ When the human body is in balance, there is unobstructed flow of 'qi', which is the vital energy, required for the maintenance and nourishment of the organs and associated tissues.

Acupoints

Acupoints (or acupuncture points) are special nodes (or outlets) on the meridians, where 'qi' enters, exits, meets and accumulates.¹ There are 14 major meridians corresponding to internal organs, along which there are a total of 361 acupoints. The locations of commonly used acupoints for the FGIDs and the related meridians are illustrated in the Figure 1. A healthy body requires

preservation of the harmonious balance, while an imbalance of energy flow within these meridians results in diverse ailments. The basic theory of acupuncture is that the insertion and manipulation of a needle at a particular point or points along a meridian related to an impaired organ stimulates the energy flow, restores a proper energy balance and thus normalizes the functions of the organ.

Implementation of acupuncture

Most commonly, acupuncture is accomplished by manual manipulation or electrical stimulation via thin, stainless steel needles inserted in the acupoints. 'Manual acupuncture' involves the manipulation of the inserted needles by the hand of the acupuncturist, such as lifting, thrusting, twisting, twirling or other complex combinations. It is believed that different manipulations may elicit different effects for different conditions.¹³ It is a traditional method of acupuncture, and most commonly used in clinical practice.

'Electroacupuncture (EA)' is achieved by attaching the acupuncture needles to an electrical pulse generator and stimulating the acupoints with electrical pulses. EA

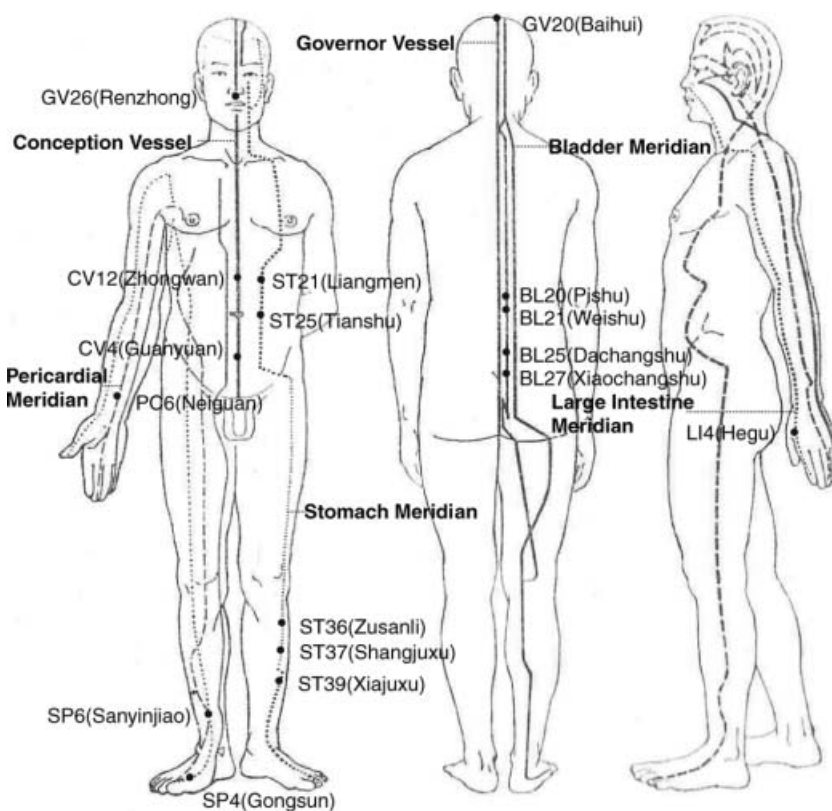


Figure 1. Acupoints and related meridian for the FGIDs. In TCM, the human body is considered as a dynamic organism composed of internal and external organs, connected with channels called meridians, through which 'qi' is circulating. Acupoints (acupuncture points) serve as specific areas on the meridians, where 'qi' entering, exiting, meeting and accumulating. FGIDs, functional gastrointestinal disorders; TCM, traditional Chinese medicine.

appears to be more consistent and generate more reproducible results and is thus commonly used in research.^{14–16}

‘Transcutaneous electrical acustimulation (TEAS)’ or ‘transcutaneous electrical nerve stimulation (TENS)’ refers to electrical stimulation performed via skin surface electrodes placed on the acupoints or nerve dermatomes. TEAS and TENS are very similar because acupoints are very likely distributed along the nerve dermatomes. Accordingly some TENS studies are also reviewed in this paper.

‘Other methods’ of acupuncture include stimulating acupoints by heat (moxibustion, burning of the herb moxa), pressure (acupressure), laser irradiation or magnetic or electromagnetic waves.

Auricular acupuncture

Auricular (ear) acupuncture is a variation of acupuncture and also used for FGIDs. Different areas on the external ear are believed related to particular organs. These particular areas are auricular points named after the corresponding organs (Figure 2). Stimulation of auricular points is applied via press needles (staple-puncture), beads (acupressure) and so on.

TREATMENT OF FUNCTIONAL OESOPHAGEAL DISORDERS

Dysphagia

Dysphagia is one of most common functional oesophageal disorders that are second in prevalence among the FGIDs.¹⁷ Manometrically, dysphagia is characterized by poor or absent oesophageal peristalsis, increased lower oesophageal sphincter (LES) pressure and/or a failure of LES relaxation during swallow. It is often reported in patients with achalasia, systemic sclerosis or cervical vertebroproathy. Vasoactive intestinal peptide (VIP)¹⁸ and nitric oxide¹⁹ are believed to be the inhibitory neurotransmitters responsible for LES relaxation.

Effects of acupuncture on dysphagia have been investigated in a number of studies, mostly using transcutaneous electrical stimulation. Two of three uncontrolled studies in patients with achalasia and systemic sclerosis reported a reduced LES resting pressure, improved oesophageal peristalsis and LES relaxation, and an accompanied increase in plasma VIP with TENS,^{20, 21} whereas the third study failed to

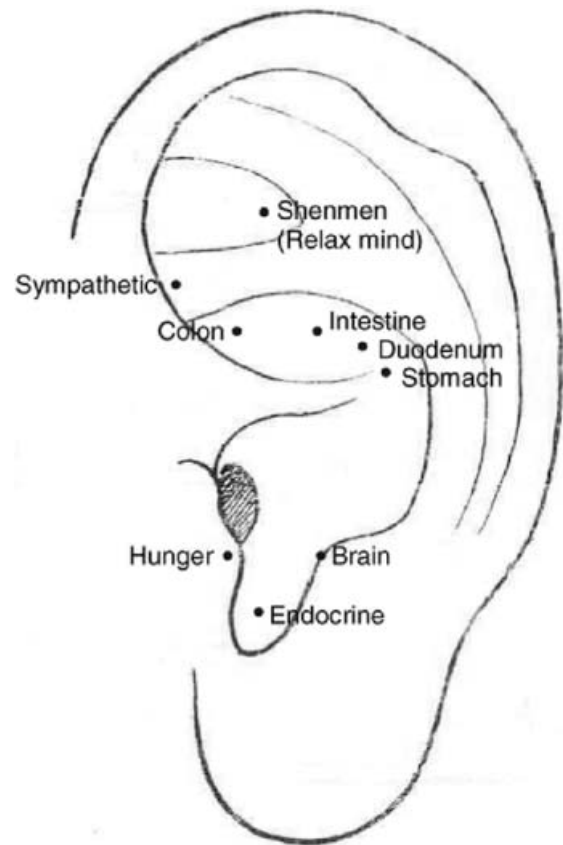


Figure 2. Auricular acupoints for the functional gastrointestinal disorders (FGIDs). The particular areas on the external ear are believed related to particular organs. These particular areas are auricular points named with the corresponding organ.

induce any detectable changes.²² In a controlled study in normal subjects, Chang *et al.* found that manual acupuncture improved LES relaxation by 11.3% and increased the peristaltic contractions by 4.3% during swallows.²³ These effects were not noted with needling of non-acupoints. Using dynamic scintigraphy, acceleration in oesophageal transit was noted with auricular acupuncture in patients suffering from cervical vertebroproathy.²⁴

Non-cardiac chest pain

The concept of non-cardiac chest pain has emerged because of the fact that up to 30% of patients with angina-like chest pain who undergo coronary angiography have normal or only slightly abnormal coronary arteries.²⁵ TENS was found effective in the treatment of visceral heart pain in severe angina pectoris.^{26, 27} The efficacy of TENS for chest pain of oesophageal origin was

also noted.²⁸ It was reported that the increased visceral perception was positively correlated to the amplitude and duration of oesophageal peristalsis, and TENS reduced oesophageal pain sensitivity during balloon distension and decreased the intensity of oesophageal peristalsis.²⁸

Surprisingly, almost nothing is found in the literature regarding the effect of EA on gastro-oesophageal reflux disorder (GERD). It is unclear whether no studies were performed or no effective data were obtained.

TREATMENT OF NAUSEA AND VOMITING

Nausea and vomiting are common symptoms of upper gastrointestinal disorders. A number of randomized-controlled trials (RCTs) have provided convincing evidences on the efficacy of acupuncture for treating nausea and vomiting under various conditions in adult patients, such as postsurgery, chemotherapy, pregnancy, motion sickness, etc.^{29–34} Acupoint PC6 (Neiguan) is commonly used for treating nausea and vomiting, and acupuncture is implemented using various methods including manual manipulation,³⁵ EA,³⁶ acupressure,³⁷ TEAS³⁸ and even laser stimulation.³⁹

In adult patients, Dundee's group performed a series of well-designed studies including prospective, randomized, sham-controlled trials^{40–42} and provided reliable evidence on the efficacy of acupuncture in treating postsurgical nausea and vomiting. The findings in postsurgical paediatric patients are, however, controversial^{43, 44} with some studies showing a complete failure of acupuncture in reducing nausea and vomiting^{45, 46} and more studies demonstrating its efficacy.^{39, 47} In patients receiving chemotherapy, nausea and vomiting were reduced with acupuncture. Dundee *et al.* showed a beneficial effect of TEAS at PC6 as an adjuvant to antiemetics in over 100 patients in whom chemotherapy-induced sickness was not adequately controlled by antiemetics alone.⁴⁸ In a RCT with concealed allocation, sham control and careful blinding, EA was found effective in controlling emesis in 104 patients with breast cancer receiving chemotherapy.⁴⁹ In a recent single-blinded study involving 593 women with early pregnancy, nausea was significantly reduced with both traditional acupuncture (selection of points based on TCM diagnosis) and acupuncture at P6 alone.^{50, 51}

The TEAS, acupressure or acuband is most commonly used for the treatment of motion sickness. In a carefully designed study involving different races

of subjects, Hu *et al.* found that TEAS at PC6 significantly reduced the severity of vection-induced motion sickness in Chinese as well as white and black.⁵² Similar effects were also noted with acupressure at PC6⁵³ or acuband.⁵⁴

Acupuncture has also been performed in animal model of vomiting in a few studies. In ferrets, EA at PC6 reduced the number of emetic episodes induced by morphine⁵⁵ or cyclophosphamide.⁵⁶ In dogs, EA at both PC6 and ST36 reduced the incidence of vomiting and symptomatic behaviour suggesting nausea induced with vasopressin and the effect was found to be vagally mediated.⁵⁷

TREATMENT OF FUNCTIONAL GASTRODUODENAL DISORDERS

Gastric acidity

Gastric acidity refers to the hyper function of acid secretion of the stomach with excessive acid output, leading to ulcer diseases. A number of studies have consistently demonstrated a reduction of acid secretion with acupuncture in both humans and animals. Acupuncture was shown to lower the acid output in patients with duodenal ulcer⁵⁸ and patients with chronic superficial gastritis.⁵⁹ In healthy volunteers, EA decreased basal acid output as well as sham feeding-stimulated (vagally mediated) acid output, but had no effects on the pentagastrin-stimulated acid output.⁶⁰ In another clinical study, Lux *et al.* reported that EA and TENS, but not manual, laser or sham acupuncture reduced the sham feeding-stimulated acid output.⁶¹ In rats with stress-induced gastric ulcer, EA was able to protect the stomach by thickening gastric mucosal barrier, stabilizing mast cells and decreasing the gastrin level in gastric mucosa.⁶² In cats, EA reduced gastric blood flow, celiac blood flow and gastric acid secretion, whereas manual acupuncture increased the level of all these measurements.⁶³ These studies seem to suggest that electrical stimulation is crucial in reducing acid secretion.

Functional dyspepsia

Functional dyspepsia is a symptom complex characterized by epigastric pain, early satiety, nausea, vomiting, abdominal distension, bloating and/or anorexia in the absence of organic diseases.⁶⁴ Little information is available, except a few case reports, on the treatment

of functional dyspepsia with acupuncture. In one study of 103 patients, acupuncture was reported effective in reducing dyspeptic symptoms, mainly epigastric pain, in 95% of the patients.⁶⁵

Dyspeptic symptoms may be caused by various neuromuscular dysfunctions of the stomach,⁶⁶ and a few studies have been performed to investigate the effects of acupuncture on these aetiopathological conditions including visceral hypersensitivity, impaired gastric accommodation, abnormal motility and delayed gastric emptying. In healthy humans, TENS increased the tolerance threshold to gastric or duodenal distention,⁶⁷ and EA at PC6 and ST36 reduced gastric dysrhythmia.⁶⁸ In patients with functional dyspepsia and delayed gastric emptying, EA at PC6 and ST36 was reported to accelerate solid gastric emptying.⁶⁹ In a canine study, impaired gastric accommodation induced by vagotomy was normalized with EA at ST36.⁷⁰ As shown in Figure 3, the postprandial gastric volume in the vagotomized dogs was low in the control session without EA but increased with EA to a level comparable with the healthy dogs.

Antroduodenal dysmotility

Motility in the regions of stomach, pylorus and duodenum plays a major role in the regulation of gastric emptying. A number of human and animal studies have been performed to investigate the effects of acupuncture, mostly EA, on antroduodenal motility and gastric emptying.

Acupuncture has an excitatory effect on antroduodenal motility when there is an impairment or hypomo-

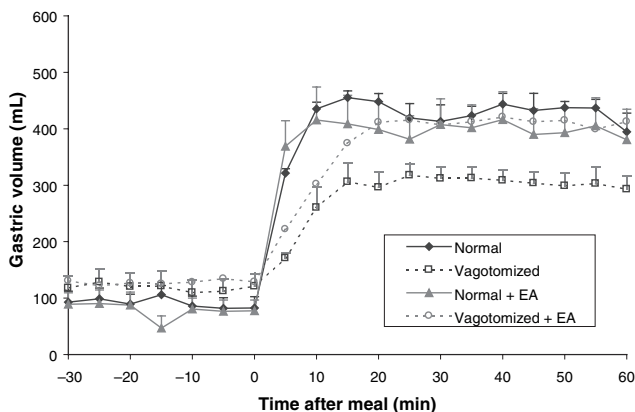


Figure 3. Representative tracings of gastric volume without electroacupuncture (EA) (a) and with EA (a) recorded by barostat device.

tility,⁷¹⁻⁷³ whereas it may have an inhibitory effect in the case of hypermotility.^{74, 75} In a preliminary clinical study, acupuncture at ST2 (Sibai) and ST44 (Neiting) enhanced gastric peristalsis observed by ultrasonography.⁷² In a canine study, EA at PC6 and ST36 increased the length of phase II and phase III of migrating motor complex.⁷³ However, acupuncture or EA at GV26 (Renzhong) resulted in a decrease in the amplitude of antral contractions in dogs,⁷⁴ and ear acupuncture reduced the frequency of gastric peristalsis in humans.⁷⁵ Dual effects of acupuncture have also been noted on gastric,^{76, 77} pyloric⁷⁸ and intestinal motility.^{79, 80}

Acceleration of gastric emptying with acupuncture has also been reported. As mentioned previously, acceleration in gastric emptying of solid was noted with EA in patients with functional dyspepsia and delayed gastric emptying.⁶⁹ In a canine study of delayed gastric emptying, we found that EA at PC6 and ST36 significantly accelerated gastric emptying. A substantial (more than two folds) increase in the percentage of gastric emptying was noted during the 45-min postprandial period with EA (Figure 4).⁸¹

Gastric dysrhythmia

Gastric motility is regulated by a number of factors including gastric myoelectrical activity,⁸² and tachygastric (an abnormally high frequency of the gastric slow wave) is known to cause gastric hypomotility.⁸³ A number of studies have been reported that EA is able to reduce gastric dysrhythmia, particularly tachygastric, measured by non-invasive electrogastrography. In vection-induced motion sickness in healthy volunteers, there was excessive tachygastric or tachyarrhythmia that was reduced with TEAS,⁵² or acupressure at

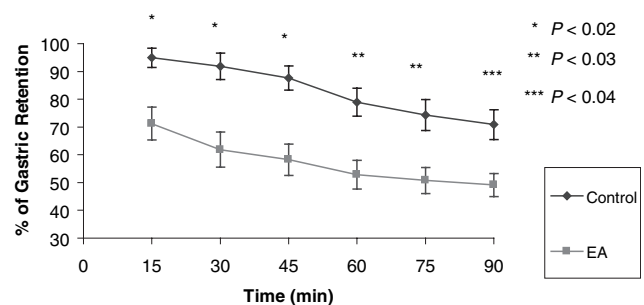


Figure 4. Effect of electroacupuncture (EA) on gastric emptying. The percentage of gastric retention was significantly less with EA than that without EA.

PC6.^{53, 54} EA at both PC6 and ST36 reduced arrhythmia and increased normal gastric slow waves.⁶⁸ EA at ST36 alone reduced tachygastria in patients with diabetic gastroparesis,⁸⁴ but had little effect on atropine-induced gastric dysrhythmia in healthy volunteers.⁸⁵ Similar regulatory effects of EA on gastric dysrhythmia were reported using implanted serosal electrodes in animals.^{81, 86, 87}

TREATMENT OF FUNCTIONAL BOWEL DISORDERS

Post-operative ileus

Post-operative ileus is one of the most significant side-effects of abdominal surgery, and reflected as an initial absence and subsequent impairment of motor functions of the stomach, intestinal and colon.⁸⁸ Three RCTs in patients with abdominal surgeries suggested an enhancement of gastrointestinal motility with acupuncture evidenced by a shortening of the first bowel sound time, flatus passage time and excretion time.^{89–91} Combination of ear and body acupuncture also relieved abdominal distension and other discomforts after abdominal surgery.⁹²

Irritable bowel syndrome

Irritable bowel syndrome (IBS) is most common among various FGIDs,⁹³ and comprises a group of functional bowel disorders in which abdominal discomfort or pain is associated with defecation or a change in bowel habit, and with features of disordered defecation.⁹⁴ A lowered sensory threshold to rectal distention is a hallmark of IBS patients.^{95, 96}

The effect of acupuncture on IBS is inconclusive.^{97–100} In an open-design pilot study,¹⁰¹ the patients with IBS showed an improvement in overall well-being and bloating but not abdominal discomfort or defecation frequency after a 4-week course of acupuncture. In a double-blind trial¹⁰² in patients with IBS, no statistically significant difference was noted in the improvement of IBS symptoms between acupuncture and sham-acupuncture although the improvement seemed more consistent with acupuncture.

Improvement in rectal sensation with acupuncture has been reported in recent studies. In one study of patients with diarrhoea-predominant IBS, TEAS at PC6 and ST36 improved rectal sensation but had no effects on rectal tone or compliance.¹⁰³ In another study with

treatments of two times per week for 2 months, TEAS at LI4 (Hegu) and ST36 improved the abnormal rectal sensation and related symptoms in patients with diarrhoea-predominant IBS, but not in constipation-predominant IBS and functional constipation.¹⁰⁴

Constipation

Little effort has been made to investigate the efficacy of acupuncture on constipation and there is scarce information in the literature. In one study of 17 children with chronic constipation, acupuncture gradually increased the frequency of bowel movement to the control level as well as the plasma opioid level during a 10-week treatment period.¹⁰⁵ This finding was, however, not confirmed in adult patients with constipation.¹⁰⁶

MECHANISMS OF ACUPUNCTURE

Gastric acid secretion

Inhibition of gastric acid secretion with acupuncture was found to be mediated by interconnected neural and humoral pathways. The neural pathway is a somatovagal reflex, with the somatic nerve afferent limb from the lower extremities and the vagal nerve efferent limb to the stomach. It was demonstrated that the effects of acupuncture on gastric acid secretion was blocked by either a local anaesthetic agent or anticholinergic agent^{107, 108} in conscious dogs, or after the section of the sciatic nerve or vagotomy in anaesthetized rats.¹⁰⁹

The humoral pathway involves the release of gastrin, β -endorphin and somatostatin (SS), in which endogenous opiates play an important role. Gastrin plays an important role in gastric acid secretion. Gastrin content was increased in G cell in the canine antrum with acupuncture, implicating an increased storage and a decreased release of gastrin in G cell.⁷⁴ Furthermore, acupuncture not only decreased the abnormally high number of G cells in patients with duodenal ulcer, but also increased the abnormally low number of G cells in patients with chronic atrophic gastritis.¹¹⁰ Jin *et al.* found that EA inhibited meal-stimulated acid secretion in dogs, which coincided with an increase in plasma SS and β -endorphin, as well as a decrease in plasma gastrin. Naloxone completely reversed the EA-induced inhibition of acid secretion and changes in plasma peptides. Exogenous SS inhibited acid output.¹¹¹

The neural and humoral pathways are interconnected, and vagal-mediated gastrin plays a key role in acid secretion. In rats, an elevation of plasma gastrin and SS with EA was abolished by vagotomy or atropine.¹¹²

Gastrointestinal motility

The effects of acupuncture on gastrointestinal motility also seemed to be mediated via the neural and humoral pathways. The neural pathway has been systematically studied. Acupuncture at lower extremities evokes an excitatory response – the afferent limb is composed of cutaneous and muscular afferent nerves of extremities, the efferent limb is the gastric vagal nerve, and reflex centre is not clear yet. Acupuncture at the face or abdomen elicits an inhibitory response – the afferent limb is composed of the facial or abdominal afferent nerve, the efferent limb is the gastric sympathetic nerve, and the reflex centre is the ventrolateral medulla (VLM). In anaesthetized rats, acupuncture at the abdomen inhibited gastric motility and acupuncture at hindpaw excited gastric motility, and these are reflex responses involving different neural pathways.¹¹³ Tada *et al.* proposed a somatosympathetic reflex for acupuncture-induced gastric relaxation. The reflex centre is within the medulla and the VLM neurones play an important role.¹¹⁴ However, little is known on the mechanisms involved with the excitatory effect of acupuncture on gastric motility.

The opioid pathway is involved with both stimulatory and inhibitory effects of acupuncture on gastric motility. Acupuncture at rat hindlimb induced phase III-like contractions, and naloxone shortened the duration of the stimulatory effect,⁷⁸ whereas the inhibition of motility in dogs was reversed by infusion of naloxone.⁷⁴

5-Hydroxytryptamine (5-HT) is known to play an important role in regulating gastric motility. Acupuncture at GV26 (Renzhong) inhibited antral motor activity in dogs, with a decrease of 5-HT in blood as well as an increase of 5-HT intensity in the enterochromaffin cell and the amount of the cell.¹¹⁵ With the normalization of rotation-induced gastric dysrhythmia with acupuncture in rabbits, 5-HT was decreased in serum and increased in antral tissue.¹¹⁶

In addition to gastric motility, Noguchi *et al.* also found, in rats, the inhibitory effect of duodenal motility elicited by acupuncture was via a spinal reflex response involving splanchnic nerves, and the excitatory response was a supraspinal reflex involving vagal nerves.¹¹⁷

DISCUSSION AND CONCLUSION

In this paper, we briefly introduced the methodology of acupuncture and systematically reviewed the effects and mechanisms of acupuncture in the treatment of FGIDs.

The FGIDs are very common in clinical gastroenterology. The prevalence of one or more FGIDs is estimated to be as high as 70% in general population^{118, 119} using Rome diagnostic criteria,¹²⁰ FGIDs reduce the quality of life¹²¹ and result in a significant economic burden¹²² on the health care system. Since FGIDs are diagnosed based on symptoms and the exact aetiologies for most of FGIDs are not completely known,¹²³ it is not unusual that the treatment for these disorders is unsatisfactory and alternative therapies are attractive to both patients and practitioners. Accordingly, it is of great clinical significance to explore the therapeutic potential of acupuncture for FGIDs.

The therapeutic role of acupuncture for various FGIDs or gastrointestinal motility disorders can be summarized as follows:

Proven efficacy of acupuncture

It seems conclusive that acupuncture is capable of reducing nausea and vomiting, inhibiting gastric acid secretion and normalizing gastric dysrhythmia. The therapeutic role of acupuncture for nausea and vomiting is well-established although there is a lack of convincing data in paediatric patients. Similarly, ample data are available, demonstrating a consistent inhibitory effect of acupuncture on gastric acid secretion. However, it is very likely but yet uncertain that acupuncture could be a viable therapy for GERD since there are little data in the literature. Because of the availability of non-invasive electrogastrigraphy, there have been sufficient data in the literature to indicate that acupuncture is effective in enhancing gastric slow waves in patients with motility disorders.

Potential applications of acupuncture with limited data

Acupuncture may have a great potential for gastroparesis as it has been shown to accelerate gastric emptying, restore impaired gastric accommodation and normalize gastric slow waves. However, more data are needed to further confirm this potential. Similarly, acupuncture may be used to treat patients with visceral hypersensitivity; yet, there are not sufficient data to make a final

conclusion. Alterations or regulation of gastrointestinal motility with acupuncture may be possible but there are not conclusive data, especially in humans.

Potential applications of acupuncture without sufficient data

It is anticipated that acupuncture may have a role in treating patients with functional dyspepsia or IBS. Despite a number of positive studies, there is a lack of well-designed and controlled studies to make any conclusions. It is well known that patients with functional dyspepsia or IBS respond to placebo-treatment and thus any studies investigating the efficacy of acupuncture in these groups of patients must be carefully designed and controlled. In the area of functional oesophageal disorders, there is little data on acupuncture except of a few studies with TENS.

Mechanisms of actions with acupuncture

For centuries and millennia, acupuncture were used empirically for treating various diseases and not necessarily considered as a real science. However, mechanistic studies performed during the past decades have provided scientific evidences and greatly facilitated its widespread applications. It is now known that the effects of acupuncture may be mediated via neural pathway, humoral pathway, opioid pathway and/or serotonic pathway.

In conclusion, the available data in the literature suggest a great potential of acupuncture in treating FGIDs or gastrointestinal motility disorders. Convincing data have become available in certain areas with acupuncture, such as treatment of nausea and vomiting. In general, more studies are needed to define the clinical roles of acupuncture in treating various disorders, such as functional dyspepsia and IBS.

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