



# Electroacupuncture decreases the urinary bladder pressure in patients with acute gastrointestinal injury

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**ABSTRACT.** The present study investigates the effects of electroacupuncture (EA) on urinary bladder pressure (UBP) in patients with acute gastrointestinal injury (AGI). Twenty patients with AGI admitted to the First Hospital of Jiaying intensive care unit from December 2011 to June 2013 were evaluated. Conventional group patients (n = 10) were administered moderate enteral nutritional support, and electroacupuncture group patients (n = 10) were administered enteral nutritional support followed by EA at bilateral Zusanli (ST-36), Shangjuxu (ST-37), Hegu (LI-4), and QuChi (LI-11) acupoints. UBP was then measured every 6 h and the serum creatinine once daily for 7 days. There were no statistically significant patient demographic differences in the study groups ( $P > 0.05$ ). The initial UBP of both patient groups was  $\geq 12$  mmHg. On days 6 and 7, the UBP significantly decreased in the EA group compared to the conventional group ( $P < 0.05$ ). The serum creatinine concentration on day 7 was significantly lower in the EA group than in the conventional group ( $P < 0.05$ ). Based on these

results, electroacupuncture contributed to gastrointestinal motility recovery in patients with AGI. This procedure may reduce UBP and provide organ-protective effects in AGI patients.

**Key words:** Electroacupuncture; Acute gastrointestinal injury; Urinary bladder pressure

## INTRODUCTION

Acute gastrointestinal injury (AGI) is frequently reported in the intensive care unit (ICU), affecting up to 62% of critically ill patients (Mutlu et al., 2001; Reintam et al., 2009). Gastrointestinal function is severely affected in the condition; AGI is frequently associated with acute pancreatitis and infectious peritonitis (Reintam Blaser et al., 2012). Evidence increasingly indicates that AGI is closely associated with a poor clinical outcome in critically ill patients (Lam et al., 2007; Reintam et al., 2008).

The steady-state abdominal cavity pressure, known as intra-abdominal pressure (IAP), ranges 0-5 mmHg and inversely varies with the intrathoracic pressure during normal respiration (Lee, 2012). Temporary IAP changes can be induced by numerous factors, including coughing, sneezing, and even loud singing. However, chronically increased IAP reportedly predisposes patients to various systemic disorders, and critically ill patients with persistent IAP elevation 12 mmHg or greater are at particular risk (Cheatham et al., 2007). To date, the ability of transurethral bladder catheter pressure to accurately reflect IAP is well defined (Yol et al., 1998). The procedure is also noninvasive, and thus, is commonly used clinically to measure IAP.

Electroacupuncture (EA), which electrically stimulates acupoints derived from traditional Chinese medicine theory, is commonly used in clinical practice, particularly in mainland China, but there are no clinical trials evaluating the procedure at present. The current study evaluates the potential efficacy of EA in alleviating elevated IAP in critically ill patients diagnosed with acute gastrointestinal injury.

## MATERIAL AND METHODS

### Patient information

In total, 20 patients diagnosed with AGI and admitted to the First Hospital of Jiaying ICU from December 2011 to June 2013 were included in this study. The inclusion criteria were as follows: aged  $\geq 18$  years; AGI secondary to acute pancreatitis and/or gastrointestinal perforation surgical repair; clinically confirmed abdominal distension; poor tolerance to enteral nutrition, typified by vomiting or gastric retention  $\geq 200$  mL at least once; and ICU hospitalization greater than 1 week. The exclusion criteria included: administration of other drugs without the investigator's permission; persistent hypotension  $\leq 90$  mmHg refractory to vasoactive agents; infectious dermatitis preventing administration of electroacupuncture; and a permanent cardiac pacemaker. Patients reporting severe adverse effects were also excluded. All patients provided written informed consent. This study was approved by the Ethics Committee of the First Hospital of Jiaying.

## Treatment

Patients were randomly assigned two study groups using a random number table, a conventional group (n = 10) and electroacupuncture group (n = 10). Investigators played no role in patient allocation. Patients in both groups received moderate enteral nutritional support and gastrointestinal promotility agents, such as enteroclytic rhubarb (20-30 g per day). Electroacupuncture was performed on the electroacupuncture group at the bilateral Zusanli (ST-36), Shangjuxu (ST-37), Hegu (LI-4), and QuChi (LI-11) acupoints using an electronic acupuncture instrument (Huato SDZIV, Suzhou Medical Appliance Factory, Suzhou, China) at a 5.0 Hz continuous wave and 2-5 V for 30 min once daily for 7 days.

## Urinary bladder pressure measurement

Urinary bladder pressure (UBP) was measured with a bladder pressure monitoring device (ABV300, Wolfe Tory Medical Inco., Salt Lake City, UT, China). Sodium chloride solution (0.9%) 25 mL was administered into the urinary bladder through a catheter, and pressure was measured every 6 h for 7 days with a sensor located at midaxilla.

## Serum creatinine measurement

Serum creatinine concentration was measured as previously described once daily for 7 days (Peake and Whiting, 2006).

## Statistical analysis

Data was analyzed with the SPSS 13.0 software and reported as means  $\pm$  standard deviation. Student *t*-test compared inter-group data at a statistical significance of  $P < 0.05$ .

## RESULTS

### Patient characteristics

Table 1 summarizes the patient demographics, including gender, age, APACHEII score, associated etiology, noradrenalin administration, and the bladder volume. No statistical demographic differences were observed in the experimental groups ( $P > 0.05$ ).

**Table 1.** Patient characteristics

	Conventional group	EA group
Gender		
Male (N)	7	8
Female (N)	3	2
Age (yrs)	61.3 $\pm$ 19.1	58.7 $\pm$ 18.4
APACHE II score	23.8 $\pm$ 7.6	24.9 $\pm$ 7.5
Inducing factors		
Acute pancreatitis (N)	5	5
Surgery of intestinal perforation (N)	5	4
Surgery of gastric perforation (N)		1
Noradrenalin (mg)	4.89 $\pm$ 4.54	4.60 $\pm$ 3.52
Input volume - output volume (mL)	3044.44 $\pm$ 2050.68	2920.00 $\pm$ 2023.09

EA = electroacupuncture.

## Comparison of daily UBP

The UBP of both experimental groups was normal ( $\geq 12$  mmHg) prior to therapy. The UBP significantly decreased in the EA group compared to the conventional group at days 6 and 7 ( $P < 0.05$ , Table 2).

**Table 2.** Urinary bladder pressure in experimental groups.

Group	Urinary bladder pressure (mmHg)							
	Baseline (mmHg)	D1 (mmHg)	D2 (mmHg)	D3 (mmHg)	D4 (mmHg)	D5 (mmHg)	D6 (mmHg)	D7 (mmHg)
Conventional group <sup>a</sup>	18.2 ± 2.80	18.1 ± 2.77	17.8 ± 2.94	16.6 ± 3.57	15.8 ± 4.08	15.4 ± 3.31	14.9 ± 3.73	14.1 ± 3.67
EA <sup>c</sup> group <sup>b</sup>	18.7 ± 3.28	18.5 ± 3.24	17.6 ± 2.80	15.8 ± 3.05	14.6 ± 3.66	13.2 ± 3.08	11.7 ± 2.58*	10.9 ± 2.28*
<i>t</i> value	0.265	0.297	-0.156	-0.539	-0.693	-1.539	-2.232	-2.344
<i>P</i> value	0.792	0.770	0.878	0.596	0.497	0.141	0.039	0.031

<sup>a</sup>Conventional group was administered moderate enteral nutrition support. <sup>b</sup>EA group was administered moderate enteral nutrition support followed by electroacupuncture once daily at bilateral ST-36, ST-37, LI-4, and LI-11 acupoints. <sup>c</sup>EA = electroacupuncture. \* $P < 0.05$ , compared to the conventional group.

## Serum creatinine concentration

Table 3 summarizes the daily serum creatinine concentrations. Compared to the conventional group, the serum creatinine was remarkably decreased in the EA group on day 7 ( $P < 0.05$ ).

**Table 3.** Daily serum creatinine concentration.

Group	Baseline ( $\mu$ M)	D1 ( $\mu$ M)	D2 ( $\mu$ M)	D3 ( $\mu$ M)	D4 ( $\mu$ M)	D5 ( $\mu$ M)	D6 ( $\mu$ M)	D7 ( $\mu$ M)
Conventional group <sup>a</sup>	101.1 ± 24.0	100.8 ± 23.9	107.5 ± 37.1	111.2 ± 40.3	112.5 ± 53.7	119.1 ± 74.3	113.2 ± 72.4	113.0 ± 68.8
EA <sup>c</sup> group <sup>b</sup>	103.4 ± 22.2	103.2 ± 22.3	112.0 ± 28.2	109.0 ± 38.8	107.1 ± 45.7	101.7 ± 37.2	92.3 ± 29.0	88.4 ± 17.5*
<i>t</i> value	0.226	0.232	0.305	-0.124	-0.242	-0.662	-0.847	-1.096
<i>P</i> value	0.958	0.956	0.786	0.585	0.427	0.142	0.127	0.049

<sup>a</sup>Conventional group was administered moderate enteral nutrition support. <sup>b</sup>EA group was administered moderate enteral nutrition support followed by electroacupuncture once daily at bilateral ST-36, ST-37, LI-4, and LI-11 acupoints. <sup>c</sup>EA = electroacupuncture. \* $P < 0.05$ , compared with conventional group.

## DISCUSSION

AGI is commonly reported in critically ill patients and the causes associated are numerous. Among the most frequently causes reported of AGI is intestinal hypoperfusion, ischemia, and anoxia, which activates xanthine oxidase, increases oxygen radical accumulation, injures the intestinal mucosa, reduces digestive enzymatic activity, and decreases gastrointestinal digestion and absorption. Another common cause is endotoxin and inflammatory cytokine release, which decrease intestinal absorption and oxygen utilization, ultimately impairing intestinal mucosal recovery. Decreased enteric nervous system activity and gastroenteric dyskinesia are also cited, as is intestinal bacteria proliferation, which causes an accumulation of bacteria in the intestinal wall, generates metabolites and toxins, and injures the intestinal mucosa. Finally, activation of intestinal antigen presenting cells, platelet activating factor and tumor necrosis factor release, and decreased mucosal barrier protection also contribute to AGI.

The clinical symptoms of AGI are primarily abdominal distension, gastric retention, poor tolerance to enteral nutrition, and death (Mutlu et al., 2001; Reintam et al., 2009); IAP is

considered an important index for gauging AGI severity. Generally, the normal IAP in humans is 5-7 mmHg, and a sharp IAP increase is associated with numerous conditions (De Keulenaer et al., 2009). For example, intra-abdominal hypertension (IAH) has been associated with an IAP  $\geq$  12 mmHg, while a higher risk of abdominal compartment syndrome (ACS) was reported in patients with an IAP  $\geq$  20 mmHg (Vidal et al., 2008). In a multicenter epidemiological study performed in 6 countries analyzing the IAH prevalence in the intensive care unit, Malbrain et al. (2004) reported that 57 critically ill patients (58.8%) were diagnosed with IAH and 8 (8.2%) with ACS. In a previous study, an IAP increase of up to 20 mmHg decreased the mesenteric perfusion by 40%, and an increase to 40 mmHg decreased the mesenteric perfusion by 70%; intestinal permeability portal vein endotoxin concentration both remarkably increased in response (Lee, 2012). A persistent IAP  $\geq$  15 mmHg is a reported independent risk factor for renal impairment. Acute IAP increase has been associated with respiratory, cardiovascular, and central nervous system disorders. Notably, IAP induced intra-abdominal hypertension has a well-known correlation to elevated mortality in critically ill patients.

Compared to manual acupuncture, electroacupuncture has several advantages such increased control and easier standardization, enabling stronger and continuous stimulation with less pain and tissue injury (Yeung et al., 2009). Electroacupuncture purportedly improves gastrointestinal function by enhancing gastrointestinal electric activity, increasing mucosa perfusion, and restoring immune and endocrine regulation. Under suitable electroacupuncture stimulation, functional disorders and metabolic disturbances may improve. In rats with reduced gastric mucosal blood flow (GMBF) caused by gastric mucosal injury, electroacupuncture performed at the Sibai (ST-2), Tianshu (ST-25), and Zusanli (ST-36) acupoints, GMBF increased after Sibai (ST-2) and Zusanli (ST-36) EA (Lin et al., 2003). A similar study evaluating EA in rabbits showed increased motilin and cholecystokinin concentrations in the smooth muscle, sphincter, and gastric antrum. In a randomized controlled trial investigating EA effects on critically ill patients with delayed gastric emptying (Chang et al., 2006), the gastric residual volume decreased from  $970 \pm 87$  mL to  $346 \pm 71$  mL ( $P = 0.003$ ) after EA stimulation (Pfab et al., 2011).

In our study, the UBP was greater than 12 mmHg in both groups, with no statistical difference ( $P > 0.05$ ). After EA treatment, the UBP significantly decreased in the EA group compared to the conventional group, specifically on days 6 and 7. In addition, on day 7, the serum creatinine in the EA group was significantly decreased compared to the conventional group. Collectively, these results demonstrate that EA contributed to gastrointestinal motility recovery in the critically ill patients. Electroacupuncture may also decrease the IAP, which may have protective effects for the organs.

### Conflicts of interest

The authors declare no conflict of interest.

### ACKNOWLEDGMENT

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