

Efficacy of acupoint massage combined with acupoint application on arterial blood gas in patients undergoing laparoscopic cholecystectomy

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Abstract: To explore efficacy of acupoint massage combined with acupoint application on arterial blood gas and postoperative complications for patients undergoing laparoscopic cholecystectomy. Patients undergoing laparoscopic cholecystectomy (LC) in general anesthesia condition were randomly enrolled from local hospital into control group and experimental group. Four acupuncture points were prepared for acupoint massage and acupoint application, including bilateral Hegu acupoint (LI4), Neiguan Point (PC6), Zusanli Point (ST36) and Tanzhong acupoint (CV17). All patients in experimental group were treated with point acupressure treatment combined with acupoint application before LC, while control group directly receive LC surgery. The peak inspiratory pressure (PIP), end-tidal CO₂ pressure (PETCO₂), oxygen saturation (SpO₂) and pH were examined at multiple time points during LC surgery. Related postoperative complications were documented for further analysis. All data were analyzed to assess efficacy of acupoint massage combined with acupoint application on arterial blood gas. There is no difference in baseline condition between experimental group and control group. Compared with control group, PetCO₂ and SpO₂ in experimental group were significantly increased while PIP was decreased. PH in experimental group ranged in a more stable domain. Hypercapnia and deep venous thrombosis were mitigated in experimental group compared with control group. Moreover, multiple pneumoperitoneum-related complications were alleviated after combined treatment, including pain and frequency of nausea and vomiting. Acupoint massage combined with acupoint application ameliorated related postoperative complications, and reduced side events of LC surgery via improving carbon dioxide metabolism.

Keywords: Acupoint massage, acupoint application, blood gas, laparoscopic cholecystectomy The NCT number of original study was NCT02096835.

INTRODUCTION

As the most sought-after traditional therapeutic in China, acupuncture treatment, also known as acupoint therapy, is proved with ideal efficacy as a complementary and alternative strategy (Mayberry, 2018). Clinical showed that appropriate acupoint therapy could significantly alleviated post-surgery pain (Niemtzow *et al.*, 2018). Moreover, acupoint therapy could improve multiple clinical events of post-surgery prognosis. For example, patients under P6 acustimulation had remarkable lower rates of post-operative nausea and vomiting (Antor *et al.*, 2014) and specific acupoint could alleviate postpartum anxiety via influencing plasma sex hormone level (Arvalho *et al.*, 2019). As for detailed therapeutic schedule of acupoint therapy, recent studies indicated that both acupoint massage and acupoint application had their specific advantages, while combination of acupoint massage with acupoint application not only improve clinical efficacy, but also made remedies to the disadvantages of both methods (Youssef *et al.*, 2014; Lu *et al.*, 2019; Ng *et al.*, 2016). Thus, combination of acupoint massage with acupoint application has been recommended as the preferred treatment for patients who

received acupoint therapy (Youssef *et al.*, 2014; Luo *et al.*, 2015).

Laparoscopic cholecystectomy (LC) is a common surgery for patients who suffered from gallbladder disease. Previous studied showed that clinical monitoring was essential for patients under LC and arterial blood gas is an effective predictive index to monitor prognosis after LC (Yao *et al.*, 2017). On the other hand, there are previous reports that LC could regulate arterial blood gasses via sympathetic nerve system, including pain stimulus, surgical stress and compensatory response (Kim *et al.*, 2019). In addition, recent clinical trials showed that it is of great clinical significance to maintain stability of arterial blood gas, and for patients under LC, normal arterial blood gas is associated with favourable prognosis (Yeoh *et al.*, 2016). Accordingly, novel therapy was warranted for regulating arterial blood gas of patients under LC. Moreover, acupoint therapy has been demonstrated with effect on hemodynamic condition (Lu *et al.*, 2019; Wang *et al.*, 2015). For example, it is proved that stimulating PC6 (Neiguan), CV12 (Zhongwan), ST36 (Zusanli) and LI4 (Hegu) could effectively prevent thrombus events after percutaneous coronary intervention (Wang *et al.*, 2015). Electro-acupuncture on PC6 (Neiguan) and ST36 (Zusanli) could be used to alleviate

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hemodynamic dysfunction related emesis. Based on multiple clinical studies, the combination of acupoint massage with acupoint application can also regulate hemodynamic condition, but it remains unclear that whether such combination therapy influenced post-LC hemodynamic condition. As an aspect of hemodynamic condition, arterial blood gas should be firstly explored.

Therefore, we propose a randomized, controlled trial to determine efficacy of acupoint massage combined with acupoint application on arterial blood gas in patients undergoing laparoscopic cholecystectomy. We aim to determine whether acupoint massage combined with acupoint application could improve prognosis after LC.

MATERIALS AND METHODS

Clinical objective

This study was aimed to: (1) explore the clinical efficacy and safety of combination of acupoint massage with acupoint application on patients undergoing LC; (2) examine the effect of combination of acupoint massage with acupoint application on arterial blood gas and postoperative prognosis.

Clinical patients Randomization and Recruitment

This study was approved by the ethic committee of Taizhou people's hospital, and all patients have written informed consent before participation. The randomization protocol and the CONSORT statement for the present study was previously reported in our last study (Li-Li *et al.*, 2016). The sample size was calculated with routine statistical formula ($n=C^2\sigma^2/p^2$) reported previously.

All patients were recruited from the Taizhou people's hospital in Jiangsu Province. This clinical trial started from April 2015 to April 2017. All patients signed informed consent, and registered number JSTZ20110314Q4 were included in our Serial Research No. 13. The present study was registered and approved by local Ethical Committee Ref. No.JSTZ20110314Q4. Baseline of two groups patients were adjusted before recruitment, including age, sex, body weight and BMI.

Clinical inclusion criteria

The following criteria were set according to suggestion of local academic board. The inclusion criteria were as follows: (1) Diagnosed with gallbladder disease. (2) Aging between 30 and 60 years old (for both sex). (3) No history of LC treatment or any kinds of biliary tract surgery. (4) No history of any kinds of acupoint therapy. (5) No obvious concomitant disease which could influence arterial blood gas (6) Life expectancy ≥ 5 years. (7) Willing to participate in the treatment of acupoint therapy.

Exclusion criteria

The exclusion criteria of this study were as follows: (1)

History of radiotherapy, chemotherapy or major surgery. (2) Severe pulmonary disease. (3) Kidney disease which could influence concentration of HCO_3 in blood. (4) Presence of tumor disease. (5) Active skin disease or infection which hampered acupoint therapy. (6) Unable to provide self-care or communicate, or have mental illness. (7) History of hypertension or peripheral vascular disease. (8) Pregnant or lactating.

Laparoscopic cholecystectomy and routine nursing

All patients in two groups received LC according to standard protocols of European Association for Endoscopic Surgery (Giménez *et al.*, 2018). All patients were treated with routine nursing, and drug therapy was performed with the same standard.

Experimental and control grouping

The acupoint therapy group (experimental group) received combination of acupoint massage with acupoint application three hours before anesthesia in LC surgery. Four acupuncture points were prepared for acupoint massage and acupoint application, including bilateral Hegu acupoint (LI4), Neiguan Point (PC6), Zusanli Point (st36) and Tanzhong acupoint (CV17), which were reported with the effect on arterial blood gas or sympathetic nerve (Li-Li *et al.*, 2016; Liu *et al.*, 2018).

Acupoint massage and acupoint application were performed according to standard protocols of World Federation of Acupuncture-Moxibustion Societies (Meng *et al.*, 2016). Acupoint massage was manually performed by experienced physician at specific acupoints. Every single time of acupoint massage was sustained with 10 minutes and repeated 3 times. After acupoint massage, acupressure application was subsequently performed with acupressure wristband at specific acupoints. Acupoint application was sustained with 30 minutes. Routine postoperative care was also performed for acupoint therapy group.

All patients in control group were treated with routine postoperative care without any kinds of acupoint therapy. There are 49 patients in experimental group and 49 patients in control group. Sample size calculation or power analyze were performed with routine protocols described in our previous study (Li-Li *et al.*, 2016).

Primary outcome measures

The primary outcome measures are as follows:

- (1) Index of arterial blood gas, including pH value, carbon dioxide pressure, oxygen pressure, total carbon dioxide and oxygen saturation.
- (2) Postoperative complications

Frequency of nausea and vomiting: total nausea and vomiting episodes per person over the 6-day study period will be recorded. We have recorded the total number of

nausea and vomiting after LC for 6 days, and evaluated these episodes according to routine nursing record. Grading of nausea and vomiting: nausea and vomiting will be graded by Common Terminology Criteria for Adverse Events Version 4.0 (Li-Li Zhang, *et al.*, 2016).

Postoperative pain: including shoulder, season rib and lower extremities.

Bile leakage and abdominal infection: Diagnosis follows the standards of European Association for Endoscopic Surgery.

Hypercapnia: Diagnosis follows the standards of European Association for Endoscopic Surgery.

Deep venous thrombosis: Diagnosis follows the standards of European Association for Endoscopic Surgery.

STATISTICAL ANALYSIS

Statistical analysis was blinded performed by professionals from the allocation of study grouping with SPSS 18.0. The Kruskal-Wallis test was performed for the analysis of skewed distribution data. Chi-square analysis was performed for categorical variables, and Analysis of variance (ANOVA) for numerical variables. Repeated measures (Kruskal-Wallis test, Chi-square analysis and ANOVA) analysis was performed by different statisticians. $P < 0.05$ was regarded as statistically significance.

RESULTS

Demographic data and risk faktors

As showed in table 1, we assessed multiple variables of baseline condition in control group and experimental group, including sex ratio, age, weight and BMI. As for baseline condition, there was no significance difference in two groups, suggesting no extra factors could influence post-operational prognosis in further experiment.

Hemodynamic Changes: Combination of acupoint massage with acupoint application improve blood gas index

We further assessed multiple blood gas index during different time points in LC surgery. Statistical analysis showed that combination acupoint therapy did not influence preoperative blood gas index compared with control group. However, in the first 5 minutes of LC, experimental group has a more stable PH value (7.39 ± 0.04 vs 7.49 ± 0.13 , $P < 0.05$), despite there were no other different in other blood gas index. In the 15 minutes of LC, experimental group has a more stable PH value (7.41 ± 0.03 vs 7.47 ± 0.15 , $P < 0.05$) and $PetCO_2$ and SpO_2 in experimental group were significantly increased while PIP was decreased ($P < 0.05$). Moreover, such effects on blood gas index in experimental group were maintained to the end of LC surgery. Related data were showed in table 2 to table 5.

Postoperative Complications: Combination acupoint therapy alleviated the postoperative complications

To explore blood-gas-regulating effect of combination acupoint therapy on LC prognosis, postoperative complications were assessed in two groups. As showed in table 6, hypercapnia and deep venous thrombosis were mitigated in experimental group compared with control group (hypercapnia: 6 vs 13; deep venous thrombosis: 5 vs 11, $P < 0.05$). Moreover, frequency of nausea and vomiting were significantly decreased after combination acupoint therapy ($11/49$ vs $25/49$, $P < 0.05$), and postoperative pain cases were reported to be reduced in experimental group ($7/49$ vs $23/49$, $P < 0.05$).

DISCUSSION

Our study proved that acupoint massage combined with acupoint application was an ideal therapy to maintain intraoperative blood gas homeostasis, and such combined therapy improve postoperative prognosis for patients undergoing LC.

Acupoint massage and acupoint application were reported with efficacy on surgery, respectively. For example, acupoint massage could alleviated intraoperative pain for patients undergoing dental operation, suggesting acupuncture analgesia could be a technical adjunct to pain control in patients with acute dental pain, contributing to the restoration of health with social benefit (Grillo *et al.*, 2014) and acupoint application improved postoperative prognosis for many kinds of surgery, including appendectomy, pneumonectomy and lung cancer surgery (Lu *et al.*, 2019; Ng *et al.*, 2016; Li *et al.*, 2017). Previous study indicated acupoint massage mainly perform intraoperative effect, while acupoint application influenced postoperative prognosis (Wildes *et al.*, Mehta *et al.*, 2015). Intriguingly, a latest study showed that auricular point sticking combined with acupoint application therapy can effectively decrease the incidence of postoperative constipation on the basis of routine measures to prevent constipation after lung cancer surgery (Rozenfeld *et al.*, 2016). However, there was no report on combination of acupoint massage and acupoint application in Laparoscopic cholecystectomy.

Laparoscopic cholecystectomy was a surgery which is reported with suitable condition for acupoint therapy (Fathy *et al.*, 2019), and the main aim of acupoint therapy is to improve blood gas. Patients undergoing LC must receive anesthesia, which is responsible for blood gas changes. On the other hand, anesthesia in LC need a stable blood gas condition for better surgery performance. Moreover, previous clinical trials showed that intraoperative blood gas was associated with postoperative complications (Akbarzade *et al.*, 2016). Thus, we assessed intraoperative blood gas changes and postoperative complications with or without combination of acupoint massage and acupoint application.

Table 1: Variables of baseline condition in experimental and control groups

Grouping	N	Male/Female	Age(years)	Weight(kg)	BMI(kg/m ²)
Experimental	49	26/23	49.3±12.6	62.5±10.6	24.2±3.4
Control	49	26/23	51.1±10.4	61.5±8.6	23.8±3.5

Table 2: PH value in experimental and control groups

Grouping	Preoperative	5 minutes	15 minutes	the end of LC
Experimental	7.37±0.03	7.39±0.04*	7.41±0.03*	7.40±0.05*
Control	7.36±0.05	7.47±0.14	7.46±0.13	7.45±0.08

LC, laparoscopic cholecystectomy. *P<0.05 vs control group.

Table 3: PetCO₂ value in experimental and control groups

Grouping	Preoperative	5 minutes	15 minutes	the end of LC
Experimental	42.3±1.5	41.7±1.7	44.7±2.7*	43.3±1.9*
Control	41.9±1.3	41.3±1.4	40.9±0.9	41.1±1.4

Unit of measurement, mmHg. LC, laparoscopic cholecystectomy. *P<0.05 vs control group

Table 4: SpO₂ value in experimental and control groups

Grouping	Preoperative	5 minutes	15 minutes	the end of LC
Experimental	97.3±1.3%	95.1±0.8%	96.9±1.1%*	97.4±1.0 %*
Control	98.1±0.7%	96.2±0.6%	95.1±0.4%	95.2±0.7%

LC, laparoscopic cholecystectomy. *P<0.05 vs control group

Table 5: PIP value in experimental and control groups

Grouping	Preoperative	5 minutes	15 minutes	the end of LC
Experimental	40.4±1.3	45.6±2.7	41.1±1.3*	40.1±0.4*
Control	40.2±0.9	47.2±2.9	45.5±1.1	43.2±0.9

Unit of measurement, mmH₂O. LC, laparoscopic cholecystectomy. *P<0.05 vs control group

Table 6: Postoperative complications in experimental and control groups

Grouping	Experimental	Control
Total number after LC	49	49
Nausea and vomiting	11*	24
Postoperative pain	7*	23
Severe postoperative complications		
Hypercapnia	6*	13
Deep venous thrombosis	5*	11

*P<0.05 vs control group

We found that combination of acupoint massage and acupoint application mainly maintained PH value at a stable level at the starting 5 minutes for patients undergoing LC. What's more, as operation time goes by, combination of acupoint massage and acupoint application increased PetCO₂ and SpO₂, suggesting blood gas condition was improved. PetCO₂ and SpO₂ are two important factors for LC surgery. It has been proved that increased PetCO₂ and SpO₂ directly improved cardio-pulmonary function (Akbarzadeh *et al.*, 2014). We also assessed lung compliance via PIP examination, and found that combination of acupoint massage and acupoint application improved lung compliance, verified by

decreased PIP. This data indicated that combination acupoint therapy could improve pulmonary function via more complicated mechanisms, such as regulating pulmonary function.

Postoperative complications were also examined in our study, and combination acupoint therapy was proved with ideal effect on reducing multiple postoperative complications. Hypercapnia and deep venous thrombosis are two severe postoperative complications for LC surgery, and was proved to be associated with cardio-pulmonary function of patients. We found that hypercapnia and deep venous thrombosis events were decreased in experimental

group, and such phenomenon could be explained by PetCO₂ increasing effect of combination acupoint therapy. The patients undergoing combination acupoint therapy had a more positive and normal carbon dioxide metabolism. Besides, some other postoperative complications were also mitigated in experimental groups. We postulated that combination acupoint therapy might have more effects on neuron system in LC, verified by decreased postoperative pain and alleviated nausea/vomiting events. Intriguingly, some experiment showed that acupoint indeed improve neuron function in many pathological events, including cerebral infarction and diabetes (Shu *et al.*, 2016).

Study limitation

(1) CO₂ gas insufflation and even the insufflation pressure may also influence the condition of patients and insufflation pressure could influence frequency of postoperative complications. However, our study could not analyze robust data about these diagnostic indicators due to data collection limitation. Further study should be focused on acupoint therapy on CO₂ gas insufflation and the insufflation pressure. (2) We have not recorded adequate data of pneumoperitoneum pressure rate, which might influence DVT events.

CONCLUSION

Acupoint massage combined with acupoint application ameliorated related postoperative complications and reduced side events of LC surgery via improving carbon dioxide metabolism.

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