

Original Article

Potential Role of Acupoint Thread-Embedding to Enhance Recovery in Patients Undergoing Pulmonary Lobectomy

Xichun Xing, Dengming Zhao, Yihong Li, and Wenzhi Li

ABSTRACT

Background: Thoracic surgery is associated with marked impairment of pulmonary function and severe postoperative pain, which can increase the incidence of postoperative complications and adversely affect recovery after surgery. The purpose of this study was to investigate whether acupoint thread-embedding can play a beneficial effect for patients undergoing pulmonary lobectomy and enhance postoperative recovery.

Methods: A total of fifty patients, ASA I or II, undergoing pulmonary lobectomy were randomly divided into the thread-embedding group (group TE) or control group (group C). One day prior to surgery, patients in the group TE received minimally invasive acupoint thread-embedding. While patients in the group C did not receive any intervention. Visual analog score (VAS) in resting state and Bruggemann comfort scale (BCS) were evaluated after surgery. Blood samples were collected to determine the plasma levels of inflammatory factors before surgery, 10 minutes after finishing one-lung ventilation (OLV), 24 and 72 hours after surgery. The postoperative hospital stay was recorded. Meanwhile, postoperative complications were observed during the follow-up period.

Results: The patients in the group TE exhibited significantly lower VAS from 2 hours after surgery, and at 48 hours after surgery the VAS in the group TE was still much lower compared with the group C ($P < 0.05$). Meanwhile, the BCS of patients in the group TE was higher than that in the group C ($P < 0.05$). The IL-6 levels in the two groups increased after finishing OLV, and reached the peak levels at 24 hours after surgery. However, IL-6 levels in the group TE decreased significantly compared to the group C at 72 hours after surgery ($P < 0.05$). At 24 hours after surgery 2 cases of patients in the group C developed hypoxemia (pulse oximetry $< 90\%$). However, no patient in the group TE developed hypoxemia. The postoperative hospital stay in the group TE was shorter than that in the group C ($P < 0.05$).

Conclusion: The results of the study showed that acupoint thread-embedding can play a beneficial role for patients undergoing pulmonary lobectomy and enhance postoperative recovery. (Funded by the Second Affiliated Hospital of Harbin Medical University; Chinese Clinical Trial Registry (ChiCTR) number, ChiCTR-INR-16007922.)

From the Department of Anesthesiology, The Second Affiliated Hospital of Harbin Medical University, Heilongjiang Key Laboratory of Anesthesiology and Intensive Care Research & Key Laboratory for Basic Theory and Application of Anesthesiology of the Heilongjiang Higher Education Institution, Harbin, China.

Correspondence to Dr. Wenzhi Li at wenzhili9@126.com.

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Thoracic surgery is associated with marked impairment of pulmonary function and severe postoperative pain, which can increase the incidence of postoperative complications and adversely affect recovery after surgery (1, 2). Therefore, an effective complementary treatment is needed to enhance postoperative recovery in patients undergoing pulmonary lobectomy.

Acupuncture is an important part of ancient Chinese medicine that can be traced back almost 3000 years. This ancient Chinese intervention consists of applying pressure, needling, heat, and electrical stimulation to specific points in the body to restore the patients to good health (3-5). The mechanism can be understood as the adjustment of the flow of “vital energy” known as “Qi”, that is believed to circulate in a network of 12 primary channels called meridians (3, 6). These meridians bring “Qi” from the internal organs to the skin surface. Along these meridians, there are acupuncture points that can be stimulated (3). Because the mechanism of acupuncture cannot be explained by western medicine, acupuncture was not accepted by western countries until 1997 when the National Institutes of Health (NIH) supported the efficacy of acupuncture for specific conditions, such as pain, nausea, and vomiting, based on the results of well-designed and appropriately controlled clinical trials (7). In 1998, acupuncture became the most popular complementary and alternative medicine modality prescribed by western physicians (8). In 1999, the National Center for Complementary and Alternative Medicine was established within NIH. At present, acupuncture has been widely used to treat many different symptoms and diseases, such as acute infection and inflammation, pain, dysfunction of autonomic nervous system, peripheral and central nervous system disease and heart disease (9-13). Moreover, dysfunction of the respiratory system can also be improved by acupuncture (14). Acupuncture is capable of improving symptoms of Chronic obstructive pulmonary disease (COPD) (15, 16). The previous study has demonstrated that acupuncture could be an effective approach for improving shortness of breath and well-being in patients with lung cancer (17). Acupuncture has regulatory effects on mucosal and cellular immunity in patients with allergic asthma

and could be an adjunctive therapy for allergic asthma (18, 19).

Acupoint thread-embedding is a special type of acupuncture. By the continuous stimulation to the acupoint, acupoint thread-embedding can generate a much more long-lasting and steady-going effect than traditional acupuncture and electro-acupuncture. In view of the analgesia and beneficial effect on the respiratory system of acupuncture, we made a hypothesis that acupoint thread-embedding can potentially offer some beneficial effects for patients undergoing pulmonary lobectomy and enhance postoperative recovery.

A large number of studies indicate that Danzhong (CV17) and Zhongwan (CV12) in the conception vessel, Dingchuan (EX-B1) in the extra nerve points, Feishu (BL13) in the bladder meridian, Neiguan (PC6) in the pericardium meridian, Hegu (LI4) in the large intestine meridian, and Zusanli (ST36) in the stomach meridian are helpful in analgesia, anti-inflammation, expectoration and bronchodilation (15-20). Therefore, we selected the above-mentioned acupoints to investigate the effect of acupoint thread-embedding on patients' recovery after pulmonary lobectomy.

METHODS

Patients and Groups

This randomized, parallel-group controlled trial was approved by the Ethics Committee of Second affiliated Hospital of Harbin Medical University. Written informed consents were obtained before the study.

A total of fifty patients, ASA I or II, undergoing pulmonary lobectomy were randomly divided into thread-embedding group (group TE) and control group (group C). One day prior to surgery, patients in the group TE received minimally invasive acupoint thread-embedding at Danzhong (CV17) and Zhongwan (CV12), and bilateral acupoints of Dingchuan (EX-B1), Feishu (BL13), Neiguan (PC6), Hegu (LI4), and Zusanli (ST36). While patients in the group C did not receive any intervention. Exclusion criteria included following items: age > 70 years; abnormal blood coagulation; local infection at acupoints; severe systemic disease; duration of surgery > 3

hours; lobe resection ≥ 2 ; blood transfusion.

Minimally Invasive Acupoint Thread-embedding
Before acupoint thread-embedding, compound lidocaine cream was applied at each acupoint and kept at least 30 minutes to avoid the pain or discomfort. Then minimally invasive technology was applied to perform the acupoint thread-embedding by a chartered anesthesiologist with disposable embedding needle (Shanghai Yatai Medical Instrument Co., Ltd., China) and absorbable surgical suture (Shanghai Tianqing Bio-materials Co., Ltd., China). When the needle was inserted in the proper direction and depth, the sensation of “De-Qi” appeared. Then a 1 cm thread was injected into the acupoint.

Anesthesia and Analgesia

In the operation room, standard monitoring included continuous electrocardiography, invasive blood pressure, pulse oximetry, and end-tidal carbon dioxide partial pressure (PETCO₂). General anesthesia was induced with midazolam (0.05 mg/kg), sufentanil (0.4 μ g/kg), vecuronium (0.1 mg/kg), lidocaine (1 mg/kg), and propofol (2 mg/kg). After confirming the position of the double-lumen endotracheal tube, mechanical ventilation was initiated in the volume-controlled mode. Tidal volume of 8 ml/kg with a positive end-expiratory pressure of 5mmHg was used, with the rate adjusted to maintain PETCO₂ between 35 and 45mmHg. Maintenance of anesthesia was performed with sevoflurane (1.5-2%) and remifentanil (0.20-0.25 μ g \cdot kg⁻¹ \cdot min⁻¹). The vecuronium (0.03mg/kg) was administered when needed.

At the end of surgery, intercostal nerve block with a 15ml compound of 1% lidocaine and 0.5% ropivacaine combined with intravenous injection of flurbiprofen axetil (100 mg) were applied to control postoperative pain. Meanwhile, flurbiprofen axetil (50 mg) was administered twice a day for 3 days. When visual analog score (VAS) was higher than 6, morphine (5-8 mg) was administered intramuscularly.

Clinical and Laboratory Evaluation

During the perioperative period, the vital signs were recorded. At the end of surgery, and 2, 4, 24, 48 and 72 hours after surgery VAS in resting

Table 1. The Demographics of the Patients and the General Information During Surgery.

Characteristic	Group TE (n = 21)	Group C (n = 23)
Male gender (%)	10 (47.61)	13 (52.17)
Age (years)	59.67 \pm 6.87	58.61 \pm 9.1
ASA	2 (1-2)	2 (1-2)
BMI (kg/m ²)	23.5 \pm 3.57	23.59 \pm 4.16
Duration of anesthesia (min)	158.43 \pm 41.06	184.3 \pm 47.19
Duration of surgery (min)	128 \pm 39.49	155.7 \pm 46.27
Duration of OLV (min)	108.71 \pm 36.15	133.61 \pm 46.97
Volume of transfusion (ml)	1023.81 \pm 246.79	1178.26 \pm 284.78
Volume of fluid loss (ml)	400 (300-690)	550 (350-850)

state was used to evaluate patient pain. At 24, 48 and 72 hours after surgery, Bruggemann comfort scale (BCS) was also evaluated. Blood samples were collected to determine the plasma levels of inflammatory biomarkers before surgery, 10 minutes after finishing one-lung ventilation (OLV), 24 and 72 hours after surgery. The plasma levels of inflammatory biomarkers were analyzed using ELISA kits (Boster Biological Technology, Wuhan, China) according to the manufacturer's instructions. Meanwhile, postoperative complications were observed during the follow-up period, and the postoperative hospital stay was recorded.

Statistical Analysis

Measurement data are presented as mean \pm SD or M (P25-P75), and enumeration data are presented as N (%). All analyses were performed using the SAS software, version 9.3 (SAS Institute, USA). Comparisons of normal distribution data were made using Student's t-test and non-normal distribution data were made using rank sum test. Repeated measures data were compared using a mixed-effect model followed by Bonferroni's tests. P value < 0.05 was considered significant.

RESULTS

We excluded 6 cases of patients in this study, including 2 patients whose duration of surgery was longer than 3 hours, 1 case of blood transfusion during surgery, and 3 patients who refused the collection of blood samples postoperatively.

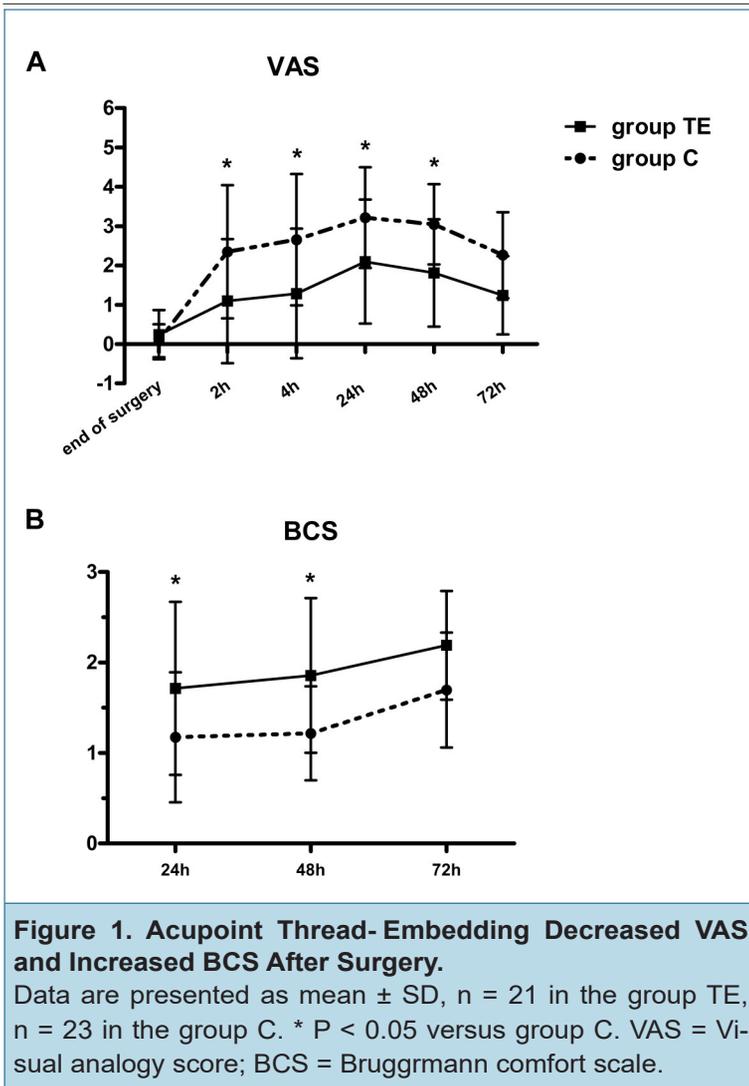


Table 2. Comparison of Postoperative Hospital Stay.

Group	Postoperative hospital stay (days)
Group TE	8 (6.5-8.5)*
Group C	9 (8-13)

Data are presented as M (P25-P75), * P < 0.05 versus group C

gery. However, IL-6 levels in the group TE decreased significantly compared to the group C at 72 hours after surgery. The difference between the two groups was significant (P < 0.05).

At 24 hours after surgery 2 cases of patients in the group C developed hypoxemia (pulse oximetry <90%), which was managed by supplemental oxygen. No patient needed re-intubation. However, no patient in the group TE suffered from hypoxemia. There was no other severe postoperative complications observed in both groups during the follow-up period. The postoperative hospital stay of patients in the group TE was shorter than that in the group C (P < 0.05) (Table 2).

DISCUSSIONS

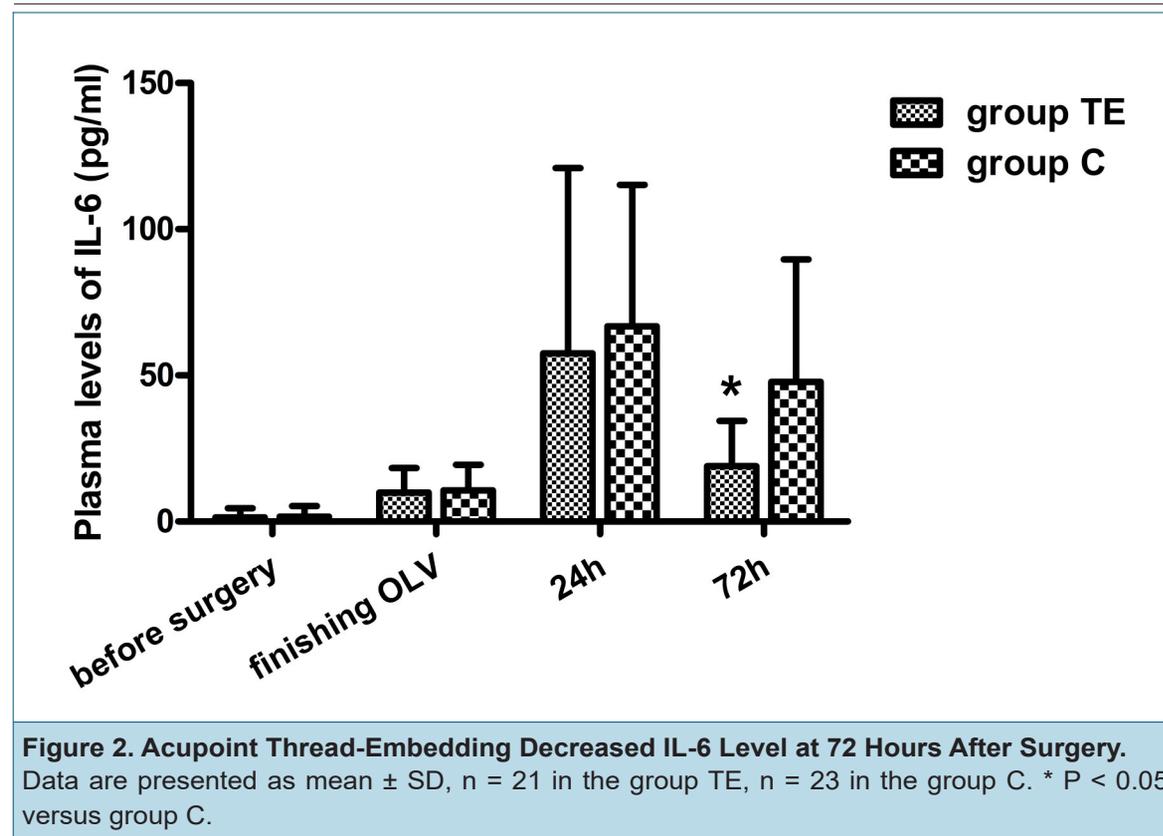
The results of the study showed that acupoint thread-embedding relieved the postoperative pain and improved comfortable levels of patients undergoing pulmonary lobectomy. The alleviation of a systemic inflammatory response by acupoint thread-embedding might also participate in enhancing recovery after surgery.

Postoperative pain after pulmonary lobectomy is one of important risk factors that increase the incidence of postoperative pulmonary complications (1, 2). Patients who suffer from severe postoperative pain usually have difficulty in breathing, coughing, and expectorating. And early ambulation can only be achieved in patients without pain (21). Therefore, effective analgesia could potentially prevent the postoperative impairment of respiratory function and improve the outcome of these patients. Acupuncture is an effective non-pharmacological method for pain control. It has been used for many clinical conditions, such as cancer pain, neuropathic pain and

Finally, 21 patients in the group TE and 23 patients in the group C finished the whole study. The demographics of the patients and the general information during surgery were presented in table 1.

The patients in the group TE exhibited significantly lower VAS scores from 2 hours and at 48 hours postoperatively than group C (P < 0.05, Figure 1A). Meanwhile, the BCS of patients in the group TE was higher than that in the group C (P < 0.05) (Figure 1B).

As shown in Figure 2, the IL-6 levels in the two groups increased after finishing OLV, and reached the peak levels at 24 hours after sur-



acute postoperative pain (22-28). In this study, we applied minimally invasive acupoint thread-embedding preoperatively to see its impact on VAS and BCS. It is a special type of acupuncture. The thread is 1 cm long and can be absorbed after 7 days. Therefore, the stimulation of the thread to the acupoint can maintain for about 7 days. Our study showed that patients who received acupoint thread-embedding still had relatively lower VAS and better comfortable levels at 72 hours after surgery.

Previous clinical and experimental studies showed that the analgesic mechanism of acupuncture is related to a sequence of events involving the release of neurotransmitters, endogenous opioid-like substances and adenosine. Imaging studies demonstrate that the limbic system plays an important role in acupuncture-induced analgesia (3). However, in addition to the limbic system, the hypothalamus, the pituitary gland, and the autonomic nervous system can also be modulated by acupuncture, leading to a range of

changes in the neuroendocrine system (29, 30). Consequently, many physiological dysfunctions and severe diseases can potentially be prevented or treated by acupuncture (9- 19). Studies showed that the inflammatory response is an important part of the development of different diseases, and alleviation of inflammation is one of the mechanisms of acupuncture (9, 31, 32). IL-6 is a vital pro-inflammatory cytokine and commonly used to reflect the level of inflammatory response. In our study, the acupoint thread-embedding significantly decreased the plasma level of IL-6 at 72h after surgery, which might result in the shorter postoperative hospital stay and the faster recovery. Similar to our study, Zhou J et al. found that a combined acupuncture-analgesics strategy reduced the postoperative hospital stay and the postoperative morbidity in patients undergoing open heart surgery with cardiopulmonary bypass (33). In this study, no patient received the acupoint thread-embedding developed postoperative hypoxemia. However, there

was no statistical difference in postoperative complications, which might be associated with the relatively small sample size.

Currently, enhanced recovery after surgery has been a goal sought by domestic and foreign medical communities (21, 34, 35). In addition to postoperative pain, patients may experience feelings of nervousness and anxiety, nausea and vomiting, fatigue and sleep disturbances during the perioperative period (36, 37). All of these are detrimental to postoperative recovery, and can be controlled by acupuncture (38- 41). Hence, acupuncture has potential to become an effective complementary treatment for enhanced recovery after surgery (42-45). Acupoint thread-embedding possesses a long-lasting effect, avoiding repeated needling. It can be well accepted by patients undergoing surgery. Therefore, acupoint thread-embedding has great advantages in practicability compared with traditional acupuncture.

In summary, acupoint thread-embedding ex-

erts a beneficial effect for patients undergoing pulmonary lobectomy and it can potentially be a component to the protocol of enhanced recovery after surgery. There are several limitations in our study. Firstly, the sample size is relatively small. Secondly, this study is not a double-blinded one. Thirdly, we did not evaluate the postoperative pulmonary function. In the future, a large-scale randomized controlled trial is needed to confirm the beneficial effects of acupoint thread-embedding in patients undergoing pulmonary lobectomy and/or other surgical procedures.

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