Ultrasound-Guided Thoracic Paravertebral Block in Thoracoscopic Sympathectomy: Post-print

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Abstract

Objective: To investigate the safety and efficacy of ultrasound-guided thoracic paravertebral nerve block in thoracoscopic thoracic sympathectomy. Methods: 120 patients with moderate to severe hyperhidrosis were randomly divided into an ultrasound-guided thoracic paravertebral nerve block group (Group A) and an endotracheal intubation general anesthesia group (Group B) using a random number method, with 60 cases in each group. Both groups underwent routine monitoring and radial artery cannulation for invasive blood pressure monitoring upon entering the operating room. Group A received only nasal cannula oxygen after thoracic paravertebral nerve block; Group B underwent surgery under routine endotracheal intubation general anesthesia. Both groups underwent arterial blood gas analysis before surgery and at 5 min after surgery, and clinical outcomes and complications were recorded. Results: Both groups completed the surgery successfully, with no cases in Group A converted to endotracheal intubation general anesthesia. There were statistically significant differences between Group A and Group B in anesthesia preparation time (15.46±8.32 min vs 35.65±11.12 min), time to awakening and leaving the operating room (6.26±2.09 min vs46.32±15.76 min), and hospitalization cost (6355.54±426.00 yuan vs 8932.25±725.98 yuan) ($P<0.05$). Group A was superior to the endotracheal intubation general anesthesia group in postoperative throat discomfort (0% vs 100%), postoperative monitoring time (2 h vs 12 h), and postoperative feeding time (2 h vs 6 h). Preoperatively, there were no differences in blood gas analysis parameters between the two groups; postoperatively, blood PH, PaCO 2, and PaO 2 showed no significant changes; compared with preoperative values, blood PaCO 2 increased and PH decreased in both groups, with statistically significant differences between the two groups, while PaO 2 showed no significant change. Conclusion: Ultrasound-guided thoracic paravertebral nerve block

applied in thoracoscopic thoracic sympathetic ganglionectomy is safe, effective, has fewer complications, and promotes patient recovery.

Full Text

Abstract

Objective: To explore the anesthetic effect and safety of ultrasound-guided thoracic paravertebral blockade in video-assisted thoracoscopic sympathectomy for treatment of palmar hyperhidrosis. **Methods**: A total of 120 patients undergoing video-assisted thoracoscopic sympathectomy for moderate or severe hyperhidrosis were randomized to receive ultrasound-guided thoracic paravertebral blockade (group A, n=60) or general anesthesia with tracheal intubation (group B, n=60). In both groups routine monitoring and radial artery catheterization were used. The patients in group A were given oxygen inhalation via a nasal tube after thoracic paravertebral blockade, and those in group B had intratracheal intubation. Blood gas analyses were conducted 5 min before and 5 min after the operation and the clinical outcomes and complications were recorded in each group. **Results**: All the patients completed the operations safely and none of the patients with thoracic paravertebral blockade required conversion to general anesthesia. Significant differences were recorded between groups A and B in anesthetic preparation time (6.26 ± 2.09 vs 46.32 ± 15.76 min), awakening time (6.26 ± 2.09 vs 46.32 ± 15.76 min), and mean hospitalization expense (6355.54±426.00 vs 8932.25±725.98 RMB Yuan). Compared with those in group B, the patients in group A showed a significantly lower rate of postoperative throat discomfort (0% vs 100%), a shorter monitoring time (2 h vs 12 h), and faster recovery time for food intake (2 h vs 6 h). The parameters of artery blood gas analysis both before and after the operation were similar between the two groups, but the postoperative variations differed significantly between the two groups in pH value and PaCO2 but not in PaO2. **Conclusion**: Ultrasound-guided thoracic paravertebral blockade is safe and effective in video-assisted thoracoscopic sympathectomy for palmar hyperhidrosis and is associated with less complications and better postoperative recovery.

Key words: ultrasound; thoracic paravertebral blockade; sympathectomy with video-assisted thoracic surgery; tracheal intubation; fast-track surgery

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Hyperhidrosis is a condition characterized by persistently moist skin caused by hyperactive sympathetic function, which severely impacts patients' quality of life [1]. Currently, the standard clinical treatment is bilateral thoracic sympathetic transection via single-port thoracoscopic surgery under general anesthesia [2]. Although most hyperhidrosis surgeries abroad are performed as outpatient procedures, they still rely on general anesthesia [3]. However, conventional general anesthesia leads to increased respiratory secretions and a range of postoperative issues including throat discomfort, nausea, vomiting, and delayed recovery [4].

In 2010, Jeong [5] reported a method using local anesthesia in three cases, which required percutaneous infiltration anesthesia from the back to the thoracic sympathetic trunk. This approach suffered from inaccurate positioning, uncertain anesthetic effect, and numerous complications, making it difficult to popularize. Ultrasound-guided nerve blockade has become increasingly widely used in clinical anesthesia due to its visualization, safety, efficiency, and low complication rate [6]. Meanwhile, with the development of fast-track surgery concepts, anesthesiologists have placed greater emphasis on reducing anesthetic complications and promoting rapid patient recovery [7]. To date, no reports have described the application of ultrasound-guided thoracic paravertebral blockade in thoracoscopic sympathetic transection for hyperhidrosis. Since 2013, our hospital has attempted to apply ultrasound-guided thoracic paravertebral blockade in thoracoscopic sympathetic transection for hyperhidrosis based on fast-track surgery principles, achieving rapid postoperative recovery and excellent therapeutic outcomes. We report our findings below.

1.1 General Data

We prospectively and consecutively enrolled patients with moderate to severe hyperhidrosis who underwent thoracoscopic thoracic sympathetic transection at Guangdong General Hospital between May 2013 and May 2016. Inclusion criteria were: age 16–35 years, no heart disease, and voluntary participation with signed informed consent. Exclusion criteria included: dementia, psychiatric disorders, or other central nervous system diseases; coagulation dysfunction; current use of anticoagulant medication; cardiopulmonary disease; severe cardiovascular, respiratory, hepatic, or renal system diseases; and body mass index (BMI) >30 kg/m². This study included 120 patients with moderate to severe hyperhidrosis (78 males and 42 females) with a mean body weight of 57.32±12.22 kg. According to the American Society of Anesthesiologists (ASA) classification and using SPSS 19.0 software to generate a random number sequence, patients were divided into an ultrasound-guided thoracic paravertebral blockade group (Group A, n=60) and a general anesthesia with tracheal intubation group (Group B, n=60). Group A comprised 38 males and 22 females with a mean age of 21.32±5.71 years, while Group B comprised 40 males and 20 females with a mean age of 22.56±6.58 years. There were no statistically significant differences in baseline characteristics between the two groups. All patients underwent routine preoperative blood tests, coagulation studies, electrocardiography, and chest radiography, all of which were normal. No patients had prior medical histories or surgical histories. After being informed of the advantages and disadvantages of both ultrasound-guided thoracic paravertebral blockade and general anesthesia with tracheal intubation, all patients signed informed consent forms.

1.2.1 Anesthesia Method

Upon entering the operating room, all patients in both groups received standard anesthetic monitoring with continuous electrocardiography, pulse rate, and pulse oximetry. Radial artery catheterization was performed for invasive blood pressure monitoring. Patients in the thoracic paravertebral blockade group were placed in the lateral decubitus position. The spinous processes above and below the intended puncture segment were palpated and marked. After skin disinfection, a convex low-frequency probe was used for overweight patients [Figure 1: see original paper]A, while a linear high-frequency probe was used for thin patients [Figure 1: see original paper]B. The probe was placed perpendicular to the dorsal midline at the T3 spinous process, with the medial end of the probe on the dorsal midline. The T3 spinous process and the transverse process of the next segment were visualized. The probe was then moved upward to avoid the transverse process of the next segment, positioning it between two transverse processes parallel to them. The space bounded by the deep aspect of the articular process and the pleura laterally constitutes the thoracic paravertebral space [8]. The needle was inserted from the lateral side of the probe, avoiding the pleura, and positioned in the space between the articular process and pleura. After negative aspiration for blood or cerebrospinal fluid, 12 mL of 0.4% ropivacaine was injected. The same procedure was performed on the contralateral side. Patients were then placed supine, the anesthetic block level was assessed, and oxygen was administered via nasal cannula or face mask with spontaneous breathing maintained and consciousness preserved.

In the general anesthesia group, anesthesia was induced with midazolam 0.05 mg/kg, fentanyl 3 μg/kg, cisatracurium 0.2 mg/kg, and propofol 2 mg/kg, followed by tracheal intubation and mechanical ventilation. Anesthesia was maintained with intravenous propofol infusion at 2–4 mg/(kg · min). Arterial blood samples for blood gas analysis were obtained 5 min before surgery in both groups.

1.2.2 Surgical Procedure

All patients in both groups were placed in a 70° sitting position with both upper limbs elevated and fixed. A 3–5 mm skin incision was made at the third/fourth intercostal space along the midaxillary line bilaterally. Through the right chest incision, single-port thoracoscopic artificial pneumothorax was established, and the T3/T4 sympathetic trunk and communicating branches 2 cm lateral to it were transected using electrocautery. For moderate hyperhidrosis, T4 was transected; for severe cases, T4 plus partial T3 were transected; and for those with concurrent axillary hyperhidrosis, T5 was also transected [Figure 2: see original paper]. After confirming complete lung re-expansion under thoracoscopic visualization, the thoracoscope was removed and the incision was closed. The same procedure was performed on the left side.

1.2.3 Postoperative Management

Five minutes after surgery completion, arterial blood samples were obtained for blood gas analysis in both groups. Patients in Group A awakened immediately and were returned to the ward for cardiac monitoring for 2 h, with oral intake permitted 2 h postoperatively. Patients in Group B were extubated after awakening and returned to the ward for cardiac monitoring for 12 h or until the next morning, with oral intake permitted 6 h postoperatively. Both groups underwent postoperative blood tests and chest radiography, which were normal, and were discharged on the same day or the following day.

1.2.4 Observation Indices

Blood gas analysis, vital signs, and related complications were recorded preoperatively and at 5 min postoperatively in both groups.

1.3 Statistical Analysis

Data were analyzed using SPSS 19.0 software. Baseline characteristics between groups were compared using the ² test. Measurement data were expressed as mean ± standard deviation and compared between groups using independent samples t-test. P<0.05 was considered statistically significant.

Results

There were no statistically significant differences in baseline clinical data between Groups A and B (Table 1). All patients completed the surgery successfully, and no patients in Group A required conversion to general anesthesia with tracheal intubation. Significant differences were observed between Groups A and B in anesthetic preparation time (15.46±8.32 min vs 35.65±11.12 min), awakening time (6.26±2.09 min vs 46.32±15.76 min), and hospitalization expenses (6355.54±426.00 vs 8932.25±725.98 RMB Yuan) (all P=0.000). Group A demonstrated superior outcomes compared with the general anesthesia group in postoperative throat discomfort (0% vs 100%), postoperative monitoring time (2 h vs 12 h), and postoperative feeding time (2 h vs 6 h) (Table 2). Neither group developed significant hypoxemia or hypercapnia. Four patients in Group A experienced transient SpO <95%, which improved with face mask oxygen supplementation. There were no differences in preoperative blood gas parameters between the two groups. Postoperative blood pH, PaCO , and PaO showed no significant changes in either group. However, compared with preoperative values, both groups exhibited increased PaCO and decreased pH postoperatively, with statistically significant differences between groups, though all values remained within clinically acceptable ranges. PaO showed no significant changes (Table 3).

Discussion

The concept of thoracotomy for thoracic sympathetic transection to treat palmar hyperhidrosis was proposed in the early 20th century, but it failed to gain widespread acceptance due to its invasive nature and numerous complications. In 1942, Hugh introduced thoracoscopic thoracic sympathectomy for hyperhidrosis. With the advent of video-assisted thoracoscopy in the late 20th century and the evolution from double-port to single-port techniques, single-port bilateral thoracoscopic thoracic sympathetic transection has become the optimal treatment for hyperhidrosis [9-10].

The progression from double-port to single-port thoracoscopic surgery has been accompanied by evolution in anesthetic airway management from double-lumen to single-lumen endotracheal intubation. Due to advantages including reduced perioperative airway trauma and complications, shorter anesthetic management time, and higher postoperative patient satisfaction, research on non-intubated general anesthesia for hyperhidrosis treatment has emerged and rapidly developed [11-13]. However, bilateral thoracic sympathetic transection with spontaneous breathing requires adequate analgesia as its foundation, along with proper patient education and sedation. Guo and Gong [14-15] investigated remifentanil infusion-assisted local anesthesia for double-port thoracoscopic bilateral thoracic sympathetic transection, but intraoperative irritative coughing, pain, discomfort, and respiratory depression still occurred. Our research group attempted thoracoscopic sympathetic transection for hyperhidrosis under non-intubated local anesthesia with propofol and remifentanil infusion [16]. We found that without muscle relaxants, patients still experienced coughing, movement, and varying degrees of chest wall muscle contraction during electrocautery of the pleura and sympathetic nerve, which not only interfered with surgical manipulation but also significantly increased surgical risk. Although remifentanil is a potent, ultra-short-acting analgesic with reliable analgesic effect, no accumulation, and rapid awakening, patients quickly experienced postoperative chest tightness and pain [17]. High thoracic epidural blockade provides significant analgesia for thoracoscopic surgery, but it remains primarily a blind technique lacking visualization, carrying high risk of spinal cord injury and numerous complications [18].

With the widespread clinical application of ultrasound, Hara et al. [19] first reported real-time ultrasound-guided thoracic paravertebral blockade in 2009, using parasagittal scanning to visualize the transverse processes and pleura with an out-of-plane needle approach. In the same year, Shibata et al. [20] described an in-plane technique for real-time ultrasound-guided thoracic paravertebral blockade. In 2010, Piccioni [21] first reported video-assisted thoracoscopy and talc pleurodesis under thoracic paravertebral blockade with spontaneous breathing, demonstrating smooth intraoperative course. Since then, ultrasound-guided paravertebral blockade has been gradually applied to thoracoscopic surgery due to its safety, accuracy, and significant analgesic effect.

In this study comparing 120 patients undergoing single-port bilateral thoracic sympathetic transection in our hospital with previous research [22-25], we identified several advantages of ultrasound-guided thoracic paravertebral blockade for single-port thoracoscopic bilateral sympathetic treatment while maintaining spontaneous breathing and consciousness: (1) Ultrasound guidance enables complete visualization throughout the puncture process, ensuring safety, efficacy, efficiency, and fewer complications; (2) It provides satisfactory analgesia without patient discomfort or movement, eliminates chest wall muscle contraction during electrocautery, creates optimal surgical conditions, and prevents postoperative chest tightness and pain; (3) Compared with tracheal intubation general anesthesia, it eliminates postoperative throat discomfort, reduces postoperative monitoring time, shortens postoperative fasting time, and improves perioperative comfort and satisfaction; (4) It shortens hospital stay and reduces hospitalization costs. Furthermore, blood gas analysis revealed that although both groups showed statistically significant increases in PaCO and decreases in pH postoperatively compared with baseline, all values remained within clinically acceptable ranges, and there were no significant differences in blood pH, PaCO , or PaO between groups before or after surgery. This indicates that the impact on the respiratory and circulatory systems during the perioperative period did not differ significantly between the two approaches.

In summary, the application of ultrasound-guided thoracic paravertebral blockade in thoracoscopic thoracic sympathetic transection is safe, effective, and feasible. This technique is simple, quick, easy to master, minimally invasive, associated with few complications, and provides painless conditions with rapid recovery and lower costs, better aligning with fast-track surgery principles. Therefore, investigating the implementation of ultrasound-guided thoracic paravertebral blockade for hyperhidrosis surgery to maximize its advantages holds significant clinical and social importance.

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