Original Article
Overall effect of sufentanil-propofol general anesthesia combined with paravertebral block on patients with lung cancer resection

Long Zhan, Jianxu Er, Wenqian Zhai, Jiapeng Liu, Jiange Han

Department of Anesthesiology, Tianjin Chest Hospital, Tianjin, China

Abstract: To study the overall clinical effect of sufentanil-propofol general anesthesia combined with paravertebral block on patients underwent lung cancer resection. 122 lung cancer patients underwent the pulmonary lobectomy at the department of thoracic surgery from May 2014 to May 2015 were enrolled in this study. According to the digital meter method, they were randomly divided into two groups, patients in observational group were underwent CTPVB (continuous thoracic paravertebral block) and the control group received PCIA (patient-controlled intravenous analgesia) therapy. The operation time, intraoperative blood lose, eyes opening time after calling, extubation time and the usage amount of sufentanil and propofol were recorded in patients of two groups. The mean arterial pressure (MAP) and heart rate (HR) were respectively recorded at different time points of anesthesia pre-induction (E0), 5 min preoperatively (E1), 10 min after operation initiation (E2), 30 min after operation initiation (E3) and the time when operation is finished (E4). Visual analogue scale (VAS) was also recorded at 2 h, 6 h, 12 h and 24 h after operation. In respect of comparison of general situations during perioperative period, there were no significant differences in operative duration of two groups (P>0.05), however the eyes opening time after calling, extubation time and the usage amount of sufentanil and propofol were significantly less in observational group than those of control group, with a statistically significant difference (P<0.05); In the process of anesthesia, the mean arterial pressure (MAP) and heart rate (HR) recorded at different time points of anesthesia pre-induction (E0), 5 min preoperatively (E1), 10 min after operation initiation (E2), 30 min after operation initiation (E3) and the time when operation is finished (E4) were significantly lower in observational group than those of control group, with a statistically significant difference (P<0.05); the usage amount of sufentanil and propofol needs to be adjusted to deepen anesthesia depth for patients in control group; analgesia situation was observed after surgery therapy, and visual analogue scale (VAS) scores at 2 h, 6 h, 12 h and 24 h after operation in observational group were significantly less than those of control group, which demonstrates a better analgesic effect of continuous thoracic paravertebral block (CTPVB) after operation. Introducing continuous thoracic paravertebral block in lung cancer resection fits general anesthesia and brings better clinical effect, with high security and low incidence of complications, this therapy provides a more effective and everlasting analgesic activity for patients after surgery, reduces the usage amount of anesthesia medication or opioid during surgery, has lower effect on hemodynamics, thus it's suitable to be widely used in clinic.

Keywords: Lung cancer resection, sufentanil, propofol, general anesthesia combined with paravertebral block

Introduction

Surgery is the primary therapy for elderly lung cancer patients in clinic, while the operation wound is usually big and the operation procedure takes relatively long time, therefore, intraoperative anesthesia plays a very important role during surgery [1]. The therapy of general intravenous anesthesia is commonly used in clinic for its recognized efficacy, but the adverse effects are increasingly emerging [2]. Con-

tinuous thoracic paravertebral block (CTPVB) continuously injects local anesthetic drugs into paravertebral space to gain effective block on motor and sensory nerves and sympathetic nerves [3]. Paravertebral block has relatively little effect on patients' cardiorespiratory system during anesthesia and the sensorimotor function of nerves below vertebral segment block was better maintained [4]. In this study, 122 lung cancer patients underwent the pulmonary lobectomy at the department of thoracic

surgery from May 2014 to May 2015 were enrolled, the therapy of sufentanil-propofol general anesthesia combined with paravertebral block was utilized, detection indexes such as hemodynamics in elderly patients were observed in the process of operation, now it is reported as follows.

Materials and methods

General data

Accepting criteria: ① all the patients were classified as ASAI-II according to the disease classification of American Society of Anesthesiologists (ASA); ② all the lung cancer patients were underwent pulmonary lobectomy; ③ without the history of chest trauma and surgery; ④ without disorders of important organs such as heart, brain, liver, kidney; ⑤ without diseases in the immune system, endocrine function or blood coagulation; ⑥ without psychological problems; ⑦ insensitive to anesthesia drugs used in this study.

122 lung cancer patients underwent the pulmonary lobectomy at the department of thoracic surgery from May 2014 to May 2015 were enrolled. According to the digital meter method, they were randomly divided into two groups. Patients in observational group were underwent CTPVB (continuous thoracic paravertebral block), 38 male cases, 23 female cases, aged 49-78, averaged 65.29±4.16, weight 56-73 kg, averaged 62.47±4.13 kg, 34 cases were classified as ASAI and 27 cases were classified as ASAII; On another hand, patients in observational group were underwent patient-controlled intravenous analgesia (PCIA) therapy, 35 male cases, 26 female case, aged 48-77, averaged 64.71±5.24, weight 55-74 kg, averaged 63.56±3.91 kg, 32 cases were classified as ASAI and 29 cases were classified as ASAII; General materials were compared and no differences were found in sex, age, weight or ASA classification, etc., between two groups (P>0.05). After admission, patients and family members signed informed consent and operation agreement; the study received permission of the Medical Ethics Committee and was supervised by ethics committees during the whole course.

Instrumentals and drugs

Anesthesia machine, lienable nerve plexus block suite, vital signs monitor, BIS monitor, venous PCA pumps, peripheral electronic infusion pump, continuous intravenous infusion micro-pump and disposable pressure transducer.

Methods

All the patients were intramuscularly injected with 0.3 mg scopolamine and 10 mg morphine 30 min before operation. Peripheral vein circuit was opened after entering surgery room, INTELLIVUE multi-parameter monitor instrument was used to monitor blood pressure, electrocardiogram, heart rate, oxyhemoglobin saturation and end tidal CO_2 pressure of expiration. Utilize M1034A electroencephalogram bispectral index module and four electrode sensor to monitor the electroencephalogram bispectral index.

Anesthesia induction: General anesthesia for the control group was carried out with injection of 2.5 mg midazolam, 1.5 mg/kg propofol, 0.6 μg/kg sufentanil and 0.2 mg/kg vecuronium bromide, and then tracheal intubation and mechanical ventilation were applied. In observational group, patients took oxygen inhalation before anesthesia induction of general anesthesia, initiate sedation state was achieved with 1 mg midazolam and 0.25-0.5 μg sufentanil. Patients in observational group were placed lateral position and punctured at the position of about 2.5 cm off T_3 intervertebral disc midpoint line. Local anesthesia was implemented with 1% lidocaine after sterilization, T_4 and T_6 double-point paravertebral block was carried out and catheter was inserted at T_4 puncture point via the guidance of ultrasound. The guidance of ultrasound can improve the security and success rate of puncture. Patients were placed lateral position and scanned along intercostal space with high frequency linear array probe to reveal corresponding processus transversus and paravertebral space. Puncture deep into 5-6 cm through plane with 18 G Touchy (Braun, Germany) to costotransverse ligament, link the needle end to a syringe saturated with 2 ml saline and inject the saline. Observe the needle point to slowly insert and break costotransverse ligament under the supervision of ultrasound. Inject drug solution when no blood appears upon resorption or CSF. The chosen drug is 10-15 ml 0.5% ropivacaine. The suit

Table 1. Comparison of general conditions during perioperative period

Group	Operative duration (min)	Eyes opening time after calling (min)	Extubation time (min)	Usage amount of sufentanil (μg)	Usage amount of propofol (mg)
Observational group	136.96±16.47	7.38±2.51	10.57±2.49	42.85±7.49	619.04±116.28
Control group	138.53±11.28	12.53±4.95	15.33±4.92	58.47±12.63	794.27±174.28
T value	0.6691	2.0376	3.9642	3.9275	8.7461
P value	>0.05	<0.05	<0.05	<0.05	<0.05

included catheter is imbedded into puncture needle, with about 2 cm length remained stay in paravertebral space, immobilize it with paster. Record the block plane. 10 min after taking effect, general anesthesia is initiated and the method is applied as mentioned for control group.

Propofol was pumped at the same pace during operation and anesthesia was maintained with vecuronium bromide and sufentanil injected intravenously, the infusion amount of propofol was adjusted according to related BIS examination value. When patients' blood pressure or heart rate increases upon cutting open skin at the beginning of operation, one-kick extra 0.1 μg/kg sufentanil can be added. 10 min before the end of operation, propofol injection is stopped. Extubate when patients restore spontaneous breathing or eyes open after operation. Analgesia is performed after operative.

Patients in control group received PCIA (patient-controlled intravenous analgesia) therapy, PCA pump was used, mix 150-200 mg sufentanil, 120 mg flurbiprofen axetil and 16 mg ondansetron, adjust the volume up to 100 ml with saline solution. Flow rate is controlled at 2 ml/h, self-controlled dosage is 2 ml, and lockout time is set 30 min, PCA pump can be launched immediately upon operation is started. In observational group, 10 ml 0.5% ropivacaine was injected via vertebral indwelling catheter 20 min before operation was finished, link infusion pump, 250 ml 0.5% ropivacaine, base-flow was controlled at 7 ml/h, self-controlled dosage was 10 ml, and lockout time was set 45 min.

Observational index

The operation time, intraoperative blood lose, eyes opening time after calling, extubation time and the usage amount of sufentanil and propofol were recorded in patients of two groups. The

mean arterial pressure (MAP) and heart rate (HR) were respectively recorded at different time points of anesthesia pre-induction (E0), 5 min preoperatively (E1), 10 min after operation initiation (E2), 30 min after operation initiation (E3) and the time when operation is finished (E4). Visual analogue scale (VAS) was also recorded at 2 h, 6 h, 12 h and 24 h after operation.

Statistical methods

Data base was established with SPSS 19.0 software, by which statistical analysis through quantitative data ($\overline{x}$±s) using *t* test and count data (%) using X^2 test were applied in this study, P<0.05 were considered with statistical significance.

Results

Comparison of general conditions during perioperative period

There were no significant differences in operative duration of two groups (P>0.05), however the eyes opening time after calling, extubation time and the usage amount of sufentanil and propofol were significantly less in observational group than those of control group, with a statistically significant difference (P<0.05), see **Table 1**.

Comparison of MAP and HR at different timepoints during anesthesia

In the process of anesthesia, the mean arterial pressure (MAP) and heart rate (HR) recorded at different timepoints of anesthesia pre-induction (E0), 5 min preoperatively (E1), 10 min after operation initiation (E2), 30 min after operation initiation (E3) and the time when operation is finished (E4) were significantly lower in observational group than those of control group, with a statistically significant difference (P<0.05); the usage amount of sufentanil

Table 2. Comparison of MAP (mmHg) at different timepoints during anesthesia

Group	E0	E1	E2	E3	E4
Observational group	94.29±4.38	85.49±6.27	83.45±4.56	84.67±5.73	91.26±7.22
Control group	101.37±5.16	91.52±7.38	100.78±6.32	95.39±6.91	103.96±8.11
T value	2.7461	1.8836	4.2285	3.3916	3.6492
P value	<0.05	<0.05	<0.05	<0.05	<0.05

Table 3. Comparison of HR (bpm) at different timepoints during anesthesia

Group	E0	E1	E2	E3	E4
Observational group	70.36±9.37	64.49±7.21	63.68±7.27	63.16±7.04	66.47±7.28
Control group	76.39±10.32	70.52±9.38	78.46±8.11	71.26±9.24	81.84±8.11
T value	20.954	1.7363	3.1195	2.8959	2.5363
P value	<0.05	<0.05	<0.05	<0.05	<0.05

Table 4. Comparison of visual analogue scale (VAS) scores at 2 h, 6 h, 12 h and 24 h after operation

Group	Postoperation 2 h	Postoperation 6 h	Postoperation 12 h	Postoperation 24 h
Observational group	4.83±0.87	4.91±0.95	3.32±0.86	2.49±0.73
Control group	6.11±0.93	5.83±0.84	4.73±0.97	2.99±0.85
T value	3.8275	2.0981	2.6721	1.6174
P value	<0.05	<0.05	<0.05	<0.05

and propofol needs to be adjusted to deepen anesthesia depth for patients in control group, see **Tables 2** and **3**.

Analgesia situation was observed after surgery therapy, and visual analogue scale (VAS) scores at 2 h, 6 h, 12 h and 24 h after operation in observational group were significantly less than those of control group, which demonstrates a better analgesic effect of continuous thoracic paravertebral block (CTPVB) after operation, see **Table 4**.

Discussion

Lung cancer is one malignant metastatic tumor with high clinical incidence of death. Radical surgery is the main therapy for lung cancer patients in clinic. Different ways of anesthesia during operation have different effects in reducing pain or sedation, even though the technic of anesthesia is gradually developed, the dangerousness is still large. The central nerve system of elderly patients is relatively sensitive to anesthesia drugs generally, the incidence of adverse effects is high [5]. Since the neuron in central nerve system is gradually decreased, the nerve fiber in transducing pathway is also decreasing, which leads to downscaling of activities and contents of central neurotrans-

mitters and increasing the threshold for feelings. Sufficient studies for detecting physiological changes and drug kinetics features in aged patient are needed for choosing ideal intravenous anesthetics. Choose suitable anesthetics and dose to improve the anesthesia security is the most urgent issue for clinical anesthesiologist at present [6].

Sufentanil is the N-4 abbreviate of fentanyl, the function of analgesia is strong, the time for inducing anesthesia is short and recovery is quick, in addition, it has minimal effects in respiration and cardiovascular system, and is widely used in clinic [7]. Propofol is frequently used in clinic to induce and maintain anesthesia, the advantages of which are quick both in exerting effect and recovery, the action time is short and stable, but has slight inhibitory effects for cardiovascular system, which can reduce heart rate, expand peripheral vessels, block the activities of sympathetic nerve and result in hypotension in elderly patients [8].

Paravertebral block has less effects on patients' respiration or circulation system than other nerve block methods. In addition, paravertebral block performs better in protecting the psychomotor and sensorimotor functions below the blocked vertebral segments [9]. The

nerve block on different parathoracic vertebral segments can be carried out by single infusion or continuously blocked with indwelling catheter [10]. When patients are placed lateral position, T_4 and T_6 double-point paravertebral block is carried out and catheter was inserted at T_4 puncture point via the guidance of ultrasound [11]. The guidance of ultrasound can improve the security and success rate of puncture. Patients were placed lateral position and scanned along intercostal space with high frequency linear array probe to reveal corresponding processus transversus and paravertebral space. Puncture deep into 5-6 cm through plane with 18 G Touchy (Braun, Germany) to costotransverse ligament, link the needle end to a syringe saturated with 2 ml saline and inject the saline. Observe the needle point to slowly insert and break costotransverse ligament under the supervision of ultrasound [12]. Inject drug solution when no blood appears upon resorption or CSF. The major action of analgesic is injecting local anesthetic drugs into paravertebral space, which can directly act on intercostal (spinal) nerves and its dorsal branches, communicating branches and sympathetic chains, local anesthetics can continuously take actions on lumbar plexus or diffuse to epidural space, block the posterior root of lumbar spinal nerves dominating sense and sympathetic nerves.

With regard to the relationship between paravertebral block and hemodynamics, this study holds that as for patients' blood pressure are influenced by multifaceted factors, intraoperative external stimuli or high tension etc., our results reveal that paravertebral block has better effects and more advantages on patients' MAP and HR during operation. The MAP and HR recorded at different timepoints during anesthesia pre-induction (E0), 5 min preoperatively (E1), 10 min after operation initiation (E2), 30 min after operation initiation (E3) and the time when operation is finished (E4) were significantly lower in observational group than those of control group, with a statistically significant difference (P<0.05). Paravertebral block can simultaneously block sense sympathetic nerves and single-side sympathetic nerves, the block scope is wider than sensory block, and the utmost scope of sympathetic block can reach 7-8 vertebral segments, which is related to the direct effect of local anesthetics on sympathetic chains and communicating branches.

In addition, 0.75% ropivacaine (2 mg/kg) administration in patients of observational group can effectively block 5-6 segments of spinal nerves, which provide a more effective anesthesia and analgesia. Because paravertebral block can partially block the pain transduction from operation area to central nerves, the usage of intravenous anesthetics or opioid analgesics is effectively reduced, therefore the cardiovascular stress responses and hemodynamic fluctuations are also reduced, which brings higher anesthesia stationarity. Our study also shows that the visual analogue scale (VAS) scores at 2 h, 6 h, 12 h and 24 h after operation in observational group were significantly less than those of control group, which demonstrates a better analgesic effect of continuous thoracic paravertebral block (CTPVB) after operation.

In conclusion, introducing continuous thoracic paravertebral block in lung cancer resection fits general anesthesia and brings better clinical effect, with high security and low incidence of complications, this therapy provides a more effective and everlasting analgesic activity for patients after surgery, reduces the usage amount of anesthesia medication or opioid during surgery and has lower effect on hemodynamics, thus it's suitable to be widely used in clinic.

Disclosure of conflict of interest

None.

Address correspondence to: Dr. Jiange Han, Department of Anesthesiology, Tianjin Chest Hospital, 261 Taierzhuang Street, Jinnan District, Tianjin 300222, China. Tel: +86-22-88185164; E-mail: hanjiangetjch@163.com

References

[1] Sims PG. Preoperative, intraoperative, and postoperative anesthesia assessment and monitoring in oral surgery. Oral Maxillofac Surg Clin North Am 2013; 25: 367-371, v.

[2] Mehra P, Arya V. Temporomandibular joint arthrocentesis: Outcomes under intravenous sedation versus general anesthesia. J Oral Maxillofac Surg 2015; 73: 834-842.

[3] Ali MA, Akbar AS. Report of a case of ultrasound guided continuous thoracic paravertebral block for post thoracotomy analgesia in a child. Middle East J Anaesthesiol 2013; 22: 107-108.

[4] Fortier S, Hanna HA, Bernard A, Girard C. Comparison between systemic analgesia, continuous wound catheter analgesia and continuous thoracic paravertebral block: A randomised, controlled trial of postthoracotomy pain management. Eur J Anaesthesiol 2012; 29: 524-530.

[5] Kaye AD, Baluch A, Scott JT. Pain management in the elderly population: A review. Ochsner J 2010; 10: 179-187.

[6] Rollins M, Lucero J. Overview of anesthetic considerations for cesarean delivery. Br Med Bull 2012; 101: 105-125.

[7] Gong L, Qin Q, Zhou L, Ouyang W, Li Y, Wu Y. Effects of fentanyl anesthesia and sufentanil anesthesia on regulatory t cells frequencies. Int J Clin Exp Pathol 2014; 7: 7708-7716.

[8] Xu WY, Wang N, Xu HT, Yuan HB, Sun HJ, Dun CL, Zhou SQ, Zou Z, Shi XY. Effects of sevoflurane and propofol on right ventricular function and pulmonary circulation in patients undergone esophagectomy. Int J Clin Exp Pathol 2014; 7: 272-279.

[9] Simpson J, Ariyarathenam A, Dunn J, Ford P. Breast surgery using thoracic paravertebral blockade and sedation alone. Anesthesiol Res Pract 2014; 2014: 127467.

[10] Glass EN, Kent M. The clinical examination for neuromuscular disease. Vet Clin North Am Small Anim Pract 2002; 32: 1-29, v.

[11] Park JS, Kim YH, Jeong SA, Moon DE. Ultrasound-guided Aspiration of the Iatrogenic Pneumothorax Caused by Paravertebral Block -A Case Report-. Korean J Pain 2012; 25: 33-37.

[12] Chida M, Hayama M, Kobayashi S, Ishihama H, Oyaizu T, Minowa M, Matsumura Y. Benefits of rib head resection via costotransverse ligament release method for t3 lung cancer in the paravertebral space. Ann Thorac Cardiovasc Surg 2013; 19: 268-272.