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CLINICAL RESEAPCH

Effects of General Anesthesia Combined with USG-PVB on Pain and Cognitive Function in Patients Undergoing Esophagectomy

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Abstract

Objective To analyze the effect of general anesthesia combined with ultrasound-guided paravertebral nerve block (USG-PVB) on pain and cognitive function in patients undergoing esophagectomy. **Methods** A total of 60 patients with esophageal cancer who underwent thoracic-laparoscopic radical esophagectomy in our hospital from Jan. 2015 to Jul. 2016 were selected and dichotomized into control group (n=30) and observation group (n=30) according to different treatment methods. Patients in the control group were treated with general anesthesia, while those in the observation group were treated with general anesthesia combined with USG-PVB. The intraoperative and postoperative conditions, postoperative pain and cognitive function were compared between the two groups. **Results** The postoperative conditions, analgesic effect and mini-mental state examination (MMSE) score at 7 days after operation in the observation group were notably better than those in the control group (P<0.05), with no significant differences in the incidence of postoperative cognitive dysfunction (POCD) between the two groups (P>0.05). **Conclusion** General anesthesia combined with USG-PVB exerted a relatively superior analgesic effect on patients undergoing esophagectomy, and positively improved patients' cognitive function.

Introduction

Esophageal carcinoma is a common malignant tumor prevalent in China with a high morbidity and a poor prognosis [1,2], patients with which have clinical manifestations mainly covering progressive dysphagia and referred pain, accompanied by surgery as the dominant treatment at present [3]. Studies have indicated that patients may experience hemodynamic changes during the induction period of anesthesia, while parts of them may suffer intense pain, which triggers postoperative cognitive dysfunction (POCD) to affect their quality of life after esophagectomy [4,5]. Therefore, it is critical to enhance the analgesic effect and postoperative cognitive capacity towards patients with esophageal carcinoma. Ultrasound-guided paravertebral nerve block (USG-PVB) is a regional block technique in which anesthetic is locally injected into the thoracic paravertebral space under direct vision of ultrasonic [6]. In order to improve the clinical therapeutic efficacy of patients with esophageal cancer, this study used general anesthesia combined with USG-PVB to anesthetize patients undergoing esophagectomy, with remarkable achievements reported below.

Information and methods

Clinical information

Research objects

A total of 60 patients who underwent thoracic-laparoscopic radical esophagectomy in Affiliated Hospital of Jiangnan University from January 2015 to July 2016 were selected as the research objects, and randomly divided into control group and observation group, with 30 cases in each group. The control group consisted of 21 males and 9 females, with the conditions as follows: 49-68 years old, a mean age of 59.3 ± 8.7 years old, body mass index (BMI) of 15.4-24.3 kg/m^2, a mean BMI of 20.3 ± 3.8 kg/m^2, and American Society of Anesthesiologists (ASA) classification of 17 cases in Class I and 13 cases in Class II. The observation group was composed of 19 males and 11 females, with the conditions as follows: 51-69 years old, a mean age of 60.2 ± 8.3 years old, BMI of 14.9-25.1 kg/m^2, a mean BMI of 21.7 ± 4.1 kg/m^2, and ASA classification of 16 cases in Class I and 14 cases in Class II. The study was approved by the Ethics Committee of our hospital, and all patients volunteered to participate and signed written informed consent. The comparison of general information between the two groups had no statistically significant difference (P>0.05), the data of which were comparable.

Inclusion and exclusion criteria

Inclusion criteria: patients who were clinically diagnosed with esophageal carcinoma. Exclusion criteria: (i) patients with coexisting severe liver and kidney disease, cardiovascular disease and coagulation disorder; (ii) patients with infected lesions at the puncture site.

Methods

All patients participated received general anesthesia, whose indicator levels such as mean arterial pressure and heart rate were monitored since entering the operating room. Patients in the control group were directly induced with general anesthesia, while those in the observation group received USG-PVB ahead of general anesthesia in right lateral position, bowed head and arched back. Specifically, after routine sterilization of the patient's skin, 1% lidocaine was used for local infiltration of the puncture site. Next, images were obtained using a color Doppler ultrasonic diagnostic equipment. The ultrasonic probe was first placed 5-6 cm outside of the spinous process to confirm the wall pleura, ribs and intercostal space. Then the probe was moved towards the spine to identify the transverse process which was square with the position deeper than the ribs. After contacting the transverse process, the puncture needle entered the paravertebral space above or below the transverse process. A local anesthetic needle (20 g) was inserted on the side of the ultrasonic probe, and 15-20 ml of 0.5% ropivacaine was injected slowly since no blood was drawn back from both points. The diffusion of the local anesthetic was observed under ultrasonic. A successful block was indicated when the patient's pain

was diminished or disappeared, and 10 minutes (min) later, patients received general anesthesia induction. General anesthesia induction: the patients were inserted with a double-lumen endobronchial tube containing midazolam (0.03 mg/kg), propofol (1.0 mg/kg), sufentanil (0.5 μg/kg) and cisatraeurium (0.3 mg/kg). Maintenance of anesthesia: intravenous pump injection of 4.0-10 mg/(kg·h) propofol. Maintenance of muscle relaxation: intermittent additional injection of 2-4 mg cisatraeurium. The dosage was adjusted according to the degree of surgical stimulation and the patient's vital signs.

Observational indicators

(i) The operative time, extubation time, post anesthesia care unit (PACU) stay time, and post-operative hospital dwell time were compared between the two groups. The restlessness score (RS) was applied to evaluate patients in the PACU with 0 point for patients with basically no restlessness, 1 point for patients with mild restlessness but following the instructions of the health care staff, 2 points for patients with moderate restlessness requiring control by paramedics, and 3 points for patients with severe restlessness, extremely noncooperation and violent struggle requiring multiple attendant assisted compressions. RS ≥ 2 was defined as the occurrence of restlessness. (ii) The pain of patients in the resting or coughing state was compared between the two groups based on visual analogue scale (VAS) scores at awakening, leaving PACU, and 1 day (d), 3 d and 5 d after surgery. (iii) The mini-mental state examination (MMSE) was applied to evaluate patients 1 d before and 7 d after surgery from the following aspects: temporal orientation, place orientation, delayed memory, immediate memory, attention, calculation, visual-spatial perception syndrome, and language. The MMSE score more than 2 points below the preoperative score was considered as POCD appeared. We compared the incidence of POCD between the two groups at 7 d postoperatively. POCD incidence = number of cases with POCD/total cases × 100%.

Statistical analysis

SPSS software (version 19.0) was used for statistical analysis. Count data were compared using χ^2 test. Quantitative data were expressed as the mean ± standard deviation ($\bar{x}\pm s$), with comparison using the *t*-test. Differences were considered statistically significant at $P<0.05$.

Results

Comparison of intraoperative and postoperative conditions between the two groups

There was no obvious difference in the operative time between the two groups ($P>0.05$). The extubation time, PACU stay time, post-operative hospital dwell time and incidence of PACU restlessness of patients in the observation group were notably lower than those in the control group ($P<0.05$), as shown in Table 1.

Comparison of pain between the two groups

VAS scores of patients at awakening, at leaving PACU, as well as at 1 d, 3 d and 5 d postoperatively in the observation group were markedly lower than those in the control group in both resting and coughing conditions ($P<0.05$), as delineated in Table 2.

Comparison of cognitive capacity between the two groups

No evident difference in MMSE scores between the two groups was uncovered 1 d before surgery ($P>0.05$). At 7 d postoperatively, the MMSE score of patients in the control group was notably lower than that before surgery ($P<0.05$), while the score in the observation group was not remarkably different from that before surgery ($P>0.05$), but overtly higher than that in the control group ($P>0.05$). Besides, the two groups shared the relatively same incidence of POCD 7 d after surgery ($P>0.05$), as depicted in Table 3.

Table 1. Comparison of intraoperative and postoperative conditions between the two groups

group	case	operative time	extubation time	PACU stay	post-operative	PACU restlessness

		(h)	(min)	time (min)	hospital dwell time (d)	[n(%)]
observation group	30	4.45±0.81	31.45±11.26	59.62±18.77	9.73±1.85	1（3.33）
control group	30	4.37±0.85	39.77±12.54	91.33±24.62	15.12±4.25	9（30.00）
t		0.373	-2.704	-5.610	-6.369	7.680
P		>0.05	<0.05	<0.05	<0.05	<0.05

Table 2. Comparison of pain between the two groups

condition	group	case	awakening	leaving PACU	1 d after surgery	3 d after surgery	5 d after surgery
resting	observation group	30	0.67±0.42	0.95±0.48	0.85±0.43	1.48±0.45	2.03±0.26
	control group	30	3.15±0.98	2.86±0.91	2.26±0.74	2.23±0.57	2.62±0.38
	t		-12.740	-10.168	-9.024	-5.657	-7.019
	P		<0.05	<0.05	<0.05	<0.05	<0.05
coughing	observation group	30	1.48±0.82	2.03±0.34	1.98±0.57	3.27±0.51	2.95±0.50
	control group	30	4.33±1.08	4.16±0.85	3.96±0.63	4.46±0.62	4.31±0.54
	t		-11.512	-12.744	-12.765	-8.119	-10.122
	P		<0.05	<0.05	<0.05	<0.05	<0.05

Table 3. Comparison of cognitive capacity between the two groups

group	case	MMSE score (point)				incidence of POCD [n(%)]
		1 d before surgery	7 d after surgery	*t*	*P*	
observation group	30	26.62±2.31	25.63±1.94	1.798	>0.05	3（10.00）
control group	30	25.89±2.50	23.27±2.15	4.352	<0.05	7（23.33）
t/χ^2		1.175	4.464			1.920
P		>0.05	<0.05			>0.05

Discussion

Although esophagectomy is the major treatment for esophageal cancer, patients are prone to acute and chronic pain after surgery, thereby leading to complications such as myocardial ischemia and POCD [7]. Single general anesthesia and combined general anesthesia are preferred choices in the course of surgery for patients with esophageal cancer, but both have their limitations [8]. Patients receiving general anesthesia alone experience poor analgesic effect during surgery, while general anesthesia combined with thoracic epidural block operation generates a better analgesic effect, but there are certain negative impacts on the patient's hemodynamics, resulting in hemothorax, aerothorax and other possible adverse reactions in the postoperative period [9]. In recent years, USG-PVB has been wildly applied in clinic, especially with prominent results in radical mastectomy and radical resection of pulmonary cancer [10,11]. In this study, we probed into the effect of general anesthesia combined with USG-PVB on pain and cognitive capacity in patients with esophageal cancer undergoing esophagectomy, aiming to provide a

reference for the clinical treatment.

Our study revealed that patients receiving general anesthesia combined with USG-PVB had obviously shorter extubation time, post anesthesia care unit (PACU) stay time, and post-operative hospital dwell time than those receiving single general anesthesia, with PACU restlessness also significantly better than those receiving single general anesthesia, indicating that the combined method could effectively improve patients' postoperative condition. The reason lies in that ultrasound could not only allow the anesthetist to see the paravertebral space clearly and inject local anesthetic accurately, but also dynamically guide the puncture procedure. The combination of general anesthesia and USG-PVB can reduce the damage in pleura caused by deep needle insertion and minimize the negative impact on the patient's hemodynamics by virtue of ease operation and precise positioning. In addition, under ultrasound guidance, the partial view is magnified, enabling the operator to accurately inject local anesthetic to rapidly block sympathetic nerves and inhibit the release of catecholamine mediators, thus effectively suppressing the stress response. Patients who received general anesthesia combined with USG-PVB enjoyed faster postoperative wound healing and shorter recovery time owing to less stress response and more stable hemodynamics. Thus, general anesthesia combined with USG-PVB could shorten patients' extubation time, PACU stay time and postoperative hospitalization time and improve their PACU restlessness condition.

At the same time, this study unveiled that patients who received general anesthesia combined with USG-PVB had notably lower VAS scores at awakening, leaving PACU, and 1 d, 3 d and 5 d postoperatively than those treated with single general anesthesia in the resting and coughing states, manifesting that this combination treatment could effectively enhance the analgesic effect. As the thoracic paravertebral space is posteriorly lined with the transverse process, costotransverse ligament and ribs, general anesthesia combined with USG-PVB could determine the puncture location and route through ultrasound images to inject local anesthetic precisely into the paravertebral space, which not only allows real-time observation of the spread of local anesthetic and reduces the number of repeated punctures but also blocks multiple segments of the intercostal nerves, dorsal branches and sympathetic chains unilaterally at the injection site [12]. In this combined method, the injected local anesthetic acted on the unilateral intercostal nerves, dorsal branches and sympathetic chains to produce an anesthetic effect on one side of the chest wall, which blocked the transmission of nerve impulses stimulated by surgical trauma to the nerve center and prevented nociceptive sensitization of the central nervous system, thus exerting an analgesic effect. Therefore, general anesthesia combined with USG-PVB could control the patient's postoperative pain by blocking the transmission of pain stimulation.

Moreover, our study proved that MMSE scores of patients receiving general anesthesia combined with USG-PVB were markedly higher than those with single general anesthesia at 7 d postoperatively, while the incidence of POCD at 7 d postoperatively was not notably different between the two groups, signifying that this conjoint method could reduce the incidence of POCD at 7 d postoperatively in patients with esophageal cancer and make positive impacts upon their cognitive capacity. POCD mostly emerges in geriatric patients after surgical anesthesia with the clinical manifestation of mild cognitive dysfunction, including mental disorder, anxiety and memory impairment. MMSE score is the basis for evaluating patients' post-operative cognitive function in clinic [13, 14]. The occurrence mechanism of POCD is closely related to the stress response which can induce lesions in the central nervous system and promote the development of POCD [15]. Furthermore, the development of stress response is associated with surgical trauma, blood loss and pain. The general anesthesia combined with USG-PVB maintains hemodynamic stability by accurately injecting anesthetic into the paravertebral space, avoiding the negative effects of single general anesthesia on the circulatory system function of patients. Hence, the combination of general anesthesia and USG-PVB

could reduce the incidence of POCD by suppressing stress response and improving analgesic effect in patients with esophageal cancer.

In conclusion, general anesthesia combined with USG-PVB exerted a dramatically analgesic effect on patients with esophageal cancer undergoing esophagectomy and positively improved patients' cognitive function.

Declaration of conflict-of-interest

The authors declare no conflict-of –interest.

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