

## Original Article

# Efficacy and safety analysis of modified intercostal nerves protection technique in the application of esophageal cancer surgery

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**Abstract:** Object: To investigate the analgesic effect and safety of applying modified intercostal protection in esophageal carcinoma surgery. Method: 80 esophageal cancer patients were chosen from August, 2014 to October, 2015. The patients were randomly divided into observation group and control group. In observation group, patients were received modified intercostal protection in esophageal cancer surgery, while the patients in the control group were received routine esophageal cancer surgery. The VAS scores, analgesic side reactions, chest tube time, pulmonary complications and hospitalization time at postoperative 1 d, 2 d, 3 d, 4 d, 5 d, 7 d, 10 d were analyzed. Result: Comparing to the control, the pain scores of patients in the observation group at postoperative 1 d, 2 d, 3 d, 4 d, 5 d, 7 d, 10 d were significantly lower, the difference was statistically significant ( $P<0.05$ ); the incidence rate of patients with vomiting, nausea, dizziness and other adverse reactions in observation group were less than in the control, significantly ( $P<0.05$ ); the patients with painless, or mild, moderate or severe pains were significantly reduced in the observation group, significantly ( $P<0.05$ ); the average hospitalization time and drainage tube staying time in the observation group were less than that in the control, while pulmonary complications rate in observation group were less than that in the control, significant ( $P<0.05$ ). Conclusion: The modified intercostal nerve protection technology in esophageal cancer surgery has an analgesic effect, with safety and shortening the hospital stay.

**Keywords:** Esophageal carcinoma, open chest operation, the protection technology of modified intercostal nerve, clinical curative effect

## Introduction

Esophageal cancers accounts for a large proportion of gastrointestinal cancer in our country, for which the major treatment is surgical resection. The common complication of thoracotomy surgery is severe postoperation chest pain, which strongly decreases the quality of life and clinical practice [1, 2]. Postoperative pain also impact vital signs including respirations, temperature, heart rate and blood pressure and then would delay healing process [3]. Some studies have showed that postoperative pain not only related to surgery incision but also the intercostal nerves injury. Adopt some measures to protect intercostal nerves during the operation whole relieve the postoperative pain [4]. In this study, we research the intercostal

nerve protection technique in the application of esophageal cancer surgery and analyzed its analgesic effect and safety.

## Materials and methods

### Patients

80 patients with esophageal cancer who underwent thoracotomy from August 2014 to October 2015 in our hospital were selected as subjects of this study. Inclusion criteria: the patients met diagnostic criteria for esophageal cancer, without operation contraindication, with informed consents. Exclusion criteria: patients with liver or kidney dysfunctions, with a high level of mental stress, with chronic pain or poor compliance. 80 patients were divided into treatment group

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**Table 1.** The VAS scores of two groups

Groups	Cases	D1	D2	D3	D4	D5	D7	D10
The treatment group	40	3.2±0.6	3.0±0.6	2.9±0.8	2.7±1.0	2.6±1.2	2.4±0.8	2.3±0.6
The control group	40	5.5±0.8	5.1±1.0	4.9±0.7	4.6±1.1	4.3±0.7	4.1±0.8	4.0±0.8
t		7.538	9.132	6.334	10.196	12.663	8.159	7.731
P		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

**Table 2.** Analgesia related adverse reactions of two groups

Groups	Cases	Vomiting	Nausea	Dizziness	Hypotension	Respiratory depression	Enteroparalysis
The treatment group	40	12 (32.50)	9 (22.50)	8 (20.00)	0 (0.00)	0 (0.00)	0 (0.00)
The control group	40	28 (72.50)	30 (75.00)	24 (60.00)	14 (35.00)	5 (12.50)	14 (35.00)
$\chi^2$		5.731	14.718	10.412	6.228	11.091	8.345
P		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

and control group on average according to random number table. The treatment group (27 men and 13 women) aged from 40 to 71 years, with average age 57.2±11.4 years, with average weight 64.5±11.9 Kg. 30 out of 40 were middle and lower thoracic esophageal carcinoma, 10 were cardiac carcinoma. All operations were performed by left thoracotomy posterolateral incision, with incision length 21.5±3.7 cm, with 20 anatomosis on the aortic arch and 20 anatomosis under the aortic arch. The control group (22 men and 18 women) aged from 42 to 73 years, with average age 58.4±12.1 years, with average weight 63.7±11.4 Kg. 28 out of 40 were middle and lower thoracic esophageal carcinoma, 21 were cardiac carcinoma. All operations were performed by left posterolateral incision, with incision length 22.3±4.5 cm, with 17 anatomosis on the aortic arch and 23 anatomosis under the aortic arch. There were no significant difference between general characteristics of two groups (P>0.05).

### Methods

All patients received combined intravenous anesthesia under double-lumen endotracheal intubation, all operations were performed via left intercostal thoracotomy. Incise the intercostal muscles and parietal pleura from the upper border of the lower rib and enter chest. The control groups underwent conditional intercostal thoracotomy: incise the intercostal muscles, place and spread the thoracic retractor directly, finish the surgery according to different lesion locations and different procedures.

Before closure, place the chest drainage tube. Closure was performed with pericostal suture closure and layer sutured (whereby stitches are placed from the lower intercostal muscles to the upper intercostal of the incision with double line 10). The treatment groups: modified intercostal nerves protection technique was used. Incise the skin and subcutaneous tissue, muscles in turn, and enter the chest cavity. Before spreading the thoracic retractor, incise the periosteum of inferior border of the upper rib with electric knife, separate the periosteum of the inferior border with periosteum elevator with appropriate length which the retractor could be placed in easily. Draw the intercostal muscle, vessel and nerves to medial lower, place and spread the thoracic retractor, during which the fractured should be avoided. Finish the operation as soon as possible. Place the chest drainage tube, make a small incision in intercostal space on midclavicular line, place the tube oblique from superior border of the lower rib to middle of the upper rib, sutured and fixed the tube to reduce the compression of the intercostal nerves. Before thoracotomy closure, incise the periosteum of inferior border of the lower rib by electric knife with incision length 1.0 cm and 4 incisions, and then separate the periosteum of the inferior border and sulcus costae with vessel clamp and surgical forceps. Inserted the needle between the inferior border and periosteum, out the needle from inside of the rib, sutured the superior border of the upper rib, close the incision by continuous suture from ends to middle, with 2 PDSII-0 line, through 4 position, tension the ends of line instead of tie

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**Table 3.** Pain intensity of two groups

Groups	Cases	Painless	Mild pain	Moderate pain	Severe pain
The treatment group	40	9 (22.50)	28 (70.00)	3 (7.50)	0 (0.00)
The control group	40	4 (10.00)	17 (45.00)	16 (40.00)	3 (7.50)
$\chi^2$		6.918	8.174	11.125	9.332
P		<0.05	<0.05	<0.05	<0.05

**Table 4.** General index such as pulmonary complications of two groups

Groups	Cases	Hospitalization time (d)	Drainage tube staying time (d)	Pulmonary complications [n (%)]
The treatment group	40	16.5±4.4	4.0±1.5	1 (2.50)
The control group	40	20.3±5.7	5.0±1.9	6 (15.00)
t		9.724	7.837	6.135
P		<0.05	<0.05	<0.05

the first needle, tension two lines directly instead of using rib approximator to fold the incision. All operations were performed by the same group of cardiac surgeon. After sobering and extubation, postoperative pain was reduced by intramuscular injection of drugs. When the pain was unbearable, intramuscular injection of 10 mg morphine sulfate was allowed once or twice.

### Results

#### *The main observation points and criteria of pain*

Pain intensity was assessed with a visual analog scale on postoperative days 1, 2, 3, 5, 7 and 10. Observed analgesia related adverse reaction, pain status, hospitalization time, tube steadying time of two groups. When the patients were completely awake and answered the questions correctly and independently, Patients' pain was evaluated with a VAS graded from 0 to 2 (painless), 3 to 4 (mild pain), 5 to 8 (moderate pain) and 9 to 10 (severe pain).

#### *Statistical analysis*

Statistical analysis was performed using the SPSS software (version16.0). Measurement data like VAS score were showed with mean  $\pm$  standard deviation ( $\pm$ s), analyzed with T-test. Count data like adverse effects rate were showed with rate, analyzed with  $\chi^2$  test. A P values <0.05 were considered statistically significant.

#### *The VAS scores of two groups*

The VAS score of the treatment group decrease on postoperative days 1, 2, 3, 4, 5, 7 and 10, the difference were significant when comparing with the control group (P<0.05) (Table 1).

#### *Analgesia related adverse reactions of two groups*

Adverse reaction such as vomiting, nausea, dizziness and so on, in treatment group were lower

than those in the control group, the difference were significant (P<0.05) (Table 2).

#### *Pain intensity of two groups*

There were more patients with painless or mild pain and less patients with moderate pain or severe pain in the treatment group than those in the control group, the difference were significant (P<0.05) (Table 3).

#### *General index such as pulmonary complications of two groups*

The average hospitalization time and drainage tube staying time of the treatment group were less than those of the control group, while pulmonary complications rate of the treatment group were less than those of the control group. The difference were significant (P<0.05) (Table 4).

### Discussion

Esophagectomy for esophageal cancer, a very complicated operation with severe trauma, long operation time, could subsequently not only cause difficulty in expectoration and breath due to the impairment of the postoperative cardiopulmonary function and chest pain, which also make patients at an increased risk of atelectasis, pneumonia, hypoxemia and even respiratory failure [5, 6]. Some studies have demonstrated that pulmonary complications were high risk factors of death after esophagectomy and have an impact on prognosis [7].

## Modified intercostal nerves protection technique

Many studies have shown that poor control or failing timely control of acute pain in the immediate postoperative period is associated with a higher occurrence of chronic pain, a severe problem that decreases the quality of sleep and life. A new method for performing thoracotomy with less postoperative chest pain needed. Many studies have demonstrated that post-thoracotomy pain is primarily due to intercostal nerve injury during surgery, which may be induced by stretch of the thoracic retractor, compression of drainage tube, direct nerve injury and so on [8, 9]. The upper intercostal nerves can be injured by the retractor, while the lower intercostal nerves by thoracotomy closure. To reduce postoperative chest pain, various suture techniques like intracostal suture closure (whereby stitches perforate the rib), extrapleural suture method, intercostal muscle flap, free intercostal nerves, and analgesia techniques like intercostal nerve blocks, intercostal nerve cold, have been tried. Those methods have reduced the pain partly but not produced exciting results, because the intercostal nerves still subjected to certain injuries because of single protection [10-12]. Recently, protective techniques for all intercostal nerves have been promoted with advances in medical technology.

In this study, we use modified intercostal nerves protection technique in the application of esophageal cancer surgery, base on the anatomic position of intercostal nerves which pass forward in the costal groove and periosteum in the inferior border of rib. We improved some procedure of the conventional thoracotomy that may damage the intercostal nerves to reduce the postoperation pain. ① Protect the upper intercostals nerves from being compressed by the retractor: incised the periosteum of inferior border of the upper rib which placed thoracic retractor with electric knife, separate the periosteum with periosteum elevator, draw the intercostal muscle, vessel and nerves to medial lower, and then place and spread the thoracic retractor. ② Instead of vertical method, we place oblique from superior border of the lower rib to middle of the upper rib, which could reduce the compression of the upper intercostal nerves and reduce the diverse stimulus to lung and pleura because of fixation, and then reduce the pain. ③ Protect the lower intercostals nerves during thoracotomy closure: separate the periosteum of the inferior

border and middle part of the lower ribs, inserted the needle between the inferior border and periosteum, and pull PDSII lines tight instead of rib approximator to avoid puncture and compression of the lower intercostal nerves. We reduced the intercostal nerves injury as much as possible with those improved technique. Our study have showed that the VAS score of the treatment group decrease obviously on postoperative days 1, 2, 3, 4, 5, 7 and 10 when comparing with the control groups, which may infer that modified protection technique could relieve acute and long-term pain. Adverse reactions such as vomiting, nausea, dizziness, etc, in treatment group were lower than those in the control group, which may demonstrate that modified protective techniques are safer.

There were more patients with painless or mild pain and less patients with moderate pain or severe pain in the treatment group than those in the control group. The average hospitalization time and drainage tube staying time of the treatment group were less than those of the control group, while pulmonary complications rate of the treatment group were less than those of the control group. All those result showed that modified protection technique may shorten the stay in time of drainage tube, and then reduce the stimulus to intercostals nerves and pleura, and have a good impact on the recovery of the pulmonary function. In this study, with less postoperation pain, patients' fear of cough and breath seem to decrease. Patients could doing cough, take deep breath and get out of bed independently and effectively, which would promote the recovery of the gastrointestinal function, promote the drainage of pleural effusion and shorten the staying time of the drain tube, promote the recovery of the pulmonary function, promote secretion clear function and lower the risk of atelectasis and shorten hospitalization time.

In summary, in the application of esophagectomy for esophageal cancer, modified intercostal nerves protection technique have significant analgesic effect and high safety, could shorten hospitalization time, is worth of being widely used in clinic.

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### Disclosure of conflict of interest

None.

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