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Original Article

Is the double edge closure technique effective against post-thoracotomy pain in the long term?

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ABSTRACT

Background: In this study, we aimed to evaluate the long-term pain and quality of life of patients following the pericostal closure (PC) and double edge closure (EC) techniques.

Materials and Methods: This prospective study was conducted between April 2019 and January 2021 with 60 patients who underwent thoracotomy and surgical resection for non-small cell lung cancer

Results: The median length of stay was 4 days for both the EC and PC groups ($p = 0.608$). Complications occurred in 11 patients (18.3%) overall, including 5 patients in the PC group (16.7%) and 6 patients in the EC group (20%). The complication rate did not differ significantly between the groups ($p = 0.739$). The most common complication was prolonged air leak (n = 9, 15%). Mean postoperative pain scores were lower in the EC group than in the PC group on the first 4 days and at 2 weeks ($p < 0.05$). While there was no difference between the two groups in terms of neuropathic pain at 6 months, an analysis of quality of life showed that the PC group experienced more perceived pain.

Conclusions: The EC technique was associated with less thoracotomy pain in the early postoperative period. However, it was not found to affect neuropathic pain in the long term.

Keywords: thoracotomy, pain, double edge technique

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Introduction

Postoperative pain presents a significant challenge that can impede treatment adherence. Specifically, larger incisions made for better exposure tend to increase morbidity [1]. Thoracotomy is recognized as one of the most painful surgical procedures. Although various drugs and surgical techniques have been proposed to alleviate this pain, effective treatment for neurogenic pain remains elusive [2,3]. Consequently, different techniques have been developed to protect intercostal nerves intraoperatively. This study aims to assess the early and long-term pain and quality of life of patients with the double edge closure technique.

Materials and Methods

The study was conducted prospectively between April 2018 and January 2020. It included a total of 60 patients undergoing lung resection for non-small cell lung cancer (NSCLC). Patients with a history of previous chest trauma, those undergoing rethoracotomy, exploratory thoracotomy or surgeries involving video-assisted thoracoscopy, as well as those with thoracic wall resection, were excluded due to the potential for pre-existing intercostal nerve injury. Additionally, patients who developed perioperative rib fractures, those who underwent iatrogenic rib resection, and those with regular opioid or analgesic drug use were also excluded from the study.

The patients' comorbidities were evaluated using the Charlson Comorbidity Index (CCI). Lung cancer staging was conducted according to the IASLC 8th edition staging system.

A posterolateral thoracotomy (preserving the serratus anterior muscle) was performed in all procedures. Incisions measuring approximately 20-30 cm were made in the fifth or sixth intercostal space. Two different surgical techniques were used in the study. In surgeries using the pericostal closure (PC) technique, a Finochietto retractor was placed in the intercostal space during the procedure. At the end of the procedure, two Z-shaped 2/0 polyglycolic acid sutures were passed through the intercostal muscles to close the intercostal space. In the double edge closure (EC) technique, the intercostal muscle tissue was separated from the rib using electrocautery and a dissector. The intercostal vessels and nerve were protected by passing the needle along the posterior surface of the rib. Two or three sutures were used, and a Z suture was applied (Figure 1). No retractor was used during the procedure, and measurements did not show that the procedure significantly increased the total surgical time.

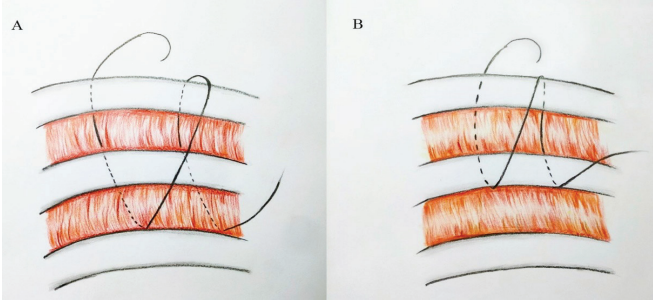

Figure 1. Conventional thoracotomy closure technique **(A),** double edge thoracotomy closure technique **(B)**.

During the operation, standard opioid and analgesic procedures were applied to all patients by the anesthesia team. Early postoperative monitoring was done in the intensive care unit. After the patients' general conditions stabilized, they were monitored in the inpatient ward.

Patients in both groups received patient-controlled analgesia (PCA) with intravenous pethidine HCl (50 mg bolus and 5 mg with a 15-minute lockout time) for the first 2 postoperative days. Subsequently, pain control was maintained with oral diclofenac potassium 50 mg twice daily and paracetamol 500 mg three times daily. After discharge, all patients continued on the same oral analgesia regimen. Oral analgesia treatment was discontinued in the first postoperative month of the patients included in the study. Analgesic treatments were administered in doses appropriate to the patient's body mass index (BMI). No perioperative or postoperative intercostal blockade was applied to any patient included in the study.

Postoperative pain was evaluated using a visual analog scale (VAS), where a score of 0 indicated no pain and a score of 10 indicated the worst pain ever experienced. Pain levels at rest and during coughing were assessed every 6 hours until postoperative hour 72. Pain assessment with the VAS was repeated at 2 weeks postoperative.

Leeds Assessment of Neuropathic Symptoms and Signs (LANSS) pain scores were assessed at 6 months postoperatively to evaluate chronic neuropathic pain. The LANSS scale has a maximum of 24 points. Patients with a score of 12 or lower were not considered to have neuropathic pain, whereas those with a score above 12 were classified as having neuropathic pain. Quality of life was also assessed at 6 months postoperatively using the SF-36 quality of life scale.

Demographic characteristics, complications, early and long-term pain, operation time, and quality of life were evaluated based on the two different surgical techniques

applied. Postoperative complications occurring in the first 30 days included atelectasis, wound site infection, prolonged air leak (7 days or more), and atrial fibrillation.

Approval for the study was obtained from the local ethics committee of our hospital.

Statistical Analyses

Continuous variables are presented as mean ± standard deviation, and discrete variables are expressed as frequencies. The demographic and clinical characteristics of the patients were tested for normal distribution using the Kolmogorov-Smirnov test. The t-test was used to calculate the means of these variables, and the chi-square test was used to compare morbidity between these groups. All analyses were performed using SPSS software (version 22; IBM Corp., Armonk, NY, USA). $P < 0.05$ was considered as significant.

Results

Sixty patients, consisting of 17 women (28.3%) and 43 men (71.7%), were included in the study. There were 38 patients (63.3%) with a Charlson Comorbidity Index (CCI) of 1 or higher. The mean age was 61.3 ± 10.23 years, and the mean tumor diameter was 4.32 ± 2.27 cm. Table 1 displays the demographic and histopathological characteristics of the patients. No significant differences were found between the two groups in terms of age, sex, side of disease, tumor size, and operative time.

The mean duration of chest tube drainage was 3 days, and the median length of hospital stay was 4 days for both the EC and PC groups ($p = 0.608$). Complications occurred in 11 patients (18.3%) within the study. The complication rate was 16.7% (n = 5) in the control group and 20% (n = 6) in the EC group ($p = 0.739$). The most common complication was a prolonged air leak, observed in 9 patients (15%), followed by atrial fibrillation in 2 patients (3.3%), non-operative hemorrhage in 1 patient (1.6%), wound infection at 1 week postoperative in 1 patient (1.6%), pneumonia in 1 patient (1.6%), and an expansion defect due to atelectasis in 1 patient (1.6%).

Mean postoperative pain scores were significantly lower in the EC group compared to the PC group during the first 4 days and at 2 weeks ($p < 0.05$). Table 2 presents the comparison of postoperative pain scores.

The mean LANSS score for patients in the study was 7.90 ± 6.89. At 6 months postoperative, the median LANSS score was 5 in the EC group and 7.5 in the PC group ($p > 0.252$). In assessing the quality of life at 6 months, patients in the EC group had a significantly lower body pain score than those in the PC group ($p = 0.026$). No differences were observed in other quality of life indices. Table 3 displays the comparison of postoperative quality-of-life scores.

Table 1. Comparison of patients' demographic and histopathological characteristics.

Variable		PC		EC		p value
		n	%	n	%	
Gender	Male	20	66.7	23	76.7	0.390
	Female	10	33.3	7	23.3	
Age (years), mean ± SD						0.250
CCI	0	10	33.3	12	40	0.592
	>1	20	66.7	18	60	
Resection	Lobectomy	25	83.3	26	86.7	0.718
	Pneumonectomy	5	16.7	4	13.3	
Stage	1	12	40	12	40	0.792
	2	12	40	10	33.3	
	3	6	20	8	26.7	
Side	Right	12	40	13	43.3	0.793
	Left	18	60	17	56.7	
Histopathology	Adeno ca	16	53.3	13	43.3	0.450
	Squamous cell ca	12	40	12	40	
	Other	2	6.7	5	16.7	

Abbrev.; PC: Pericostal closure group, EC: Double edge closure group, CCI: Charlson comorbidity index, SD: Standard deviation, CA: Cancer

Table 2. Comparison of postoperative pain scores.			
Variable	PC	EC	p value
Pain score at rest			
Day 1 (mean ± SD)	5.65±1.40	3.53±1.69	<0.001
Day 2 (mean ± SD)	4.46±2.30	3.21±2.11	0.025
Day 3 (mean ± SD)	2.70±1.77	1.81±1.54	0.043
Day 4 (mean ± SD)	2.13±0.96	1.65±0.74	0.038
Pain score while coughing			
Day 1 (mean ± SD)	7±1.48	5.03±1.79	<0.001
Day 2 (mean ± SD)	5.83±2.26	4.58±2.31	0.050
Day 3 (mean ± SD)	4.06±1.96	2.97±1.98	0.032
Day 4 (mean ± SD)	3.99±0.97	3.43±085	0.023
Postoperative week 2 pain score (mean ± SD)	3.66±1.29	2.23±1.27	<0.001
Abbrev.; PC: Pericostal closure group, EC: Double edge closure group			

Table 3. Comparison of postoperative pain scores.			
Variable	PC	EC	p value
Physical functioning	50	60	0.619
Role limitations due to physical problems	100	100	0.430
Body pain	77.5	55	0.026
Role limitations due to emotional problems	50	100	0.798
Emotional well-being	80	76	0.789
Social functioning	68.7	62.5	0.976
Energy/fatigue	62.5	65	0.947
Global health perception	65	77.5	0.558
Abbrev.; PC: Pericostal closure group, EC: Double edge closure group			

Discussion

Although thoracoscopic surgery is increasingly common in the treatment of lung cancer, thoracotomy is still the preferred method for advanced-stage tumors, patients with extensive adhesions, and other cases where greater exposure is required [4]. Post-thoracotomy pain is a common issue for patients and a significant concern for thoracic surgeons. Postoperative pain can lead to complications such as pneumonia and atelectasis due to sputum retention; pulmonary embolism as a result of limited mobility; and hypoxia and cardiac ischemia due to non-adherence to pulmonary physiotherapy [5].

Post-thoracotomy pain is associated with numerous factors, including the duration of surgery, location and length of the incision, intercostal nerve damage, the positioning of the chest tube, chest wall inflammation, as well as psychophysiological and social factors [6]. Increased surgical time due to complications such as bleeding and adhesions also raises the risk of intercostal nerve damage [7], which is one of the primary risk factors for chronic pain.

In half of the patients, post-thoracotomy pain can persist for two years following surgery. Consequently, various closure techniques for pain prevention have been documented in the literature. These methods include the subcostal suture technique, the double edge suture technique, the intracostal suture technique, and intercostal muscle flap harvesting [7-10]. Cerfolio et al reported in their study that harvesting an intercostal muscle flap before chest wall retraction reduced post-thoracotomy pain and improved spirometric values [11]. Bayram et al found that the intracostal suture technique decreased early postoperative pain while only adding two minutes to the operative time [7].

In 2010, Sakakura et al introduced the edge closure technique as a method to mitigate post-thoracotomy pain [9]. This technique involves the dissection and preservation of the neurovascular bundle on the caudal side of the intercostal space, thereby preventing compression of the intercostal nerve. In our study, we compared 30 patients who underwent the edge closure technique with a control group that received pericostal closure. The comparison was based on VAS pain scores measured both at rest and during coughing. The patients who received the edge closure technique experienced less early postoperative pain,

both at rest and while coughing, and required fewer postoperative analgesics. However, no statistically significant difference was observed between the two groups in terms of chronic neuropathic pain at the 6-month postoperative LANSS assessment. Similar outcomes -significant reductions in acute pain without a significant difference in chronic post-thoracotomy pain -have been noted with other closure techniques [7,8,12,13]. Nonetheless, in our 6-month postoperative quality of life assessment using the SF-36, patients who underwent the edge closure technique reported less body pain, although there was no significant difference in other quality of life dimensions.

A risk of lung herniation has been reported following closure techniques, particularly after the intracostal closure technique [14]. However, lung herniation was not observed as a complication in our study, which is consistent with findings from previous studies. The most common complication we encountered was a prolonged air leak, occurring in 15% of patients. Atrial fibrillation was noted in 3.3% of patients, while non-operative hemorrhage, wound site infection, pneumonia, and atelectasis-related expansion defects each presented in 1.6% of cases. There were no differences in the length of hospital stay or complication rates between the EC and PC groups.

The primary limitation of our study is the subjective nature of pain assessment. Additionally, the small sample size constitutes another limitation. Despite there being no comorbidities within our study group, the use of the VAS for patients with motor or cognitive impairments may also represent a limitation.

In conclusion, the double edge closure technique is a fast, reliable, and effective procedure that does not increase the risk of complications but reduces acute post-thoracotomy pain and allows an earlier return to normal daily life.

Declaration of conflicting interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

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Ethics approval

The study was approved by Yedikule Chest Diseases and Thoracic Surgery Training and Research Hospital Ethics Committee (No: 223/1, date: 08.01.2020).

Authors' contribution

SB; conceptualized and drafted the article, wrote the paper, visualization, CBS,OVY,MSOM,YA,CA; drafted the article, collected and analyzed data, OS,MM; critical review. All authors actively contributed to discussion of the results from the study and reviewed and approved the final version to be released.

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