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ORIGINAL ARTICLE

## Outcome of Thoracotomy Wound Closure Using Rib Drill and Transcostal Sutures in Middle-Aged Patients.

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### Abstract

**Background:** Post thoracotomy pain remains an important challenge for surgeons and patients. It affects respiratory function, quality of life and limits patients from performing normal daily activities. We aimed to assess the efficacy of using rib drill and transcostal sutures to close intercostal space to minimize post thoracotomy pain and respiratory complications.

**Methods:** A prospective follow up study, included 86 middle-aged patients operated through posterolateral thoracotomy for lung resection. Thoracotomy was reclosed using rib drill with passing transcostal heavy vicryl sutures. Follow up was done for one month duration to assess postoperative pain score and respiratory functions.

**Results:** The intensity of post thoracotomy pain significantly decreased over time with its lowest level after 1 month where the mean pain score was  $0.63 \pm 0.65$ . There was a nonsignificant decrease in all spirometry variables results at 30 days postoperative.

**Conclusion:** Patients in our study showed low postoperative pain score and nonsignificant reductions in the postoperative spirometry variables compared to preoperative results after using drill and transcostal heavy vicryl sutures for thoracotomy wound closure in middle-aged patients.

**Keywords:** Thoracotomy closure, drill, transcostal sutures, spirometry, post thoracotomy pain.

### Introduction

Posterolateral thoracotomy is the standard incision used in most thoracic surgeries. The main complain of majority of patients operated through thoracotomy approach is pain. Thoracotomy wounds are considered among the most painful surgical procedures, causing acute and chronic post-operative pain, which frequently detected in about 40% up to 60% of patients. This leads to a limitation of life activities in these patients [1].

Post thoracotomy pain is the main cause of shallow breathing, resulting in lower lung volume and capacity. This results also in retention of secretions

and lung atelectasis. The surgeon must deal with the specific pathology of the patients and with pain management over his career course [2].

Novel approaches have been used to minimize the acute post-thoracotomy pain and respiratory complications resulting from thoracic procedures. The video-assisted surgery (VATS) advent enabled the surgeons to perform resections through smaller access ports to the thoracic cavity and smaller thoracotomy incisions. Consequently, postoperative pain and pulmonary complications incidence had reduced. However, it is not applicable to operate patients having tumors and chronic infectious diseases using minimally invasive approaches. Resection procedures in these cases mostly require

major poster-lateral or antero-lateral thoracotomies [2,3].

Thoracotomy closure technique that may lead to chronic intercostal nerve compression and damage is considered as a risk factor for chronic pain. Some precautions are needed during thoracotomy closure to minimize postoperative pain, infection and respiratory problems. The most popular technique for thoracotomy closure is the placement of peri-costal sutures (PSs) around the ribs, because it is a fast and an easy technique. Excessive tightening of these peri-costal stitches mostly leads to postoperative pain [1,2].

Several surgical maneuvers have been designated to prevent intercostal nerves injury with resulting lesser pain. Currently, some thoracic surgeons are using trans-costal suture (TSs) instead of peri-costal sutures. It is performed by passing the approximation stitches through the drilled holes in the ribs. Trans-costal suture technique has shown promising outcomes regarding diminished postoperative pain [4,5, 6].

We designed our study to assess the efficacy of intercostal space closure using rib drill and transcostal sutures in minimizing post thoracotomy pain and respiratory complications in cases operated through major surgical procedures.

## Patients and Methods

### Study design and population

The study was performed over 6 months duration, from March 2022 to September 2022. The study was performed at Cardiothoracic Surgery Department at Zagazig University Hospitals, as a prospective cohort study. Number of patients included in our study were 86 patients. All patients included in our study were operated through posterolateral thoracotomy and intercostal closure was done using the rib drill and passed heavy Vicryl suture. All patients were followed up during hospitalization period and after discharge for one month postoperative to assess postoperative thoracotomy wound infection, pain score and respiratory functions.

### Inclusion criteria

Middle-aged patients, patients who had posterolateral thoracotomy incision for treatment of lung pathology and the patients who had accepted preoperative respiratory functions.

### Exclusion criteria

We excluded patients younger than 18 years old and older than 45 years old, patients who had VATS treatment for lung pathology, patients who had preoperative restrictive respiratory functions and other side lung pathology, patients who had preoperative pain related to other morbidity and the patients dependent on opioids and analgesic drugs. The final analysis included 86 patients. They were all operated through posterolateral thoracotomy incision and closed using rib drill with passing heavy vicryl sutures.

### Surgical closure technique

After completion of the surgical procedure indicated for each single patient (wedge resection, segmentectomy, lobectomy and bilobectomy), two silicone intercostal chest drains (32 Fr) were inserted and fixed. Then the thoracotomy closure was performed as the following: the inferior and superior ribs were stripped from the periosteum and soft tissues, without damaging the intercostal nerve bundle. Then holes were done in the center of the inferior and superior ribs at proper equal distances using the 7 mm diameter drill. Heavy vicryl sutures (size 2) with rounded needle (40 mm) were passed through the drilled holes in the inferior rib from outside to inside, and then were passed around the flesh through the holes in the superior rib from inside to outside. The metal rib approximator was used to re-approximate the upper and lower ribs gradually. Then the heavy suture limbs were pulled tightly and tied secure. The rib approximator was removed. Then closure of the next muscular, soft tissue and cutaneous layers was done in an anatomical fashion using monofilament absorbable sutures.

Patients were extubated on table, and they were transferred to the postoperative intermediate care unit for few hours before transfer to the ward.

All patients received prophylactic antibiotics and good systemic medical analgesics. Analgesics were standardized for all patients. Local wound analgesics and epidural analgesics were forbidden in cases included in our study.

Patients were followed up during hospitalization period and for one month after discharge in our outpatient clinic to assess postoperative thoracotomy wound infection, pain and respiratory function assessed by spirometry.

Pain in the post-operative period for the patients included in this study was measured using the visual analogic pain scale (VAS) described by petrache et

al [1]. The details of VAS was categorized as the following: no pain (score 0), mild pain (score 1,2,3), moderate pain (score 4,5,6), severe pain (score 7,8,9) and the worst pain possible (score 10). Pain score was recorded on post-operative day 1, 7, and 30.

**Ethical statement**

The study was approved by the institutional review board (IRB) of Zagazig University. IRB approval number is (9863-28-1-2022). A written informed consent was taken from all patients involved in the study. The study was conducted according to the ethical principles of the declaration of Helsinki.

**Statistical Analysis**

Microsoft Excel was used to code, enter, and interpret the data. The data was then analyzed using the SPSS version 20.0. The Chi-square test was applied for comparison. The correlation was done by the Pearson correlation test.

**Results**

Our study included 86 patients operated through posterolateral thoracotomy and had transcostal closure technique using drill. There were 51 male patients (59.3%) and 35 female patients (40.7%). Mean age of the patients was  $31.4 \pm 8.35$  years old (Table 1).

Surgeries performed to patients enrolled in our study were lobectomy (30.2%), segmentectomy (24.4%), bilobectomy (22.1%) and wedge resection (22.1%). Mean length of skin incision was  $15.4 \pm 2.45$  centimeter. Mean length of hospital stay was  $5.56 \pm 0.85$  days.

Regarding post thoracotomy wound infections, 84 patients showed clean wound with no infection (97.6%). One patient had superficial wound infection (1.2%) in the subcutaneous layer of the wound and another one patient had superficial wound discharge (1.2%). However, no patients had deep or open infected wound thoracotomy wound (Table 2).

There was a high statistically significant decrease in pain score over time post-operative reaching the lowest level after 1 month with mean of  $0.63 \pm 0.65$  ( $p < 0.001$ ) (Table 3). On the first postoperative day, all patients (100%) had moderate pain (score 4,5,6). On the seventh postoperative day, 2.5% had no pain (score 0), 84.9% had mild pain (score 1,2,3) and 15.1% had moderate pain (score 4,5,6). After one month postoperative, 46.5% had no pain (score 0), 44.2% had mild pain (score 1,2,3) and 9.3% had moderate pain (score 4,5,6). This indicates resolving of pain over 1 month duration postoperative with resulting earlier recovery to normal function and life practice.

Pulmonary function assessment by spirometry was performed at two fixed time points: one week preoperative and 30 days postoperative. There was a decrease in all spirometry results (FVC (L), FEV1(L), PEF(L/s) and FEV1\FVC (%)) at 30 days postoperative as shown in table 4. This is accepted because the surgical procedure results in partial resection of the lung. However, according to the statistical analysis, there was nonsignificant difference between preoperative and postoperative values ( $p > 0.05$ ).

**Table (1):** Basic characteristics of the studied group of patients.

Patient data	Studied group N=86
Age/ years Mean $\pm$ SD. Range	$31.4 \pm 8.35$ 18-45
Gender Male Female	51 (59.3%) 35 (40.7%)

Data represent number of patients and percentage in parenthesis. Other data represent the mean  $\pm$  standard deviation and range in parenthesis. SD: standard deviation, N: number

**Table (2):** Operative and perioperative data of the studied group of patients.

Patient data	Studied group N=86
<b>Surgery type</b>	
Lobectomy	26 (30.2%)
Segmentectomy	21 (24.4%)
Bilobectomy	19 (22.1%)
Wedge resection	20 (23.3%)
<b>Skin incision length/ cm</b>	
Mean ± SD.	15.4 ± 2.45
Range	10-20
<b>Hospital stays /days.</b>	
Mean ± SD.	5.56 ± 0.85
Range	4-7
<b>Recovery to normal functions/ days</b>	
Mean ± SD.	12.9 ± 1.58
Range	10-15
<b>Post-operative wound infection</b>	
No infection	84 (97.6%)
Superficial wound infection	1 (1.2%)
Serous discharge	1 (1.2%)

Data represent number of patients and percentage in parenthesis. Other data represent range and the mean ± standard deviation and range in parenthesis.

N: number, SD: standard deviation, cm: centimeters

**Table (3):** Change in post-operative pain score on follow up.

Pain score	Studied group N=86 Mean ± SD
1-day post-operative	5.22 ± 0.62
7 days post-operative	2.95 ± 0.59
30 days post-operative	0.63 ± 0.65
<b>P value*</b>	<b>&lt;0.001 HS</b>

\*Repeated measures ANOVA, HS: P<0.001 is high significant

Data represent the mean ± standard deviation and range in parenthesis.

N: number, SD: standard deviation.

**Table (4):** Spirometry results pre- and post-operative among studied group.

Spirometry data	Studied group. N=86		P
	Pre-operative	30 days post-operative	
FVC (L)	2.85 ± 0.2	2.38 ± 0.2	0.14 NS
FEV 1 (L)	2.33 ± 0.3	1.91 ± 0.3	0.28 NS
PEF (L\s)	5.3 ± 0.6	4.41 ± 0.4	0.29 NS
FEV1\FVC (%)	79.8 ± 4	83.2 ± 3	0.51 NS

P value > 0.05 is nonsignificant

Data represent the mean ± standard deviation and range in parenthesis.

N: number, SD: standard deviation, NS: nonsignificant.

### Discussion

Post thoracotomy pain presents an important challenge for surgeons and patients. Chronic postoperative pain remains an important worry for the patients because it affects their life quality and limits them from performing their daily activities. It is advised to be treated with regimens directed to the patient and procedure. This may lead to multiple hospital admissions with subsequent higher costs [7,8].

Moreover, most countries are now in the VATS era, and VATS techniques are proven to be less painful. However, in many low-income or mid-income countries the VATS technique is justified for diagnostic purposes and surgical procedures, such as lung resections in these countries, are mainly performed by an open thoracotomy. This aspect has represented the motivation to perform this study [9,10].

Studies have shown that high levels of acute thoracotomy pain immediately postoperative mostly leads to chronic thoracotomy pain [9]. Authors indicate that the intercostal nerve damage is the probable cause for chronic pain is, apparition of degeneration, axonal sprouting, or neuromata, occurring both intraoperative and postoperative, generating hyperalgesia and allodynia [5], describing it as “neuropathic” which is responsible for pain in about half of the patients [8,11].

In our study, we evaluated the efficacy and outcome of using drill to make holes in the ribs and pass transcostal heavy vicryl sutures to close the intercostal space after posterolateral thoracotomy. We assessed the post-operative pain for the patients included in this study using visual analogic pain scale (VAS). Pain was recorded on 3 fixed points: 1, 7, and at 30 days postoperative. We found a high statistically significant decrease in pain score over time post-operative reaching the lowest level after 1 month ( $p < 0.001$ ).

Increased acute pain score postoperatively especially during hospitalization period causes higher morbidity due to sputum retention with resulting chronic post thoracotomy pain syndrome [12]. Proper management of post-thoracotomy pain prevent atelectasis, pneumonia, pulmonary embolism, and emergency intensive care admission. Additionally, earlier ambulation and good

respiratory physiotherapy overcomes hypoxemia and hypercarbia with attendant ischemia and arrhythmias [11].

Furthermore, pulmonary complications are a major cause of morbidity and mortality during the post-operative period after thoracic surgery. The major respiratory complications are atelectasis, pneumonia and respiratory failure. These occur in 15–20% of the patients and account for the majority of the expected 3–4% mortality [12].

Most surgeons prefer to close the thorax with peri costal sutures. In this usual approach, sutures are passed from the upper border of the rib of the lower intercostal space (seventh rib if the fifth space was opened) to the upper border of the rib corresponding to the space. Many authors agree that this type of closure causes serious post-thoracotomy pain, and therefore constitutes a major reason for postoperative morbidity [2, 4, 5, 13].

Additionally, Cerfolio and colleagues [5] described a technique mainly consisted of intracostal sutures (sutures placed on top of the fifth rib and through the small holes drilled in the bed of the sixth rib) and harvesting of intercostal muscle flap before chest retraction. They used the numeric pain score to assess the effect of protection of the lower intercostal nerve through intracostal suture and stated that it is less painful than peri costal suture at 2 weeks, 1, 2 and 3 months after thoracotomy.

On the first postoperative day, we found that all patients had moderate pain (score 4,5,6). On the seventh postoperative day, 2.5% had no pain (score 0), 84.9% had mild pain (score 1,2,3) and 15.1% had moderate pain (score 4,5,6). After one month postoperative, 46.5% had no pain (score 0), 44.2% had mild pain (score 1,2,3) and 9.3% had moderate pain (score 4,5,6). This indicates an interesting decrease of pain over 1 month duration postoperative. This enabled patients to recover earlier and restore their normal function and life practice.

Bayram et al. [1] recommended closing the thorax by drilling two holes into the ribs which sutures were passed through these holes. They concluded that thoracotomy closure by a technique that avoids intercostal nerve compression significantly decreases post-thoracotomy pain [10].

Other literatures found that immediate and late postoperative pain in the patients who received thoracotomy wound closure with transcostal sutures (TS) is significantly lower than patients who received thoracotomy closure with peri costal sutures (PS). Additionally, the patients in the TS group showed smaller reductions in the spirometry parameters. Therefore, TS is recommended over PS as the thoracotomy closure technique of choice [15].

On the contrary, Sakakura et al. described pain reduction over a year postoperatively through his novel edge closure method that also protects the lower intercostal nerve without need for drilling holes in the rib, they thought that drilling holes was time-consuming and carries the risk of injury to the underlying lung or mediastinum [16]. Other literatures mentioned that the extra-costal chest closure is a cheap, easy, and fast, safe, and effective in reducing the apparition of chronic post thoracotomy pain [1].

In our study, assessment of pulmonary function using spirometry was performed at two fixed time points: one week preoperative and 30 days postoperative. There was a non-significant decrease in all spirometry variables results (FVC (L), FEV<sub>1</sub>(L), PEF(L/s) and FEV<sub>1</sub>\ FVC (%)) at 30 days postoperative when compared to preoperative values. This is accepted because the surgical procedure results in partial resection of the lung with resultant early limitation of the pulmonary functions.

Authors found that the patients who received thoracotomy closure using peristernal sutures showed significantly lower FVC, FEV<sub>1</sub>, and PEF on postoperative days 21 than in the preoperative period. These results were historically expected in the postoperative period after thoracotomy [14, 17].

However, A previous study investigated pulmonary function in 16 patients after major thoracotomy. Spirometry assessment was done on postoperative day 14. The authors found that FVC, FEV<sub>1</sub>, and PEF were significantly lower postoperatively than preoperatively. Patient recovery in terms of these variables was due to improvement in ventilatory capacity, reduction of the chest wall injury caused by the surgical procedure, and pain relief [15].

## Conclusion

We prefer the described technique of closure of a posterolateral thoracotomy using drill to make holes in the superior and inferior ribs and passing transcostal heavy vicryl sutures through these holes in middle aged patients. Patients experienced a significant decrease thoracotomy pain early postoperative and after 30 days duration of follow up. Moreover, patients showed nonsignificant reductions in the spirometry variables analysis when comparing preoperative and postoperative results.

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