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Midterm results of rib fixation surgery for patients with thoracic trauma

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ABSTRACT

Objective: To assess mid-term outcomes of rib fixation surgery using screws in patients with thoracic trauma. **Subjects:** This study included 164 patients with thoracic trauma across three hospitals: Viet Duc Friendship Hospital, Viet Tiep Friendship Hospital, and Cho Ray Hospital. **Methods:** A non-randomized multicenter clinical trial was conducted. **Results:** The majority of the patients (75.6%) were male. Traffic accidents were the primary cause of injury, accounting for 65.9% of cases. One-month post-surgery, the intervention group's average VAS score was 0.83, compared to 1.47 in the control group ($P < 0.05$). At three months, hemothorax complications were observed in 3.1% of the control group, while only one patient (1.6%) in the intervention group experienced pulmonary embolism, although this difference was not statistically significant. The intervention group's average quality of life score increased from 0.7 points after one month to 0.95 points after three months. In contrast, the scores of the control group's scores were 0.62 points after one month and 0.77 points after three months ($p < 0.01$). **Conclusion:** Rib fixation with screws is effective in mid-term outcomes by reducing complications, enhancing quality of life, and providing effective pain relief in patients with thoracic trauma.

Keywords: Mid-term outcome, Rib fixation surgery, Thoracic trauma

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INTRODUCTION

Rib fractures are a common injury in thoracic trauma (blunt chest trauma - BCT), accounting for up to 10% of all trauma-related hospital admissions and contributing to more than one-third of trauma-related deaths [1]. This injury often leads to severe acute respiratory distress, chronic chest pain, chest wall deformity, and long-term sequelae [2],[3]. Conservative treatment methods, including pain control, respiratory support, progressive injury reduction, and physical therapy, are recommended for patients with rib fractures [2].

Recently, researchers worldwide have recommended rib fixation surgery as a routine treatment for rib fractures [3]. This surgery aims to stabilize the fractured ribs early, thereby reducing pain and facilitating the rapid return of the lungs to normal functional status. Multiple rib fractures have been shown to significantly and long-term affect the quality of life. Recently, rib fixation surgery in patients with chest trauma and multiple rib fractures has gained increasing attention. Rib fixation surgery (RFS) has been shown to be

effective in reducing the rates of tracheostomy, length of hospital stays, and pneumonia. However, research on the impact of rib fixation surgery on the quality of life of patients with BCT is limited and has not been fully assessed. Therefore, this study aimed to evaluate the medium-term outcomes of rib fixation surgery using plates and screws in patients with BCT.

METHODS

Patients: Patients admitted with a diagnosis of BCT and rib fractures on chest radiography. Inclusion criteria included Diagnosis of BCT with a flail chest, chest wall deformity, fracture of ≥ 4 displaced ribs, and consent to undergo rib fixation surgery using plates and screws. Patients with progressive chest wall infection, coagulopathy, or multiple traumas were excluded.

Study Sites: Research was conducted at three facilities: Cardiovascular and Thoracic Center - Viet Duc Friendship Hospital; Cardiovascular and Thoracic Surgery Department, Viet-Tiep Friendship Hospital; Thoracic Surgery Department, Cho Ray Hospital, between October 2020 and October 2023.

Study Design: Non-randomized controlled clinical trial, multicenter study

Sample Size and Sampling Method: Convenience sampling of 164 eligible patients. Among these, 63 patients underwent rib fixation surgery and 101 patients were included in the control group.

Study Procedures:

Step 1: Patient selection according to the study criteria.

Step 2: Examination, testing, diagnosis, and surgical indication. The patients and their families were fully informed about their condition, conservative treatment options, surgical methods, benefits, and potential complications.

Step 3: Patients were categorized into two groups: Group 1, patients with BCT who underwent rib fixation surgery; and Group 2, patients with BCT who did not undergo rib fixation surgery.

Step 4: Monitoring, care, and treatment of patients in both groups during hospitalization.

Step 5: Follow-up visits or home visits for patients 1 and 3 months after discharge in both groups.

Step 6: Data collection and analysis, assessment of medium-term outcomes post-surgery, and report writing.

Study Variables:

General Characteristics: Age, sex, number of fractured ribs, and injury mechanism.

Mid-Term Outcomes:

- Post-surgical complications included pleural adhesions, rib displacement, and pleural effusion–pneumothorax (PE-P).

- Visual Analog Scale (VAS) score (10-point scale) used to assess pain levels at 1 month and 3 months.

- The EQ-5D-5L quality of life scale was assessed three months post-surgery. This scale includes five questions corresponding to five aspects (mobility, self-care, usual activities, pain/discomfort, and anxiety/depression) and uses the Vietnamese quality of life scoring system. Each question had five response options: no problems (Level 1), slight problems, moderate problems, severe problems, and extreme problems (Level 5). The scale has minimum and maximum quality of life scores of -0.5115 and 1, respectively. Higher scores indicate better quality of life.

Data Analysis: The analysis was performed using STATA 15, and differences between two qualitative variables were tested using the

Chi-square or Fisher's exact test. Comparisons between two quantitative variables were performed using the t-test or Mann-Whitney U test. Statistical significance was set at $P < 0.05$.

Ethical Considerations: This study was conducted with the approval of the Ethics Committee of Biomedical Research of Hanoi Medical University. Patients and their families were fully informed about the surgical methods, benefits, and risks and voluntarily consented to undergo rib fixation surgery for rib fractures due to trauma. Patient confidentiality was maintained, and information was used solely for research purposes.

RESULTS

More than three-quarters of the patients were male (75.6%). Seven patients (4.3 %) belonged to a minority ethnic group. There was a significant difference in sex distribution between the rib fixation and control groups ($p < 0.05$). Trauma was primarily caused by traffic accidents (65.9%), followed by occupational accidents (12.2%), falls from heights (11.0%), and domestic accidents (9.1%). (Table 1)

Table 1. *General Characteristics of the patients*

Characteristic	**Rib Fixation Group n = 63, (%)**	**Control Group n = 101, (%)**	**Total n = 164, (%)**	**p**
Gender				
Male	43 (68,3%)	81 (80,2%)	124 (75,6%)	0,006
Female	20 (31,7%)	20 (19,8%)	40 (24,4%)	
Ethnicity				
Kinh	60 (95,2%)	97 (96,0%)	157 (95,7%)	0,586
Other	3 (4,8%)	4 (4,0%)	7 (4,3%)	
Cause of trauma				
Traffic accident	43 (68,3%)	65 (64,4%)	108 (65,9%)	0,100
Industrial accident	8 (12,7%)	12 (11,9%)	20 (12,2%)	
Fall from height	4 (9,5%)	14 (13,9%)	18 (11,0%)	
Crush injury	2 (3,2%)	1 (1,0%)	3 (1,8%)	
Domestic accident	6 (9,4%)	9 (8,9%)	15 (9,1%)	
Number of Rib Fractures				
Mean ± SD	4,81 ± 2,30	5,25 ± 2,59	5,11 ± 2,51	0,294

The mean VAS score at 1-month post-surgery was 0.83 in the rib fixation group, compared to 1.47 in the control group, with a statistically significant difference ($p < 0.05$). At 3 months, the rib fixation group had a significantly lower mean VAS score (0.23, compared to 0.58 in the control group. (Table 2)

Table 2. *Chest Pain Levels According to the VAS Scale (n = 164)*

Characteristic	**Rib Fixation Group n = 63 (%)**	**Control Group n = 101 (%)**	**Total n = 164 (%)**	**p**
1-month-Post operative VAS				

Mean ± SD	0,83 ± 1,60	1,47 ± 1,69	1,26 ± 1,69	0,012
Range	1- 6	1 - 7	1 - 7	
3-month-Post operative VAS				
Mean ± SD	0,23 ± 0,64	0,58 ± 0,88	0,46 ± 0,82	0,006
Range	1 - 3	1 - 4	1- 4	
Pain After 1 Month	20 (31,2%)	71 (55,5%)	91 (47,4%)	0,001
Pain After 3 Months	10 (15,6%)	48 (37,5%)	58 (30,2%)	0,002

Three months post-surgery, pneumothorax, and hemothorax were observed in 3.1% of the patients in the control group, while only one patient in the rib fixation group had these complications (1.6%). However, this difference was not statistically significant. (Table 3)

Table 3. *Postoperative Complications at 3 Months (n = 164)*

Characteristic	**Rib Fixation Group n = 63 (%)**	**Control Group n = 101 (%)**	**Total n = 164 (%)**	**p**
Postoperative Complication Rate	0	7 (5,5%)	7 (3,6%)	0,057
Type of Complication				
Pleural Adhesion	0	1 (0,8%)	1 (0,5%)	0,667
Rib Displacement	0	1 (0,8%)	1 (0,5%)	0,667
Pneumothorax/Hemothorax	0	4 (3,1%)	4 (20,8%)	0,303

The quality of life in the rib fixation group improved significantly compared with that in the control group. The proportion of patients with mobility difficulties in the rib fixation group was 7.8%, which was significantly lower than that in the control group (57.8 %). In addition, 6.3% of the patients in the rib fixation group reported substantial pain, whereas half of those in the control group experienced pain ranging from moderate to extreme difficulty. (Figure 1)

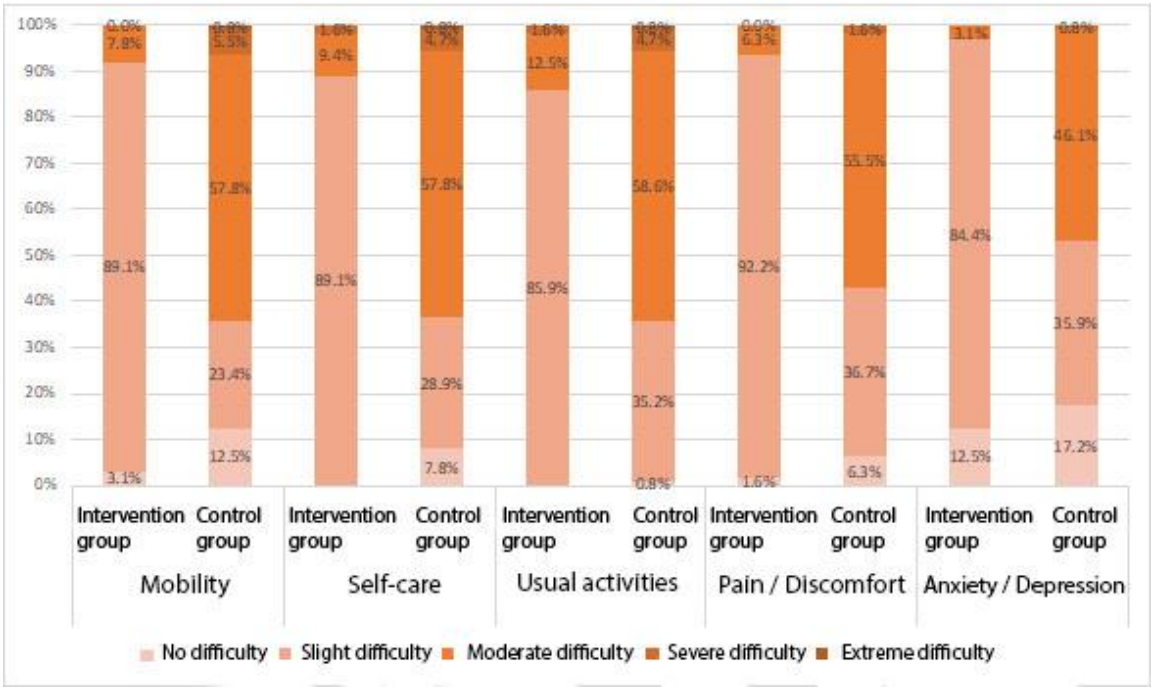

Figure 1. *Quality of Life Aspects Using EQ-5D-5L Scale 3 Months Post-Surgery*

The average EQ-5D-5L score in the rib fixation group was 0.70 after 1 month and 0.95 after 3 months. In comparison, the control group had scores of 0.62 and 0.77, respectively, indicating a statistically significant improvement in quality of life for the rib fixation group at both time points ($p < 0.001$). (Table 4)

Table 4. *Quality of Life Characteristics 3 Months Post-Surgery (n = 164)*

EQ-5D-5L Score	**Rib Fixation Group n = 63 (%)**	**Control Group n = 101 (%)**	**Total n = 164 (%)**	**p**
1-month-Post operation				
Mean ± SD	0,70 ± 0,05	0,62 ± 0,16	0,65 ± 0,14	0,001
3-month-Post operative VAS				
Mean ± SD	0,95 ± 0,10	0,77 ± 0,11	0,83 ± 0,14	<0,001

DISCUSSIONS

Our study indicated that at one month post-surgery, the incidence of residual chest pain in the rib fixation group was 31.2%, which was significantly lower than the 55.5% observed in the control group (Table 3.28). By three months post-surgery, the incidence of residual chest pain had decreased sharply in the rib fixation group to 15.6%. The average VAS score at one month post-surgery was 0.83 in the intervention group, compared to 1.47 in control group.

Our findings are consistent with those of several other studies conducted worldwide. Beks et al. reported that nearly 40% of patients continued to experience chest pain for an average of three years after BCT [4]. Marasco et al. (2015) found that among patients with a VAS score of 5/10, 16% identified the location of their chest pain as significant at 6 months, 21% at 12 months, and 20% at 24 months [5]. Other common pain locations include the lower back and the shoulders. While acute pain can lead to respiratory issues, chronic pain can cause shortness of breath and reduced quality of life. Ragounis found that 13% of patients experienced persistent chest pain at rest after one year [6]. An observational study by Lander showed that 49% of patients experienced persistent pain after an average follow-up period of five years [7].

According to the results in Table 4, our study demonstrated that the average quality of life score in the intervention group was 0.70 after 1 month and 0.95 after 3 months. At both time points, the intervention group consistently had significantly higher quality of life scores than the control group ($p < 0.001$).

These results are consistent with those of various studies conducted worldwide. In the study by Bek et al., the EQ-5D-5L score was 0.85 for patients with rib fragments and 0.79 for those with multiple rib fractures, compared to a Dutch reference population score of 0.87. This result is favorable compared to other studies that describe multiple trauma patient groups [4]. The authors found no significant difference in quality of life between patients with rib fragments and those with multiple rib fractures. Ragounis et al. reported similar results after a 1-year follow-up of 45 patients with rib fixation for multiple rib fractures, with an EQ-5D-5L score of 0.93 [6]. Similar findings were reported by Mayberry et al. in a group of 15 patients who underwent rib

fixation [8]. In another study, Campbell et al. reported the quality of life of 20 patients after > 1 year of rib fixation, noting a lower quality of life compared to the reference population, potentially due to higher ISS scores in this patient group [9]. This study showed that patients with the lowest QoL scores experienced significant pain and anxiety/discomfort. Farquhar et al. reported the EQ-5D-5L score for 11 patients with rib fixation for unstable rib fractures during an unspecified long-term follow-up, noting a slightly higher number of issues per domain compared with our results, with the highest problem rates in pain and discomfort [10]. Although there is strong evidence suggesting that rib fixation may have long-term benefits for quality of life, further evidence is needed to identify the differences in outcomes between rib fixation and nonsurgical management.

CONCLUSIONS

Rib fixation using plates and screws has demonstrated mid-term efficacy in patients with BCT, with a low complication rate. The results also indicate that rib fixation surgery provides effective pain relief and improves the patients' quality of life.

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Conflict of interests

The authors declare no conflicts of interest regarding the publication of this article.

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Consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal upon request.

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