Comparison of Post-Removal Complications of Chest Tube Extraction at 48 Versus 72 Hours After Insertion in Trauma Patients

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Abstract- Pneumothorax is one of the most common consequences of chest trauma, typically managed with chest tube insertion. However, the optimal timing for chest tube removal remains controversial. This study aimed to compare the incidence of clinical complications following chest tube removal at 48 hours versus 72 hours after insertion in trauma patients admitted to Sina Hospital. This prospective, single-center, parallel-group randomized controlled trial enrolled 194 trauma patients requiring tube thoracostomy. Participants were randomized in a 1:1 ratio using computer-generated block randomization with allocation concealment into two groups: removal at 48 hours (n=97) and removal at 72 hours (n=97). The primary endpoint was post-removal complications, defined as recurrent pneumothorax or incomplete lung re-expansion confirmed radiographically. Absolute risk differences (ARD) with 95% confidence intervals (CI) were calculated. Logistic regression analysis was performed to evaluate potential predictors of complications. Statistical significance was defined as $P<0.05$. The mean age of patients was 43.27±13.05 years. The 72-hour group had slightly higher mean oxygen saturation than the 48-hour group (94.89% vs. 94.76%, $P=0.690$), and higher mean heart rate (84.04 vs. 83.11, $P=0.507$) and respiratory rate (13.44 vs. 13.38, $P=0.822$). In contrast, mean pain intensity was higher in the 48-hour group (4.03 vs. 3.98, $P=0.673$). Recurrent pneumothorax occurred in 12 patients (12.4%) in the 48-hour group and 10 patients (10.3%) in the 72-hour group (ARD: 2.1%; 95% CI: −6.8% to 11.0%; $P=0.651$). Incomplete lung re-expansion occurred in 2 patients (2.1%) and 4 patients (4.1%), respectively (ARD: −2.0%; 95% CI: −6.7% to 2.7%; $P=0.407$). No statistically significant differences were detected between groups. Logistic regression analysis did not identify independent predictors of post-removal complications. Chest tube removal at 48 hours was not associated with a statistically significant increase in post-removal complications compared with removal at 72 hours. However, confidence intervals were wide, and the findings should be interpreted cautiously pending confirmation in larger adequately powered studies.

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Introduction

Trauma remains the fourth leading cause of death in developed countries and is the most common cause of mortality among children and young adults, accounting for approximately 10% of all deaths and ranking third after malignancies and cardiovascular diseases in overall mortality statistics (1). It is the primary cause of death during the first four decades of life, with over 150,000 trauma-related deaths reported annually in the United States alone. Furthermore, for every trauma-related death, two to three individuals are left permanently disabled, contributing to an estimated $400 billion in associated costs each year (2).

Penetrating chest trauma can lead to life-threatening conditions such as hemothorax and pneumothorax. Timely and appropriate intervention, including chest tube placement, can significantly reduce morbidity and

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mortality (3). Approximately 85% of patients with penetrating chest trauma are effectively managed with tube thoracostomy. Despite being considered a relatively minor procedure, chest tube insertion is associated with serious complications in 2% to 20% of cases, including empyema, lung tissue damage, impaired gas exchange, pulmonary embolism, infection, and various technical failures (4).

Chest tubes are commonly indicated for pneumothorax, hemothorax, or pleural effusion secondary to trauma. Their management depends on several factors, including mechanical ventilation status and whether pulmonary resection has been performed. Optimizing the timing of chest tube removal is essential to minimize patient discomfort, procedural complications, hospital length of stay, healthcare costs, staff workload, radiation exposure, and medical errors, while supporting clinical decision-making (5).

Among the most critical complications following chest tube removal is recurrent pneumothorax, which can prolong hospitalization and increase patient burden (6). Although chest tube placement can be life-saving, identifying the optimal removal time remains a point of clinical uncertainty (7). Factors influencing complication rates include urgency of insertion, tube positioning, and provider experience. Reported complications include intercostal artery bleeding, injury to visceral organs (e.g., lung, heart, diaphragm), damage to major vessels (e.g., aorta, subclavian), intercostal neuralgia, re-expansion pulmonary edema, infection (e.g., empyema), and technical issues such as tube obstruction or misplacement, all potentially resulting in ineffective drainage (8).

While removal is generally considered when drainage is less than 200 cc/day and non-purulent, studies offer conflicting recommendations regarding the ideal removal timing (9). Therefore, the present study aims to compare the incidence of clinical complications associated with chest tube removal at 48 versus 72 hours following insertion in trauma patients, to help clarify best practices for timing of removal.

Materials and Methods

Study design

This was a prospective, single-center, parallel-group randomized controlled trial conducted at Sina Hospital, Tehran University of Medical Sciences. The study was designed and reported in accordance with CONSORT guidelines.

Study population

The study population consisted of trauma patients admitted with indications for chest tube placement due to pneumothorax or related thoracic injuries. A total of 194 eligible patients were enrolled and randomly assigned into two equal groups. Inclusion criteria were age over 18 years, confirmed diagnosis of traumatic pneumothorax requiring chest tube insertion, hemodynamic stability, and informed consent. Exclusion criteria included the presence of major thoracic surgery, bilateral chest tubes, severe comorbidities (such as uncontrolled diabetes, chronic obstructive pulmonary disease, or coagulopathies), mechanical ventilation dependency, prior history of thoracic malignancies, or incomplete data during follow-up.

Sample size determination

Sample size was calculated assuming a 20% complication rate in the 72-hour group and a minimum clinically important absolute difference of 15%, with a two-sided α level of 0.05 and 80% statistical power. Based on these assumptions, 94 patients per group were required. To account for potential attrition, 97 patients were enrolled in each group (total sample size: 194).

Measurement

Baseline measurements were recorded immediately after admission and prior to randomization. These included demographic data (age, sex), vital signs such as heart rate, respiratory rate, and oxygen saturation (SpO_2), as well as initial pain assessment using the Visual Analogue Scale (VAS). All data were documented by trained clinical staff under standardized protocols to ensure consistency.

Randomization and allocation concealment

Participants were randomly assigned in a 1:1 ratio using computer-generated block randomization with variable block sizes. Allocation sequences were placed in sequentially numbered, opaque, sealed envelopes that were opened after enrollment, ensuring allocation concealment.

Blinding

Due to the nature of the intervention, blinding of surgeons and patients was not feasible. However, outcome assessment was performed by clinicians who were blinded to treatment allocation.

Outcome and follow-up

The primary outcome of the study was the incidence

of clinical complications following chest tube removal, specifically recurrence of pneumothorax and incomplete lung re-expansion. Patients were randomized using a block randomization method into two groups: in Group A, the chest tube was removed at 48 hours post-insertion, and in Group B, it was removed at 72 hours. Randomization sequences were computer-generated and sealed in opaque envelopes to maintain allocation concealment. Due to the nature of the intervention, patients and care providers could not be blinded; however, outcome assessment was conducted by a separate clinical team blinded to the group assignments to reduce observer bias.

Definition of terms

Recurrent pneumothorax was defined as the reappearance of air in the pleural cavity after chest tube removal, confirmed by clinical symptoms and chest radiography. Incomplete lung re-expansion was defined as persistent lung collapse or failure of full re-expansion on follow-up imaging despite tube thoracostomy. Pain intensity was assessed using the VAS, a validated 10-point scale ranging from 0 (no pain) to 10 (worst pain imaginable).

Statistical analysis

Following the completion of data collection, all extracted information from checklists and questionnaires was entered into SPSS software (version 22). Prior to analysis, the dataset was carefully reviewed for missing values and data entry errors, which were corrected as needed. Descriptive statistics, including mean, standard deviation, median, range, frequency, and percentage, were used to summarize quantitative and qualitative variables.

To compare continuous variables between the two groups (48-hour vs. 72-hour chest tube removal), the normality of data distribution was assessed using the Kolmogorov-Smirnov or Shapiro-Wilk tests. If the data were normally distributed, independent samples t-tests were used. In cases where normality was not confirmed, the non-parametric Mann–Whitney U test was applied. For categorical variables, comparisons between groups were conducted using the chi-square test. When the assumptions of the chi-square test were not met, Fisher's exact test was used as an alternative. Univariable logistic regression analysis was performed to identify potential predictors of post-removal complications. A P of less than 0.05 was considered statistically significant. All results were presented in the form of tables and figures, and observed differences between the two groups were interpreted accordingly.

This study was approved by the Research Ethics Committee of [Institution Name], and written informed consent was obtained from all participants prior to enrollment. The study adhered to the ethical principles of the Declaration of Helsinki and complied with institutional and national regulations regarding human research. Participants were informed of the voluntary nature of the study and were assured of the confidentiality of their data and their right to withdraw at any time without consequence.

Results

Table 1 presents the overall baseline characteristics and outcomes of the study population, which included 194 trauma patients who underwent chest tube placement. The mean age of participants was 43.27±13.05 years. The mean oxygen saturation was 94.82±2.15%, with a mean heart rate of 83.58±9.70 beats per minute and a mean respiratory rate of 13.41±1.91 breaths per minute. The average pain score, measured using the Visual Analogue Scale (VAS), was 4.01±0.85. Recurrent pneumothorax was observed in 22 patients (11.3%), while incomplete lung re-expansion occurred in 6 patients (3.1%). Exactly half of the patients (n=97) had chest tubes removed at 48 hours, and the other half at 72 hours.

Table 1. Baseline characteristics and overall clinical outcomes (n=194)

Variable	Mean±SD/Frequency (%)
Age (years)	43.27±13.05
Oxygen saturation (%)	94.82±2.15
Heart rate (beats per minute)	83.58±9.70
Respiratory rate (breaths per minute)	13.41±1.91
Pain intensity (VAS score)	4.01 ± 0.85
Recurrent pneumothorax	22 (11.3%)
Incomplete lung re-expansion	6 (3.1%)
Chest tube removal time	
– 48 hours	97 (50.0%)
– 72 hours	97 (50.0%)

Table 2 provides a detailed comparison of demographic and clinical variables between the two study groups. The mean age in the 48-hour group was 42.11±12.30 years, compared to 44.43±13.72 years in the 72-hour group, with no statistically significant difference (*P*=0.217). Mean oxygen saturation was 94.76±2.09% in the 48-hour group and 94.89±2.22% in the 72-hour group (*P*=0.690). Similarly, mean heart rate (83.11 ±9.67 vs. 84.04 ±9.76 bpm; *P*=0.507), respiratory rate (13.38 ±1.87 vs. 13.44 ±1.95 breaths/min; *P*=0.822), and pain intensity (VAS score: 4.03 ±0.90 vs. 3.98 ±0.80; *P*=0.673) showed no statistically significant differences between the two groups.

Table 2. Comparison of clinical and demographic variables between the 48-hour and 72-hour groups

Variable	48-hour Group (n = 97)	72-hour Group (n = 97)	*P*
Age (years)	42.11 ± 12.30	44.43 ± 13.72	0.217
Oxygen saturation (%)	94.76 ± 2.09	94.89 ± 2.22	0.69
Heart rate (beats per minute)	83.11 ± 9.67	84.04 ± 9.76	0.507
Respiratory rate (breaths/min)	13.38 ± 1.87	13.44 ± 1.95	0.822
Pain intensity (VAS score)	4.03 ± 0.90	3.98 ± 0.80	0.673
Recurrent pneumothorax (n, %)	12 (12.4%)	10 (10.3%)	0.651
Incomplete lung re-expansion (n, %)	2 (0.02%)	4 (0.04%)	0.407

Recurrent pneumothorax occurred in:

12 of 97 patients (12.4%) in the 48-hour group

10 of 97 patients (10.3%) in the 72-hour group

The absolute risk difference was 2.1% (95% CI: −6.8% to 11.0%; *P*=0.651).

Incomplete lung re-expansion occurred in:

2 of 97 patients (2.1%) in the 48-hour group

4 of 97 patients (4.1%) in the 72-hour group

The absolute risk difference was -2.0% (95% CI: -6.7% to 2.7%; *P*=0.407).

No statistically significant differences were observed between groups for either outcome.

To evaluate potential predictors of complications following chest tube removal, univariable logistic regression analysis was performed for all recorded variables. As shown in Table 3, none of the variables were identified as statistically significant predictors. Age (OR=1.014, 95% CI: 0.992-1.037; *P*=0.215), oxygen saturation (OR=1.038, 95% CI: 0.894-1.204; *P*=0.627), heart rate (OR=1.016, 95% CI: 0.982-1.050; *P*=0.370), respiratory rate (OR=1.008, 95% CI: 0.857-1.186; *P*=0.921), and pain intensity (OR=0.941, 95% CI: 0.665-1.332; *P*=0.732) were not significantly associated with the likelihood of complications. Similarly, the presence of recurrent pneumothorax (OR=0.675, 95% CI: 0.242-1.883; *P*=0.452) and incomplete lung re-expansion (OR=1.735, 95% CI: 0.291-10.333; *P*=0.545) did not show statistically significant predictive value.

Table 3. Univariable logistic regression analysis of predictors for post-removal complications

Variable	Odds Ratio (OR) [95% CI]	*P*
Age (years)	1.014 [0.992 – 1.037]	0.215
Oxygen saturation (%)	1.038 [0.894 – 1.204]	0.627
Heart rate (beats per minute)	1.016 [0.982 – 1.050]	0.370
Respiratory rate (breaths/min)	1.008 [0.857 – 1.186]	0.921
Pain intensity (VAS score)	0.941 [0.665 – 1.332]	0.732
Recurrent pneumothorax (yes)	0.675 [0.242 – 1.883]	0.452
Incomplete lung re-expansion (yes)	1.735 [0.291 – 10.333]	0.545

Discussion

In this randomized controlled trial, chest tube removal at 48 hours did not result in a statistically significant increase in post-removal complications compared with removal at 72 hours in clinically stable trauma patients.

The absolute risk differences for both recurrent pneumothorax and incomplete lung re-expansion were small, and the corresponding confidence intervals crossed zero. These findings indicate statistical uncertainty regarding the true magnitude and direction of effect. Importantly, the absence of statistical significance should

not be interpreted as evidence of equivalence or non-inferiority, as the study was not designed with a formal non-inferiority framework.

The findings of this study, which demonstrated no statistically significant difference in post-removal complications between chest tube extraction at 48 hours and 72 hours, are consistent with those of Abdulrahman *et al*., and Çobanoğlu *et al*., (10,11). Both studies, similar to ours, concluded that early chest tube removal can be safe in most patients, provided the patient is clinically stable and there are no signs of active air leak or excessive drainage. Although Çobanoğlu's study reported a higher recurrence rate of pneumothorax with earlier removal, this difference was not statistically significant in our population. This aligns with the pathophysiological understanding that, following chest trauma, if negative intrapleural pressure is adequately re-established and no ongoing air leak exists, the lungs possess a natural capacity for re-expansion without the need for prolonged tube drainage. Additionally, pain scores were comparable between the two groups, suggesting that shorter tube duration alone may not significantly influence patient discomfort. The use of the Visual Analogue Scale (VAS) for pain assessment in our study is further supported by the findings of Rezvani Amin et al., who validated the tool's reliability in a different clinical context (12), reinforcing the methodological rigor of our outcome measurement.

Furthermore, our results are in line with the broader implications of studies by El-Faramawy and Abbasi *et al*., which emphasize the role of evidence-based, patient-specific protocols in minimizing complications and optimizing care efficiency (13,14). While El-Faramawy focused on reducing complications related to chest tube insertion through standardized protocols, our study addressed whether timing of tube removal could be similarly optimized without increasing adverse outcomes. Abbasi et al. investigated mechanically ventilated trauma patients in the ICU setting, using longer removal intervals (5-7 days), yet similarly concluded that early removal is feasible under stable clinical conditions. Despite differences in study populations and timing strategies, all three studies converge on the principle that in the absence of air leak, with stable vital signs and low drainage volume, early tube removal may be both safe and clinically beneficial. From a physiological perspective, timely tube removal may reduce the risk of infection, chronic pain, or gas exchange impairment, without compromising pulmonary function. Finally, the absence of statistically significant predictors in our regression model further underscores the multifactorial nature of post-removal complications and the importance of individualized clinical assessment in decision-making.

This study has several limitations that should be acknowledged. First, it was conducted at a single center, which may limit the generalizability of the findings to other settings with different patient populations or clinical practices. Second, due to the nature of the intervention, blinding of patients and care providers was not feasible, which may have introduced some degree of performance or observation bias despite blinded outcome assessment. Additionally, the relatively small number of complication events may have limited the statistical power to detect subtle differences or identify significant predictors in regression analysis. Nevertheless, the study also has notable strengths, including its randomized design, balanced group allocation through block randomization, standardized data collection, and focus on a clinically relevant and underexplored question regarding optimal chest tube removal timing in trauma patients.

In this randomized controlled trial involving stable trauma patients, chest tube removal at 48 hours was not associated with a statistically significant increase in post-removal complications compared with removal at 72 hours. Although point estimates suggest comparable outcomes, the confidence intervals were wide, and the findings should be interpreted cautiously. Further large-scale randomized studies are warranted to confirm these results and define optimal timing strategies.

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