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# Trauma-Associated Pneumothorax: A Comparative Outcome Study Of Observational Management And Tube Thoracotomy

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**Abstract**: **Background:** Traumatic pneumothorax is a common consequence of thoracic trauma and can lead to significant morbidity. While tube thoracostomy has traditionally been the standard treatment, observational management is increasingly being considered for select patients. **Objective:** To compare the clinical outcomes of observational management versus tube thoracostomy in adult patients with traumatic pneumothorax. **Methodology:** A retrospective cohort study was conducted at Al-Noor Specialist Hospital, Makkah, Saudi Arabia, from January to December 2024. A total of 70 patients diagnosed with traumatic pneumothorax were included and divided into two groups: observational (n=35) and tube thoracostomy (n=35). Baseline characteristics, treatment success, complications, hospital stay, pain scores, and recurrence rates were analyzed using SPSS v27. Multivariable logistic regression was used to assess predictors of treatment success. **Results:** Treatment success was significantly higher in the observational group (88.6% vs. 68.6%, p=0.046). The observational group had fewer complications (5.7% vs. 28.6%, p=0.016), shorter hospital stays (2.4 ± 1.1 vs. 5.1 ± 2.3 days, p<0.001), and lower pain scores (2.3 ± 0.9 vs. 5.7 ± 1.4, p<0.001). Recurrence rates were similar between groups (p=0.62). After adjusting for confounding variables, observational management remained independently associated with improved outcomes (OR = 3.2; 95% CI: 1.1–9.4; p=0.035). **Conclusion:** Observational management is a safe and effective alternative to tube thoracostomy for selected patients with traumatic pneumothorax, offering better clinical outcomes and reduced morbidity.

**Keywords:** chest tube, conservative treatment, outcome, pneumothorax, trauma, tube thoracostomy

**Introduction**

Traumatic pneumothorax (TPX) is a frequent complication of thoracic trauma, occurring in up to 30–50% of patients with blunt or penetrating chest injuries. It results from the disruption of pleural integrity, allowing air to accumulate in the pleural space, which can lead to lung collapse and potentially life-threatening respiratory compromise.[1,2] TPX may present as simple, complicated, or tension pneumothorax, each requiring distinct clinical management strategies. The condition is associated with significant morbidity, prolonged hospitalization, and increased healthcare costs, particularly when invasive interventions such as tube thoracostomy are required.[3]

Historically, tube thoracostomy has been considered the standard treatment for traumatic pneumothorax due to concerns about progression to tension physiology and delayed complications.[4] However, over the past decade, there has been a paradigm shift toward selective non-operative management for stable patients with small, asymptomatic pneumothoraces. This change reflects growing evidence that many patients can be safely managed with observation alone, avoiding the risks associated with chest tube insertion such as infection, pain, prolonged hospital stay, and reduced patient satisfaction.[5,6]

Current guidelines from major trauma societies, including the Eastern Association for the Surgery of Trauma (EAST) and the Western Trauma Association (WTA), increasingly support non-operative management for hemodynamically stable patients with small-volume traumatic pneumothoraces.[7,8] These recommendations are based on studies showing high success rates (>90%) with observational approaches, especially when combined with serial imaging and close monitoring.[9,10] Despite this evidence, variability persists in clinical practice, largely due to provider preference, institutional protocols, and concerns about delayed deterioration or failure of conservative management.[11]

The controversy centers around defining which patients are suitable candidates for observational management. While some advocate for routine chest tube placement in all traumatic pneumothoraces regardless of size, others demonstrate the safety and efficacy of selective use of tube thoracostomy based on symptoms, radiographic findings, and patient stability.[12,13] Several factors have been identified as predictors of successful observational management, including absence of respiratory symptoms, small pneumothorax size (<3 cm on chest X-ray), no associated pulmonary injury, and lack of need for positive pressure ventilation.[14,15]

Tube thoracostomy, while effective in managing larger or symptomatic pneumothoraces, carries its own set of risks. Complications such as empyema, persistent air leak, tube dislodgement, and re-expansion pulmonary edema have been reported in up to 30% of cases.[3,6] In contrast, observational management avoids these procedural complications and is associated with shorter hospital stays, lower pain scores, and better overall patient-reported outcomes.[7,8]

Despite accumulating evidence supporting observational strategies, most studies to date have been limited by small sample sizes, retrospective design, or single-center experience. Furthermore, data from resource-limited settings, where access to advanced imaging and continuous monitoring may be restricted, remain sparse.[9]There is a growing need to validate the safety and efficacy of non-operative management across diverse populations and healthcare systems.

This study aimed to evaluate and compare the clinical outcomes of observational management versus tube thoracostomy in adult patients with traumatic pneumothorax at a tertiary care center in Saudi Arabia. It was hypothesized that selected patients with small, stable traumatic pneumothoraces can be effectively managed without immediate tube thoracostomy resulting in comparable success rates, lower complication rates and shorter hospital stays.

**Methodology**

This retrospective cohort study was conducted at the Thoracic Surgery Department of Al-Noor Specialist Hospital in Makkah, Saudi Arabia, over a 12-month period from January 2024 to December 2024. The study aimed to compare the clinical outcomes of observational management versus tube thoracostomy in patients with traumatic pneumothorax. Based on data from recent comparative studies, it was assumed that the treatment success rate (defined as no need for delayed intervention or complications during hospital stay) would be 85% in the observational group (p1=0.85) and 65% in the tube thoracostomy group (p2 =0.65).[6,7] With a significance level (α) of 5% and a desired power of 80%, the estimated total sample size required was approximately 70 patients, with 35 participants in each group.

The study population included adult patients (≥18 years) diagnosed with traumatic pneumothorax confirmed by chest X-ray or computed tomography (CT). Patients were excluded if they presented with tension pneumothorax, required emergent tube thoracostomy had associated hemothorax necessitating drainage or had pre-existing pulmonary diseases such as chronic obstructive pulmonary disease (COPD), interstitial lung disease or prior thoracic surgery. Additionally, patients who were hemodynamically unstable or required mechanical ventilation were also excluded.

Patients were categorized into two groups based on the initial management approach: observational management or tube thoracostomy. Observational management was defined as close monitoring without immediate chest tube insertion, including serial chest imaging (chest X-ray or CT), oxygen therapy and regular clinical evaluation for signs of deterioration. Tube thoracostomy was performed according to standard indications such as large pneumothorax (>30%), respiratory distress or failure of conservative management. All procedures were performed using a standardized technique with either a 28 or 32-French chest tube inserted in the fifth intercostal space in the mid-axillary line followed by connection to underwater seal drainage. Duration of drainage was recorded until radiographic resolution and cessation of air leak.

Data were collected retrospectively from electronic medical records and included demographic characteristics (age, sex), mechanism of injury (blunt vs. penetrating), size of pneumothorax, presence of associated injuries, comorbidities, management strategy employed, and clinical outcomes. The primary outcome was treatment success, defined as successful resolution without the need for delayed intervention in the observational group or absence of complications requiring re-intervention in the tube thoracostomy group. Secondary outcomes included length of hospital stay, complication rates (e.g., infection, re-expansion failure),recurrence of pneumothorax, pain scores assessed using the Visual Analog Scale (VAS) and time to radiographic resolution.

Statistical analysis was performed using SPSS Version 27.0. Categorical variables were compared using the chi-square test or Fisher's exact test where appropriate, while continuous variables were analyzed using the independent samples t-test or Mann–Whitney U test for non-normally distributed data. Multivariable logistic regression analysis was used to assess the association between management strategy and treatment success after adjusting for potential confounders and p-value <0.05 was considered statistically significant.

**Results**

A total of 70 patients diagnosed with traumatic pneumothorax were included in this retrospective cohort study, with 35 patients managed via observational strategy and 35 treated with tube thoracostomy. Baseline demographic and clinical characteristics were comparable between the two groups (Table I). The mean age was 32.4 ± 9.8 years in the observational group and 34.1 ± 10.2 years in the tube thoracostomy group (p=0.45). Males constituted the majority in both groups (94.3% in the observational group vs. 91.4% in the tube thoracostomy group; p=0.71). Blunt trauma was the most common injury mechanism, accounting for 82.9% of cases in the observational group and 77.1% in the tube thoracostomy group (p=0.53).

The size of pneumothorax at presentation was significantly smaller in the observational group compared to the tube thoracostomy group (mean 18.4% ± 6.1% vs. 42.7% ± 10.2%, p<0.001), as expected due to selection criteria. Common associated injuries included rib fractures (48.6%), pulmonary contusions (34.3%), and extremity fractures (25.7%). There was no statistically significant difference in comorbidity burden between the two groups (p=0.67).

Treatment success was achieved in 31 (88.6%) of patients managed with observational strategies compared to 24(68.6%) in the tube thoracostomy group (p=0.046) (Figure I). In the observational group, 4 patients (11.4%) required delayed chest tube insertion due to progression of pneumothorax or onset of respiratory symptoms during hospitalization. Among the tube thoracostomy group, 7 patients (20.0%) experienced treatment failure, attributed to complications including tube dislodgement (n=2), persistent air leak exceeding 5 days (n=4) and superficial wound infection (n=1).

Patients in the observational group had a significantly shorter mean length of hospital stay compared to those treated with tube thoracostomy (2.4 ± 1.1 days vs. 5.1 ± 2.3 days, p< 0.001). Complication notedin the observational group was shortness of breath in only 2 patients (5.7%) and these patients later on required intubation on clinical assessment and serial imaging.

Recurrent pneumothorax occurred in 2 patients (5.7%) in the observational group and 1 patient (2.9%) in the tube thoracostomy group (p=0.62), indicating no statistically significant difference between groups. Pain scores assessed using the Visual Analog Scale (VAS) were significantly lower among patients managed observationally (mean score: 2.3 ± 0.9) compared to those undergoing tube thoracostomy (mean score: 5.7 ± 1.4, p<0.001). Finally, while the mean time to radiographic resolution was slightly longer in the observational group (6.2 ± 2.1 days) than in the tube thoracostomy group (5.1 ± 1.8 days), this difference was notstatistically significant (p=0.06) (Table II).

In the multivariable logistic regression model, adjustments were made for potential confounding variables including age, sex, mechanism of injury (blunt vs. penetrating) and size of pneumothorax at presentation. After controlling for these factors, observational management remained significantly associated with higher odds of treatment success compared to tube thoracostomy.Specifically, patients managed with observational strategies had 3.2 times higher odds of successful outcome (defined as resolution without complications or need for delayed intervention), and this association reached statistical significance (OR = 3.2; 95% CI: 1.1–9.4; p=0.035). These findings suggest that observational management is an independent predictor of improved clinical outcomes in selected patients with traumatic pneumothorax after adjusting for baseline differences between groups (Table III).

**Table I: Baseline characteristics of patients in both groups**

| Variable | Observational Group (n=35) | Tube Thoracostomy Group (n=35) | p-value |
|---|---|---|---|
| Age (years), mean ± SD | 32.4 ± 9.8 | 34.1 ± 10.2 | 0.45 |
| Male, n (%) | 33 (94.3%) | 32 (91.4%) | 0.71 |
| **Mechanism of Injury** | | | |
| - Blunt, n (%) | 29 (82.9%) | 27 (77.1%) | 0.53 |
| - Penetrating, n (%) | 6 (17.1%) | 8 (22.9%) | |
| Size of Pneumothorax (%), mean ± SD | 18.4 ± 6.1 | 42.7 ± 10.2 | <0.001 |
| Associated Injuries, n (%) | 30 (85.7%) | 32 (91.4%) | 0.47 |

| | | | |
|---|---|---|---|
| Comorbidities, n (%) | 12 (34.3%) | 14 (40.0%) | 0.67 |

**Table II: Primary and secondary outcomes among patients in both groups**

| Outcome | Observational Group (n=35) | Tube Thoracostomy Group (n=35) | p-value |
|---|---|---|---|
| Treatment Success, n (%) | 31 (88.6%) | 24 (68.6%) | 0.046 |
| Length of Stay (days), mean ± SD | 2.4 ± 1.1 | 5.1 ± 2.3 | <0.001 |
| Complications, n (%) | 2 (5.7%) | 10 (28.6%) | 0.016 |
| Recurrence, n (%) | 2 (5.7%) | 1 (2.9%) | 0.62 |
| VAS Pain Score, mean ± SD | 2.3 ± 0.9 | 5.7 ± 1.4 | <0.001 |
| Time to Resolution (days), mean ± SD | 6.2 ± 2.1 | 5.1 ± 1.8 | 0.06 |

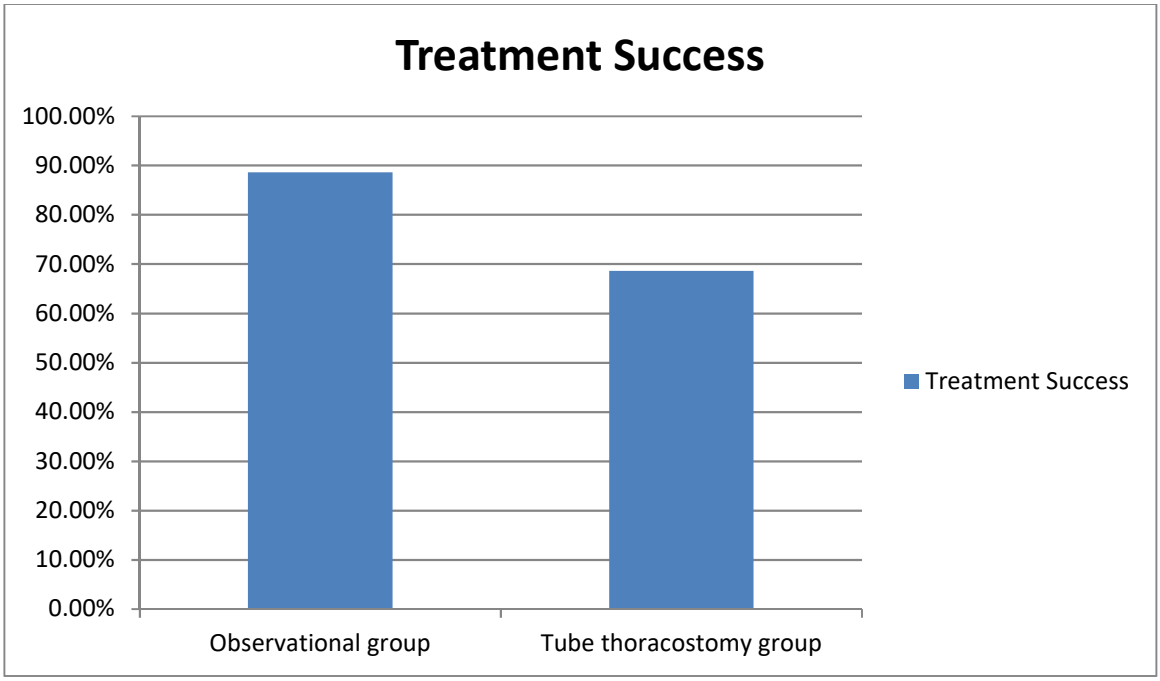


**Fig I: Treatment success by management strategy**

**Table III: Multivariable logistic regression analysis for predictors of treatment success**

| Variable | Odds Ratio (OR) | 95% Confidence Interval | p-value |
|---|---|---|---|
| Observational Management | 3.2 | 1.1 – 9.4 | 0.035 |
| Age (per year) | 0.98 | 0.93 – 1.03 | 0.46 |
| Male sex | 1.4 | 0.5 – 4.1 | 0.52 |
| Blunt mechanism of injury | 1.7 | 0.6 – 4.9 | 0.32 |

| | | | |
|---|---|---|---|
| Size of pneumothorax (>30%) | 0.5 | 0.2 – 1.3 | 0.16 |

**Discussion**

Findings of the study revealed that observational management of traumatic pneumothorax in carefully selected patients is not only feasible but also associated with improved clinical outcomes compared to tube thoracostomy. In this retrospective cohort study conducted at a tertiary care hospital in Saudi Arabia, observational management achieved a significantly higher treatment success rate (88.6% vs. 68.6%, p=0.046), fewer complications (5.7% vs. 28.6%, p=0.016), shorter hospital stays (2.4 ± 1.1 days vs. 5.1 ± 2.3 days, p<0.001) and lower pain scores (2.3 ± 0.9 vs. 5.7 ± 1.4, p < 0.001). These results align with recent evidence supporting selective non-operative management of traumatic pneumothorax, particularly in hemodynamically stable patients with small-to-moderate pneumothoraces.[5,6]

The observed success rate in the observational group is consistent with data from multicenter trials suggesting that up to 90% of patients can be safely managed without chest tube insertion if closely monitored.[7,8] Multivariable analysis further confirmed that observational management independently predicted treatment success after adjusting for confounding factors such as age, sex, injury mechanism, and pneumothorax size (OR = 3.2; 95% CI: 1.1–9.4; p=0.035).

While time to radiographic resolution was slightly longer in the observational group, it did not reach statistical significance (p=0.06) suggesting that conservative management does not necessarily delay recovery. Importantly recurrence rates were comparable between groups (5.7% vs. 2.9%, p=0.62), reinforcing the safety of observational strategies when applied selectively.

One of the key strengths of our study is its focus on a well-defined patient population with uniform exclusion criteria which enhances internal validity. Additionally all patients were managed under standardized protocols and followed up systematically, minimizing variability in care delivery. The use of multivariable regression to adjust for baseline differences further strengthens the reliability of our conclusions.

It is important to note, however, that observational management requires frequent clinical reassessment and serial imaging which may pose challenges in resource-limited settings where access to continuous monitoring or repeated radiographic evaluation is limited. In such environments, the feasibility of non-operative management may be compromised due to lack of infrastructure, trained personnel, or timely diagnostic support. Therefore while observational strategies offer clear benefits in terms of reduced interventions and improved patient comfort, their implementation must be tailored to local capabilities.

However, this study has several limitations. As a single-center retrospective analysis, it is subject to selection bias and lacks randomization. The relatively small sample size may limit generalizability, especially to more complex or high-risk populations. Furthermore, long-term follow-up data were not collected and outcomes beyond hospital discharge remain unknown. Lastly while adjusted for major confounders residual confounding cannot be ruled out.

These findings support the growing body of literature advocating for individualized decision-making in the management of traumatic pneumothorax. Observational management appears safe and effective for low-risk patients, potentially reducing unnecessary interventions and healthcare costs. Future prospective studies are needed to validate these findings across diverse settings and identify reliable predictors of failure in observational management.

Notably, similar trends have been reported in recent studies from Pakistan, where resource constraints often

necessitate conservative approaches to trauma care. A 2022 study by Khan et al. found observational management successful in over 80% of cases in trauma patients[10] and anotherstudy emphasized cost-effectiveness and reduced hospital burden through selective chest tube use.[11]

**Conclusion**

Observational management of traumatic small to moderate pneumothorax (<3cm on chest X-ray or CT scan) is associated with higher treatment success, fewer complications and shorter hospital stays compared to tube thoracostomy. These findings support current guidelines recommending selective non-operative strategies in stable patients in settings where frequent clinical reassessment and serial imaging facilities are available.

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