

Management of minimal pneumothorax in penetrating chest trauma: Is observation safe?

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ABSTRACT

BACKGROUND: Traumatic pneumothorax is one of the most common findings encountered after chest trauma and often forces clinicians to quickly decide between tube thoracostomy and observation. Although large pneumothoraces (LP), most often defined radiologically as a pleural gap greater than 2 cm, are routinely managed with chest tube drainage, the management of minimal pneumothoraces (MP) is still a matter of debate.

METHODS: In this study, we analyzed 193 consecutive penetrating thoracic trauma patients managed in our center over a five-year period (2020–2025). Patients were classified into minimal pneumothorax and large pneumothorax groups based on computed tomography (CT) findings. Clinical and radiological parameters, Injury Severity Score (ISS), complications, and hospital stay were recorded, and their associations with chest tube placement were assessed.

RESULTS: Among the 193 patients, 112 (58%) were in the MP group and 81 (42%) in the LP group. The median age was comparable between groups (30.5 years [interquartile range, IQR: 22.8–39.3] vs. 28 years [IQR: 23–39], $p=0.797$). Gender distribution was also similar, with males accounting for 93.3% in the MP group and 93.8% in the LP group ($p=1.000$). Pneumothorax size strongly influenced treatment ($p<0.001$): chest tube thoracostomy was performed in 95.1% of LP vs. 9.8% of MP cases. Conservative observation was successful in 90.2% of MP patients. LP patients had significantly longer hospital stays (8.29 vs. 4.56 days, $p<0.001$), higher ICU admission rates (27.2% vs. 5.4%, $p<0.001$), and higher ISS (21.33 vs. 13.68, $p<0.001$). Complications were more frequent in LP (24.7% vs. 0.9%, $p<0.001$), with hemothorax, persistent air leak, and pleural effusion being the most common. Most hemothorax cases were attributed to the initial penetrating trauma, while only a small minority were tube-related. Among patients with LP (>2 cm), four were managed conservatively due to their stable clinical condition, and no mortality occurred in this subgroup. Mortality occurred exclusively in the chest tube group (18/88, 20.5%), with no deaths among observed patients overall ($p<0.001$). In subgroup analysis, gunshot wounds were associated with a higher need for chest tube even in MP (20.7% vs. 6.0%, $p=0.033$).

CONCLUSION: Our findings indicate that careful observation is a safe option in patients with minimal pneumothoraces, while large pneumothoraces generally necessitate invasive treatment and are associated with worse outcomes. Our results are consistent with previous reports in the international literature.

Keywords: Conservative management; Injury Severity Score (ISS); Penetrating thoracic trauma; traumatic pneumothorax; tube thoracostomy.

Cite this article as: Duman S, Kassim R, Erdogan E, Ercan LD, Gök AFK, Özkan B, et al. Management of minimal pneumothorax in penetrating chest trauma: Is observation safe?. *Ulus Travma Acil Cerrahi Derg* 2025;31:966-970.

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Ulus Travma Acil Cerrahi Derg 2025;31(10):966-970 DOI: 10.14744/tjtes.2025.40552

Submitted: 05.09.2025 Revised: 16.09.2025 Accepted: 19.09.2025 Published: 07.10.2025

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INTRODUCTION

Thoracic trauma occurs in approximately 10–15% of all trauma patients and is responsible for up to 25–50% of trauma-related deaths, making it one of the most significant causes of morbidity and mortality in emergency practice.^[1,2] This is particularly important, as even a small lesion can alter ventilation. Following disruption of the visceral or parietal pleura—most often due to blunt or penetrating trauma—air may accumulate within the pleural cavity.^[3] In clinical practice, patients with minimal pneumothoraces can often be managed safely with observation, while larger collections usually require tube thoracostomy.^[4,5] During observation, some patients may develop severe tension pneumothorax, whereas others remain stable and resolve on follow-up without tube thoracostomy.^[6,7]

Management of traumatic pneumothorax is not uniform. While certain patients require urgent chest drainage, many can be followed safely under observation. The decision is guided mainly by pneumothorax size, hemodynamic stability, and the presence of associated thoracic injuries.^[8] A two-centimeter

threshold is commonly used in clinical practice; however, this cutoff does not always correspond with actual outcomes.^[9,10]

Given the lack of consensus regarding the management of minimal pneumothorax, we designed this study to evaluate the safety of observation without intervention, assess potential management strategies and clinical outcomes, and provide further insight to guide future practice.

MATERIALS AND METHODS

We collected the data of 193 patients with penetrating traumatic pneumothorax between 2020 and 2025. Based on initial computed tomography (CT) imaging, patients were classified into minimal pneumothorax (MP, ≤2 cm) and large pneumothorax (LP, >2 cm) according to the maximal pleural gap between the visceral pleura and chest wall. We compared demographic characteristics (age, sex), trauma-related variables (mechanism of injury, pneumothorax size), treatment modality (observation vs. chest tube thoracostomy), and clinical outcomes, including intensive care unit (ICU) admission, length of hospital stay, complications, mortality, and Injury

Table 1. Clinicopathologic features and treatment distribution according to pneumothorax size

Variable	Minimal Pneumothorax (≤2 cm)	Large Pneumothorax (>2 cm)	p-value
Number of patients, N (%)	112 (58)	81 (42)	
Age (years), median [IQR]	30.5 [22.8–39.3]	28 [23–39]	0.797
Sex			
Male, N (%)	104 (93.3)	76 (93.8)	1.000
Female, N (%)	8 (6.7)	5 (6.2)	
Intervention			
Chest tube thoracostomy, N (%)	11 (9.8)	77 (95.1)	<0.001
Observation, N (%)	101 (90.2)	4 (4.9)	
ICU admission			
Absent, N (%)	106 (94.6)	59 (72.8)	<0.001
Present, N (%)	6 (5.4)	22 (27.2)	
Length of stay (days, mean±SD)	4.56±6.5	8.29±7.2	<0.001
Complication			
Absent, N (%)	111 (99.1)	61 (75.3)	<0.001
Present, N (%)	1 (0.9)	20 (24.7)	
Complication type			
Hemothorax, N (%)	0 (0.0)	12 (14.8)	—
Persistent air leak, N (%)	0 (0.0)	5 (6.2)	—
Pleural effusion, N (%)	1 (0.9)	3 (3.7)	—
Injury Severity Score (mean±SD)	13.68±10.68	21.33±12.50	<0.001
Mechanism of injury			
Stabbing, N (%)	83 (43)	66 (34.2)	0.302
Gunshot wound, N (%)	29 (15)	15 (7.8)	

Severity Score (ISS).

This study was approved by the İstanbul University Ethics Committee (Date: 28.08.2025, Decision no: 2025/1333). The study was carried out according to the human rights principles of the Declaration of Helsinki

Statistical Analysis

Statistical analyses were conducted using SPSS software (version 29.0; IBM Corp., Armonk, NY, USA). The Kolmogorov-Smirnov test was used to determine the distribution of continuous data. Categorical variables were analyzed with the chi-square and Fisher's exact tests, as appropriate in contingency tables, whereas Student's t-test was performed for comparison of continuous variables. A p-value of <0.05 was considered indicative of statistical significance.

RESULTS

A total of 193 patients with penetrating traumatic pneumothorax were analyzed. Pneumothorax size exceeded 2 cm in 42% of cases, whereas 58% presented with a pneumothorax of 2 cm or less. The median age was 30.5 years in the minimal pneumothorax group and 28 years in the large pneumothorax group ($p=0.797$). Males constituted 104 patients (93.3%) in the MP group and 76 patients (93.8%) in the LP group.

A strong correlation was observed between pneumothorax size and treatment modality ($p<0.001$). Almost all patients with larger pneumothoraces (>2 cm) required chest tube thoracostomy (95.1%), while only a small fraction were managed conservatively. In the MP group, conservative observation failed and chest tube insertion was required in 11 cases (9.8%), whereas the majority (90.2%) resolved without inter-

vention.

ICU admission was significantly higher in the LP group compared with the MP group (27.2% vs. 5.4%, $p<0.001$).

Clinical outcomes were also influenced by pneumothorax size: LP patients had a longer mean hospital stay (8.29 vs. 4.56 days, $p<0.001$) and higher ISS values (21.33 vs. 13.68, $p<0.001$).

Overall, complications were observed in 21 of 193 patients (10.9%). The incidence was significantly higher in the LP group compared with the MP group (24.7% vs. 0.9%, $p<0.001$). In patients with LP, hemothorax was the most frequent complication ($n=12$, 14.8%), followed by persistent air leak ($n=5$, 6.2%) and pleural effusion ($n=3$, 3.7%). Of the 12 hemothorax cases, most were directly attributed to the initial penetrating trauma, whereas only two were considered tube-related bleedings. In contrast, only one complication occurred in the MP group (a pleural effusion, 0.9%) (Table 1).

Among patients with LP (>2 cm), four were managed conservatively due to their stable clinical condition, and no mortality occurred in this subgroup. Mortality was confined to patients who underwent chest tube thoracostomy, with 18 deaths among 88 patients (20.5%), whereas no deaths were observed among those managed conservatively ($p<0.001$). Overall mortality in the study population was 18 of 193 patients (9.3%) (Table 2).

Subgroup analysis according to mechanism of injury demonstrated that among patients with minimal pneumothoraces (≤ 2 cm), the need for chest tube thoracostomy was higher in gunshot injuries compared with stab wounds (20.7% vs. 6.0%, $p=0.033$). In contrast, for patients with large pneumothoraces (>2 cm), the requirement for tube thoracostomy

Table 2. Association between treatment modality and mortality

Treatment Modality	Alive, N (%)	Mortality, N (%)	Total, N (%)	p
Chest tube	70 (79.5)	18 (20.5)	88 (45.6)	<0.001
Observation	105 (100.0)	0 (0.0)	105 (54.4)	
Total	175 (90.7)	18 (9.3)	193 (100.0)	

Table 3. Treatment distribution by mechanism of injury stratified by pneumothorax size

Pneumothorax Size	Mechanism	Chest Tube N (%)	Observation N (%)	Total	p
≤ 2 cm	Stabbing	5 (6.0)	78 (94.0)	83	0.033
	Gunshot wound	6 (20.7)	23 (79.3)	29	
>2 cm	Stabbing	55 (83.3)	11 (16.7)	66	0.750
	Gunshot wound	13 (86.7)	2 (13.3)	15	

was uniformly high in both gunshot and stab wound groups (86.7% vs. 83.3%, $p=0.75$) (Table 3).

DISCUSSION

Traumatic pneumothorax remains a significant cause of morbidity and mortality in penetrating thoracic trauma, and its management continues to be a critical decision point, particularly regarding the indications for chest tube thoracostomy versus observation.^[11] Large-scale trauma registries have emphasized the prognostic importance of pneumothorax size and associated injuries.^[12]

The trauma mechanism also influenced treatment. Even small pneumothoraces in gunshot injuries often required intervention, reflecting the destructive nature of ballistic trauma, whereas stab wounds were more frequently managed conservatively.^[13]

Mortality was observed exclusively in the chest tube group, which likely reflects the higher overall injury severity in patients requiring intervention rather than the procedure itself. This supports the concept that chest tube placement is a marker of severity rather than an independent predictor of mortality.^[14]

Our study confirms that pneumothorax size is a decisive factor influencing therapeutic approach and outcomes. This is consistent with earlier reports advocating tube thoracostomy for larger or symptomatic pneumothoraces, while conservative management is safe and effective for smaller, stable cases. Both prospective and retrospective studies have demonstrated the reliability of observation in carefully selected patients. The 2 cm radiological threshold appears to be a practical and reproducible parameter that facilitates clinical decision-making.^[15]

In centers with close clinical monitoring, observation remains a safe option, as deterioration can be promptly detected and managed with tube thoracostomy when required. In contrast, in settings with limited monitoring capacity, prophylactic tube placement may serve as a safeguard against delayed recognition of deterioration.^[15]

Longer hospitalization in patients undergoing chest tube drainage parallels prior studies that associated invasive management with prolonged stay due to tube maintenance, air leak monitoring, and procedure-related risks. Similarly, the higher Injury Severity Scores in patients with large pneumothorax reflect their association with severe trauma and multiple injuries, consistent with findings that elevated ISS correlates with poorer outcomes.^[16]

Complications were more frequent in patients with large pneumothorax, with hemothorax being the most prominent complication, consistent with literature describing increased bleeding risk in penetrating trauma. The greater demand for intensive care in this group also reflects their overall physiological burden, as noted in previous series linking pneumo-

thorax size to ICU utilization.^[16-18]

In our cohort, the majority of hemothorax cases were directly attributed to the penetrating injury itself, whereas only a small minority were considered tube-related bleedings. This finding is in line with previous reports, which emphasized that iatrogenic hemothorax due to chest tube insertion is relatively uncommon (<5%).^[17,18] Therefore, the overall hemothorax rate of 14.8% in our study should primarily be interpreted as a trauma-related consequence rather than a procedure-related complication.

The overall complication profile in our study was at the lower end of the spectrum reported in the literature. Meta-analyses and large cohorts have documented complication rates varying widely depending on technique, patient selection, and institutional protocols. Importantly, standardized approaches have been shown to significantly reduce complication rates. Higher frequencies have been described in other series, and a meta-analysis highlighted the impact of tube size and technique selection on complication risk.^[18] Taken together, our findings reinforce the evidence that pneumothorax size is a decisive prognostic factor. By integrating clinical decision-making with radiological measurement, our study contributes to the understanding that accurate early assessment of pneumothorax size directly impacts hospital stay, ICU utilization, complication profile, and survival outcomes.

CONCLUSION

Pneumothorax size has a decisive impact on therapeutic strategies and clinical outcomes in penetrating chest trauma. While patients with large pneumothoraces commonly required chest tube drainage and were associated with longer hospital stays and higher complication rates, those with minimal pneumothoraces were predominantly managed safely by observation. Our study confirms that observation is a safe approach for minimal pneumothorax. These results emphasize the role of early radiologic assessment, supporting pneumothorax size as a reliable predictor in guiding initial treatment decisions.

Data Availability Statement: Following publication, the data used in this study will be made available from the corresponding author upon reasonable request, provided that the proposal is methodologically sound and consistent with the approved study objectives.

Ethics Committee Approval: This study was approved by the İstanbul University Ethics Committee (Date: 28.08.2025, Decision No: 2025/1333).

Peer-review: Externally peer-reviewed.

Authorship Contributions: Concept: S.D., A.F.K.G.; Design: S.D., E.E., R.K.; Supervision: S.D., M.K., C.E.; Resource: S.D., A.F.K.G.; Materials: S.D., M.İ., B.Ö.; Data collection and/or processing: S.D., R.K., L.D.E.; Analysis and/or interpretation: L.D.E., S.D., E.E.; Literature review: S.D., E.E., R.K.; Writ-

ing: S.D., E.E., R.K.; Critical review: S.D., M.K., C.E.

Conflict of Interest: None declared.

Financial Disclosure: The author declared that this study has received no financial support.

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ORİJİNAL ÇALIŞMA - ÖZ

Penetran göğüs travmasında minimal pnömotoraks yönetimi: Gözlem güvenli mi?

AMAÇ: Travmatik pnömotoraks, toraks travması sonrasında sık karşılaşılan bulgulardan biridir ve çoğunlukla klinisyeni tüp torakostomi ile basit gözlem arasında hızlı karar vermeye zorlar. Bilgisayarlı Tomografide (BT) pnömotoraks alanı 2 santimetreden geniş olan vakaların rutin olarak drene edilmesi yaygın kabul görmüş olsa da, minimal pnömotoraks için en uygun tedavi yaklaşımı konusunda kesin bir görüş birliği bulunmamaktadır.

GEREÇ VE YÖNTEM: Merkezimizde 2020-2025 yılları arasında takip edilen ardışık 193 penetran toraks travmalı hasta retrospektif olarak incelendi. Hastalar BT'de ölçülen pnömotoraks oranına göre minimal pnömotoraks (MP) ve geniş pnömotoraks (LP) olarak iki gruba ayrıldı. Klinik ve radyolojik parametreler, travma şiddet skorları, komplikasyonlar ve hastanede kalış süreleri kaydedildi; bunların tüp torakostomi ile ilişkisi değerlendirildi. **BULGULAR:** Toplam 193 hastanın 112'si (%58) MP grubunda, 81'i (%42) LP grubunda yer aldı. Gruplar arasında medyan yaş benzerdi (30.5 yıl [IQR 22.8-39.3] vs. 28 yıl [IQR 23-39], $p=0.797$) ve cinsiyet dağılımı da farklı değildi (erkek %93.3 vs. %93.8, $p=1.000$). Tüp torakostomi LP grubunda %95.1 oranında uygulanırken, MP grubunda yalnızca %9.8 oranında gerekliydi ($p<0.001$). MP hastalarının %90.2'si konservatif izlemle başarıyla yönetildi. LP hastalarında hastanede kalış süresi daha uzundu (8.29 vs. 4.56 gün, $p<0.001$), yoğun bakım ihtiyacı daha fazlaydı (%27.2 vs. %5.4, $p<0.001$) ve ISS değerleri daha yüksekti (21.33 vs. 13.68, $p<0.001$). Komplikasyon oranı LP grubunda anlamlı olarak daha yüksekti (%24.7 vs. %0.9, $p<0.001$); en sık görülenler hemotoraks (%14.8), persistan hava kaçağı (%6.2) ve plevral efüzyon (%3.7) idi. MP grubunda yalnızca bir hastada (%0.9) plevral efüzyon gelişti. Genel mortalite %9.3 (18/193) olup, tüm ölümler tüp torakostomi grubunda izlendi (%20.5), gözlem grubunda ölüm görülmedi ($p<0.001$). Alt grup analizinde, minimal pnömotoraks olanlarda ateşli silah yaralanmalarında tüp torakostomi ihtiyacı bıçaklanmalara göre daha yüksekti (%20.7 vs. %6.0, $p=0.033$).

SONUÇ: Bulgularımız, minimal pnömotoraksli hastalarda dikkatli gözlemin güvenli bir seçenek olduğunu, buna karşılık geniş pnömotoraks saptanan vakaların genellikle invaziv tedavi gerektirdiğini ve daha kötü klinik sonuçlarla ilişkili olduğunu göstermektedir.

Anahtar sözcükler: Konservatif tedavi; penetran toraks travması; travmatik pnömotoraks; tüp torakostomi; yaralanma şiddeti skoru.

Ulus Travma Acil Cerrahi Derg 2025;31(10):966-970 DOI: 10.14744/tjtes.2025.40552