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Original research article

RISK FACTORS AND INCIDENCE OF PNEUMOTHORAX AFTER ULTRASOUND-GUIDED THORACENTESIS

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Abstract: *The retrospective study was conducted in tertiary care hospitals between June 2021 and June 2022 to evaluate the risk factors and occurrence of pneumothorax after ultrasound-guided thoracentesis. The study included subjects with pleural effusion in whom pre-procedural thoracentesis under ultrasound guidance was performed. Outcomes were recorded, including chest tube insertion, rate of re-expansion of lungs, length of hospital stay, ICU admission, and mortality rate. Results showed that 500 65 (13%) patients developed pneumothorax. The most frequent etiologies of pleural were congestive heart failure (21%) and malignancy (55%). Multivariate analysis showed an independent association between the volume of pleural fluid drained and the occurrence of thoracentesis-associated pneumothorax (Odds ratio 1.002, 95% Confidence interval 1–1.002; P=.042). It was concluded that pre-procedural thoracentesis under US guidance is associated with a relatively high incidence of pneumothorax. Drainage of a larger volume of pleural fluid is a significant risk factor for developing pneumothorax.*

Keywords: Thoracentesis, pneumothorax, Pleural effusion, Ultrasound

Introduction

Thoracentesis is a common diagnostic and therapeutic procedure(Sperandeo et al., 2022). Generally, it can be regarded as a safe procedure; however, studies have reported thoracentesis-related pneumothorax. A systemic review reported a .62% occurrence rate of pneumothorax among 9231 patients undergoing thoracentesis(Fong et al., 2021). Thoracentesis-related pneumothorax is associated with significant morbidity and mortality(Martinez-Zayas et al., 2022; Tublin et al., 2022). Pneumothorax necessitates chest intubation in about half of the patients, which increases the length of hospital stay (Nishizawa et al., 2023). The use of ultrasound (US) during thoracentesis has decreased the incidence of pneumothorax, as the US enables the identification of pleural effusion and increases access to pleural fluid(Wang et al., 2022). Previous studies showed that US-guided thoracenteses decreased the incidence of pneumothorax from 4 to 30% to 1.2 to 6.5%(HINES et al., 2023; Martinez-Zayas et al., 2022). However, it is unclear whether or not intraoperative US guidance has additional benefits compared to pre-procedural US.

Different studies have evaluated risk factors for pneumothorax and reported that being underweight increased the risk of thoracentesis-related pneumothorax(El-Sayed et al., 2023). Multiple needle punctures and drainage volume > 1500 mL have also been associated with pneumothorax(Shechtman et al., 2020). Additionally, a study reported that the pneumothorax rate in thoracentesis performed by experienced surgeons was 3.8% compared to 8.1% performed by inexperienced operators (Shechtman et al., 2020).

There are limited studies on risk factors and prevalence of pneumothorax associated with pre-procedural US-guided thoracentesis. Thus, this study aims to evaluate risk factors and the occurrence of pneumothorax after ultrasound-guided thoracentesis.

Methodology

The retrospective study was conducted in tertiary care hospitals from between June 2021 to June 2022. The study included patients with pleural effusion who underwent pre-procedural thoracentesis under US guidance. The ethical review committee of the hospital approved the study.

All patients underwent chest X-rays after thoracentesis, and pneumothorax was diagnosed based on x-ray findings. The baseline data, including age, sex, BMI, height, weight, comorbidities, use of anticoagulants, and laboratory findings were recorded. Procedure-related information was recorded, including purpose (therapeutic or diagnostic), rate of dry taps, depth of pleural marking, previous intervention and amount and nature of the pleural fluid. Outcomes were recorded, including chest tube insertion, rate of re-expansion of lungs, length of hospital stay, ICU admission, and mortality rate. These parameters were compared between patients who did and did not develop pneumothorax.

SPSS version 23 was used for data analysis. Continuous data was represented as mean and standard deviation and was compared using a t-test. Categorical data was expressed as frequency and percentage and was compared using the Chi-square test. Multivariate regression analysis determined the association between baseline factors and pneumothorax. P value <0.05 was considered statistically significant

Results

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A total of 500 patients were included in the study. The mean age of the participants was 66.9 years, and 300 (60%) were male. Of 500, 65 (13%) patients developed pneumothorax. There was no significant difference in baseline and clinical characteristics of patients with and without pneumothorax, except rate of congestive heart failure (P=.02)

135 (27%) procedures were performed for diagnostic and 365 (73%) for therapeutic purposes. The most frequent etiologies of pleural were congestive heart failure (21%) and malignancy (55%). Thoracentesis-associated factors in subjects with and without pneumothorax are compared in Table I. Depth of pleural fluid was significantly smaller in patients who developed pneumothorax than those who did not (P=.024).

The outcomes of the procedure are summarized in Table II. Of 65 subjects diagnosed with pneumothorax, 11 (16.9%) showed lung reexpansion. The rate of mortality rate and hospital stay was significantly higher in patients diagnosed with pneumothorax. Results of multivariate analysis showed a significant association between the volume of pleural fluid drained and the occurrence of thoracentesis-associated pneumothorax (Table III).

Table I Comparison of thoracentesis-associated variables between both groups

Variable	Patients without pneumothorax (n=435)	Patients with pneumothorax (n=65)	P value
Diagnostic	125 (28.7)	10 (15.3)	0.274
Therapeutic	305 (70.1)	60 (92.3)	0.274
Bilateral procedure	10 (2.2)	4 (6.1)	0.044
Dry tap	17 (3.9)	1 [1.5]	0.925
Depth of pleural marking (cm)	3.5 ±.63	3.1±.5	0.024
Previous paracentesis	255 (58.6)	46(70.7)	0.066
≥3 previous paracentesis	133 (30.7)	25 (38.4)	0.192
Amount of fluid drained (mL)	903.4 ±537	1083 ±690.4	0.01
Transudate	100 (22.9)	19 (39.2)	0.278
Exudate	265 (60.9)	37 (56.9)	0.695
Etiology of pleural effusion			
CHF	78 (17.9)	18 (27.6)	0.074
Infectious	21 (4.8)	2 (3)	1
Malignant	230 (52.7)	38 (58.4)	0.49
Postoperative	8 (1.8)	1 (1.5)	0.881

Table II Comparison of procedure outcome between both groups

Variable	Patients without pneumothorax (n=435)	Patients with pneumothorax (n=65)	P value
Chest tube insertion	4 (0.9)	11(16.9)	<0.001
ICU admission	1(0.2)	1 (1.5)	0.803
Operation	0	0	-
In-Hospital mortality	34 (7.9)	11 (16.9)	0.032
Length of hospital stay	8.2 (±14.6)	14.1 ±22.5	0.007
Lung re-expansion	435 (100)	11 (16.9%)	<0.001

Table III: Multivariate analysis

Parameter	Odds ratio (95% CI)	Probability
Age	1.005 (.985–1.028)	0.621
Male sex	1.483 (.873–2.124)	0.206
BMI	.932 (.859–1.004)	0.058
Depth of pleural marking	.607 (.089–1.128)	0.066
CHF	1.825 (1.26–2.481)	0.077
The volume of fluid drained	1.002 (1–1.002)	0.042

Discussion

The rate of thoracentesis-related pneumothorax in our study was 13%. A previous study using portable US reported a .61% rate of thoracentesis-related pneumothorax(El-Sayed et al., 2023). Another study, in which only a few procedures were performed under US guidance, reported an 11.6% pneumothorax rate(Wang et al., 2022). Many studies have reported that US-guided thoracentesis decreased the incidence of pneumothorax(Lentz et al., 2020). In the current study, the incidence of CHF was higher in patients with pneumothorax than without it. However, according to multivariate analysis, CHF was not the independent predictor of the development of pneumothorax. In the current study, patients with lower BMI were at increased risk of developing pneumothorax. These findings are consistent with previous studies that reported an association between underweight and risk of thoracentesis and pneumothorax(Shechtman et al., 2020; Sundaralingam et al., 2022). In the current study, the BMI of the patients with and without pneumothorax did not differ significantly, which can be explained by the sample size compared to the abovementioned study. We evaluated the association between pneumothorax and thoracentesis-related factors. Unlike previous studies, we considered pre-procedural thoracentesis and factors like depth of pleural marking. The

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depth of pleural fluid was significantly smaller in patients who developed pneumothorax than those who did not. This suggests that risk-benefit analysis of thoracentesis should include consideration of pleural marking depth. Additionally, it was found that an immense amount of pleural fluid was drained from patients who ultimately developed pneumothorax. A previous study suggested that pleural pressure decreases significantly with removing a large volume of pleural fluid; visceral pleura may rupture and cause a pneumothorax(Shimoda et al., 2021). In the current study, bilateral procedures increased the risk of pneumothorax, unlike a previous study, which did not report any association between bilateral function and pneumothorax(Jackson et al., 2021).

The multivariate analysis showed a significant association between the volume of pleural fluid drained and the occurrence of thoracentesis-associated pneumothorax. This was consistent with the results of the previous study, which suggested that the procedure should not be continued after aspiration of 1500 ml of the fluid to lower the risk of pneumothorax(Stanton et al., 2020). In the current study, thoracentesis-associated pneumothorax was associated with increased length of hospital stay and mortality, as confirmed by a previous study, which found a rise in thoracentesis-related pneumothorax economic burden, morbidity, and mortality. The limitation of this study is its retrospective design and lack of data about operator experience; thus, the association between the development of pneumothorax and operator experience could not be evaluated.

Conclusion

It is concluded that pre-procedural thoracentesis under US guidance is associated with a relatively high incidence of pneumothorax. Drainage of a larger volume of pleural fluid is a significant risk factor for developing pneumothorax.

Declarations

Data Availability statement
All data generated or analyzed during the study are included in the manuscript.
Ethics approval and consent to participate.
Approved by the department Concerned.
Consent for publication
Approved
Funding
Not applicable

Conflict of interest

The authors declared an absence of conflict of interest.

References

El-Sayed, S. M., Sobeih, H. S., Ameen, D. A., and Elmetwaly, R. M. (2023). Effect of Nursing Guidelines Regarding Safe Procedure of Thoracentesis on Patients' Outcomes. *Journal of Survey in Fisheries Sciences* **10**, 1753-1778.

Fong, C., Tan, C. W. C., Tan, D. K. Y., and See, K. C. (2021). Safety of thoracentesis and tube thoracostomy in patients with uncorrected coagulopathy: a systematic review and meta-analysis. *Chest* **160**, 1875-1889.

HINES, B., SHEEHAN, K. N., and THOMAS, K. W. (2023). COMPLICATIONS AND POST-PROCEDURE IMAGING UTILIZATION AFTER THORACENTESIS. *CHEST* **164**, A5309.

Jackson, K., Kafi, O., Bhullar, D. S., Scott, J., Storey, C., Hyatali, S., Carlin, H., Brown, A., Grimshaw, E., and Miller, J. (2021). Complications after Thoracocentesis and Chest Drain Insertion: A Single Centre Study from the North East of England. *Journal of Respiration* **1**, 135-140.

Lentz, R. J., Shojaee, S., Grosu, H. B., Rickman, O. B., Roller, L., Pannu, J. K., DePew, Z. S., Debiane, L. G., Cicenia, J. C., and Akulian, J. (2020). The impact of gravity vs suction-driven therapeutic thoracentesis on pressure-related complications: the GRAVITAS multicenter randomized controlled trial. *Chest* **157**, 702-711.

Martinez-Zayas, G., Molina, S., and Ost, D. E. (2022). Sensitivity and complications of thoracentesis and thoracoscopy: a meta-analysis. *European Respiratory Review* **31**.

Nishizawa, S., Tobino, K., Murakami, Y., Uchida, K., Kawabata, T., Ota, H., Hiramatsu, Y., Sueyasu, T., and Tsuruno, K. (2023). Mortality and prognostic factors for spontaneous pneumothorax in older adults. *Plos one* **18**, e0291233.

Shechtman, L., Shrem, M., Kleinbaum, Y., Bornstein, G., Gilad, L., and Grossman, C. (2020). Incidence and risk factors of pneumothorax following pre-procedural ultrasound-guided thoracentesis. *Journal of Thoracic Disease* **12**, 942.

Shimoda, M., Morimoto, K., Tanaka, Y., Yoshimori, K., and Ohta, K. (2021). Evaluation of the position of the needle tip during thoracentesis: Experimental study. *Medicine* **100**.

Sperandeo, M., Quarato, C. M. I., Squatrito, R., Fuso, P., Dimitri, L., Simeone, A., Notarangelo, S., and Lacedonia, D. (2022). Effectiveness and safety of real-time transthoracic ultrasound-guided thoracentesis. *Diagnostics* **12**, 725.

Stanton, A. E., Edey, A., Evison, M., Forrest, I., Hippolyte, S., Kastelik, J., Latham, J., Loewenthal, L., Nagarajan, T., and Roberts, M. (2020). British Thoracic Society training standards for thoracic ultrasound (TUS). *BMJ Open Respiratory Research* **7**, e000552.

Sundaralingam, A., Bedawi, E. O., Harriss, E. K., Munavvar, M., and Rahman, N. M. (2022). The frequency, risk factors, and management of complications from pleural procedures. *Chest* **161**, 1407-1425.

Tublin, J. M., Lindquester, W. S., Dhangana, R., and Tublin, M. E. (2022). Growth in Thoracentesis and Paracentesis Performed by Radiology and Advanced Practice Providers: Medicare Volume and Reimbursement Trends From 2012 to 2018. *Journal of the American College of Radiology* **19**, 597-603.

Wang, T., Du, G., Fang, L., Bai, Y., Liu, Z., and Wang, L. (2022). Value of ultrasonography in determining the nature of pleural effusion: Analysis of 582 cases. *Medicine* **101**..