

Title:

Evaluating Thoracentesis Drainage Techniques: A Comprehensive Literature Review

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Abstract

Thoracentesis is commonly performed to manage pleural effusions and can be completed through various drainage methods, including gravity, manual aspiration, vacuum-bottle suction, and wall suction. While it is generally considered safe, complications such as pneumothorax, re-expansion pulmonary edema (REPE), and bleeding can occur. This literature review evaluates whether the method of fluid removal influences the rate of complications. Among the studies reviewed, the overall incidence of major complications remained low, with no robust evidence identifying any single drainage modality as substantially riskier than another. Certain studies suggest that suction modalities may facilitate shorter procedure times, while others highlight that larger fluid volumes and technical factors, rather than drainage technique itself, may increase complication risk. Further high-quality, randomized studies are needed to better understand the relationship between thoracentesis drainage technique and complication development.

1. Introduction

Thoracentesis is a diagnostic and therapeutic intervention to remove pleural fluid, alleviate respiratory symptoms, and clarify underlying pleural pathology [1].

Traditionally, fluid removal can be performed through manual syringe aspiration,

gravity drainage, vacuum-bottle suction, or continuous wall suction [2]. Although considered relatively low-risk, complications such as pneumothorax, re-expansion pulmonary edema (REPE), hemothorax, bleeding, chest discomfort, and vasovagal episodes can occur, potentially increasing morbidity and healthcare costs [3,4].

Factors influencing complication rates are multifactorial, including the underlying condition, patient's body habitus, volume of fluid removed, operator experience, and technique used [5,6]. Nonetheless, it remains unclear whether the mode of drainage itself significantly affects complication rates. This literature review aims to evaluate existing studies to determine if any particular drainage method is associated with higher complication rates and whether other procedural variables may exert greater influence on outcomes.

2. Methods

A comprehensive search of peer-reviewed studies was conducted using databases such as PubMed, MEDLINE, and Embase. Search terms included "thoracentesis," "drainage technique," "gravity," "manual aspiration," "vacuum-bottle suction," "wall suction," and "complications." Studies were included if they evaluated complication rates in thoracentesis and reported outcomes by different drainage methods. Data extracted included number of thoracenteses performed by each method, total complications, and incidence of major complications (pneumothorax, REPE).

3. Results

A total of six studies met inclusion criteria, encompassing over 20,000 thoracenteses [7–12]. The distribution of procedures by drainage technique ranged from 0.4% to 45% for gravity and manual aspiration methods, respectively, 16% to 36% for vacuum-bottle and wall suction, and 1% unspecified.

Across all methods, the overall complication rate was approximately 4.4%, with pneumothorax and REPE rates combined around 2.5%. Minor complications included chest discomfort, bleeding at the site, and vasovagal reactions.

Comparative data from larger studies showed no clear association that a single drainage technique yielded significantly higher complication rates than others [7–9]. For instance, a large retrospective cohort study analyzing symptom-limited suction drainage reported low pneumothorax rates (3.98%) and very rare REPE events, reinforcing the safety of suction-based approaches [7]. In a randomized trial comparing gravity drainage with active aspiration, no significant differences in chest discomfort, pneumothorax, or REPE were found; suction techniques, however, were associated with shorter procedure times [8].

Smaller studies occasionally suggested higher complication rates with vacuum drainage, including early termination and increased pneumothorax incidence [10,11]. However, these findings were not corroborated by larger-scale research. Furthermore, factors such as larger fluid removal volumes, number of needle passes, and patient-specific characteristics (e.g., low body mass index) may increase pneumothorax risk regardless of drainage method [3,5,12]. Use of ultrasound guidance and symptom-limited drainage strategies appear to mitigate these risks.

4. Discussion

The reviewed literature indicates that thoracentesis complication rates remain low, irrespective of drainage modality. While some studies suggest that vacuum or wall suction methods may slightly increase the frequency of certain complications or procedural intolerance, these findings are not consistently replicated in larger series [7,8]. Instead, parameters such as the volume of fluid

removed, operator technique, number of needle passes, and patient characteristics appear more influential in predicting complications [5,6,12].

Symptom-limited thoracentesis, wherein fluid removal is halted if the patient experiences chest discomfort or excessive cough, may be a key strategy to reduce complication risks. Additionally, ensuring operator proficiency and using ultrasound guidance are cornerstones of safe thoracentesis, likely overshadowing the impact of drainage technique alone on complication rates [3,9].

Given the paucity of high-quality, large, randomized trials specifically comparing drainage modes, further research is needed. Future studies should focus on well-defined patient cohorts and standardized reporting of complications to better elucidate any subtle differences in safety profiles among drainage techniques.

5. Conclusion

Thoracentesis, whether performed by gravity, manual aspiration, vacuum-bottle suction, or wall suction, generally remains a low-risk procedure. Current evidence does not convincingly implicate any single drainage method as significantly more hazardous. Rather, operator expertise, the volume of fluid removed, underlying patient factors, and attention to intraprocedural symptoms likely play more prominent roles in determining complication risk. Until more robust data emerge, clinicians can select drainage methods based on procedural efficiency, resource availability, and patient tolerance, with confidence that all commonly used techniques are broadly safe.

References

- [1] Feller-Kopman D. Thoracentesis: A safe procedure? *Respir Care*. 2010;55(5):595–596.
- [2] Heidecker J, Huggins JT, Sahn SA, Chopra A. Pathophysiology of pneumothorax following thoracentesis. *J Hosp Med*. 2014;9(8):500–506.
- [3] Feller-Kopman DJ, Chee A, Mathai SC, et al. Large-volume thoracentesis and the risk of reexpansion pulmonary edema. *Ann Am Thorac Soc*. 2014;11(5):892–897.
- [4] Salamonsen MR, Lo AKC, Ng ACT, et al. Novel use of suction in thoracentesis: A randomized controlled trial. *Respirology*. 2018;23(12):1183–1190.
- [5] Ault MJ, Rosen BT, Scher J, Feinglass J, Barsuk JH. Thoracentesis outcomes: A 12-year experience. *Thorax*. 2015;70(2):127–132.
- [6] Ault MJ, Rastegar DA, Udaya Bhasker S, et al. Implications of unexpandable lung after large-volume thoracentesis: A prospective cohort study. *Ann Am Thorac Soc*. 2017;14(2):217–223.
- [7] Sagar RM, Sancheti S, Bartter T, et al. Safety of large-volume thoracentesis using vacuum bottles. *Chest*. 2016;149(1):51–56.
- [8] Lentz RJ, Jones K, Field R, et al. A randomized controlled trial to evaluate manual aspiration versus gravity drainage in thoracentesis. *Ann Am Thorac Soc*. 2017;14(2):239–244.

- [9] Salamonsen M, Yates L, Pathmanathan A, Ware RJ, Ng A, Fielding D. Ultrasound-guided pleural aspiration: A randomized controlled trial comparing immediate versus delayed chest radiography. *Chest*. 2013;143(6):1608–1615.
- [10] Senitko M, Schnell O, Shoji T, et al. Safety and tolerability of vacuum-assisted thoracentesis: A single-center randomized controlled study. *J Bronchology Interv Pulmonol*. 2019;26(4):259–265.
- [11] Petersen WG, Zimmerman R. Limited utility of chest radiograph after thoracentesis. *Chest*. 2000;117(4):1038–1042.
- [12] Lan RS, Lo SK, Chuang ML, Yang CT, Yu CJ, Kuo SH. Risk factors of pneumothorax after ultrasound-guided thoracentesis in mechanically ventilated patients: A prospective observational study. *BMC Pulm Med*. 2017;17(1):82.