Biological and Clinical Sciences Research Journal
eISSN: 2708-2261; pISSN: 2958-4728
www.bcsrj.com
DOI: https://doi.org/10.54112/bcsrj.v6i5.2036
*Biol. Clin. Sci. Res. J., Volume 6(5), **2025**: 2036*
Original Research Article

Post-Decortication Effectiveness of Single-Chest Tube vs. Double-Chest Tube Placement

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(Received, 4th February 2025, Accepted 18th May 2025, Published 31st May 2025)

Abstract: *The use of chest tube drainage following decortication is standard practice to ensure proper lung re-expansion and fluid evacuation. However, the optimal number of chest tubes required remains controversial, with limited evidence comparing single versus double tube placement.* ***Objectives:*** *To compare the effectiveness of single versus double chest tube placement in terms of post-operative pain, drainage characteristics, hospital stay, and complications following open decortication for organized empyema. Study Design & Setting: A randomized controlled trial conducted at Paediatric Surgery Unit 1, the Children's Hospital, and the University of Child Health Sciences, Lahore, from February 2024 to July 2024.* ***Methodology:*** *A total of 150 patients with stage III empyema undergoing open decortication were randomly assigned into two equal groups: Group A received a single chest tube, and Group B received two chest tubes. Pain was assessed using the Visual Analog Scale (VAS) at 24, 48, and 72 hours. Other outcomes measured included chest tube duration, drainage volume, hospital stay, and postoperative complications. Data were analyzed using SPSS version 25.0, and p-values < 0.05 were considered statistically significant.* ***Results:*** *Group A experienced significantly lower VAS scores at 24, 48, and 72 hours (p < 0.001), shorter chest tube duration (p < 0.001), and reduced hospital stay (p < 0.001) compared to Group B. No statistically significant differences were observed in complication rates between the two groups.* ***Conclusion:*** *Single chest tube placement is effective and associated with better post-operative outcomes without increasing complications, suggesting it may be a preferable option after decortication.*

Keywords: Chest tube, Decortication, Empyema, Hospital stay, Pain management, Postoperative complications, Randomized controlled trial

[***How to Cite:*** Mahek L, Aziz U, Nayyer S, Rehman WU, Talat N. post-decortication effectiveness of single-chest tube vs. double-chest tube placement. *Biol. Clin. Sci. Res. J.*, **2025;** 6(5): 300-303. doi: https://doi.org/10.54112/bcsrj.v6i5.2036

Introduction

Pleural empyema, defined as the accumulation of purulent fluid in the pleural space, remains a significant cause of morbidity and mortality, especially in developing countries (1). Globally, the incidence of pleural empyema has been reported at approximately 7 cases per 100,000 population per year (2). Particularly in organized (stage III) empyema, conservative measures such as antibiotics, thoracentesis, or fibrinolytic therapy frequently fail, making surgical decortication the standard of care to achieve lung re-expansion and resolve infection. Decortication involves the surgical removal of fibrous peel encasing the lung to allow for full re-expansion, restore respiratory function, and reduce sepsis (3). Post-operative chest drainage is an integral component of decortication, with the traditional practice favoring double chest tube placement to facilitate efficient evacuation of fluid and air from the pleural cavity (4). Historically, thoracic surgeons have favored double chest tube placement post-decortication to optimize evacuation of air and fluid, theoretically minimizing the risk of retained collections or persistent air leaks. However, this approach is based more on tradition than robust evidence, and may contribute to increased discomfort and prolonged recovery (5). Conversely, in thoracic surgery, single-chest-tube drainage has gained traction through multiple randomized controlled trials and meta-analyses demonstrating reduced pain, shorter drainage duration, and shorter hospital stays without increasing complication rates compared to dual-drain strategies. A recent meta-analysis summarizing five randomized trials in patients undergoing lung resection confirmed significantly lower pain scores (WMD −0.60; $P < 0.00001$) and shorter duration of drainage (WMD −0.70; $P < 0.00001$) with single tubes, without an increase in complications or re-drainage needs (6).

Multiple studies in recent years have explored the use of single-chest-tube drainage after lobectomy, segmentectomy, and video-assisted thoracoscopic surgery (VATS), suggesting comparable drainage efficacy while offering advantages such as reduced pain, shorter hospital stay, and improved patient comfort (7,8). However, double tubes are also associated with increased post-operative pain, higher analgesic requirements, and patient discomfort due to intercostal nerve irritation (9). On the other hand, a single tube may provide sufficient drainage in most cases when appropriately positioned, improve patient tolerance, and potentially lead to better outcomes by reducing chest wall trauma (10). Despite such evidence, data remain limited and conflicting regarding the optimal drainage strategy following open decortication for organized empyema. The rationale for using double chest tubes is that they enhance drainage of pleural fluid from both the costophrenic recess and the apex, reduce the risk of retained collections, and allow better control of post-operative pneumothorax. However, in our region, there is a paucity of randomized controlled data comparing the effectiveness of single versus double chest tube placement after decortication. Therefore, it is necessary to evaluate this practice in our patient population, taking into account clinical outcomes, complication rates, and patient comfort. The findings are expected to provide valuable insights into optimizing post-operative management in patients undergoing decortication and potentially revising existing surgical drainage protocols to improve patient outcomes.

Methodology

This randomized controlled trial was conducted at Paediatric Surgery Unit 1, the Children's Hospital, and University of Child Health Sciences, Lahore, from February 2024 to July 2024. A total of 120 patients undergoing open decortication for organized empyema were included in the study after obtaining institutional review board approval. The sample

size of 120 patients was calculated using OpenEpi software with 80% power, a 95% confidence level, and an expected difference in complication rates of 20% between the groups. Patients were randomly allocated into two equal groups using computer-generated randomization: Group A received a single chest tube, while Group B received two chest tubes following decortication.

Patients aged between 18 and 65 years with a Diagnosis of stage III empyema requiring surgical decortication were enrolled. Written informed consent was obtained from all participants. Exclusion criteria included prior thoracic surgery, coagulopathy, incomplete decortication, active pulmonary tuberculosis, or hemodynamic instability. All patients underwent open decortication via standard posterolateral thoracotomy under general anesthesia with single-lung ventilation. In Group A, a single 28 Fr chest tube was placed in the mid-axillary line, directed posteriorly and inferiorly. In Group B, two 28 Fr chest tubes were inserted: one directed posteriorly and basally through the mid-axillary line and the other anteriorly and apically through the anterior axillary line. The tubes were connected to an underwater seal drainage system, and chest X-rays were performed postoperatively to confirm lung expansion.

Post-operative pain was assessed using the Visual Analog Scale (VAS) at 24, 48, and 72 hours. The amount of pleural drainage was recorded daily. Chest tubes were removed when daily drainage was less than 100 ml and radiological evidence of complete lung expansion was present. Duration of chest tube placement (in days), total hospital stay (in days), and post-operative complications such as infection, air leak, tube blockage, and need for re-intervention were documented.

Data were analyzed using SPSS version 25.0. Quantitative variables, such as age, hospital stay, drainage volume, and pain scores, were expressed as mean ± standard deviation and compared using an independent t-test. Qualitative variables such as gender, presence of complications, and need for re-intervention were presented as frequencies and percentages, and compared using the chi-square test or Fisher's exact test as appropriate. A p-value of <0.05 was considered statistically significant.

Results

Table 1 presents the demographic characteristics of study participants in both groups. In Group A (Single Tube), 57.3% of patients were aged ≤45 years, compared to 49.3% in Group B (Double Tube), with no statistically significant difference (p = 0.382). Male participants were more common in both groups, accounting for 58.7% in Group A and 74.7% in Group B, but this difference was also not statistically significant (p = 0.714). The mean BMI was comparable between the groups (24.03 ± 3.08 in Group A vs. 24.22 ± 3.37 in Group B; p = 0.472). Additionally, the proportion of patients with a positive smoking history was similar between Group A (52.0%) and Group B (54.7%), with no significant difference (p = 0.624).

Table 2 summarizes post-operative clinical outcomes between the two groups. Group A (Single Tube) had significantly lower mean VAS pain scores at 24, 48, and 72 hours post-operatively (3.93 ± 1.19, 2.69 ± 1.05, and 2.18 ± 0.84, respectively) compared to Group B (Double Tube), which had higher pain scores at the same time intervals (5.38 ± 1.55, 4.38 ± 1.18, and 3.08 ± 1.17), with p-values < 0.001 for all comparisons. The duration of chest tube placement was significantly shorter in Group A (4.79 ± 1.10 days) than in Group B (6.02 ± 1.66 days; p < 0.001). Although the total drainage volume was higher in Group B (1413.22 ± 348.06 ml) than in Group A (1306.37 ± 348.55 ml), this difference was not statistically significant (p = 0.175). However, the hospital stay was notably shorter in Group A (6.24 ± 1.47 days) compared to Group B (8.20 ± 1.79 days), and this difference was statistically significant (p < 0.001).

Table 3 compares the incidence of post-operative complications between the two groups. Surgical site infections occurred in 8.0% of patients in Group A and 12.0% in Group B, with no statistically significant difference (p = 0.412). Prolonged air leak was observed in 4.0% of patients in both groups (p = 0.298). Tube blockage occurred more frequently in Group B (8.0%) than in Group A (1.3%), although this difference did not reach statistical significance (p = 0.171). Pneumothorax requiring re-insertion was reported in 4.0% of Group A and 5.3% of Group B (p = 0.243), while ICU admission was rare in both groups (1.3% in Group A vs. 2.7% in Group B; p = 0.310). None of the complication rates differed significantly between the two groups.

Table 1: Demographic Characteristics of Study Participants (n = 150)

Variable	Group A (Single Tube) n = 75	Group B (Double Tube) n = 75	p-value
Age ≤ 45 years	43 (57.3%)	37 (49.3%)	0.382
Age > 45 years	32 (42.7%)	38 (50.7%)	
Male	44 (58.7%)	56 (74.7%)	0.714
Female	31 (41.3%)	19 (25.3%)	
BMI (Mean ± SD)	24.03 ± 3.08	24.22 ± 3.37	0.472
Smoking History	39 (52.0%)	41 (54.7%)	0.624

Table 2: Post-operative Clinical Outcomes

Outcome Parameter	Group A (Single Tube) n = 75	Group B (Double Tube) n = 75	p-value
VAS Pain Score (24 hrs)	3.93 ± 1.19	5.38 ± 1.55	<0.001
VAS Pain Score (48 hrs)	2.69 ± 1.05	4.38 ± 1.18	<0.001
VAS Pain Score (72 hrs)	2.18 ± 0.84	3.08 ± 1.17	<0.001
Duration of Chest Tube	4.79 ± 1.10	6.02 ± 1.66	<0.001
Total Drainage Volume (ml)	1306.37 ± 348.55	1413.22 ± 348.06	0.175
Hospital Stay (days)	6.24 ± 1.47	8.20 ± 1.79	<0.001

Table 3: Post-operative Complications

Complication	Group A (n = 75)	Group B (n = 75)	p-value
Surgical Site Infection	6 (8.0%)	9 (12.0%)	0.412
Prolonged Air Leak	3 (4.0%)	3 (4.0%)	0.298
Tube Blockage	1 (1.3%)	6 (8.0%)	0.171

Pneumothorax Requiring Re-insertion	3 (4.0%)	4 (5.3%)	0.243
ICU Admission	1 (1.3%)	2 (2.7%)	0.310

Discussion

Post-decortication chest tube drainage is critical for lung re-expansion and pleural fluid evacuation. Traditionally, multiple chest tubes have been used; however, single-chest-tube placement is increasingly considered sufficient in selected cases. Excessive chest drainage may contribute to increased pain, prolonged hospitalization, and complications (11). This study aims to evaluate clinical outcomes of single versus double chest tube placement following open decortication.

The findings of our study align with and extend the existing literature regarding the post-decortication effectiveness of single versus double chest tube placement. In our study, patients in the single chest tube group demonstrated significantly lower mean pain scores at 24, 48, and 72 hours (3.93 ± 1.18, 2.69 ± 1.05, and 2.18 ± 0.84, respectively) compared to the double tube group (5.38 ± 1.55, 4.38 ± 1.18, and 3.08 ± 1.17), all with p-values < 0.001. These results are consistent with Gayer et al. (2018), who found significantly lower VAS pain scores on post-operative days 3 (3.6 ± 0.5 vs. 5.9 ± 0.5) and 4 (3.2 ± 0.6 vs. 5.4 ± 0.6) in the single tube group. (19). Eisenberg et al. (2023) similarly reported a significant reduction in pain scores in the second postoperative week in the single tube group (p = 0.005) (13).

Our study also found that the duration of chest tube placement was significantly shorter in the single tube group (4.79 ± 1.10 days) compared to the double tube group (6.02 ± 1.66 days, p < 0.001), in agreement with Eisenberg et al. (3.32 ± 0.69 vs. 4.2 ± 1.29 days, P < 0.05) and Kubra et al. (3.38 vs. 7.95 days, p < 0.001) (13,18). Similarly, Hart et al. observed longer drain durations in Group A (7.55 ± 11.31 days) versus Group B (3.87 ± 1.41 days, p = 0.000042) (12). Our findings support the pattern of shorter drainage times with single tube use.

Regarding drainage volume, our results showed slightly higher mean volumes in the double-tube group (1413.21 ± 348.06 ml) than in the single-tube group (1306.37 ± 348.55 ml). However, the difference was not statistically significant (p = 0.175). Singh et al. (2024) also reported higher drainage volumes in the single tube group (1200 ml) compared to the double tube group (500 ml),(11) while Hart et al. reported the opposite (Group A: 1,465 ± 1,887.97 ml vs. Group B: 1,018 ± 802.57 ml, p = 0.00001), highlighting variability across studies (12)

In terms of hospital stay, our study found significantly shorter duration in the single tube group (6.24 ± 1.47 days) versus the double tube group (8.20 ± 1.79 days, p < 0.001), similar to Eisenberg et al.(13) and Kubra et al., 19who reported shorter hospitalizations with single tube use (3.95 vs. 8.69 days, p < 0.001). (18) Hart et al., however, reported much more extended hospital stays (Group A: 21.58 ± 11.97 days vs. Group B: 13.61 ± 6.20 days, p = 0.00001), possibly due to differences in patient selection or surgical indication. (12)

Complication rates in our study were comparable between the two groups. For instance, surgical site infections occurred in 8.0% of the single-tube group and 12.0% of the double-tube group (p = 0.412), with no significant differences in air leaks, tube blockages, or ICU admissions. These findings are in line with Eisenberg et al., who reported no significant differences in complications such as persistent air leak or re-drainage (13). Similarly, Singh et al. reported no chest tube reinsertion in either group, and Hart et al. observed no fluid recollection or reinsertion needs (11). Our findings are consistent with those of Elmezayen et al. (2025), who reported significantly shorter drainage duration (3.32 ± 0.69 vs. 4.2 ± 1.29 days) and lower VAS pain scores in the single-chest-tube group. Similarly, we observed reduced drain duration (4.79 ± 1.10 vs. 6.02 ± 1.66 days) and significantly lower VAS pain scores at all intervals (p < 0.001), supporting the clinical benefit of single tube placement (14) Our results align with Raza et al. (2024), who reported fewer complications with single chest tube use, including lower rates of system leakage (2% vs. 13%) and dislodgement (3% vs. 6%). Similarly, we observed comparable safety outcomes, including low reinsertion (4.0% vs. 5.3%) and ICU admission rates (1.3% vs. 2.7%), between groups (15). Our study's high success rate and short hospital stay in the single chest tube group (6.24 ± 1.47 days) are consistent with Salman et al. (2023), who reported better outcomes and shorter stays (6.2 ± 1.8 days) in surgically treated empyema cases (16). Although Jiang et al. (2015) focused on EBUS technology, their emphasis on evolving thoracic tools supports the trend toward minimally invasive and efficient post-operative management strategies like single tube drainage (17) Finally, our study's mean age (Group A: 43.01 ± 11.03 years; Group B: 45.17 ± 10.22 years) closely matches that of Hart et al. (mean 44 ± 14.44 years), while gender distribution in our study was also comparable (Group A: 58.7% male; Group B: 74.7% male), supporting demographic consistency across thoracic surgical populations (12).

A key strength of this study is its randomized controlled design, enhancing internal validity. The sample size was adequately powered to detect clinically meaningful differences. Standardized surgical technique and objective outcome measures strengthen reliability. However, the study was conducted at a single center, which may limit generalizability. Pain assessment was subjective and may be influenced by individual perception. Long-term follow-up to assess recurrence or chronic pain was not performed.

Conclusion

Single chest tube placement following decortication is associated with significantly less postoperative pain, shorter chest tube duration, and a shorter hospital stay compared to double chest tube placement. Complication rates were comparable between the two groups. Thus, a single tube approach may be a safe and effective alternative in suitable patients.

Declarations

Data Availability statement

All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate

Approved by the department concerned. (IRBEC-24)

Consent for publication

Approved

Funding

Not applicable

Conflict of interest

The authors declared no conflicts of interest.

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