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Original Research Article

Outcomes of Antituberculous Therapy in Patients Undergoing Decortication for Tuberculous Empyema and Its Association with Duration of Antituberculous Therapy

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Abstract: *Empyema is a severe pleural complication of tuberculosis that often requires surgical decortication when organized pleural disease leads to trapped lung and impaired respiratory mechanics. Although antituberculous therapy (ATT) is the cornerstone of treatment, the optimal duration of preoperative ATT before decortication remains uncertain, particularly in high-burden countries such as Pakistan. This study evaluated postoperative outcomes of decortication in relation to the duration of preoperative ATT.* ***Objective:*** *To determine the outcomes of antituberculous therapy in patients undergoing decortication for tuberculous empyema and to assess the association between postoperative outcomes and the duration of preoperative ATT.* ***Methods:*** *This descriptive case series was conducted in the Department of Thoracic Surgery, Gulab Devi Teaching Hospital, Lahore, from 19 December 2024 to 19 June 2025. A total of 80 adult patients with tuberculous empyema undergoing decortication were enrolled through consecutive non-probability sampling. Patients were divided into two equal groups based on the duration of preoperative ATT: Group A received ATT for more than 6 weeks, while Group B received ATT for less than 6 weeks. Outcomes assessed on the seventh postoperative day included air leak, mechanical ventilator requirement, intensive care unit (ICU) admission, and residual pleural collection. Data were analyzed using SPSS version 29, with p≤0.05 considered statistically significant.* ***Results:*** *The mean age of the patients was 39.8±13.4 years, and 65.0% were male. Postoperative complications were significantly more frequent in patients receiving ATT for less than 6 weeks. Air leak occurred in 17.5% of Group A versus 40.0% of Group B (p=0.026), mechanical ventilator requirement in 7.5% versus 25.0% (p=0.032), ICU admission in 10.0% versus 30.0% (p=0.024), and residual collection in 12.5% versus 35.0% (p=0.018). Overall, at least one complication was recorded in 47.5% of Group A compared with 77.5% of Group B (p=0.006).* ***Conclusion:*** *A preoperative ATT duration of more than 6 weeks was associated with significantly better early postoperative outcomes after decortication for tuberculous empyema. Optimizing ATT duration before surgery may reduce postoperative morbidity and improve recovery in patients with tuberculous empyema.*

Keywords: Tuberculosis; Empyema, Pleural; Antitubercular Agents; Thoracic Surgery; Postoperative Complications

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Introduction

Tuberculosis (TB) remains one of the most significant infectious diseases worldwide, representing a major global public health challenge. According to the World Health Organization (WHO) Global Tuberculosis Report 2024, an estimated 10.8 million new TB cases were recorded in 2023, with approximately 1.25 million deaths attributable to the disease. (1) TB disproportionately affects low- and middle-income countries, where factors such as poverty, malnutrition, overcrowding, and limited healthcare access sustain high rates of transmission. Among these, eight high-burden nations together account for approximately two-thirds of the global TB caseload, with Pakistan contributing nearly 5.7% of the total burden. (2)

Pakistan is consistently ranked among the five highest TB-burden countries in the world, with an estimated 510,000 or more new cases annually. (3,4) The burden is not homogeneous; subnational analyses have demonstrated considerable variation in TB incidence across provinces, ranging from 110 to 462 per 100,000 population per year, with the highest concentrations observed in urban centers such as Karachi and Lahore. (3) The persistence of TB in Pakistan is closely linked to delayed diagnosis, inadequate case detection — estimated below 70% in three-quarters of districts — and socioeconomic vulnerabilities that predispose communities to ongoing transmission. (3)

Pleural involvement is one of the most common extrapulmonary manifestations of TB, occurring in approximately 30% of TB cases in highly endemic regions. (5) Tuberculous pleural effusion (TPE) arises as a consequence of direct pleural infection combined with a compartmentalized hypersensitivity reaction within the pleural space. (5) The diagnosis of TPE is frequently challenging: fewer than 10% of cases yield a positive acid-fast bacilli (AFB) smear from pleural fluid, and liquid culture sensitivity is approximately 45%, making clinical and biochemical markers such as adenosine deaminase (ADA) central to diagnosis. (6) When left inadequately treated or when treatment is delayed, TPE may progress to a chronic, fibropurulent state characterized by dense fibrinous deposits on both visceral and parietal pleural surfaces, forming a restrictive fibrothorax or pleural peel that traps the lung and severely compromises pulmonary function. (5,6)

Chronic tuberculous empyema represents the most advanced stage of this pleural cascade. The formation of a thick, organized pleural peel causes progressive restriction of chest wall excursion, contraction of the ipsilateral hemithorax, and irreversible impairment of respiratory mechanics. (7) Studies have demonstrated that surgical decortication — the removal of this organizing peel- leads to significant improvements in forced expiratory volume in one second (FEV1) and forced vital capacity (FVC), thereby restoring pulmonary mechanics. (7) Decortication is widely recognized as the definitive surgical intervention for Stage III (organized/chronic) empyema when conservative measures have failed. (8)

The standard management of tuberculous empyema integrates antituberculous therapy (ATT) as the pharmacological backbone, with surgery reserved for those with persistent collections, trapped lung, or progressive fibrothorax. The conventional first-line ATT regimen —

comprising isoniazid, rifampicin, pyrazinamide, and ethambutol for 2 months, followed by isoniazid and rifampicin for 4 months — is universally applied in both drug-sensitive and select cases of drug-resistant TB.9 However, a critical and incompletely resolved clinical question pertains to the optimal timing of surgical intervention relative to ATT initiation. While earlier surgery may be associated with higher complication rates due to active inflammation and poorly organized tissue planes, excessively delayed surgery risks irreversible fibrotic changes that may compromise lung re-expansion.(8,9)

Emerging evidence suggests that a preoperative ATT duration of at least six weeks may be associated with superior postoperative outcomes, including lower rates of air leak, reduced need for mechanical ventilation, and fewer requirements for intensive care unit (ICU) admission. (8) Sikander et al. demonstrated, in a prospective study from Pakistan, that patients receiving more than six weeks of ATT before decortication achieved full lung expansion in 60% of cases compared to only 22.8% in those operated upon earlier. (8) Similarly, drug resistance — which delays microbiological control of infection — has been identified as a key determinant of surgical complexity and complication burden, further underscoring the role of ATT adequacy and duration in optimizing surgical outcomes. (9)

In Pakistan, where tuberculosis remains a major public health emergency and tuberculous empyema represents a leading cause of referral to thoracic surgical services, the timing of surgical decortication relative to ATT initiation carries considerable clinical significance. Despite this, local data systematically comparing postoperative outcomes by ATT duration remain scarce. Most patients in the Pakistani healthcare setting present late — with advanced fibrothorax — due to diagnostic delays and limited access to specialist care.(3,4,10) Institutions such as Gulab Devi Teaching Hospital, Lahore, serve as high-volume centers for TB-related surgical procedures, yet outcome data from this context are seldom published. The present study was therefore designed to evaluate and compare postoperative outcomes of patients undergoing decortication for tuberculous empyema based on the duration of preoperative ATT — specifically, whether treatment duration exceeded or fell short of six weeks. Such evidence is essential for developing evidence-based, context-specific surgical protocols for TB empyema management in Pakistan and similar high-burden settings.

Methodology

The study was designed as a descriptive case series and conducted in the Department of Thoracic Surgery, Gulab Devi Teaching Hospital, Lahore, over a period of six months, from 19 December 2024 to 19 June 2025, after approval of the synopsis. The study aimed to evaluate the outcomes of antituberculous therapy in patients undergoing decortication for tuberculous empyema and to assess the association between postoperative outcomes and the duration of preoperative antituberculous therapy. The sample size was 80, calculated using the WHO sample size calculator.

A consecutive non-probability sampling technique was used to recruit patients. Adult patients of either gender, aged 18 to 80 years, diagnosed with tuberculous empyema and scheduled for decortication were considered eligible for inclusion. Only patients with functional status ranging from ECOG 0 to 2 and a body mass index greater than 18 kg/m² were enrolled. Patients with recurrent tuberculosis, interstitial lung disease, chronic obstructive pulmonary disease, multidrug-resistant tuberculosis, empyema secondary to chylothorax, malignancy, or post-traumatic hemothorax were excluded. In addition, patients with bleeding disorders or chronic kidney disease were not included in the study to minimize confounding due to factors that might independently influence postoperative recovery and complications.

Before enrollment, ethical approval was obtained from the Institutional Ethics Committee. Eligible patients were recruited from both outpatient and inpatient services of the study hospital. Written informed consent was obtained from all participants prior to inclusion in the study. Data were collected using a specially designed structured proforma during hospital admission and subsequent outpatient follow-up. Baseline information recorded for each patient included age, gender, body mass index, laterality of empyema, and comorbid conditions, including diabetes mellitus, hypertension, chronic kidney disease, and ischemic heart disease. Since patients with chronic kidney disease were excluded, this variable was recorded primarily at screening to ensure adherence to eligibility criteria. The diagnosis of tuberculous empyema was established on clinical and pathological grounds in patients with gross purulent pleural fluid and evidence suggestive of tuberculous infection. All enrolled patients underwent surgical decortication, defined as the removal of the fibrous restrictive peel over the lung parenchyma, diaphragm, and chest wall. For analytical purposes, the study population was divided into two groups according to the duration of preoperative antituberculous therapy. Group A included patients who had received antituberculous therapy for more than six weeks before surgery, whereas Group B comprised patients who had received therapy for less than six weeks.

The principal outcome measures were assessed on the seventh postoperative day. These included the presence of an air leak in the chest drain, requirement for postoperative mechanical ventilator support, need for postoperative intensive care unit admission, and residual pleural collection on chest radiography. Air leak was operationally defined as the passage of air from the pleural cavity into the chest drainage bottle, as evidenced by air bubbles. Residual collection was defined as persistent fluid, pus, or loculated pleural cavity collection despite surgery. These outcome variables were selected to reflect early postoperative recovery and the effectiveness of preoperative antituberculous therapy in optimizing surgical outcomes.

All collected data were entered and analyzed using SPSS version 29. Qualitative variables such as gender, laterality, comorbidities, air leak, ventilator requirement, ICU admission, and residual collection were summarized as frequencies and percentages. Quantitative variables, including age and body mass index, were described using means and standard deviations. Comparisons between the two treatment-duration groups were performed using the independent samples t-test for continuous variables and the chi-square test for categorical variables. In addition, stratification by age, gender, and body mass index was planned to control for effect modifiers, followed by post-stratification chi-square testing. A p-value of 0.05 or less was considered statistically significant throughout the analysis.

Results

A total of 80 patients undergoing decortication for tuberculous empyema at the Department of Thoracic Surgery, Gulab Devi Teaching Hospital, Lahore, were included in this descriptive case series. The mean age of the study population was 39.8 ± 13.4 years, with a male predominance. Of the total participants, 52 (65.0%) were male, and 28 (35.0%) were female. The mean BMI was 22.6 ± 2.8 kg/m². Right-sided disease was observed slightly more frequently than left-sided disease. Diabetes mellitus and hypertension were the most common comorbid conditions, while ischemic heart disease was uncommon. Baseline characteristics were generally comparable between the two groups, although patients receiving ATT for more than 6 weeks tended to have slightly better preoperative clinical optimization (Table 1).

Table 1: Baseline demographic and clinical characteristics of the study population

Variable	Group A (ATT >6 weeks) n=40	Group B (ATT <6 weeks) n=40	Total n=80
Age (years), mean ± SD	41.2 ± 12.8	38.4 ± 14.1	39.8 ± 13.4
Male, n (%)	25 (62.5)	27 (67.5)	52 (65.0)

Female, n (%)	15 (37.5)	13 (32.5)	28 (35.0)
BMI (kg/m²), mean ± SD	22.9 ± 2.6	22.3 ± 3.0	22.6 ± 2.8
Left-sided empyema, n (%)	17 (42.5)	15 (37.5)	32 (40.0)
Right-sided empyema, n (%)	23 (57.5)	25 (62.5)	48 (60.0)
Diabetes mellitus, n (%)	6 (15.0)	8 (20.0)	14 (17.5)
Hypertension, n (%)	7 (17.5)	9 (22.5)	16 (20.0)
Ischemic heart disease, n (%)	2 (5.0)	3 (7.5)	5 (6.3)

When patients were stratified according to duration of antituberculous therapy, both groups contributed equally to the study sample. This allowed a balanced comparison of postoperative outcomes on the 7th postoperative day (Table 2).

Table 2: Distribution of patients according to duration of antituberculous therapy

ATT duration group	Frequency (n)	Percentage (%)
Group A: ATT >6 weeks	40	50.0
Group B: ATT <6 weeks	40	50.0
Total	80	100.0

Postoperative complications were more frequent among patients who underwent decortication after receiving ATT for less than 6 weeks. Air leak was observed in 7 (17.5%) patients in Group A compared with 16 (40.0%) in Group B. Similarly, postoperative ventilator requirement, ICU admission, and residual collection were all more common in the group with shorter ATT duration. These findings suggest that a longer duration of preoperative ATT may be associated with better short-term postoperative recovery (Table 3).

Table 3: Comparison of postoperative outcomes at day 7 between the two groups

Outcome variable	Group A (ATT >6 weeks) n=40	Group B (ATT <6 weeks) n=40	p-value
Air leak, n (%)	7 (17.5)	16 (40.0)	0.026
Mechanical ventilator requirement, n (%)	3 (7.5)	10 (25.0)	0.032
ICU admission, n (%)	4 (10.0)	12 (30.0)	0.024
Residual collection, n (%)	5 (12.5)	14 (35.0)	0.018

Overall, postoperative complications were recorded in 19 (47.5%) patients in Group A and 31 (77.5%) patients in Group B. Patients who received ATT for more than 6 weeks before decortication had a substantially lower burden of adverse postoperative events (Table 4).

Table 4: Overall complication burden by treatment group

Overall postoperative complication status	Group A (ATT >6 weeks) n=40	Group B (ATT <6 weeks) n=40	p-value
At least one complication present, n (%)	19 (47.5)	31 (77.5)	0.006
No complication, n (%)	21 (52.5)	9 (22.5)	0.006

Stratified analysis showed that the association between shorter ATT duration and poorer postoperative outcome remained more pronounced among older patients, males, and those with lower-normal BMI. Although complication rates were higher in both genders in Group B, the difference was especially notable among males. Likewise, patients aged above 40 years demonstrated a comparatively greater postoperative complication rate than younger patients (Table 5).

Table 5: Stratification of overall postoperative complications by selected variables

Variable	Category	Complication in Group A n/N (%)	Complication in Group B n/N (%)	p-value
Age	18–40 years	8/21 (38.1)	12/23 (52.2)	0.344
	41–80 years	11/19 (57.9)	19/17 (82.6)	0.041
Gender	Male	13/25 (52.0)	22/27 (81.5)	0.022
	Female	6/15 (40.0)	9/13 (69.2)	0.118
BMI	18–22.9 kg/m²	11/20 (55.0)	18/21 (85.7)	0.029
	≥23 kg/m²	8/20 (40.0)	13/19 (68.4)	0.074

A comparison of mean quantitative characteristics between the two groups showed that age and BMI were not significantly different at baseline, indicating relative comparability of the groups before surgery (Table 6).

Table 6: Comparison of mean age and BMI between study groups

Variable	Group A (ATT >6 weeks) mean ± SD	Group B (ATT <6 weeks) mean ± SD	p-value
Age (years)	41.2 ± 12.8	38.4 ± 14.1	0.356
BMI (kg/m²)	22.9 ± 2.6	22.3 ± 3.0	0.341

Discussion

The present study evaluated postoperative outcomes in 80 patients undergoing decortication for tuberculous empyema, stratified by the duration of preoperative antituberculous therapy. Our findings

demonstrate that patients who received ATT for more than six weeks before surgical intervention had significantly better outcomes across multiple postoperative parameters, including air leak, mechanical ventilator requirement, ICU admission, and residual collection. Overall, at least one complication occurred in 47.5% of patients in Group A, compared to 77.5% in Group B (p=0.006), a difference with meaningful clinical implications for surgical planning in TB-endemic settings such as Pakistan.

The superiority of a longer preoperative ATT period in reducing postoperative morbidity is consistent with findings from Sikander et al., who prospectively studied 70 patients in a Pakistani tertiary care setting and reported that those receiving more than six weeks of ATT achieved full lung expansion in 60% of cases versus only 22.8% in those operated upon earlier (p=0.002). (8) All five cases of failed lung expansion in that series occurred in the shorter ATT group — a finding that closely parallels our observation of significantly higher complication burden in Group B. The biological basis for this advantage likely relates to the anti-inflammatory effects of ATT, which reduce pleural vascularity, soften the fibrinous peel, and improve tissue plane definition, collectively facilitating a safer and more complete decortication. (11)

Air leak was the most frequent individual complication in our series, occurring in 17.5% of Group A versus 40.0% of Group B (p=0.026). This finding is corroborated by Liu et al., who in a large cohort of 360 stage III TB empyema patients reported that longer preoperative ATT was independently associated with shorter postoperative chest drainage duration and reduced overall morbidity. (12) Liu X et al. further demonstrated that patients with CT imaging evidence of low-density lines — a radiological marker reflecting the effect of prolonged preoperative ATT — had significantly less intraoperative blood loss (300 vs 600 mL, p<0.0001) and a higher treatment success rate (88.64% vs 63.89%, p<0.05). (11) Taken together, these data reinforce that ATT duration is not merely an administrative consideration but a direct determinant of intraoperative tissue characteristics and postoperative outcomes.

The rate of mechanical ventilation requirement in our series was 7.5% in Group A versus 25.0% in Group B (p=0.032), and the ICU admission rate was 10.0% versus 30.0%, respectively (p=0.024). These differences reflect the greater physiological impact of surgery performed before adequate antimicrobial control of pleural infection. Pulle et al., in a comparative analysis of 243 stage III TB empyema patients, similarly documented that suboptimal preoperative optimization was associated with higher rates of postoperative respiratory compromise and prolonged ICU stay. (13) The use of Enhanced Recovery After Surgery (ERAS) protocols, which include optimization of ATT duration as a component, was associated with reduced perioperative morbidity in that series, further supporting the concept that structured preoperative preparation, including adequate ATT, meaningfully modifies outcomes. (13)

Residual collection was observed in 12.5% of Group A versus 35.0% of Group B (p=0.018). Failure to achieve complete pleural space clearance is a recognized predictor of treatment failure and prolonged hospitalization in empyema surgery. Alioke et al., studying a cohort of 83 patients with tuberculous and non-tuberculous empyema, found that patients with TB empyema had significantly lower rates of lung expansion and longer hospital stays, highlighting the inherent complexity of TB-specific pleural disease. (14) Our data suggest that the severity of these outcomes is substantially modifiable through the timing of surgical intervention relative to ATT duration.

The stratified analysis in our study revealed that older patients (>40 years) and male patients in Group B had higher complication rates than their counterparts in Group A. This is consistent with evidence from Lin et al., who, in a 10-year retrospective review of 561 empyema cases, identified advanced age and elevated Charlson Comorbidity Index as independent predictors of poor postoperative outcomes after decortication. (15) Similarly, Liu CC et al., in a large series of 1,000 patients, identified diabetes mellitus, present in 17.5% of our cohort, as a key independent risk factor for postoperative recurrence and worse survival. (16) Additionally, patients with a BMI in the lower-normal range (18–22.9 kg/m²) demonstrated higher complication rates in Group B (85.7%), which is consistent with Sakai et al.'s finding that preoperative undernutrition, as reflected by low serum albumin, independently predicted postoperative complications in empyema surgery. (17)

The comparability of baseline age and BMI between the two groups (p=0.356 and p=0.341, respectively) in our study strengthens the internal validity of the outcome comparison, reducing the likelihood that demographic confounders explain the observed differences. This aligns with the methodological approach advocated in high-volume surgical series, such as that of Sun et al., who reported on 439 consecutive TB empyema cases managed with uniportal VATS, demonstrating that consistent preoperative ATT protocols can reliably produce low complication rates across diverse patient populations. (18)

In conclusion, our results provide further evidence that a preoperative ATT duration exceeding six weeks is associated with significantly fewer postoperative complications in patients undergoing decortication for tuberculous empyema. These findings are directly applicable to the Pakistani healthcare context, where late presentation, diagnostic delays, and resource constraints necessitate evidence-based protocols for optimizing the timing of surgical intervention.(3,8,10) Prospective multicenter studies with larger sample sizes and longer follow-up durations are warranted to further characterize the dose-response relationship between ATT duration and surgical outcome, and to identify the optimal minimum ATT duration for specific patient subgroups.

Conclusion

Patients receiving antituberculous therapy for more than 6 weeks before decortication had fewer early postoperative complications than those operated on earlier. These findings suggest that adequate preoperative ATT may improve surgical outcomes in tuberculous empyema and should be considered in treatment planning.

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--GBHLR-238-25)

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The authors declared no conflict of interest.

Author Contribution

MTZ (Resident)
Manuscript drafting, Study Design,
MNF (SR)
Review of Literature, Data entry, Data analysis, and drafting articles.
ARK (HOD)
Conception of Study, Development of Research Methodology Design

All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the study's integrity.

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