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2026 Volume 11, Issue 3
Advances in Precision Medicine
ISSN: 2424-9106 (Online)
ISSN: 2424-8592 (Print)

Evaluation of the Efficacy of Fibrous Board Stripping under Thoracoscopy for Chronic Empyema

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Abstract: Thoracoscopic-assisted fibrous plate debridement is a minimally invasive core surgical technique for the clinical treatment of chronic empyema. Existing studies demonstrate that single-port, single-incision, and auxiliary small incision techniques each possess distinct clinical advantages, including reduced postoperative pain perception and accelerated recovery. Minimally invasive surgery achieves comparable lung re-expansion outcomes to traditional thoracotomy while exhibiting lower complication rates and superior long-term patient recovery. The timing of surgical intervention directly impacts prognosis, with early intervention reducing procedural complexity and positively influencing pulmonary function recovery. This article provides a systematic review and synthesis of relevant research findings.

Keywords: Chronic empyema; Thoracoscopy; Fibrous board stripping; Efficacy evaluation

Online publication: March 26, 2026

1. Introduction

Chronic empyema predominantly develops from tuberculous pleurisy but may also arise from inadequate management of acute empyema. Thickened fibrous tissue within the thoracic cavity directly restricts normal pulmonary expansion. Fibrous plate debridement effectively promotes lung re-expansion and clears residual thoracic cavity space. Traditional open thoracotomy procedures exhibit significant tissue trauma and prolonged postoperative recovery periods. The clinical application of thoracoscopy-assisted techniques has provided a novel minimally invasive approach for chronic empyema management. Current clinical practice has established substantial evidence regarding surgical pathway selection, perioperative management strategies, therapeutic efficacy evaluation, and optimal operative timing. Systematic synthesis of existing research findings has yielded comprehensive review content, offering critical evidence for clinical diagnosis and treatment planning.

2. Technical characteristics and clinical applications of surgical approaches

2.1. Comparison of efficacy between single-port thoracoscopic surgery and thoracotomy

The single-port thoracoscopic technique has become a focal point in clinical research. Jiang Yuhui et al. (2023) conducted

a comparative analysis between single-port thoracoscopic surgery and open thoracotomy with fibrous plate excision in patients with chronic tuberculous empyema, demonstrating that the single-port approach resulted in lower postoperative pain scores [1]. The incision appearance was superior, while the efficacy of fibrous plate excision showed no significant difference from the open thoracotomy approach. Liu Xiaoyu et al. (2022) performed a clinical observation of fibrous plate excision under single-port thoracoscopic guidance, confirming that complete fibrous plate removal could be achieved with stable intraoperative blood loss control and shorter postoperative drainage duration [2]. Wang Zhuo et al. (2023) conducted an in-depth evaluation of the clinical value and safety of this technique, finding that lung re-expansion was effectively promoted, with a low incidence of various complications. The single-port approach did not increase operative duration, and postoperative imaging revealed ideal lung re-expansion, making it a preferred treatment option for early-stage chronic empyema [3].

2.2. Indications for laparoscopic-assisted minimally invasive surgery

In complex cases with significantly thickened fibrous boards and dense adhesions, conventional thoracoscopic procedures often encounter limitations in instrument manipulation angles. Wang Sibo et al. (2021) researched thoracoscopic-assisted minimally invasive surgery for stage III chronic empyema treatment, integrating the clear visual field of endoscopy with the flexibility of small incision techniques. This approach effectively reduced the rate of thoracotomy conversion and provided favorable long-term prognostic outcomes for patients [4]. Compared to pure thoracoscopic surgery, the minimally invasive approach demonstrates superior advantages during calcified fibrous board dissection, with successful control of recurrent instrument manipulation-induced intercostal nerve compression and no significant increase in postoperative pain levels. The study results indicate that minimally invasive techniques do not represent a regression in surgical methodology but rather constitute a pragmatic optimization strategy for complex and specialized cases.

2.3. Single-port surgery technology combined with the concept of enhanced recovery after surgery (ERAS)

To further reduce the number of incisions, single-port techniques have been progressively adopted in clinical practice. Cheng Peng et al. (2021) integrated single-port thoracoscopic surgery with accelerated recovery surgery principles in the treatment of tuberculous empyema, achieving effective control over postoperative drainage tube retention duration and hospitalization length without an increasing trend in postoperative complication risks [5]. Clinical procedures typically employ a single 2–3 cm operative port combined with an observation port, providing superior protection for intercostal nerves and surrounding muscle tissues while demonstrating outstanding trauma control outcomes. The integration of minimally invasive techniques with modern perioperative management strategies offers robust support for patient recovery, with this approach being particularly suitable for debilitated patients and elderly populations.

3. Optimization and implementation of perioperative management strategies

3.1. Specific approaches for integrating the concept of accelerated rehabilitation surgery

Cheng Peng et al. (2021) investigated and validated the feasibility of the single-incision technique, elucidating the key principles for integrating the concept of Enhanced Recovery After Surgery (ERAS), which include preoperative respiratory function training, intraoperative thermal protection and restricted fluid infusion, postoperative multimodal analgesia, and early ambulation. Multimodal analgesia is implemented using nonsteroidal anti-inflammatory drugs combined with intercostal nerve blocks, while early urinary catheter removal reduces patient physical discomfort [5]. These measures collectively mitigate surgical stress responses and facilitate early recovery of cardiopulmonary function postoperatively, establishing a practical pathway for perioperative management in thoracoscopic fibrous plate detachment surgery. All aspects of perioperative management should be coordinated comprehensively to avoid isolated or partial integration of individual components.

3.2. Postoperative drainage management and indications for drain tube removal

Refined postoperative thoracic drainage management is directly correlated with residual cavity closure and infection control. When evaluating the efficacy of video-assisted thoracoscopic fibrous plate excision, Tian Zigang et al. (2024) focused on monitoring postoperative drainage volume, drainage tube retention duration, and lung re-expansion, emphasizing that strict adherence to tube removal criteria is critical for reducing residual cavity formation and infection recurrence [6]. Similarly, Zhang Hongdu et al. (2021) proposed that drainage tube management strategies should be dynamically adjusted based on intraoperative excision extent and postoperative pleural pressure changes to avoid premature tube removal leading to empyema recurrence; maintaining appropriate negative pleural pressure postoperatively promotes lung tissue adhesion to the chest wall and shortens drainage duration [7].

4. Efficacy evaluation and safety analysis

4.1. Effect of lung re-expansion and elimination rate of residual cavities

The core indicators for evaluating the efficacy of fibrous board stripping surgery are the degree of lung re-expansion and the elimination of residual cavities. In the study by Tian Zigang et al. (2024) [6], video-assisted thoracoscopic fibrous board stripping could release compressed and restricted lung tissue, with postoperative chest X-ray examinations demonstrating ideal lung re-expansion status and a high proportion of residual cavity resolution. Data from Liu Xiaoyu et al. (2022) observed that the time required for residual cavity closure in the single-port thoracoscopic group was comparable to that in the open thoracotomy group, indicating that minimally invasive surgery does not adversely affect overall therapeutic outcomes [2]. Wang Zhuo et al. (2023) conducted a quantitative analysis of pulmonary function improvement, revealing significant enhancement in forced expiratory volume at 1 second postoperatively compared to preoperative levels, along with corresponding improvements in forced vital capacity [3]. Zhang Hongdu et al. (2021) identified a positive correlation between residual cavity closure time and fibrous board thickness during postoperative chest radiography follow-up; with cases exceeding 5 mm in fibrous board thickness exhibiting markedly prolonged residual cavity closure cycles [7]. Thoracoscopic-assisted surgery achieves lung re-expansion outcomes comparable to those of open thoracotomy.

4.2. Perioperative complications and risk of transoperative thoracotomy

Jiang Yuhui et al. (2023) reported that the incidence of postoperative complications (such as persistent pneumothorax, thoracic infection, and poor wound healing) in the single-port thoracoscopic group was not higher than that in the open thoracotomy group, with no cases requiring intraoperative conversion to open surgery [1]. Wang Sibo et al. (2021) indicated that auxiliary small incision design could reduce the rate of conversion to open surgery; thereby avoiding the greater trauma associated with open thoracotomy [4]. In Cheng Peng et al. (2021) study, the single-incision group did not experience severe complications, confirming the safety of this technique when strict indications are adhered to [5]. Liu Xiaoyu et al. (2022) similarly observed that the single-port thoracoscopic group had shorter postoperative fever duration and antibiotic usage days compared to the open thoracotomy group, suggesting milder systemic inflammatory responses [2]. Wang Zhuo et al. (2023) also found that the single-port group exhibited lower incidence of postoperative arrhythmias and pulmonary infections than the open thoracotomy group, which may be related to minimal surgical trauma and reduced pain.

4.3. Long-term prognosis and recurrence prevention

Safety evaluation is equally important as efficacy evaluation. Jiang Yuhui et al. (2023) reported that the incidence of complications such as persistent pneumothorax, thoracic infection, and poor wound healing in the single-port thoracoscopic group was not higher than that in the open thoracotomy group, with no intraoperative conversion to open surgery observed [1]. Wang Sibo et al. (2021) proposed that auxiliary small incision design could reduce the conversion rate to open surgery and minimize the greater trauma associated with thoracotomy [4]. In Cheng Peng et al. (2021) study [5], no severe complications were observed in the single-incision group, demonstrating reliable safety when strict indications are adhered to. Liu Xiaoyu et al. (2022) noted that the

single-port thoracoscopic group exhibited shorter postoperative fever duration and fewer days of antibiotic use compared to the open thoracotomy group, reflecting milder systemic inflammatory responses [2]. Wang Zhuo et al. (2023) found lower incidence rates of postoperative arrhythmias and pulmonary infections in the single-port group compared to the open thoracotomy group, suggesting potential associations with reduced surgical trauma and less pain [3].

4.4. Postoperative quality of life and functional recovery assessment

In addition to objective efficacy indicators, improvement in patients 'postoperative quality of life serves as a critical dimension for evaluating surgical value. Jiang Yuhui et al. (2023) compared single-port thoracoscopic surgery with open thoracotomy without directly employing standardized quality of life scales, observing reduced postoperative pain scores and superior incision aesthetics, which indirectly suggests that minimally invasive surgery has a lesser impact on patients' daily activities and psychological status [1]. Cheng Peng et al. (2021) demonstrated that integration of accelerated recovery surgery principles resulted in earlier ambulation time and shorter hospital stays, mitigating muscle atrophy and physical decline associated with prolonged bed rest [5]. Wang Sibo et al. (2021) found through follow-up that patients undergoing thoracoscopic-assisted small-incision surgery achieved preoperative-level daily functional recovery at 6 months postoperatively, with no significant chest wall deformity or chronic pain [4].

5. Selection of surgical timing and its impact on therapeutic outcomes

5.1. Efficacy differences between early surgery and late surgery

The timing of surgical intervention significantly impacts the efficacy of fibrous board debridement. Zhang Hongdu et al. (2021) investigated the optimal surgical timing for thoracoscopic drainage combined with fibrous board debridement in the treatment of empyema, finding that patients undergoing surgery within 3 months of disease onset exhibited faster lung re-expansion rates and shorter postoperative drainage durations [7]. Yang Wenrong et al. (2021) [8] compared the therapeutic outcomes of chronic tuberculous empyema treated at different surgical timings, demonstrating that early surgical intervention resulted in superior postoperative pulmonary function recovery and lower complication rates compared to delayed surgery. The latter group exhibited prolonged hospital stays and increased intraoperative blood loss, with delayed surgery posing greater therapeutic challenges and medical burdens.

5.2. Influence of disease duration on the difficulty of fibrous board detachment

Prolonged disease course leads to thickening and calcification of the fibrous plate, which subsequently forms dense adhesions with lung tissue. Yang Wenrong et al. (2021) conducted an in-depth analysis of this pathological process and found that patients with a disease duration exceeding 12 months exhibited increased intraoperative dissection difficulty, greater blood loss, and a higher propensity for lung tissue lacerations [8]. Such cases require separation using an ultrasonic scalpel or electric hook, resulting in correspondingly extended operative time. Surgical intervention is less challenging and carries lower risks when the fibrous plate has not fully calcified. Zhang Hongdu et al. (2021) concurred with this perspective, advocating for early evaluation of surgical indications upon diagnosis of chronic empyema to avoid missing the optimal window for minimally invasive surgery due to excessive delay [7].

5.3. Clinical Criteria for Optimal Surgical Timing

The optimal timing for surgery should be determined based on imaging findings and clinical symptoms. Yang Wenrong et al. (2021) proposed that when imaging demonstrates uniform fibrous plate thickness without significant calcification and systemic toxic symptoms are largely controlled, this represents an ideal surgical window [8]. Zhang Hongdu et al. (2021) held a different view, emphasizing that if lung re-expansion remains suboptimal after standardized anti-infective therapy, prompt surgical intervention is necessary without undue delay [7]. Preoperative completion of at least two weeks of effective anti-tuberculosis treatment is essential to reduce postoperative infection risk. Performing thoracoscopic-assisted

fibrous plate excision within 3 to 6 months of disease onset yields the optimal risk-benefit ratio. For younger patients with good general condition, surgical indications may be appropriately relaxed.

6. Conclusion

Thoracoscopic fibrous plate debridement for the treatment of chronic empyema demonstrates minimal invasiveness, rapid recovery, and low complication rates, as confirmed by existing studies. Techniques such as single-port approach, single operative incision, and auxiliary small incisions each have specific indications and should be selected individually based on fibrous plate thickening and adhesion status. The integration of accelerated recovery surgery principles can further improve overall outcomes, particularly in postoperative pain management and early mobilization. Surgical timing directly impacts prognosis, with early intervention reducing operative difficulty and enhancing pulmonary function. Subsequent large-scale prospective studies are still required to refine technical protocols and establish standardized criteria for timing selection.

Disclosure statement

The authors declare no conflict of interest.

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