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Precision in Diagnosis, Excellence in Treatment: The Dual Impact of VATS in Blunt Thoracic Trauma

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Abstract: ***Background**: Blunt thoracic trauma is a significant cause of morbidity and mortality, commonly resulting in rib fractures, pneumothorax, hemothorax, and lung contusions. Video-Assisted Thoracoscopic Surgery (VATS) has emerged as both a diagnostic and therapeutic tool for managing these injuries. VATS offers enhanced visualization, enabling early detection of complications missed by imaging, and reduces morbidity and mortality through timely intervention. **Methods**: This prospective, hospital-based study was conducted at IGGMCH, Nagpur, from May 2022 to November 2024. A total of 30 patients with blunt thoracic trauma were screened, with 20 meeting the inclusion criteria. Patients were randomized into two groups: those treated with VATS and those undergoing a combination of VATS and open thoracotomy. Post-operative outcomes, including pain (Visual Analog Scale), hospital stay, and complications, were analyzed. **Results**: VATS identified diaphragmatic tears and occult lung lacerations in 20% of patients that were missed by radiological imaging. The VATS group had a shorter mean operative time (210 ± 90 minutes), less intraoperative blood loss (600 ± 150 mL), and significantly better post-operative outcomes, including shorter hospital stays. (12 ± 4 days) and lower pain scores (VAS: 5 ± 1.5), compared to the VATS + open thoracotomy group. **Conclusion**: VATS proves to be an invaluable tool for both diagnosing and treating blunt thoracic trauma. By facilitating early detection and intervention, VATS reduces morbidity and accelerates recovery, making it the preferred approach in stable patients.*

Keywords: Blunt thoracic trauma, Video-Assisted Thoracoscopic Surgery (VATS), rib fractures, pneumothorax, hemothorax, lung contusions, diagnostic tool, therapeutic intervention, morbidity, mortality, diaphragmatic tears, occult lung lacerations, prospective study, operative outcomes, Visual Analog Scale (VAS), hospital stay, complications, randomized trial, open thoracotomy, early detection.

1. Introduction

Chest trauma is becoming increasingly common, particularly due to the rise in vehicular accidents. Blunt trauma to the chest can cause rib fractures, pneumothorax, and hemothorax, posing significant threats to the airway, respiratory function, and circulatory stability. Polytrauma is a significant public health issue, with trauma being a leading cause of death and disability in individuals under 40 years old. Effective and timely management, particularly with procedures like VATS, can improve patient outcomes

2. Materials and Methods

This prospective, hospital-based study was conducted between May 2022 and November 2024 at IGGMCH, Nagpur. The study population consisted of patients presenting with blunt thoracic trauma. A total of 30 patients were initially screened, of whom 20 were included in the final analysis based on specific inclusion and exclusion criteria.

The inclusion criteria required patients to be hemodynamically stable, presenting with blunt thoracic trauma, and having indications for thoracic exploration. Indications included persistent pneumothorax despite chest tube drainage, retained clotted hemothorax unresolved by tube thoracostomy, suspected diaphragmatic injuries based on clinical or radiological findings, and ongoing hemorrhage that required surgical intervention (defined as an initial chest drain output of ≥1500 mL or a continuous bleeding rate of more than 300 mL per hour over three hours). Patients between the ages of 18 and 60 years were considered for inclusion. Conversely, exclusion criteria comprised hemodynamically unstable patients who required immediate resuscitative thoracotomy, polytrauma patients with extensive injuries to other organs, individuals with penetrating thoracic trauma, those with significant coagulopathies or chronic respiratory conditions that could interfere with the study's outcomes, as well as pregnant women and individuals unable to provide informed consent.

Upon admission, all patients underwent an initial assessment using the ABCD protocol as per the Advanced Trauma Life Support (ATLS) guidelines. Following stabilization, radiological investigations were performed, starting with chest X-rays to identify pneumothorax, hemothorax, and rib fractures. Ultrasound via a focused assessment with sonography for trauma (FAST) was used to assess for hemothorax or pericardial effusion. CT scans were employed selectively for stable patients when the suspicion of internal thoracic injuries was not adequately addressed by chest X-rays or ultrasound.

The primary outcome measurement for this study is the efficacy of Video-Assisted Thoracoscopic Surgery (VATS) in diagnosing and managing thoracic injuries. This is evaluated through procedural success rates and postoperative outcomes, including morbidity and mortality. Secondary outcome measurements include postoperative recovery metrics, such as the length of hospital stay, as well as the incidence of complications like empyema, pneumonia, atelectasis, and wound infections.

Patients were divided into two groups based on the type of surgery they received: Video-Assisted Thoracoscopic Surgery (VATS) or a combination of VATS and open thoracotomy. For the VATS group, patients were positioned in the lateral decubitus position with the affected side elevated, and general anesthesia was administered, incorporating double-lumen intubation to achieve single-lung ventilation for optimal visualization of the thoracic cavity. Typically, 2 to 3 small ports were created, with one port dedicated to the camera (a 10-mm thoracoscope) and the others used for surgical instruments. The pleural cavity was carefully inspected to identify injuries such as diaphragmatic tears, lung lacerations,

and retained clotted hemothorax. Suction and forceps were used to remove clots, while minor lung lacerations were repaired using endoscopic sutures. Diaphragmatic tears were closed with endoscopic sutures, and in cases of pneumothorax, a detailed inspection for air leaks was conducted, with any leaks identified being repaired. Post-procedure, a chest drain was inserted, and the incisions were closed with sutures.

In the group that underwent a combination of VATS and open thoracotomy, patients with more severe or complex injuries that required more extensive intervention initially underwent VATS. If the injuries proved too severe for VATS alone or if bleeding was difficult to control, conversion to open thoracotomy was performed. In these cases, a posterolateral thoracotomy was carried out, allowing better exposure to manually evacuate clots, repair large lung lacerations, or address more complex injuries.

Data collected from both groups included operative time, intraoperative blood loss (measured by weighing surgical sponges and suction container volumes), conversion rates from VATS to open surgery, and post-operative outcomes. Post-operative outcomes were assessed in terms of pain, measured using the Visual Analog Scale (VAS) on postoperative days 1, 3, and 7. Additionally, the total duration of hospital stay, along with any post-operative complications such as wound infections, pneumonia, atelectasis, and sepsis, were recorded.

Following discharge, patients were monitored at regular intervals to assess for late complications such as chronic pain, persistent air leaks, or the recurrence of pneumothorax. Any further interventions required were also documented.

Stastical analysis of patient demographics and clinical characteristics was done. Chi-square tests were used for categorical variables, and T-tests or Mann-Whitney U tests for continuous variables, depending on distribution. Kaplan-Meier curves and log-rank tests analyzed survival, while multivariate logistic regression identified predictors of postoperative complications and mortality, adjusting for confounders. Statistical significance was set at $p<0.05$.

3. Observations and Results

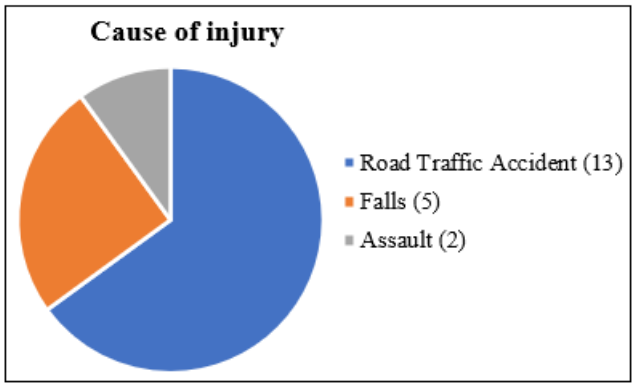
This prospective study examined 20 patients who suffered blunt thoracic trauma and underwent either Video-Assisted Thoracoscopic Surgery (VATS) or a combination of VATS and open thoracotomy. The results of the study were divided into demographic analysis, pre-operative assessments, intraoperative findings, and post-operative outcomes.

Demographic Analysis

The majority of patients were males (70%) aged between 20 and 40 years, with a mean age of 30.4 ± 11.1 years. Road traffic accidents were the primary cause of injury in 65% of cases, followed by falls and assaults.

Table 1: Demographic Profile of Patients

Total Patients (N)	20
Mean Age	30.4 ± 11.1 years
Male to Female Ratio	7:3



Pre-Operative Assessments

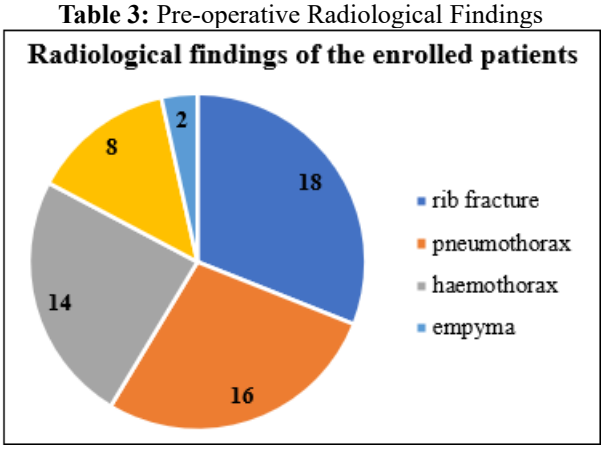
Pre-operative stabilization was carried out in all patients, with all receiving intercostal chest drains, 40% receiving blood transfusions, and 10% requiring ventilator support.

Table 2: Pre-operative Stabilization Methods

Stabilization Method	Patients (%)
Intercostal Chest Drain	20 (100%)
Blood Transfusion	8 (40%)
Ventilator Support	2 (10%)

Most patients presented within the first 4 hours of injury, and all underwent radiological assessments, which revealed rib fractures (90%) and pneumothorax (80%) as the most common injuries. However, radiological investigations such as chest X-rays and CT scans missed some internal thoracic injuries, which were later identified through VATS like diaphragmatic injuries and lung contusions

Table 3: Pre-operative Radiological Findings



Diagnostic Value of VATS

One of the key findings of this study was the diagnostic superiority of VATS in identifying thoracic injuries that were missed by initial radiological investigations. In 20% of patients, VATS identified diaphragmatic tears, small clotted hemothoraces, and occult lung lacerations that were not visible on chest X-rays or CT scans. These findings support the utility of VATS as a diagnostic tool in trauma cases where radiological imaging may fail to detect subtle but clinically significant injuries.

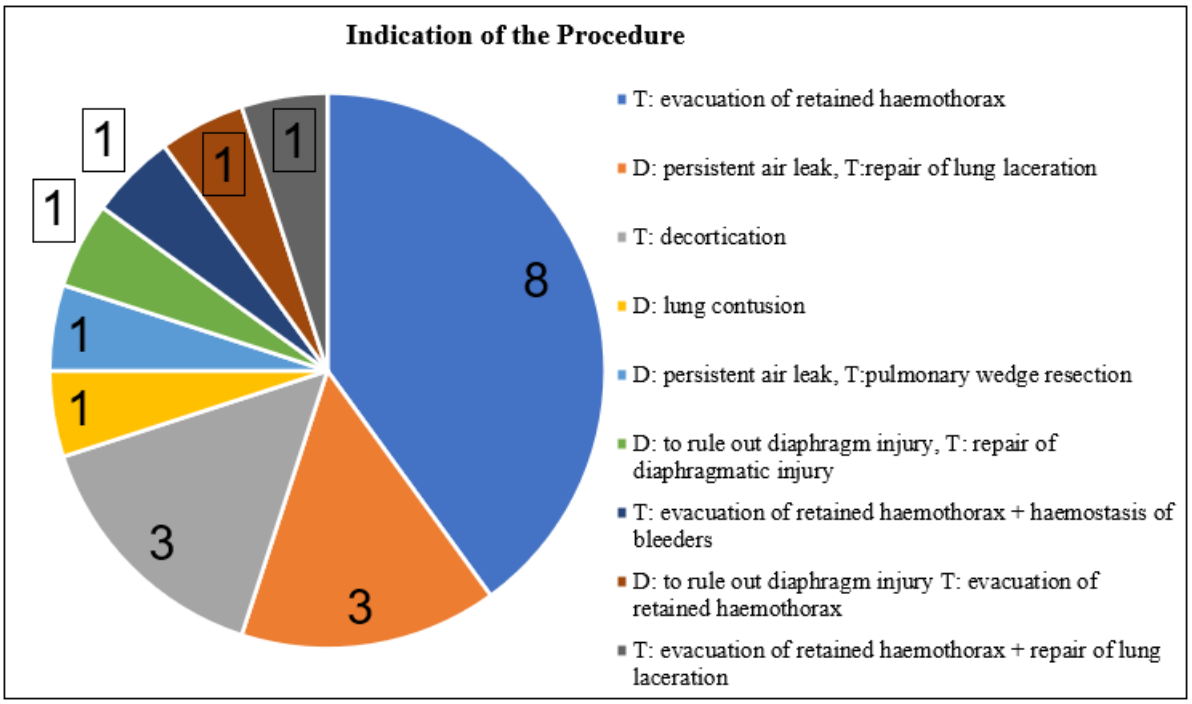
Table 2: Injuries Detected by VATS Missed by Radiological Investigations

Injury Detected by VATS	Patients (%)
Diaphragmatic Tears	3 (15%)

Clotted Hemothorax	2 (10%)
Occult Lung Lacerations	1 (5%)

Indications Of VATS

Video-Assisted Thoracoscopic Surgery (VATS) is indicated in blunt thoracic trauma primarily for managing persistent pneumothorax unresponsive to chest tube drainage, retained clotted haemothorax, and suspected diaphragmatic injuries that imaging fails to confirm. It allows for direct visualization and repair of air leaks, evacuation of haemothorax, and identification of occult injuries like lung lacerations. VATS is also useful in cases of ongoing but controlled haemorrhage, providing a less invasive alternative to open thoracotomy. Its advantages include better visualization, fewer post-operative complications, and shorter recovery times, making it the preferred approach for stable patients.



Intraoperative Findings

Patients were divided into two groups: those treated with VATS and those treated with a combination of VATS and open thoracotomy. The VATS group showed significantly better intraoperative outcomes in terms of operative time, blood loss, and ease of procedure.

Table 3: Intraoperative Findings and Comparisons

Parameter	VATS	VATS converted to Open
Mean Operative Time (mins)	210 ± 90	340 ± 120
Blood Loss (mL)	600 ± 150	950 ± 300

VATS allowed for better visualization and minimally invasive management of thoracic injuries such as pneumothorax, clotted haemothorax, and lung lacerations. Additionally, the use of VATS in diagnosing diaphragmatic tears, occult lung lacerations, and retained haemothorax provided significant clinical benefits, as these injuries were not identified through initial radiological assessment.

Post-Operative Outcomes

Post-operative outcomes were more favorable for the VATS group compared to the VATS + open group, with significantly lower pain scores, faster recovery, and shorter hospital stays[3].

Table 4: Post-Operative Observations in VATS vs. VATS + Open Surgery

Parameter	VATS	VATS converted to Open
Post-op Pain (VAS Score)	5 ± 1.5	8 ± 2
Hospital Stay (Days)	12 ± 4	28.5 ± 10
Post-op Complications	15%	35%

Post-operative pain, as measured by the Visual Analog Scale (VAS), was significantly lower in patients undergoing VATS (mean VAS score 5 ± 1.5) compared to the VATS + open group (VAS score 8 ± 2). Similarly, the hospital stay was notably shorter for the VATS group (12 ± 4 days) compared to the VATS + open group (28.5 ± 10 days).

Complications

The rate of complications was higher in the VATS + open group, with 35% experiencing post-operative issues such as wound infections, pneumonia, or atelectasis, compared to 15% in the VATS group. One mortality occurred in the VATS + open group due to post-operative sepsis.

Table 5: Post-Operative Complications

Complication	Patients (%)
Wound Infection	3 (15%)
Pneumonia	4 (20%)
Atelectasis	2 (10%)
Sepsis (Mortality)	1 (5%)

4. Discussion

Blunt chest trauma is a significant cause of morbidity and mortality[1]. worldwide, particularly in younger populations involved in high-velocity incidents, such as road traffic accidents. The management of thoracic trauma has evolved over time, with a shift towards minimally invasive techniques like Video-Assisted Thoracoscopic Surgery (VATS) replacing traditional open thoracotomy in many cases. This study sought to evaluate the efficacy of VATS in managing blunt thoracic injuries, comparing it with combined VATS and open surgery in terms of operative outcomes, post-operative recovery, and complication rates.

VATS as a Minimally Invasive Approach

In this study, VATS showed significant advantages over open thoracotomy, particularly in terms of reduced operative time, blood loss, and post-operative recovery. The VATS group had a mean operative time of 210 ± 90 minutes, which was significantly shorter than the 340 ± 120 minutes for patients undergoing a combination of VATS and open thoracotomy. This finding is consistent with Flagel et al. (2005), who also reported reduced operative times for minimally invasive procedures in chest trauma, highlighting that shorter operative times are associated with better patient outcomes and reduced complications.

Blood loss was another key parameter where VATS demonstrated superiority, with an average blood loss of 600 mL, compared to 950 mL in the VATS + open group. The minimally invasive nature of VATS, which involves smaller incisions and more targeted surgical techniques, is likely the reason for this reduced blood loss. These findings align with studies by De Moya et al. (2004), who similarly observed that VATS resulted in less intraoperative blood loss compared to open procedures, reducing the overall physiological stress on patients.

Post-Operative Recovery and Hospital Stay

Post-operative recovery was notably faster in the VATS group. The average hospital stay for patients undergoing VATS was 12 ± 4 days, compared to 28.5 ± 10 days for those who had combined VATS and open thoracotomy. This reduced recovery time mirrors the findings of Kumar et al. (2005), who also reported shorter hospital stays[3]. with minimally invasive approaches. In both studies, the faster recovery is attributed to the less traumatic nature of VATS, which involves smaller incisions, less tissue dissection, and faster mobilization of patients.

Pain management is a critical factor in post-operative care, especially in thoracic surgery. In this study, the VATS group reported significantly lower post-operative pain scores (VAS score of 5 ± 1.5) compared to the VATS + open group (VAS score of 8 ± 2). This is consistent with previous literature, including Nayyar et al. (2007), which emphasized the benefits of minimally invasive techniques in reducing post-operative pain and facilitating faster patient mobilization. Early mobilization reduces the risk of complications such as pneumonia, atelectasis, and deep vein thrombosis, all of which are more common in open surgery patients.

Complications and Mortality

The complication rates were lower in the VATS group compared to the VATS + open group. In this study, only 15% of patients in the VATS group experienced complications, such as minor wound infections or transient atelectasis, compared to 35% in the VATS + open group. One patient in the VATS + open group succumbed to post-operative sepsis, emphasizing the increased risks associated with more invasive procedures.

The most common indication for VATS in trauma, and intervention that is best supported by data, is evacuation of retained hemothorax. The use of VATS is also well supported and commonly utilized in acute hemothorax in a hemodynamically stable patient, persistent pneumothorax or prolonged air leak, diagnosis and treatment of hemopericardium in select patients, and diagnosis and treatment of diaphragm injuries as is also seen in a studty by John Duggan et al. (2024) [1]

Studies by Flagel et al. (2005) also indicated that patients with more than six rib fractures, a common injury in blunt chest trauma, were at significantly higher risk for complications, including pneumonia and acute respiratory distress syndrome (ARDS). [2] The present study confirms these findings, as patients in the VATS + open group, who had more complex injuries (such as multiple rib fractures and haemothorax), exhibited a higher incidence of post-operative complications, including pneumonia and atelectasis.

Comparative Analysis with Existing Literature

The findings of this study align with several existing studies that emphasize the advantages of VATS in trauma surgery and highlights that VATS not only reduces hospital stay and post-operative pain but also lowers complication rates when compared to open thoracotomy. This is particularly evident in stable patients with injuries such as clotted haemothorax and persistent pneumothorax, where VATS is highly effective in preventing complications.

While open thoracotomy remains the standard approach for hemodynamically unstable patients or those with massive chest trauma, the findings of this study reinforce the notion that VATS should be the first-line intervention for stable patients with less severe injuries. The evolution of minimally invasive techniques, including single-port VATS and robotic-assisted thoracic surgery, continues to push the boundaries of what can be achieved in trauma surgery, improving outcomes for patients with thoracic injuries.

5. Limitations and Future Directions

Although this study provides valuable insights into the efficacy of VATS in managing blunt thoracic trauma, it is limited by its small sample size and the single-center nature of the research. Larger, multi-center studies are needed to validate these findings and explore the long-term outcomes of VATS versus open thoracotomy in trauma settings. Also comparatively more complicated cases were eventually converted to open thoracotomy. Additionally, future studies could focus on the cost-effectiveness of VATS in trauma care, given its potential to reduce hospital stays and post-operative complications.

6. Conclusion

The findings of this study emphasize that VATS not only serves as a minimally invasive therapeutic option but also plays a crucial role in the early diagnosis of traumatic injuries that are often missed on CT scans. In particular, diaphragmatic tears, clotted hemothoraces, and occult lung lacerations were identified intraoperatively with VATS, highlighting its superior diagnostic capability in trauma settings where initial radiological imaging may fail to detect subtle yet clinically significant injuries. This study is especially the first of its kind in India, where traditionally open approach is still preferred over VATS. The early detection and management of these injuries through VATS is critical in reducing morbidity and mortality, as timely intervention can prevent complications such as persistent pneumothorax, delayed hemothorax, and subsequent infection. By offering both diagnostic and therapeutic benefits, VATS reduces the need for more invasive procedures like thoracotomy, thereby lowering the physiological stress on patients, decreasing the risk of complications, and facilitating faster recovery. As surgical techniques evolve and more clinicians recognize the diagnostic advantages of VATS in trauma care, its role in improving patient outcomes by enabling early and accurate diagnosis of blunt thoracic injuries is expected to expand significantly.

Legend:

VATS	Video assisted thoracic surgery
VAS	Visual Analogue scale

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