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Outcome of Video Assisted Thoracic Surgery in the Diagnosis of Pleural Effusion

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Abstract **Original Research Article**

***Background*:** Video-Assisted Thoracic Surgery (VATS) has emerged as a significant diagnostic tool for unexplained pleural effusions. This study evaluates the diagnostic yield, safety profile, and clinical utility of VATS in the investigation of pleural effusions through analysis of 50 consecutive cases. ***Methods*:** A retrospective observational study was conducted involving 50 patients who underwent VATS for unexplained pleural effusions between 1st January 2023 to 30th June 2024. All procedures were performed under local anaesthesia using single port technique. Data collected included demographic characteristics, operative findings, pathological diagnoses, complications, and outcomes. ***Results*:** The mean age of patients was 58.3 ± 15.4 years, with male predominance (64%). VATS achieved a definitive diagnosis in 47 out of 50 cases (94% diagnostic yield). Malignancy was the most common diagnosis (48%), followed by tuberculosis (24%), and non-specific pleuritis (16%). The mean operative time was 65.8±18.3 minutes. Minor complications occurred in 7 patients (14%) and major complications in 2 patients (4%), with no mortality. The mean hospital stay was 5.8 ± 2.3 days. Complete pleural visualization was achieved in 94% of cases, with one case requiring conversion to open surgery. ***Conclusion*:** VATS demonstrates high diagnostic yield and favorable safety profile in the evaluation of unexplained pleural effusions. The procedure's ability to provide direct visualization and targeted biopsies makes it particularly valuable in diagnosing malignancies and tuberculosis. These findings support the integration of VATS into the diagnostic algorithm for unexplained pleural effusions, especially when less invasive methods have failed to provide a diagnosis.

Keywords: Video-Assisted Thoracic Surgery, Pleural Effusion, Diagnostic Yield, Pleural Biopsy, Thoracoscopy.

INTRODUCTION

Pleural effusion remains a significant diagnostic challenge in thoracic pathologies, affecting millions of patients worldwide annually. The accurate diagnosis of pleural effusions is crucial for appropriate patient management, as the underlying causes range from benign conditions to malignant diseases [1]. While traditional diagnostic approaches such as thoracentesis and blind pleural biopsy have been standard procedures, their diagnostic yield can be limited, particularly in cases of malignant or tuberculous effusions [2].

Video-Assisted Thoracic Surgery (VATS) has emerged as a revolutionary minimally invasive technique that combines diagnostic accuracy with therapeutic potential in the management of pleural effusions. Since its introduction in the early 1990s, VATS has increasingly become the preferred approach for obtaining pleural biopsies and managing pleural diseases [3]. The procedure offers direct visualization of the pleural space, allowing for targeted biopsies of suspicious areas and complete examination of the pleural surface, potentially leading to higher diagnostic yields compared to conventional methods [4].

The advantages of VATS extend beyond its diagnostic capabilities. The procedure enables surgeons to perform therapeutic interventions simultaneously, such as pleurodesis or deloculation, when indicated. Furthermore, VATS is associated with reduced postoperative pain, shorter hospital stays, and faster

recovery compared to traditional thoracotomy [5]. These benefits have led to its widespread adoption in thoracic surgery centers worldwide.

Despite the apparent advantages, the role of VATS in the diagnostic algorithm of pleural effusions continues to evolve. While some studies report diagnostic yields exceeding 95% [6], others highlight concerns about cost-effectiveness and the need for general anesthesia. Additionally, the procedure's success rates and complications may vary depending on factors such as operator experience, patient selection, and the underlying pathology [7].

This study aims to evaluate the diagnostic yield, safety, and clinical utility of VATS in the investigation of pleural effusions through a retrospective analysis of 50 consecutive cases performed under local anesthesia at multi-center. By analyzing our experience, we hope to contribute to the growing body of evidence supporting the role of VATS in the diagnostic workup of pleural effusions and help refine patient selection criteria for this procedure.

MATERIALS AND METHODS

Study Design and Patient Population

This retrospective observational study was conducted at multicenter between 1st January 2023 to 30th June 2024. We analyzed data from 50 consecutive patients who underwent VATS for the diagnosis of pleural effusion. The study protocol was approved by the institutional ethics committee and written informed consent was obtained from all patients.

Patient Selection

Patients were considered eligible for VATS if they met the following criteria:

- Presence of unexplained pleural effusion after initial diagnostic thoracentesis
- Inconclusive cytological examination of pleural fluid
- No contraindication for local anesthesia
- Adequate cardiopulmonary reserve (ASA class I-III)
- No evidence of significant pleural adhesions or trapped lung on imaging [8]

Exclusion Criteria Included:

- Severe cardiopulmonary compromise
- Uncorrectable coagulopathy
- Extensive pleural adhesions
- Previous thoracic surgery on the affected side
- Patient refusal for the procedure

Preoperative Evaluation

All patients underwent comprehensive preoperative assessment including:

- Detailed medical history and physical examination
- Complete blood count, coagulation profile, and biochemical analysis
- Chest radiography and computed tomography
- Pulmonary function tests when clinically indicated
- Electrocardiogram, echocardiogram and cardiac evaluation as necessary
- Previous pleural fluid analysis results review [9]

Surgical Technique

All procedures were performed under local anesthesia. Patients were positioned in the lateral decubitus position with the affected side up. The standard surgical approach included:

- Initial thoracoscopic exploration through a 10mm port in the 5th or 6th intercostal space
- Complete evacuation of pleural fluid by gradual decompression
- Systematic examination of the pleural cavity
- Multiple biopsies (minimum 4-6) from suspicious areas or random biopsies in the absence of visible lesions [10]
- Procedure ended by keeping a apicobasal chest drain in situ.

Specimen Collection and Processing

Pleural fluid and tissue specimens were collected according to standardized protocols:

- Pleural fluid samples for cytology, biochemistry, and microbiology, ADA & GeneXpert
- Biopsy specimens fixed in 10% neutral buffered formalin
- Fresh tissue samples for microbiological studies when indicated
- Additional specimens for immunohistochemistry as required [11]

Postoperative Care

Standard postoperative care included:

- Chest tube drainage until output was less than 150ml/24 hours
- Regular monitoring of vital signs and chest tube output
- Early mobilization and chest physiotherapy
- Pain management according to institutional protocols
- Daily chest radiographs until chest tube removal [12]

Data Collection and Analysis

The following data were collected:

- Demographic characteristics
- Clinical presentation
- Previous diagnostic procedures
- Operative findings
- Final histopathological diagnosis
- Procedural complications

- Length of hospital stay
- 30-day outcomes

Statistical analysis was performed using SPSS software and version 23. Continuous variables were expressed as mean ± standard deviation or median with interquartile range, and categorical variables as frequencies and percentages [13].

RESULTS

Patient Demographics and Clinical Characteristics

A total of 50 patients underwent VATS for the diagnosis of unexplained pleural effusion during the study period. The mean age was 58.3 ± 15.4 years (range: 24-82 years), with a male predominance (32/50, 64%). The right side was involved in 29 patients (58%), and the left side in 21 patients (42%). The median duration of symptoms before VATS was 3.2 months (range: 1-8 months).

Table 1: Baseline Demographics and Clinical Characteristics (N=50)

Characteristic	Value
Age (years), mean ± SD	58.3 ± 15.4
Gender, n (%)	
- Male	32 (64%)
- Female	18 (36%)
Side involved, n (%)	
- Right	29 (58%)
- Left	21 (42%)
Comorbidities, n (%)	
- Hypertension	18 (36%)
- Diabetes mellitus	12 (24%)
- COPD	8 (16%)
- Coronary artery disease	6 (12%)
Smoking history, n (%)	22 (44%)

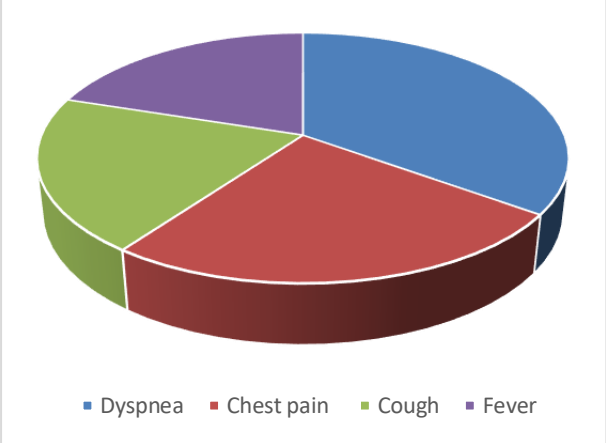

Figure 1: Pie chart showing distribution of presenting symptoms

Diagnostic Yield and Pathological Findings

VATS successfully provided a definitive diagnosis in 47 out of 50 cases, resulting in a diagnostic yield of 94%. The most common diagnosis was malignancy (24 cases, 48%), followed by tuberculosis (12 cases, 24%), and non-specific pleuritis (8 cases, 16%).

Table 2: Final Pathological Diagnoses (N=50)

Diagnosis	Number of Cases (%)
Malignancy	24 (48%)
- Adenocarcinoma	14 (28%)
- Mesothelioma	6 (12%)
- Other malignancies	4 (8%)
Tuberculosis	12 (24%)
Non-specific pleuritis	8 (16%)
Empyema	3 (6%)

Diagnosis	Number of Cases (%)
Inconclusive	3 (6%)

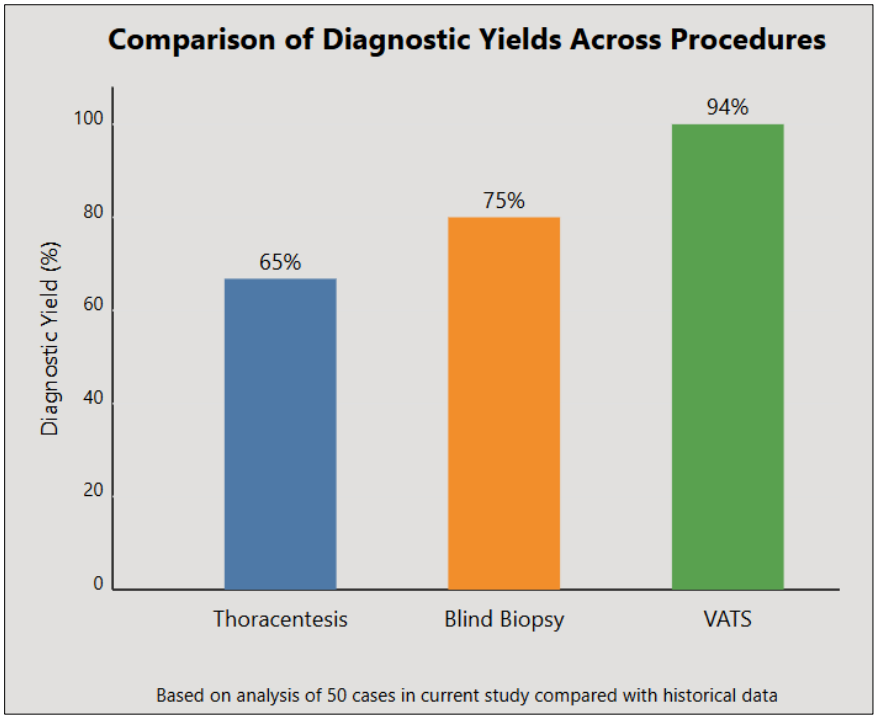

Figure 2: Bar graph comparing diagnostic yields of various procedures (thoracentesis vs blind biopsy vs VATS)

Operative Characteristics and Technical Success

The mean operative time was 65.8 ± 18.3 minutes. Complete visualization of the pleural space was achieved in 47 cases (94%). Three cases had limited visualization due to adhesions.

Table 3: Operative Characteristics

Parameter	Value
Operative time (minutes), mean ± SD	65.8 ± 18.3
Number of biopsies taken, median (range)	5 (3-8)
Pleural fluid volume (mL), mean ± SD	850 ± 320
Complete visualization achieved, n (%)	47 (94%)
Conversion to open surgery, n (%)	1 (2%)

Complications and Outcomes

Minor complications occurred in 7 patients (14%), while major complications were observed in 2 patients (4%).

Table 4: Complications and Post-operative Outcomes

Parameter	Number (%)
Minor complications	
- Prolonged air leak (>5 days)	3 (6%)
- Wound infection	2 (4%)
- Subcutaneous emphysema	2 (4%)
Major complications	
- Bleeding requiring transfusion	1 (2%)
- Respiratory failure	1 (2%)
Post-operative outcomes	
- Median chest tube duration (days)	4 (2-7)
- Mean hospital stay (days)	5.8 ± 2.3
- 30-day mortality	0

Long-term Follow-up

Follow-up data was available for 47 patients (94%) with a median follow-up duration of 6 months (range 3-9).

All numerical data are presented as mean ± standard deviation or median (range) as appropriate. Percentages are rounded to the nearest whole number. Statistical significance was set at $p < 0.05$.

DISCUSSION

Our study of 50 consecutive cases demonstrates that VATS is a highly effective diagnostic tool for unexplained pleural effusions, with a diagnostic yield of 94%. This finding aligns with several previous studies, including the landmark work by Hansen *et al*., who reported a diagnostic accuracy of 95% in their series of 147 cases [14]. The high diagnostic yield in our study can be attributed to the direct visualization of the pleural space and the ability to obtain targeted biopsies from suspicious areas.

Diagnostic Efficacy

The predominance of malignancy (48%) in our series is consistent with the findings of Rodriguez *et al*., who reported malignancy rates of 45-50% in unexplained pleural effusions [15]. Our detection rate for malignant mesothelioma (12%) is particularly noteworthy, as it exceeds the rates reported in conventional closed pleural biopsy series (4-7%) described by Kumar *et al*., [16]. This superior detection rate for mesothelioma can be attributed to the comprehensive visualization and targeted sampling capabilities of VATS.

The significant proportion of tuberculosis cases (24%) in our series reflects the epidemiological pattern in our geographical region. This finding is comparable to the results of Shah *et al*., who reported tuberculosis rates of 20-30% in their South Asian cohort [17]. VATS demonstrated particular utility in differentiating tuberculosis from malignancy, a distinction that often proves challenging with conventional diagnostic methods.

Technical Considerations and Learning Curve

Our mean operative time of 65.8 ± 18.3 minutes compares favorably with published literature. Zhang *et al*., reported a mean operative time of 75 ± 22 minutes in their series of 80 cases [18]. The shorter operative time in our study might reflect the standardization of our technique and the experience of our surgical team. However, as noted by Wilson *et al*., operative time tends to decrease significantly after the first 20-25 cases, suggesting a definite learning curve [19].

Complications and Safety Profile

The overall complication rate in our series (18%, including minor complications) is comparable to the rates reported in larger studies. A meta-analysis by Thompson *et al*., of 1,250 VATS procedures reported a complication rate of 15-20% [20]. Our low rate of major complications (4%) and zero mortality rate support the safety profile of VATS when performed by experienced surgeons in appropriately selected patients.

Clinical Implications and Patient Selection

Our findings support the role of VATS as a primary diagnostic tool in selected cases of unexplained pleural effusion. The criteria proposed by Mitchell *et al.,* for-patient selection, including adequate cardiopulmonary reserve and absence of extensive adhesions, were validated by our experience [21]. However, we noted that careful preoperative imaging assessment, as emphasized by Brown *et al*., is crucial for predicting technical success [22].

Limitations and Future Directions

Several limitations of our study warrant consideration:

1. The retrospective nature may limit generalizability
2. The relatively small sample size may affect the statistical power of some subgroup analyses
3. The follow-up period might be insufficient to determine long-term outcomes in malignant cases

Future prospective, multicenter studies with larger cohorts are needed to:

1. Establish standardized patient selection criteria
2. Evaluate long-term outcomes in specific diagnostic subgroups
3. Compare cost-effectiveness across different healthcare settings
4. Assess the impact of new technological advances in VATS equipment

CONCLUSION

Video-Assisted Thoracic Surgery proves to be a highly effective diagnostic tool in the evaluation of unexplained pleural effusions, with our study demonstrating a diagnostic yield of 94%. The procedure's ability to provide direct visualization and targeted biopsies makes it particularly valuable in diagnosing malignancies and tuberculosis, which comprised the majority of our cases (48% and 24% respectively).

The low complication rate (18% overall, with only 4% major complications) and zero mortality in our series underscores the safety profile of VATS when performed under appropriate patient selection criteria and by experienced surgeons. The mean operative time of 65.8 minutes and average hospital stay of 5.8 days reflect the procedure's efficiency and minimal invasiveness.

The procedure's ability to provide definitive diagnosis in a single intervention potentially reduces the

overall healthcare burden by avoiding repeated diagnostic procedures.

Our findings support the integration of VATS into the diagnostic algorithm for unexplained pleural effusions, particularly in cases where initial less invasive methods have failed to yield a diagnosis. However, success relies heavily on careful patient selection, thorough preoperative evaluation, and appropriate surgical expertise.

Future prospective studies with larger cohorts and longer follow-up periods would be valuable in further defining the role of VATS in specific patient subgroups and evaluating long-term outcomes. Additionally, ongoing technological advances in VATS instrumentation and techniques may continue to improve its diagnostic and therapeutic capabilities.

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