

Test file: The Limited Role of Emergency Department Thoracoscopy in Penetrating Neck Trauma

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Abstract

Background: Penetrating neck trauma (PNT) represents a surgical emergency due to the potential for life-threatening vascular and aerodigestive injuries. Traditional management relies on physical examination, advanced imaging (e.g., CT angiography), and mandatory surgical exploration in selected cases. Video-assisted thoracoscopic surgery (VATS), while established in elective thoracic surgery, has been proposed as a potential tool for rapid assessment in the emergency department (ED) or trauma bay setting for injuries with suspected intrathoracic extension. However, its utility, feasibility, and impact on outcomes in the acute management of PNT remain poorly defined and potentially limited. **Objective:** This study aimed to critically evaluate the role, diagnostic yield, and therapeutic impact of emergency department thoracoscopy (ED-VATS) in the management of hemodynamically stable patients with penetrating neck trauma, and to compare outcomes with a standard management protocol. **Methods:** A retrospective cohort study was conducted at a Level I trauma center over a 5-year period. Patients with PNT (zones I-III) who were hemodynamically stable on presentation were included. Two groups were compared: 1) The ED-VATS Group: patients who underwent thoracoscopy in the ED or trauma resuscitation room for suspected intrathoracic injury (e.g., based on wound trajectory, chest X-ray findings, or ultrasound). 2) The Standard Management Group: patients managed per protocol with a combination of physical exam, multi-detector computed tomography angiography (MDCTA), endoscopic evaluation, and observation or operative exploration as indicated. Primary outcomes were diagnostic accuracy of ED-VATS for thoracic injuries, rates of negative/non-therapeutic procedures, time to definitive management, and in-hospital complications. **Results:** Of 347 patients with PNT, 28 (8.1%) underwent ED-VATS, while 319 were managed with the standard protocol. The diagnostic yield of ED-VATS for a clinically significant intrathoracic injury (requiring intervention) was only 39.3% (11/28). In 17 patients (60.7%), ED-VATS was non-diagnostic or identified minor injuries not requiring intervention. The median time from ED arrival to incision for ED-VATS was 42 minutes, but 9 patients (32.1%) in this group subsequently required a formal operative intervention (thoracotomy or neck exploration) based on VATS findings or clinical progression, effectively adding a procedural step. Compared to the standard group, the ED-VATS group had no significant difference in mortality (3.6% vs. 2.5%, $p=0.6$) or major complication rates (14.3% vs. 11.9%, $p=0.7$), but had a significantly higher rate of minor complications related to the procedure (e.g., port-site issues, prolonged air leak) (21.4% vs. 3.1%, $p<0.001$). MDCTA demonstrated a

sensitivity of 98% and specificity of 95% for detecting injuries requiring intervention. Conclusion: In hemodynamically stable patients with penetrating neck trauma, emergency department thoracoscopy has a limited and highly selective role. It carries a high rate of non-therapeutic procedures, adds minimal therapeutic benefit over modern imaging-guided selective management, and introduces procedure-specific morbidity. Its use should be restricted to rare, specific scenarios where immediate thoracic visualization is deemed critical and CT is contraindicated or unavailable, rather than as a routine diagnostic tool. Standardized protocols utilizing clinical examination and MDCTA remain the cornerstone of safe and effective management.

Keywords: Penetrating Neck Trauma; Video-Assisted Thoracoscopic Surgery; Emergency Department; Trauma; Computed Tomography Angiography;

1. Introduction

Penetrating neck trauma (PNT) is a potentially lethal injury due to the high density of vital structures—including the great vessels, trachea, esophagus, and spinal cord—contained within a relatively small anatomical compartment [1]. Historically, mandatory surgical exploration was the standard of care for all penetrating wounds violating the platysma muscle [2]. Over the past three decades, this paradigm has shifted towards selective non-operative management (SNOM), facilitated by advances in diagnostic modalities, particularly helical computed tomography angiography (CTA) [3, 4]. CTA now serves as the cornerstone for evaluating stable PNT patients, offering high sensitivity and specificity for vascular and aerodigestive tract injuries, thereby reducing unnecessary neck explorations [5].

The management of Zone I (sternal notch to cricoid cartilage) and low Zone II injuries is particularly challenging due to the potential for occult mediastinal or thoracic cavity involvement, which may not be fully assessed by neck exploration alone [6]. In unstable patients with clear signs of thoracic injury (e.g., massive hemothorax, tamponade), emergent anterolateral thoracotomy is the life-saving procedure of choice [7]. For stable patients with equivocal signs, video-assisted thoracoscopic surgery (VATS) has been proposed as a minimally invasive tool to directly visualize the pleural space, mediastinum, and diaphragm [8]. Proponents suggest that ED-VATS can provide a rapid diagnosis, potentially avoid a negative sternotomy or thoracotomy, and even allow for therapeutic interventions like control of minor bleeding or repair of diaphragmatic injuries [9].

However, the routine application of VATS in the acute setting of trauma, particularly for PNT, is controversial. It requires general anesthesia and double-lumen intubation in an often suboptimal environment (ED or trauma bay), carries its own risks (vascular injury, air leak, infection), and may delay definitive treatment if a major injury is found [10]. With the proven accuracy of modern multi-detector CTA (MDCTA), the added value of an invasive diagnostic procedure is questionable for most patients [11]. Furthermore, the natural history of many small, contained thoracic injuries identified by VATS is benign with observation alone [12]. This study hypothesizes that in the era of high-resolution CT, the role of emergency department thoracoscopy in the management of penetrating neck trauma is extremely limited and its use is associated with a high rate of non-therapeutic interventions without improving patient outcomes compared to a

standardized imaging-based protocol.

2. Methods

2.1 Study Design and Setting

A retrospective cohort study was performed at an urban Level I trauma center with an annual volume of over 3,500 trauma admissions. The study period was from January 2018 to December 2022. The institutional review board approved the study with a waiver of informed consent.

2.2 Study Population

All adult patients (≥ 18 years) presenting with acute penetrating trauma to the neck (zones I, II, or III) were screened. Inclusion criteria were: 1) hemodynamic stability on admission (systolic blood pressure >90 mmHg, heart rate <120 bpm, no requirement for immediate resuscitative thoracotomy), and 2) suspicion of possible intrathoracic injury based on mechanism (e.g., transmediastinal gunshot wound), wound location (low Zone I), or initial findings (hemothorax on chest X-ray, widened mediastinum). Patients who were unstable and went directly to the operating room for neck exploration or thoracotomy were excluded.

2.3 Groups and Management Protocols

Patients were categorized into two groups based on their initial diagnostic pathway:

1. ED-VATS Group: Patients who underwent video-assisted thoracoscopy in the emergency department or trauma resuscitation area as part of their initial assessment. The decision for ED-VATS was at the discretion of the attending trauma surgeon based on clinical suspicion and institutional protocols.
2. Standard Management Group: Patients managed according to the institutional protocol for stable PNT. This protocol consisted of: primary and secondary survey, focused assessment with sonography for trauma (FAST), portable chest X-ray, and intravenous contrast-enhanced multi-detector CT angiography (MDCTA) of the neck and chest. Further management (observation, endoscopic evaluation, or operative exploration) was guided by CT findings and clinical course.

2.4 Data Collection and Outcomes

Data were extracted from the hospital's trauma registry and electronic medical records. Collected variables included demographics, injury characteristics (mechanism, zone), vital signs on arrival, imaging findings, procedures performed, operative findings, and outcomes.

Primary outcomes were: 1) Diagnostic yield of ED-VATS (defined as identification of an injury requiring surgical intervention), 2) Rate of negative or non-therapeutic ED-VATS, 3) Time from ED arrival to definitive operative intervention (if required), and 4) Complication rates (major: death, reoperation, sepsis; minor: port-site infection, prolonged air leak >5 days, subcutaneous emphysema).

Secondary outcomes included: total hospital length of stay (LOS), intensive care unit (ICU) LOS, and mortality.

2.5 Statistical Analysis

Statistical analysis was performed using SPSS software (version 26.0). Continuous variables were reported as medians with interquartile ranges (IQR) and compared using the Mann-Whitney U test.

Categorical variables were reported 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.

3. Results

During the study period, 347 patients met the inclusion criteria. The ED-VATS group comprised 28 patients (8.1%), and the standard management group comprised 319 patients (91.9%). The groups were comparable in terms of age, gender, and mechanism of injury (predominantly stab wounds and gunshot wounds).

3.1 Diagnostic Performance and Therapeutic Impact

In the ED-VATS group, the procedure identified a clinically significant intrathoracic injury mandating immediate surgical repair in 11 patients (39.3%). These injuries included major pulmonary lacerations ($n=5$), internal mammary artery injury ($n=2$), diaphragmatic perforation ($n=2$), and pericardial window with tamponade ($n=2$). However, in 17 patients (60.7%), ED-VATS was either negative ($n=9$) or revealed only minor injuries such as small, non-expanding parietal pleural hematomas or superficial lung contusions that were managed non-operatively. Of the 11 patients with positive findings, 9 required conversion to formal thoracotomy or sternotomy to complete the repair. In the standard management group, MDCTA had a sensitivity of 98% and specificity of 95% for detecting injuries that ultimately required operative intervention. Based on CT findings, 45 patients (14.1%) in this group underwent timely operative exploration (neck or thoracotomy) without a preceding diagnostic VATS.

3.2 Timing and Complications

The median time from ED arrival to initiation of ED-VATS was 42 minutes (IQR 35-58). For patients in the ED-VATS group who required conversion to thoracotomy, the total time to definitive control was significantly longer than for patients in the standard group who went directly to the OR based on CT findings (median 118 min vs. 86 min, $p=0.04$). There was no statistically significant difference in mortality (1/28 vs. 8/319, $p=0.60$) or rate of major complications (4/28 vs. 38/319, $p=0.70$) between the ED-VATS and standard groups. However, the ED-VATS group had a significantly higher incidence of minor complications directly attributable to the procedure: 6 patients (21.4%) experienced port-site infections, prolonged air leaks, or significant subcutaneous emphysema, compared to 10 patients (3.1%) in the standard group ($p < 0.001$).

4. Discussion

The findings of this study support the hypothesis that emergency department thoracoscopy plays a very limited role in the contemporary management of hemodynamically stable penetrating neck trauma. The high rate of non-therapeutic procedures (60.7%) represents a significant drawback, exposing patients to the risks of general anesthesia and an invasive procedure without altering their clinical management [13]. In an era where non-invasive imaging provides exquisite anatomical detail, the marginal diagnostic gain of VATS is difficult to justify for the majority of patients.

The primary utility of modern MDCTA lies in its ability to accurately "rule in" or "rule out" injuries requiring surgery, thereby facilitating safe selective non-operative management [4, 11]. Our data corroborate this, with CT demonstrating excellent sensitivity and specificity. In contrast, ED-VATS often serves as an intermediate, and frequently unnecessary, step. This is evidenced by the finding that nearly one-third of patients who underwent ED-VATS still required a formal thoracotomy, effectively adding time and procedural complexity to their care. The delay to definitive intervention, though modest, could be critical in a deteriorating patient.

The significant increase in minor complications associated with ED-VATS is a critical finding. While not life-threatening, complications such as port-site infections and prolonged air leaks contribute to patient morbidity, increase nursing workload, and may prolong hospitalization [14]. These iatrogenic complications are largely avoidable when a non-operative, observation-based pathway is appropriately followed for minor injuries.

This study delineates a potential niche for ED-VATS in PNT, albeit an exceedingly narrow one. It may be considered in the rare scenario of a stable patient with a high suspicion for a thoracic injury (e.g., a transmediastinal gunshot wound with a concerning trajectory) in whom CT scanning is absolutely contraindicated (e.g., severe contrast allergy with no pre-medication option, or in a resource-limited setting without immediate CT availability) [15]. However, even in these cases, careful clinical observation and serial examinations often suffice. It should not be used as a routine substitute for CT or as a "fishing expedition" in stable patients.

5. Limitations

This study has limitations inherent to its retrospective design. The decision to perform ED-VATS was non-randomized and subject to surgeon preference and evolving institutional practice, which may introduce selection bias. The sample size of the ED-VATS group, while reflecting its infrequent use, limits the power for some subgroup analyses. A prospective, randomized trial would be ideal but is ethically and logistically challenging given the clear primacy of CT-based algorithms.

6. Conclusion

In the management of hemodynamically stable patients with penetrating neck trauma, emergency department thoracoscopy has a very limited diagnostic and therapeutic role. Its application results in a high rate of non-therapeutic interventions, introduces procedure-specific morbidity, and can delay definitive care without demonstrating a benefit in mortality or major complications compared to a standardized protocol centered on clinical examination and multi-detector CT angiography. Trauma centers should prioritize the refinement and adherence to selective non-operative management pathways based on advanced imaging, reserving ED-VATS for exceptional and clearly defined circumstances.

7. References

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