

## The “T-Incision”: GSW to the chest and abdomen

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### Abstract

**Background:** The “T-Incision” has not been previously described in the medical literature. This combination of bilateral anterolateral thoracotomies with a midline exploratory laparotomy is a definitive approach to rapid assessment and control of hemorrhage in patients with thoracoabdominal injuries.

**Case Presentation:** A 21-year-old Caucasian female sustained a gunshot wound to her left upper chest. The missile tracked through the mediastinum and into the right lower thorax. Based on her injuries, a right anterolateral thoracotomy was converted to a clamshell thoracotomy after substantial bleeding was noted from the pericardium. As the right ventricle and pulmonary injuries were being repaired, significant bleeding was noted through two defects in the right hemidiaphragm requiring a midline laparotomy, thus creating the “T-Incision.”

**Conclusion:** Thoracoabdominal injuries require surgeons to decide which body cavity to explore first. Non-specific clinical findings, such as chest thoracostomy output, are often used as indicators for thoracotomy when the bleeding may actually originate in the abdomen. Opting to explore a single cavity may delay definitive hemorrhage control. Thus, the T-incision can be used to expose both the thoracic and abdominal cavities in patients suffering from thoracoabdominal injuries.

### Keywords

thoracoabdominal injuries; laparotomy

### Abbreviations

GSW: Gunshot Wound; CPR: Cardiopulmonary Resuscitation; ROSC: Return of Spontaneous Circulation; GCS: Glasgow Coma Score; FAST: Focused Ultrasonography in Trauma; AAST-OIS: American Association for the Surgery of Trauma – Organ Injury Scale; ICU: Intensive Care Unit; TEE: Transesophageal Echocardiography

## Introduction

In dealing with thoracoabdominal injuries, surgeons often rely on non-specific clinical clues to decide which cavity to explore first. The T-Incision, comprised of bilateral anterolateral thoracotomies and a midline exploratory laparotomy, obviates this decision and provides rapid and simultaneous exposure to areas of potential hemorrhage.

Approximately 30-40% of penetrating gunshot wounds to the chest have an associated intraabdominal injury [1]. Yet, there is no literature to date that formally describes the T-Incision and its role in resuscitating patients with thoracoabdominal injuries.

In a hemodynamically unstable patient with a gunshot wound to the chest, the immediate goal is to address any cause of hemorrhagic shock. Herein we present a case where a right ventricular cardiac injury and a significant hepatic laceration were masked by a right hemothorax necessitating a bilateral anterior thoracotomy and midline exploratory laparotomy – the “T-incision.”

## Case Presentation

A 21-year-old female was involved in an attempted car jacking suffered a close range gunshot wound to the left chest. She was found pulseless and apneic at the scene and required Cardiopulmonary Resuscitation (CPR) which led to Return of Spontaneous Circulation (ROSC). Upon arrival in the trauma bay, she had absent lung sounds bilaterally and a Glasgow Coma Scale (GCS) score of 5. She was immediately intubated and bilateral chest tubes were placed with return of 200 mls of blood from the left and 1200 mls of blood from the right. A chest radiograph following tube placement revealed a persistent large right hemothorax (Figure 1).

A FAST scan revealed fluid in the right hemithorax but was negative for pericardial or abdominal fluid. She initially responded to 2L crystalloid and 3 units of blood but again became hypotensive. A second chest tube was placed and drained an additional 600 mls of blood from the right chest, for a total of 1800 mls of blood and she was emergently taken to the operating room.

The patient again lost vital signs while prepping for surgery and required CPR for 2 minutes before ROSC. A right anterolateral thoracotomy was quickly converted to a clamshell after identification of profuse bleeding from a pericardial laceration. Further exploration led to the identification of a AAST-OIS Grade V right ventricular injury. A complex right ventricular cardiorrhaphy with 2-0 prolene sutures buttressed with Teflon pledgets and multiple pulmonary lacerations were repaired.

Bleeding into the right thorax continued despite the above-mentioned repairs. Further investigation revealed two diaphragmatic defects with fairly brisk bleeding. A standard midline laparotomy incision was then performed, revealing a AAST-OIS grade IV liver laceration. Hepatorrhaphy and packing of the right upper quadrant were conducted to temporarily control the bleeding. The patient experienced an episode of ventricular fibrillation during the hepatorrhaphy that resolved after cardiac massage and internal defibrillation. Toward the end of the procedure, she was hypothermic, coagulopathic, and requiring vasopressor support. The abdomen was temporarily closed and she was transferred to the ICU for resuscitation (Figure 2). A postoperative TEE revealed an ejection fraction of 30-35%. Seventy-two hours later, the patient returned to the operating room for re-exploration, hepatic unpacking, drainage and closure of the abdomen. An intra operative TEE revealed that her left and right

ventricular ejection fractions were normal (Figure 3).

Postoperatively, the patient's course was complicated by septic shock secondary to pneumonia that resolved with appropriate therapy. On post-operative day fifteen, she was neurologically intact and was successfully extubated. She did develop right sided vocal cord palsy, presumably due to endotracheal intubation, which is resolving. She was discharged to a rehabilitation center on post-operative day twenty and is doing well in follow-up.

## Discussion

Our patient presented with hemodynamic instability and substantial bleeding from the right thorax. Bleeding from the right ventricle and liver laceration was essentially decompressing into her right thorax. Extensive hemothorax often blurs the cardiac borders making the diagnosis of cardiac injury difficult in penetrating injuries to the thorax [2].

The indications for a thoracotomy are often a point of debate amongst surgeons. In this case, significant hemorrhage from the right chest in the setting of continued hemodynamic instability was an indication to proceed with thoracotomy, as recommended by the Western Trauma Association [3]. Based on operative findings, our right thoracotomy was converted to bilateral anterolateral thoracotomies (i.e. “a clamshell thoracotomy”).

Simms et al [4]. reported in 2013 that the “Clamshell Thoracotomy” is the 'ideal emergency thoracotomy incision' based on anatomical studies. Simms noted that a median sternotomy provides better access to intrathoracic structures than left and right anterior thoracotomies; however, definitive control of the origin of the left subclavian artery was difficult with left 2<sup>nd</sup> or 3<sup>rd</sup> intercostal space incisions. The authors also noted that a bilateral anterior thoracotomy was easy to perform and gave superior access to all intrathoracic structures thus concluding that the best incision is one that provides rapid and definitive access to all thoracic structures for assessment and control [4].

Approximately 63% of all cardiac injuries are due to gunshot wounds and the right ventricle is the most common chamber involved [5,6]. Penetrating cardiac injuries can cause disruption of valvular function and create shunts [5]. Our patient was initially suspected of having a septal defect but it was subsequently excluded by transesophageal echocardiography.

Abdominal contents can be located as cephalad as the 4<sup>th</sup> rib anteriorly during expiration. As such, penetrating injury to the lower thorax carries a risk of diaphragmatic and abdominal trauma [2]. In our patient, the missile created a AAST-OIS grade IV hepatic laceration to the liver (Segments VII and VIII). Diaphragmatic injuries from penetrating trauma rarely have specific findings on radiographs [2]. Those that present acutely carry a 3% risk of mortality, whereas those that present later confer a significantly higher mortality rate of 25% [2].

In thoracoabdominal gunshot wounds, the body cavity to open first is often a difficult choice [7]. Approximately 30-40% of penetrating gunshot wounds to the chest also have an intra abdominal injury [1]. Hirschberg et al. cautioned that high chest tube output must be treated with suspicion because it may represent intra-abdominal bleeding [7]. A study by Berg et al. concluded that exclusion of cardiac injury is the primary consideration when deciding which anatomic cavity to open [8].

As noted by Hirschberg, the surgeon managing patients with thoracoabdominal injuries must always be prepared to alter the surgical plan mid-operation [7]. Asensio et al. studied interruption rates in patients undergoing thoracotomy first and laparotomy second and vice versa; lower rates were found when thoracotomy was performed first [1]. The mortality in patients who undergo both laparotomy and a thoracotomy is 59% compared to 31% in patients who undergo only thoracotomy [2].

In summary, thoracoabdominal trauma is unpredictable in nature [7]. Severe thoracic trauma may initially distract from intra-abdominal injuries [2]. Surgeons must always maintain a high index of suspicion and remain flexible in their operative plan throughout the procedure. In this case, combining a bilateral anterior thoracotomy with a vertical midline laparotomy was necessary and led to a “T-incision” (Figure 4).

## Figures



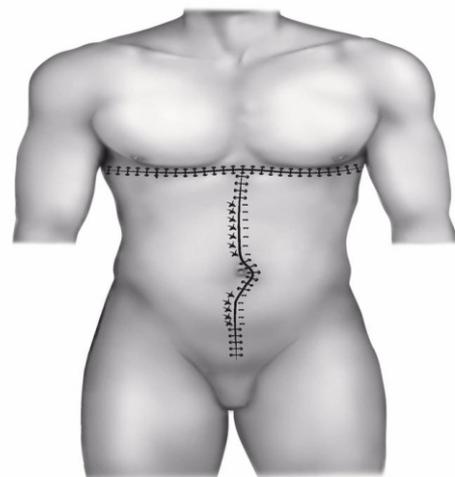
**Figure 1:** Trauma Bay Chest Radiography



**Figure 2:** Post Op Index Surgery Chest radiography



**Figure 3:** TEE showing right ventricular wall post repair



**Figure 4:** Illustration of the T-Incision

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