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Traumatic Diaphragmatic Crural Hematoma in Crush Trauma: Diagnostic Challenges and Management in a Rare Case

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Statistical Analysis C
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Manuscript Preparation E
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Patient: Female, 63-year-old
Final Diagnosis: Crural hematoma • diaphragmatic hematoma
Symptoms: Shock • thoracic pain
Clinical Procedure: —
Specialty: Orthopedics and Traumatology • Surgery

Objective: Rare disease
Background: Traumatic diaphragmatic injuries are uncommon in thoracoabdominal trauma, and traumatic diaphragmatic crural hematoma (TDCH) is even rarer in this context. Because of its retroperitoneal position, TDCH can be difficult to detect early. Although TDCH is usually not life-threatening and does not often require emergency surgery, it is important to note that it often coexists with other serious injuries. This report describes the case of TDCH and shock following crush trauma. After stabilization, whole-body contrast-enhanced CT identified TDCH and unstable pelvic fractures. She then underwent diagnostic angiography followed by surgical management of the pelvic injuries.

Case Report: A 63-year-old woman with no prior health issues was brought to the emergency department after being accidentally crushed between 2 vehicles while her husband was reversing his car. She experienced pain in her chest, abdomen, and right hip. Initially in shock, she stabilized following initial resuscitation and blood transfusion. Initial evaluation, including extended FAST ultrasound (E-FAST), was negative. Contrast-enhanced CT scan showed fractures of the right sacrum, iliac wing, acetabulum, and pubic rami, along with a hematoma in the bilateral diaphragmatic crura (T12-L1) with contrast extravasation. Diagnostic angiography showed no active contrast extravasation from the diaphragm or pelvis. She subsequently underwent surgical fixation of pelvic fractures. Her postoperative course was uneventful, and she was discharged in stable condition.

Conclusions: This case highlights that TDCH is rare and may indicate a high-energy injury requiring prompt diagnosis. Whole-body contrast-enhanced CT is reasonable in patients presenting with shock and negative E-FAST findings. Management should be guided by bleeding status, and diagnostic angiography may be considered when active bleeding is suspected.

Keywords: Diaphragm • Thoracic Injuries • Retroperitoneal Space

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Introduction

Traumatic diaphragmatic injury is a rare but potentially life-threatening result of high-energy trauma, usually caused by motor vehicle crashes, falls from heights, or pedestrian accidents [1]. In diaphragmatic injuries, involvement of the crural area—especially the retrocrural space—is very rare and frequently underdiagnosed because of its deep anatomical position and vague clinical signs [2-4]. All previously reported cases of traumatic diaphragmatic crural hematoma (TDCH) summarized in **Table 1** involved blunt trauma with high-energy mechanisms and were associated with other serious injuries [2-7]. Prompt stabilization of the patient's hemodynamic status is essential, and whole-body contrast-enhanced computed tomography (CT) with multiplanar reconstruction may

be particularly useful in stabilized patients with high-energy trauma and persistent clinical concern despite a negative E-FAST examination. We report a rare case of TDCH following a crushing injury, presenting with shock and a negative E-FAST examination. This case highlights the diagnostic challenges of TDCH and illustrates the role of contrast-enhanced CT, diagnostic angiography, and selective non-operative management in guiding clinical decision-making.

Case Report

A 63-year-old woman with no significant medical history was brought to the emergency department after being accidentally pinned between 2 vehicles while her husband was backing

Table 1. Reported cases of traumatic crural diaphragmatic hematoma.

Author(s)/ year	Cause	Mechanism of injury	Age, y/ Sex	Side	Shock requiring initial resuscitation	Combined injury	Management of crural hematoma	Prognosis
Jha et al, 2014 [7]	Motor vehicle collision	Blunt injury	24/M	Bilateral	No	Renal and splenic lacerations, bilateral hemothoraces, blunt tear of right hemidiaphragm	Laparotomy with diaphragmatic repair	Good
Choi et al, 2017 [8]	Motor vehicle collision	Blunt injury	73/M	Left	Yes	Several rib fractures, right hemothorax	Non-operative (TAE)	Good
Allaoua et al, 2023 [9]	Motor vehicle collision	Blunt injury	75/M	Right	No	Symmetric bilateral rib fractures (from 3rd to 7th), a dubious sternal fracture, mild pericardial effusion	Non-operative (parenteral analgesia, serial hemoglobin and hematocrit measurements, serial follow-up imaging)	Good
Taylor et al, 2025 [10]	Pedestrian hit by motor vehicle collision	Blunt injury	59/F	Bilateral (left > right)	Yes	Left lower lobe pulmonary contusions, left L3-L5 transverse process fractures, bilateral comminuted sacral fracture	Non-operative (pain management, close clinical monitoring and serial follow-up imaging)	Disability cared in nursing home
Present case, 2025	Being pinned between two cars	Crush injury	63/F	Bilateral (left > right)	Yes	Multiple pelvic fractures (including the right sacrum, iliac wing, acetabulum, and both superior and inferior pubic rami)	Non-operative (pain management, serial hemoglobin and hematocrit measurements, serial follow-up imaging)	Good

Abbreviations: M, male; F, female; TAE, transarterial embolization.

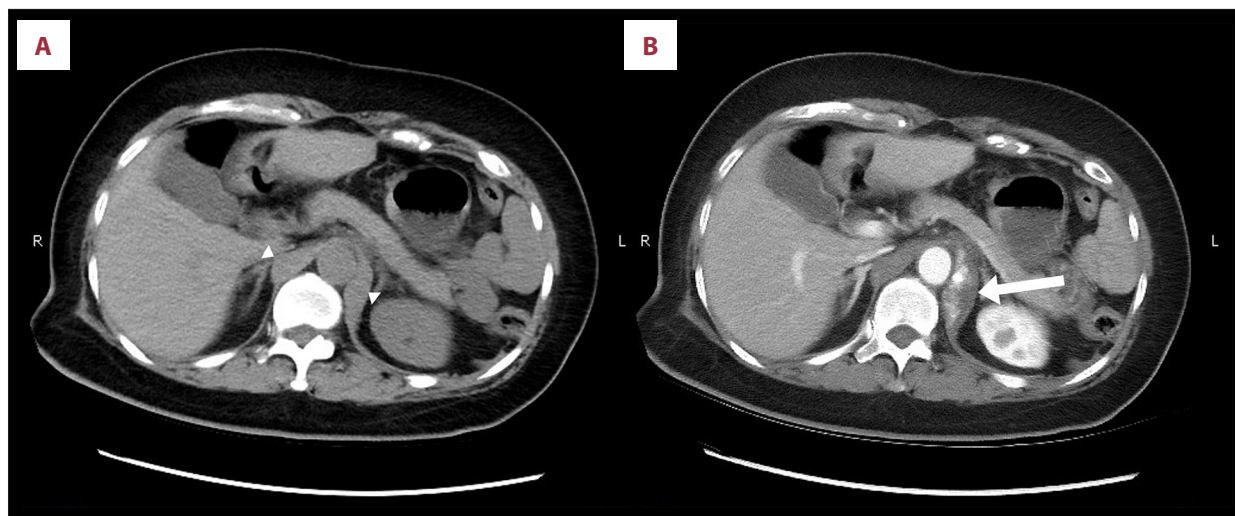


Figure 1. Non-contrast-enhanced computed tomography (CT) scans of the chest and abdomen showed focal thickening of the bilateral diaphragmatic crura (**A**, white arrowheads). Contrast-enhanced CT demonstrated intramuscular contrast extravasation within the crural hematoma, indicating active bleeding (**B**, white arrows).

up his car. She initially appeared lethargic, with vital signs indicating a blood pressure of 90/64 mm Hg, heart rate of 121 beats per minute (bpm), respiratory rate of 24 breaths per minute, and oxygen saturation of 97% while on 10 L/min supplemental oxygen via face mask. The airway was patent, and the patient was mildly drowsy, with a Glasgow Coma Scale score of 14. She reported pain in her chest, abdomen, and right hip. A pelvic binder had already been applied by emergency medical services prior to arrival at the emergency department. Two large-bore intravenous catheters were established in the upper extremities, and she received 1 g of intravenous tranexamic acid along with 4 units of type-O packed red blood cells as part of the initial resuscitation. Physical examination showed abrasions on the right wrist, chest wall, and pelvic region. A marked degree of tenderness was observed in the right pelvic region during the pelvic stability test, and the perfusion of the distal limbs was maintained. Chest auscultation was normal, with no rales, pericardial friction rubs, or murmurs. An extended FAST ultrasound (E-FAST) was performed and was negative. After initial resuscitation, the patient's hemodynamics improved, with blood pressure increasing to 107/62 mm Hg and heart rate decreasing to 105 bpm. Laboratory test results showed creatinine level of 0.63 mg/dL, creatine phosphokinase level of 226 U/L, sodium level of 135 mmol/L, potassium level of 3.7 mmol/L, aspartate aminotransferase level of 115.3 U/L, alanine aminotransferase level of 62.9 U/L, white blood cell count of $8.97 \times 10^3/\mu\text{L}$, hemoglobin level of 10.8 g/dL, and platelet count of $284 \times 10^3/\mu\text{L}$. A whole-body CT scan was performed immediately after initial resuscitation because tachycardia and hypotension remained present. Non-contrast CT revealed thickening of the bilateral diaphragmatic crura at T12-L1 (**Figure 1A**, white arrowheads). Whole-body contrast-enhanced CT then showed active extravasation of contrast



Figure 2. Three-dimensional reconstructed computed tomography images revealed right-sided pelvic fractures involving the sacroiliac joint, iliac wing, acetabulum, and superior and inferior pubic rami.

within the hematoma (**Figure 1B**, white arrow). No direct CT signs of diaphragmatic rupture, discontinuity, or visceral herniation were identified. A separate 3-dimensional reconstruction demonstrated a right-sided unstable pelvic fracture classified as LC II (Young-Burgess classification) (**Figure 2**). She received pain management and diagnostic angiography 2 hours after admission to locate the bleeding source. By the time of angiography, the patient's hemodynamic status had stabilized and no vasopressor support was required. Angiography demonstrated no active contrast extravasation, and the TDCH was therefore managed conservatively. On the second day after admission, she underwent surgical fixation of the pelvic fracture with a pelvic locking plate and sacroiliac and transiliac-transsacral screw fixation. After a 15-day hospital stay, she was

discharged to a rehabilitation program. She was doing well during a follow-up visit 6 months later.

Discussion

Traumatic diaphragmatic injuries are uncommon but potentially life-threatening injuries that often occur after high-energy trauma, such as motor vehicle collisions, pedestrian impacts, or falls from height [1,5]. Diaphragmatic injury occurs in roughly 1-7% of blunt trauma cases, predominantly affecting the left hemidiaphragm because the liver offers protection on the right side [1,5,6]. Injuries to the diaphragmatic crura are extremely rare and often go unnoticed due to their deep retrocrural location and subtle signs [2,4,7]. Four previously reported cases of TDCH were identified in the literature and are summarized in **Table 1** along with the present case.

TDCH mainly results from sudden increases in intra-abdominal pressure or deceleration forces, which cause tearing of the diaphragmatic attachments, particularly at the posterior crura attached to the lumbar vertebrae [1,4,6]. Unlike traumatic diaphragmatic rupture, which results in a structural defect and may lead to visceral herniation or intrathoracic/intra-abdominal hemorrhage, TDCH represents a localized hemorrhagic injury confined to the diaphragmatic crura without disruption of the diaphragmatic continuity [7,8]. Consequently, isolated TDCH is less likely to cause significant respiratory compromise or hemodynamic instability. Compared with the previously reported blunt trauma cases summarized in **Table 1**, our patient experienced a dominant crushing mechanism. Whereas many blunt injuries result from sudden impact or deceleration, crushing injuries involve prolonged compression. Prolonged compression may generate sustained increases in intra-abdominal pressure and shearing forces across the diaphragmatic attachments, potentially contributing to localized crural and vascular injury with hematoma formation. All cases, however, involved severe injuries and were linked to motor vehicle accidents, suggesting that high-energy mechanisms may play an important role in the development of TDCHs.

Patients with TDCH can exhibit nonspecific symptoms such as dyspnea, chest or shoulder pain, upper abdominal tenderness, or signs of respiratory distress, depending on the severity and extent of the injury [5]. In severe rupture cases, herniation of abdominal contents into the thoracic cavity can cause bowel obstruction, respiratory issues, or cardiovascular collapse [5]. Isolated TDCH can be asymptomatic or cause mild flank or back pain, which can make it difficult to identify during acute trauma assessment [7]. Since manifestations of TDCH can vary or be subtle, it is crucial to maintain a high level of suspicion, as they might be masked by other high-energy injuries such as thoracic, spinal, or pelvic trauma.

CT is the imaging modality of choice for diagnosing traumatic diaphragmatic injuries and retrocrural injuries [3,5,6]. Direct CT signs of diaphragmatic rupture include discontinuity, the “dangling diaphragm sign,” the “collar (hourglass) sign” of the herniated viscera, and the “dependent viscera sign” indicating loss of support [3,6]. When the diaphragm seems intact but a crural hematoma is detected, diagnosis depends on indirect evidence, such as focal thickening or enlargement of the crus, displacement of nearby structures, and active contrast extravasation indicating vascular injury [2,4,7,8]. Retrocrural hematomas can resemble other retroperitoneal or adrenal conditions, making diagnosis more challenging. Contrast-enhanced CT scans can detect active bleeding, localized hematomas, and indirect indicators of diaphragmatic injury, even if herniation is not apparent [2,3,6]. Multiphase CT with coronal and sagittal reformats is especially effective for identifying subtle tears or retrocrural hematomas [3,6]. Whole-body contrast-enhanced CT may be particularly useful when high-energy trauma and associated injuries are suspected. Angiography may be considered when CT suggests active bleeding or when clinical concern persists. E-FAST is limited in detecting retroperitoneal and diaphragmatic injuries because these structures are located deep within the thoracoabdominal cavity and may fall outside the standard sonographic windows used during trauma assessment [2,4]. As all cases of TDCH in **Table 1** involved other traumatic injuries, a whole-body contrast-enhanced CT scan should be considered, especially in cases of shock and negative E-FAST findings.

Management strategies for TDCH depend on the patient’s hemodynamic stability and the presence of diaphragmatic injury or other associated injuries. Recent case reports indicate that non-operative management might be a feasible option for TDCH when imaging shows no signs of diaphragmatic rupture or visceral herniation (see **Table 1**) [6,9,10]. Transcatheter arterial embolization can be performed promptly as a minimally invasive and effective treatment to halt bleeding and stabilize the patient’s condition [8]. Prompt surgical or endovascular intervention in traumatic diaphragmatic injuries can prevent complications such as strangulation, infection, or the development of a chronic diaphragmatic hernia [5,8]. Our angiographic assessment showed no ongoing active or persistent extravasation from the diaphragmatic crura. Although contrast extravasation was identified on the initial contrast-enhanced CT scan, angiography performed approximately 2 hours later demonstrated no active bleeding, suggesting that the hemorrhage had become self-limited by the time of angiographic evaluation. The patient’s initial hemodynamic instability was more likely to be attributable to the associated pelvic injury than to the TDCH alone. After initial resuscitation, the patient remained stable. Because the diaphragm is a membrane structure, bleeding may be contained within it, rarely leading to hemodynamic instability. This could explain

why many cases listed in **Table 1** were managed successfully with non-operative management.

Conclusions

Traumatic diaphragmatic injury with TDCH poses diagnostic challenges, so clinicians should remain vigilant for possible multiple systemic injuries. Whole-body contrast-enhanced CT may be beneficial, particularly in patients with shock and negative E-FAST findings. Management should be individualized according to the patient's hemodynamic status, CT findings, evidence of ongoing bleeding, and associated injuries. Patients in stable condition without diaphragmatic rupture

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or persistent hemorrhage may be treated conservatively with close monitoring, whereas diagnostic angiography may be considered when active bleeding is suspected.

Consent for Publication

Written informed consent was obtained from the patient for publication of this case report and accompanying images.

Declaration of Figures' Authenticity

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