Review Article

Blunt Abdominal Trauma in the Emergency Department: Initial Evaluation and Evidence-Based Surgical Decision-Making

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Abstract

Blunt abdominal trauma is a frequent and potentially lethal condition in emergency medicine, associated with substantial morbidity and mortality worldwide. It occurs in up to one third of severely injured patients, with the liver and spleen being the most commonly affected organs. Motor vehicle collisions remain the predominant mechanism, followed by falls, pedestrian trauma, assaults, and sports-related injuries. The biomechanical forces involved, particularly deceleration, compression, and crush injury, determine the resulting organ damage and should guide early diagnostic suspicion. Hemorrhage is the most critical immediate consequence, while hollow viscus and mesenteric injuries carry high mortality when diagnosis is delayed. Initial emergency assessment must follow the

ABCDE trauma framework, integrating airway, breathing, circulation, neurologic status, and exposure rather than focusing on the abdomen in isolation. Hemodynamic instability is the central factor guiding management: unstable patients with positive FAST findings require urgent laparotomy, whereas stable patients should undergo contrast-enhanced computed tomography for detailed lesion characterization. Clinical examination and laboratory studies remain important but are insufficient alone, particularly because abdominal findings may be subtle or absent in patients with altered mental status, polytrauma, or delayed injury presentation. Repeated examination, serial laboratory assessment, and repeat imaging when indicated are therefore essential. Management decisions depend on physiologic status, injury pattern, and institutional resources. Non-operative treatment has expanded considerably for splenic, hepatic, and selected renal injuries, supported by imaging surveillance and angioembolization. In contrast, bowel, mesenteric, pancreatic, diaphragmatic, and intraperitoneal bladder injuries more often require surgery. Overall, modern care emphasizes early recognition, balanced resuscitation, selective organ-preserving strategies, and timely operative intervention when instability, peritonitis, or ongoing hemorrhage are present.

Key words

Blunt abdominal trauma, Emergency department, Hemodynamic instability, Computed tomography, Focused Assessment with Sonography for Trauma, Non-operative management.

Introduction

Blunt abdominal trauma is defined as injury to the intra-abdominal, retroperitoneal, and pelvic structures caused by the transfer of kinetic energy from an external source without disruption of the abdominal wall, unlike penetrating trauma, in which there is a break in skin continuity caused by an external agent [1]. The pathophysiological mechanisms underlying tissue damage are fundamentally threefold: sudden deceleration, which generates shearing forces on vascular pedicles and ligamentous fixation points of mobile organs relative to relatively fixed structures - such as the distal aorta anchored to the vertebral column, the renal pedicles, or the intestinal ligaments; direct compression, which crushes solid viscera - the spleen, liver, and kidneys - between the anterior abdominal wall and the vertebral column or posterior rib cage; and a sudden increase in intra-abdominal pressure caused by external compression, which may lead to rupture of occluded hollow viscera such as the small intestine or bladder [1]. Traffic accidents - vehicle collisions, pedestrian injuries, and motorcycle crashes - constitute the predominant mechanism in most global epidemiological series, followed by falls from height, sports-related injuries, crush mechanisms, and episodes of interpersonal violence [1]. The liver and spleen are the most frequently injured parenchymal organs, whereas hollow viscus injuries - small intestine, colon, and bladder - represent a minority of cases but are associated with higher mortality when diagnosis is delayed, since in their early course they may lack the peritoneal and hemodynamic findings that would otherwise prompt the clinician toward immediate intervention [1, 2].

The clinical relevance of blunt abdominal trauma in the emergency department is based on its high frequency, its potential lethality, and the inherent difficulty of timely diagnosis. Injuries caused by traffic accidents result in approximately 1.19 million deaths annually worldwide and constitute the leading cause of death among children and young adults aged 5 to 29 years; in 2019, 93% of this mortality occurred in low- and middle-income countries, where deficiencies in road infrastructure, limited prehospital care systems, and poor implementation of preventive measures amplify the impact of each traumatic event [3]. In the context of polytrauma, the abdomen is the third most frequently affected anatomical region after thoracic and extremity injuries, and its clinical importance lies in the fact that it contains large-caliber vascular structures and richly perfused parenchymal organs whose injury may result in massive intra-abdominal hemorrhage with rapid hemodynamic deterioration and immediate threat to life [1, 4].

The diagnostic and therapeutic challenges of blunt abdominal trauma are considerable and represent one of the most demanding problems in emergency and trauma medicine practice. Unlike penetrating trauma, in which the location of the wound guides anatomical investigation, blunt trauma offers no external sign to delineate the injured organ [1]. Although abdominal physical examination remains the essential initial component of clinical evaluation, it has unacceptably low sensitivity and specificity for detecting clinically significant intra-abdominal injuries, especially in the presence of altered consciousness - due to traumatic brain injury, intoxication with alcohol or other substances, or spinal cord injury - or in the setting of cognitive distraction caused by painful concomitant injuries in other body regions [1, 4]. This limitation of physical examination has been recognized in the classical literature and remains relevant in contemporary evidence-based clinical practice guidelines [4]. Hollow viscus injuries are particularly problematic because they may not initially present with clear peritoneal findings or detectable hemoperitoneum, but rather with an insidious clinical picture that becomes apparent hours or days later, when peritonitis or septic shock has already developed into a process that is difficult to reverse; in this context, a diagnostic delay of as little as five hours has been associated with significant increases in mortality [2, 5].

The importance of early identification of potentially life-threatening injuries constitutes the central pillar of blunt abdominal trauma management in the emergency department. Non-compressible intra-abdominal hemorrhage is one of the most frequent causes of preventable death in trauma, and available data document that delay in hemostatic control is associated with a significant increase in mortality: for every three-minute delay in damage control laparotomy in the presence of active abdominal bleeding, mortality increases by approximately 1% [6]. This temporal relationship between diagnostic speed, rapid decision-making, and clinical outcomes justifies the primary trauma care approach in emergency settings, where identification of the patient in hemorrhagic shock of abdominal origin should trigger a structured, stepwise, and time-sensitive sequence of action [6]. The implementation of the ATLS - Advanced Trauma Life Support - protocol, widely adopted as the reference standard in the initial evaluation of the traumatized patient, provides a systematic framework that prioritizes the identification and sequential treatment of immediate life threats before proceeding to detailed diagnostic evaluation, integrating clinical examination with FAST - Focused Assessment with Sonography in Trauma - and computed tomography according to the patient's hemodynamic status [1, 4].

The rationale for an evidence-based approach to blunt abdominal trauma management derives from the complexity of the diagnostic and therapeutic decisions involved, which often must be made with incomplete information and under time pressure. Clinical practice guidelines from the World Society of Emergency Surgery (WSES) and other leading international organizations have systematized recommendations for the management of specific injuries - hepatic, splenic, intestinal, and retroperitoneal - based on objective criteria of severity, hemodynamic status, and computed tomography findings [4, 7]. The strategy of non-operative management of solid organ injuries in hemodynamically stable patients, which has significantly reduced mortality and morbidity associated with unnecessary laparotomy, represents one of the most important paradigm shifts in trauma surgery over the past decades and reflects the concrete benefit of systematically incorporating evidence into clinical practice [4, 7]. Throughout this review, the pathophysiological mechanisms, diagnostic strategies, injury classification, and therapeutic options available to the clinician managing the patient with blunt abdominal trauma in the emergency department are examined in an integrated manner, with emphasis on the practical application of the most recent evidence-based recommendations.

Methodology

This manuscript was developed as a structured narrative review aimed at providing an updated and clinically integrated analysis of blunt abdominal trauma in the emergency department, with particular emphasis on initial evaluation, diagnostic strategies, hemodynamic assessment, and evidence-based surgical decision-making. The review was conducted in accordance with the SANRA (Scale for the Assessment of Narrative Review Articles) framework and followed a predefined methodological protocol established prior to literature screening. Given the clinical heterogeneity of blunt abdominal trauma, the variability in injury patterns, and the differences in institutional management algorithms, a narrative interpretative synthesis was selected over quantitative pooling in order to integrate pathophysiological, diagnostic, radiologic, and surgical considerations into a coherent and clinically applicable framework. Special attention was given to the identification of life-threatening intra-abdominal injuries, the diagnostic role of physical examination and imaging modalities, the criteria for operative versus non-operative management, and the evolving role of interventional radiology in contemporary trauma care. The objective was to provide a structured synthesis capable of supporting timely and evidence-based decision-making in the emergency management of patients with blunt abdominal trauma.

A comprehensive literature search was conducted in PubMed, Scopus, and Web of Science, including peer-reviewed articles published in English or Spanish between January 2020 and December 2025. The final search was performed in April 2026. This timeframe was selected to capture contemporary advances in trauma imaging, non-operative management protocols, damage control strategies, interventional radiology applications, and updated recommendations from major trauma and emergency surgery societies. Foundational studies were incorporated when necessary to contextualize the pathophysiological mechanisms of injury, the historical evolution of trauma algorithms, or the development of current operative indications. The search strategy combined Medical Subject Headings and free-text terms using Boolean operators related to blunt abdominal trauma, abdominal injury, emergency department, trauma evaluation, hemodynamic instability, focused assessment with sonography for trauma, computed tomography, non-operative management, laparotomy, damage control surgery, angioembolization, hollow viscus injury, and solid organ injury. Searches were conducted in titles and abstracts as well as indexed subject headings to maximize sensitivity.

The initial search yielded 187 records. After removal of duplicates, 122 articles remained for title and abstract screening. Of these, 76 underwent full-text evaluation, and 32 studies were included in the final synthesis. Selection was performed independently by two authors, with disagreements resolved through discussion and consensus. Exclusion criteria comprised non-peer-reviewed publications, isolated case reports, editorials without clinical outcome data, purely technical reports lacking relevance to emergency department decision-making, redundant datasets, and studies not directly addressing diagnostic evaluation, hemodynamic assessment, operative indications, non-operative management, or outcomes in blunt abdominal trauma.

Eligible studies included randomized controlled trials, prospective and retrospective observational cohorts, systematic reviews, meta-analyses, expert consensus statements, and contemporary international guidelines from trauma surgery, emergency medicine, radiology, and critical care societies. Priority was assigned to multicenter investigations, studies with clearly defined hemodynamic stratification, and research evaluating diagnostic accuracy, mortality, need for operative intervention, failure of non-operative management, complications, and resource utilization. Extracted variables included study design, patient population, mechanism of injury, hemodynamic status, diagnostic modality, injury pattern and grade, therapeutic approach, need for surgery or angioembolization, transfusion requirements, morbidity, mortality, and predictors of management failure. Methodological quality and internal validity were assessed narratively, considering risk of bias, sample size, follow-up duration, consistency of injury classification, and reproducibility of reported outcomes. In cases of conflicting evidence, greater interpretative weight was assigned to higher-level evidence and guideline-supported recommendations.

Reference lists of included studies were manually screened to identify additional relevant publications. Given its narrative design, this review is subject to potential selection bias and does not provide pooled quantitative estimates. Artificial intelligence-based tools were used exclusively to assist in literature organization and structural coherence, whereas critical appraisal, synthesis, and final interpretation were conducted independently by the authors to preserve methodological rigor.

Epidemiology, Mechanisms of Injury, and Pathophysiology

Blunt abdominal trauma is a common condition associated with high morbidity and mortality in trauma care systems worldwide. Available epidemiological data show that abdominal injuries occur in up to one third of all patients with severe trauma, with the liver being the most frequently injured organ - identified in approximately 38% of cases - followed by the spleen, whose incidence surpasses that of the liver in some classification systems because of its greater vulnerability to direct compressive forces [8]. A 15-year epidemiological analysis conducted at a Norwegian university hospital documented an age- and sex-adjusted incidence of 7.2 abdominal injuries per 100,000 person-years, with a predominance in young men and a median age that has progressively increased as the treated population has aged [8]. Overall mortality associated with abdominal trauma varies widely according to injury severity, hemodynamic status on admission, and the availability of tertiary care resources, but it reaches as high as 20–30% in series from high-complexity trauma centers that include hollow viscus injuries with delayed diagnosis [2]. In the United States, approximately 25.5 million people visited emergency departments for unintentional injuries in 2021, with motor vehicle accidents being the leading cause of death among individuals aged 1 to 44 years, a significant proportion of which involve abdominal injuries [1].

Regarding the main causes, traffic accidents - including motor vehicle collisions, pedestrian impacts, and motorcycle crashes - account for between 50% and 75% of all cases of blunt abdominal trauma in the adult civilian population, by far representing the predominant mechanism [1]. In high-speed frontal collisions, the impact of the steering wheel or dashboard against the abdomen, combined with the sudden deceleration forces acting on vascular pedicles and fixed organs, generates a combined injury pattern that commonly involves the liver and retroperitoneal vascular structures [9]. Although seat belts significantly reduce overall mortality in traffic accidents, they may paradoxically cause injuries through direct compression of hollow viscera and the mesentery when improperly positioned over the abdomen - the so-called seat belt injury, frequently associated with Chance fractures of the lumbar spine [1, 9]. Falls from height are the second most important cause and are especially relevant in the elderly population, in whom they represent an increasingly common cause over time: an eight-year analysis of the United States National Trauma Data Bank documented that the proportion of falls increased significantly in all racial and ethnic groups, with particular concentration among adults older than 65 years, a pattern that reflects the demographic aging of the trauma population [10]. In this age group, skeletal fragility, anticoagulant use, and lower physiological reserve amplify the hemodynamic consequences of injuries that might be managed conservatively in younger patients [10].

Pedestrian trauma - understood as the impact of a vehicle on a person who is walking or running - produces a complex and potentially lethal pattern of injuries that includes high-energy abdominal trauma caused by the direct impact of the bumper and hood on the abdomen, hips, and thighs of the pedestrian, followed by the phase of falling to the ground or secondary impact against other surfaces, which generates additional injuries through compression and deceleration [3]. Physical assaults - including trauma caused by kicks, punches, blows with blunt objects, and intentional crushing - constitute a variable proportion of cases depending on the socioeconomic and geopolitical context of each region, and are especially prevalent in urban settings and in certain vulnerable populations [10]. Trauma related to sports and recreational activities - or motorcycle falls, direct blows in contact sports, equestrian accidents - represents an additional cause, generally involving lower velocity but still capable of producing solid organ injuries when the impact is focused on the right or left upper quadrant [1].

From a biomechanical perspective, understanding the physical mechanisms by which kinetic energy is transferred to the intra-abdominal organs is essential for anticipating injury patterns and guiding the diagnostic workup [9]. Sudden deceleration is the mechanism that produces the most characteristic and potentially most devastating injuries: when bodily motion is abruptly halted - as occurs in a frontal vehicle collision - the abdominal viscera, which have different inertial masses and distinct points of fixation, continue moving momentarily in the direction of the original motion. This creates shearing forces at the relatively fixed anchoring points of mobile organs: the liver tears along the round ligament, the renal pedicles sustain intimal injuries from traction, intestinal loops separate from the mesentery at the fixation points of the peritoneal folds, and the distal aorta - firmly anchored to the vertebral column - may rupture in its descending thoracic portion while the aortic arch continues its anterior trajectory [1, 9]. Direct compression acts when an external force crushes the solid viscera - the spleen, liver, kidneys, and pancreas - between the anterior abdominal wall and the vertebral column or posterior rib cage, producing parenchymal lacerations of variable depth whose severity is proportional to the magnitude of the applied energy [9]. Crushing is a variant of compression that involves prolonged or high-magnitude forces, such as those occurring in industrial accidents or compression by overturned vehicles, and generates extensive injuries that frequently affect multiple organs simultaneously, including severe muscle damage with risk of rhabdomyolysis and abdominal compartment syndrome [1]. Direct impact by a localized object or surface - such as a bicycle handlebar, the head of a hammer, or a pole - concentrates energy over a small area and may produce focal high-energy injuries that preferentially affect the underlying organs, including the pancreas when the impact occurs over the epigastrium and compresses the gland against the vertebral column [9].

The pathophysiological consequences of blunt abdominal trauma are multiple and interdependent, and their recognition allows anticipation of clinical deterioration and structuring of the therapeutic plan. Hemorrhage is the most critical immediate consequence and the main cause of preventable death in trauma: it may be intraperitoneal - visible on FAST as free fluid in the perihepatic, perisplenic, and pelvic spaces - or retroperitoneal, in which case the anatomic containment of the hematoma may temporarily mask the magnitude of blood loss and delay recognition of hemorrhagic shock [4, 7]. Injuries to solid organs - the liver, spleen, kidney, and pancreas - are the most frequent source of significant intra-abdominal hemorrhage: the liver and spleen together account for more than 60% of visceral injuries identified in blunt abdominal trauma series, and their laceration may produce active bleeding that requires arterial embolization or urgent surgical intervention when associated with hemodynamic instability [8, 9]. Hollow viscus injuries - the small intestine, colon, duodenum, and bladder - occur in approximately 5–7% of blunt abdominal trauma cases and are associated with disproportionately high mortality when diagnosis is delayed beyond the first hours, because progressive fecal peritoneal contamination triggers a systemic inflammatory response that is difficult to control [5, 6]. Mesenteric injuries may present in isolation - with tearing of mesenteric fat and vascular tissue without intestinal perforation - or together with hollow viscus injuries, and are especially problematic because they may result in delayed intestinal ischemia due to thrombosis of injured mesenteric vessels, an event that may occur hours after the initial trauma when the bowel had appeared viable during the initial surgical exploration (11). Retroperitoneal injuries - including perirenal hematomas, injuries to the aorta, inferior vena cava, iliac vessels, and pancreaticoduodenal injuries - pose particular diagnostic challenges because the retroperitoneum acts as a containment compartment that can harbor large volumes of blood without clear peritoneal findings on initial clinical examination, making contrast-enhanced computed tomography especially necessary for early identification [1, 4].

The relationship between the mechanism of injury and the expected pattern of organ damage has significant clinical predictive value and should guide the focused diagnostic evaluation of the patient. High-speed frontal collisions with seat belt use are more frequently associated with hepatic injuries and hollow viscus injuries caused by the seat belt mechanism, whereas rollover crashes correlate with splenic and renal injuries [9]. Lateral impacts - in which the vehicle door intrudes upon the occupant - produce splenic injuries when the impact occurs on the left side of the body and hepatic injuries when it affects the right side, since these organs lack muscular cushioning in their respective flanks [9]. Pedestrian trauma from being struck by a vehicle - in which the vehicle's initial impact occurs at the level of the lower extremities while the thorax and abdomen are exposed to the hood - produces complex injury patterns that include pelvic fractures with retroperitoneal hematoma, splenic and hepatic injuries due to compression, and brain injuries from impact with the ground [3]. Falls from great height produce axial deceleration injuries that preferentially affect vascular pedicles - renal and mesenteric - and the solid structures of the flanks, whereas low-energy falls in older adults are more often associated with splenic injuries from direct impact to the left upper quadrant [10]. This correlation between mechanism and injury pattern, integrated with physical examination findings, hemodynamic parameters, and FAST ultrasound results, allows the emergency physician to prioritize diagnostic studies and establish an appropriate level of clinical suspicion that minimizes the risk of overlooking injuries with delayed presentation [9, 11].

Initial Emergency Department Assessment

The initial evaluation of the patient with blunt abdominal trauma in the emergency department should not be conceived as a sequence of isolated steps focused solely on the abdomen, but rather as an integral component of a systematic and prioritized assessment of the polytraumatized patient as a whole. The structural framework of reference is the ABCDE primary survey protocol - airway, breathing, circulation, disability, exposure - promulgated by the Advanced

Trauma Life Support (ATLS) of the American College of Surgeons, whose fundamental objective is to identify and treat immediate life-threatening conditions in the shortest possible time, in an order of priorities determined by the speed with which each condition can cause death if left unaddressed [12]. This sequential yet adaptable approach is applied by trained interprofessional teams whose coordination, clarity of roles, and efficient communication are decisive for outcomes in the severely injured patient.

Airway evaluation constitutes the first step, since obstruction may cause death within minutes and because many mechanisms of blunt abdominal trauma are associated with facial trauma, maxillofacial fractures, neck trauma, or impaired consciousness that predisposes to loss of airway control [12]. Airway patency is assessed by inspection - looking for foreign bodies, blood, vomitus, edema, or displaced fractures - and auscultation, while cervical spine control is maintained simultaneously through manual immobilization until spinal injury is ruled out. When the airway is not protected by the patient - whether due to level of consciousness, massive hemoptysis, or direct injury to laryngeal structures - rapid sequence orotracheal intubation is performed as the first-line intervention [12]. Breathing assessment follows immediately, with active search for thoracic injuries that immediately compromise ventilation - tension pneumothorax, open pneumothorax, massive hemothorax, flail chest with pulmonary contusion - whose incidence in the context of blunt abdominal trauma is high, given that the mechanism of impact frequently involves the abdomen and thorax simultaneously [1, 12]. Bilateral auscultation of breath sounds, inspection of thoracic symmetry, and the search for subcutaneous emphysema or sucking wounds must be performed rapidly and systematically, proceeding to needle decompression or immediate chest tube placement when these conditions are identified [12].

Circulatory assessment is the most specifically relevant component of the primary survey in blunt abdominal trauma, since the abdomen is the most frequent source of occult massive hemorrhage in the polytraumatized patient [4]. Identification of hemodynamic instability is carried out through the combined clinical assessment of multiple parameters: systolic blood pressure below 90 mmHg, heart rate above 120 beats per minute, prolonged capillary refill time, altered mental status as a manifestation of cerebral hypoperfusion, weak and thready pulse, cold and pale skin, and oliguria [12]. The shock index - defined as the ratio between heart rate and systolic blood pressure - is an easily calculated bedside tool that has proven useful in identifying patients at higher risk of exsanguinating hemorrhage: values equal to or greater than 0.9 are significantly associated with higher mortality and the need for massive transfusion [4, 7]. In the context of abdominal trauma, hemodynamic instability without a visible external source of bleeding - neither thoracic nor from the extremities on initial examination - must be presumptively attributed to intra-abdominal hemorrhage until proven otherwise, which determines the indication for FAST ultrasound as the next immediate diagnostic step [1, 5]. Neurologic assessment – disability - is performed using the Glasgow Coma Scale and pupillary evaluation, allowing identification of traumatic brain injury as a concurrent lesion that modifies hemodynamic management: in the presence of intracranial injury with increased intracranial pressure, permissive hypotension - a resuscitation strategy that tolerates systolic blood pressure of 80–90 mmHg in patients without traumatic brain injury - is contraindicated because it compromises cerebral perfusion pressure and may worsen secondary injury [13]. Finally, complete exposure of the patient - removal of all clothing using scissors - is essential for full physical examination, looking for ecchymoses, hematomas, abrasions, abdominal distension, seatbelt signs, perineal wounds, and signs of trauma to the flanks or back that may suggest retroperitoneal injuries [12].

Identification of hemodynamic instability in the context of blunt abdominal trauma has direct and immediate algorithmic implications. The hemodynamically unstable patient who does not respond to initial resuscitation with crystalloids and blood products requires ultrarapid identification of the source of hemorrhage in order to proceed to hemorrhage control; in this setting, a positive FAST - documenting free intraperitoneal fluid - determines the indication for emergency laparotomy without further diagnostic delay [4, 5]. In contrast, the hemodynamically stable patient can tolerate contrast-enhanced computed tomography as the study of choice, which provides detailed anatomic information about the injured organ, the grade of injury, and the presence of active bleeding [1]. This algorithmic bifurcation based on hemodynamic status is a fundamental principle in the management of blunt abdominal trauma that should not be violated: submitting an unstable patient to computed tomography while exsanguination continues represents one of the most costly management errors in terms of mortality [4].

Recognition of associated extra-abdominal injuries is an integral part of the initial evaluation of the patient with blunt abdominal trauma, since the high-energy impact mechanism that produces abdominal injury frequently affects other anatomical regions simultaneously [1]. Rib fractures - especially those involving the lower left ribs (IX–XI) - are markers of elevated risk of splenic injury, whereas fractures of the lower right ribs are more frequently associated with hepatic laceration [9]. Unstable pelvic fractures may produce large-volume retroperitoneal hematomas that compromise hemodynamic stability independently or synergistically with visceral hemoperitoneum, requiring specific pelvic management - stabilization with an external fixator or pelvic binder - as part of the hemorrhage control strategy [4]. Lumbar spine injuries - especially flexion-distraction Chance fractures, frequently associated with the seatbelt mechanism - correlate with elevated risk of hollow viscus and mesenteric injury, and their identification should increase the diagnostic index of suspicion for these injuries [5]. Severe traumatic brain injury may completely mask abdominal symptoms and signs, constituting one of the most diagnostically challenging situations in trauma and requiring a lower threshold for imaging studies and serial FAST examinations in the patient with altered consciousness [1, 12].

Initial resuscitation priorities in the patient with blunt abdominal trauma and hemorrhagic shock have evolved significantly over the past decade, with abandonment of aggressive crystalloid resuscitation protocols in favor of damage control resuscitation strategies that prioritize early use of blood products in proportions that emulate whole blood - with ratios of fresh frozen plasma, platelet concentrates, and packed red blood cells of 1:1:1 - to correct traumatic coagulopathy simultaneously with restoration of circulating volume [7]. Permissive hypotension - which allows maintenance of systolic blood pressure at 80–90 mmHg in the patient without severe traumatic brain injury until surgical hemorrhage control is achieved - reduces hemodilution of coagulation factors, iatrogenic hypothermia, and the risk of worsening active bleeding through mechanical increase in hydrostatic pressure over the forming clot [13]. Early administration of tranexamic acid - ideally within the first three hours from the time of injury - has been shown to reduce mortality in the traumatized patient with active bleeding or at risk of massive hemorrhage, with greater benefit when administered in the first hour [7].

The role of clinical suspicion during the initial evaluation of blunt abdominal trauma cannot be underestimated. Physical examination of the abdomen may be entirely normal or equivocal in the presence of clinically significant intra-abdominal injuries - up to 10% of patients with trauma team activation and negative abdominal examination have occult intra-abdominal injuries documented on computed tomography - and the experienced clinician must recognize when the mechanism of injury, indirect physical findings, and hemodynamic status justify additional studies regardless of the absence of clear peritoneal signs [1, 5]. Elements that should raise the clinical index of suspicion include high-speed mechanism, presence of a seatbelt sign, ecchymosis of the flanks or epigastrium, even mild abdominal distension, tenderness to palpation in any quadrant, hemodynamic instability without identified thoracic or extremity cause, and microscopic hematuria suggesting renal or urinary tract injury [1, 9].

Serial and repeated abdominal assessment is a fundamental component of blunt abdominal trauma management and should not be omitted under any circumstances, regardless of initially negative findings [5]. Hollow viscus and mesenteric injuries may present with a characteristic temporal evolution in which the initial clinical picture is insidious or even benign, and frank peritonitis becomes evident only hours later, when fecal contamination has reached sufficient magnitude to trigger the systemic inflammatory response [5]. For this reason, all patients with significant abdominal trauma - even those with initial computed tomography showing no evidence of specific injury - must undergo repeated clinical evaluations during the observation period, looking for progressive abdominal pain, muscular guarding, rebound tenderness, or hemodynamic deterioration that may indicate an initially undetected injury [1, 5]. Integration of successive clinical findings with laboratory parameters - serum lactate, base deficit, white blood cell count, and amylase - and with repeated imaging studies when indicated constitutes the most comprehensive strategy to minimize the risk of delayed diagnosis in this group of patients [9].

Clinical Evaluation and Laboratory Assessment

The clinical evaluation of a patient presenting to the emergency department following blunt abdominal trauma begins with a focused history that, even in circumstances demanding urgency, provides critical information guiding diagnostic and therapeutic decision-making. When circumstances allow, a structured history should be obtained using the AMPLE mnemonic - Allergies, Medications, Past medical history, Last meal, and Events surrounding the trauma - addressing the mechanism of injury, the patient's symptoms, relevant comorbidities, and current medication use [12]. The mechanism of injury is among the most informative historical elements: the direction and magnitude of the impact, the speed of the vehicles involved, whether the patient was restrained by a seatbelt and whether airbags deployed, the height of a fall and the surface on which the patient landed, and the nature of the object involved in an assault all carry specific predictive value for the pattern and severity of intra-abdominal injury [9]. Patients who are conscious and communicative should be asked about abdominal pain - its onset, location, radiation, and progression - as well as nausea, vomiting, hematuria, shoulder-tip pain suggesting diaphragmatic irritation from intraperitoneal blood, and any sensation of dizziness or syncope that may reflect hemodynamic compromise [1]. Comorbid conditions are of particular relevance in determining both the physiologic reserve of the patient and the safety of potential interventions: chronic liver disease reduces baseline clotting factor synthesis and may accelerate coagulopathy; end-stage renal disease alters platelet function and fluid tolerance; diabetes impairs immune response and wound healing; and advanced age diminishes physiologic compensatory mechanisms that can mask early hemodynamic deterioration [12]. The use of anticoagulant agents - including warfarin, direct oral anticoagulants such as rivaroxaban or apixaban, antiplatelet medications, and low-molecular-weight heparins - must be ascertained immediately upon patient arrival, as these dramatically increase the risk of uncontrolled hemorrhage from solid organ lacerations or retroperitoneal hematomas and require urgent reversal strategies concurrent with the diagnostic evaluation [14].

Physical examination of the abdomen in the context of blunt trauma requires a systematic approach that integrates inspection, auscultation, percussion, and palpation, with the explicit recognition that its diagnostic sensitivity is limited and that a normal abdominal examination does not exclude clinically significant intra-abdominal injury [1]. Inspection of the exposed abdomen begins with the search for external signs of trauma: abrasions, contusions, and ecchymoses distributed over the anterior abdominal wall, flanks, or lower thorax provide important topographic information linking the surface finding to underlying visceral injury. The seatbelt sign - defined as a continuous band of erythema, ecchymosis, or abrasion across the abdomen corresponding to the trajectory of the restraint device - is a particularly significant finding that is independently associated with a substantially higher risk of hollow viscus and mesenteric injury; although its sensitivity for intra-abdominal injury is only approximately 25%, its specificity reaches 85%, and its presence mandates computed tomography regardless of other examination findings [5]. Abdominal tenderness to palpation, voluntary or involuntary guarding, and peritoneal signs such as rebound tenderness are classically associated with free intraperitoneal blood or bowel content, but their reliability is compromised by the clinical circumstances of most polytrauma patients [1]. Distension of the abdomen may reflect large-volume hemoperitoneum, pneumoperitoneum from viscus perforation, or ileus, and when progressive or associated with hemodynamic deterioration represents an urgent indication for imaging or operative intervention [12]. Examination of the lower thoracic region may reveal rib fractures at the level of ribs IX through XI on the left - a well-established risk factor for splenic laceration - or on the right, where they correlate with hepatic injury; pelvic stability testing, performed by gentle anteroposterior and lateral compression, may identify pelvic ring disruption associated with massive retroperitoneal hemorrhage [9].

The limitations of physical examination in blunt abdominal trauma are well-established and should be explicitly incorporated into the clinical decision-making framework [1]. Altered mental status - whether from traumatic brain injury, shock-induced cerebral hypoperfusion, or intoxication with alcohol or illicit substances - is perhaps the most important confounder, as it prevents the patient from localizing pain and renders abdominal tenderness unreliable as a diagnostic criterion; in the intoxicated patient, the threshold for objective imaging must be substantially lowered relative to an alert, cooperative patient with a benign abdominal examination [1, 5]. In the context of polytrauma with concomitant long bone fractures, thoracic injuries, or spinal pain, the patient's attention and pain response are distracted by multiple competing stimuli, and focal abdominal tenderness may be absent even in the presence of significant visceral injury [12]. The intubated and pharmacologically paralyzed patient presents the most extreme limitation - the abdominal examination is entirely abolished, and all clinical decision-making regarding the abdomen must rely on hemodynamic parameters, FAST ultrasound, and computed tomography [1]. These limitations make physical examination a necessary but insufficient component of the evaluation, one that should always be complemented by objective diagnostic studies when there is any reasonable clinical suspicion for intra-abdominal injury [5, 12].

Laboratory assessment in blunt abdominal trauma serves multiple simultaneous purposes: characterization of the degree of physiologic derangement from hemorrhage and shock, screening for specific organ injuries, identification of pre-existing hematologic abnormalities, preparation for potential operative intervention, and establishment of a baseline against which serial measurements can be trended [1]. Hemoglobin and hematocrit are routinely obtained, but their diagnostic value in the acute setting is limited by the phenomenon of hemodilution lag: in the immediate aftermath of acute hemorrhage, the hematocrit may remain within normal limits for several hours as plasma and red cell losses occur proportionally before fluid shifts redistribute extravascular water into the intravascular compartment [12]. A normal hemoglobin on arrival therefore does not exclude significant ongoing hemorrhage, and serial measurements over time are more informative than a single determination. Conversely, a markedly reduced hemoglobin on initial presentation reflects either pre-existing anemia, massive acute hemorrhage in a patient who has already received resuscitation fluids, or chronic blood loss from an unrelated condition [1].

Serum lactate and base deficit are among the most clinically useful laboratory markers for identifying occult shock and quantifying the severity of tissue hypoperfusion in blunt trauma patients, including those who maintain a normal blood pressure through compensatory mechanisms [15]. Elevated serum lactate - defined as a level greater than 2 mmol/L - reflects anaerobic cellular metabolism secondary to inadequate oxygen delivery, and values above 4 mmol/L correspond to profound shock with substantially increased mortality [15]. Base deficit, derived from arterial blood gas analysis, provides a complementary and readily available measure of metabolic acidosis that correlates with the volume of blood loss and the adequacy of resuscitation: a base deficit more negative than −6 mmol/L is associated with high injury severity, early transfusion requirement, and increased mortality across multiple trauma populations [15]. The combination of elevated lactate and a negative base deficit carries additive predictive value for mortality that exceeds either marker used alone, and both parameters should be monitored serially throughout resuscitation as indicators of response to treatment and persistent hemorrhage [15].

The coagulation profile - including prothrombin time, international normalized ratio, activated partial thromboplastin time, fibrinogen level, and platelet count - must be obtained early in the evaluation of the blunt trauma patient, as trauma-induced coagulopathy is a clinically distinct and life-threatening process that develops rapidly and is independently associated with increased transfusion requirements and mortality [16]. Trauma-induced coagulopathy encompasses multiple concurrent mechanisms: dilution of clotting factors from aggressive fluid resuscitation, consumption of coagulation factors in response to tissue injury, hypothermia-induced enzymatic inhibition of the coagulation cascade, acidosis-mediated impairment of thrombin generation, endothelial activation of the protein C pathway leading to systemic anticoagulation, and dysregulation of fibrinolysis that may manifest as either hyperfibrinolysis or fibrinolytic shutdown [16]. Prolongation of the prothrombin time or INR on admission identifies patients at highest risk of hemorrhage-related death and guides the decision to initiate massive transfusion protocols with balanced blood product ratios [16]. Viscoelastic hemostatic assays - such as thromboelastography and rotational thromboelastometry - offer real-time, point-of-care characterization of the entire coagulation process including clot formation, strength, and fibrinolysis, and are increasingly used as complements to conventional coagulation testing in high-volume trauma centers [16].

Serum liver enzymes - aspartate aminotransferase and alanine aminotransferase - are valuable screening tools for hepatic parenchymal injury in the context of blunt abdominal trauma. A prospective study demonstrated that ALT levels above 80 U/L achieved a sensitivity of 77.8% and specificity of 94.1% for diagnosing liver injury, while AST levels above 106 U/L showed a sensitivity of 71.7% and specificity of 90%, with ALT identified as the preferred standalone screening marker due to its superior diagnostic performance [17]. Although both enzymes are released into the circulation in proportion to the degree of hepatocellular damage, neither correlates reliably with the severity of the injury grade, meaning that markedly elevated transaminases do not necessarily predict the need for operative intervention, nor do normal values definitively exclude minor hepatic lacerations [17]. Pancreatic enzyme levels - serum amylase and lipase - are obtained when pancreatic injury is suspected based on the mechanism of injury, particularly a direct epigastric impact against a fixed object such as a steering wheel or bicycle handlebar. Their diagnostic utility is time-dependent: levels obtained within six hours of injury may be normal even in the presence of significant pancreatic trauma, and their peak elevation typically occurs 12–24 hours after the injury [1]. A combined elevation of both amylase and lipase shows 100% specificity and 85% sensitivity for pancreatic injury when obtained after a sufficient interval, although both enzymes also rise in response to hollow viscus injury, bowel ischemia, and salivary gland trauma, limiting their organ-specific diagnostic value [1].

Urinalysis is a mandatory component of the laboratory assessment of blunt abdominal trauma, as hematuria - either macroscopic or microscopic - serves as a sensitive indicator of urinary tract injury encompassing the kidney, ureter, bladder, and urethra [1]. Macroscopic hematuria in the context of blunt trauma reliably predicts the presence of significant urinary tract injury and mandates cross-sectional imaging of the kidneys and bladder; the degree of macroscopic bleeding does not, however, correlate linearly with injury severity, as some high-grade renal injuries such as renal pedicle avulsion may produce minimal or no hematuria due to vascular occlusion [1]. Microscopic hematuria in the hemodynamically stable patient without hemodynamic shock is generally associated with minor renal contusions that may be safely managed without operative intervention, but its presence in a patient with hemodynamic instability, a significant mechanism of injury, or pelvic fracture warrants computed tomographic evaluation to exclude collecting system disruption or ureteral injury [12]. Blood typing and crossmatching must be performed immediately upon patient arrival and before any active hemorrhage has been identified, as the time required to prepare fully crossmatched blood products may exceed the window of safe resuscitation with uncrossmatched or type-specific blood in a rapidly deteriorating patient [7]. The results of the crossmatch guide both the immediate transfusion strategy - using O-negative uncrossmatched blood when time does not allow for full compatibility testing - and the preparedness of the blood bank for ongoing massive transfusion support [7].

The diagnostic value of laboratory markers in blunt abdominal trauma must be understood within their collective limitations [1, 15]. No single laboratory test reliably identifies or excludes significant intra-abdominal injury in isolation: each marker must be interpreted in the context of the clinical presentation, the mechanism of injury, the hemodynamic status, and the findings on imaging. Serial laboratory assessments over time - tracking the trajectory of lactate clearance, base deficit normalization, hemoglobin trends, and coagulation parameter evolution - provide far more diagnostic and prognostic information than any single point-in-time measurement and are indispensable for monitoring the adequacy of resuscitation and detecting the early physiologic signs of deterioration that may precede clinical decompensation [15, 16].

Imaging in Blunt Abdominal Trauma

Imaging represents the cornerstone of the diagnostic evaluation of blunt abdominal trauma, as neither clinical examination nor laboratory studies alone provide the anatomical precision required to characterize the nature, severity, and operative significance of intra-abdominal injuries. The selection of the appropriate imaging modality - and the timing of its application - is determined primarily by the hemodynamic status of the patient, and constitutes one of the most critical algorithmic decision points in the early management of the blunt trauma patient in the emergency department [1, 18].

The Focused Assessment with Sonography for Trauma is a rapid, portable, non-invasive, and bedside point-of-care ultrasound examination that has become a fundamental component of the initial evaluation of all patients with significant blunt abdominal trauma [18]. In its classic form, FAST evaluates four acoustic windows: the pericardial space to detect hemopericardium; the hepatorenal interface in Morrison's pouch in the right upper quadrant; the splenorenal interface and perisplenic space in the left upper quadrant; and the pouch of Douglas in the pelvis, where small volumes of free fluid accumulate by gravity [18]. The extended FAST - eFAST - adds bilateral anterolateral thoracic views to detect pneumothorax and hemothorax, making it the most comprehensive bedside assessment currently available in the acute trauma setting [18]. The primary indication for FAST in blunt abdominal trauma is the rapid detection of free intraperitoneal fluid in any patient presenting with a significant mechanism of injury, with particular urgency in the hemodynamically unstable patient where the result directly determines the need for emergency laparotomy [18]. In the hemodynamically unstable patient who cannot tolerate the time required for computed tomography, a positive FAST - demonstrating free fluid in any of the interrogated windows - is sufficient to justify an emergency operative intervention without the need for further imaging, effectively replacing the diagnostic peritoneal lavage that was previously the standard of care in this scenario [4, 18].

The central strength of FAST in the management of the unstable blunt trauma patient lies in its speed and bedside availability: the examination can be completed within two to three minutes by a trained clinician, does not require patient transport, imposes no radiation exposure, can be repeated as often as clinical circumstances demand, and provides an immediate binary answer to the most urgent hemodynamic question - is there free intraperitoneal blood? [18]. This combination of speed, portability, and non-invasiveness makes FAST irreplaceable in the initial evaluation of the polytraumatized patient who cannot be safely moved to the computed tomography suite and in resource-limited settings where advanced imaging may not be available [18]. The examination is also particularly valuable for monitoring the hemodynamic trajectory of the patient: a negative FAST that becomes positive on serial re-examination signals ongoing hemorrhage or delayed accumulation of intraperitoneal blood from a visceral injury whose initial bleeding was minimal [18].

Despite these attributes, FAST carries important and well-characterized limitations that must be explicitly understood to prevent the underestimation of significant injuries based on a falsely reassuring negative result [18]. The sensitivity of FAST for detecting intraperitoneal free fluid in blunt trauma is highly variable across published series, ranging from 22% to 76% in hemodynamically stable patients and improving modestly to approximately 50–83% in hemodynamically unstable patients with larger volumes of intraperitoneal blood, which are inherently easier to detect sonographically [18]. The threshold volume of free fluid detectable by a standard FAST examination in Morrison's pouch has been estimated at approximately 400–619 mL, meaning that small-volume hemoperitoneum from minor solid organ lacerations or early hollow viscus injuries may be below the detection threshold and produce a false-negative result [18]. Retroperitoneal hemorrhage - including injuries to the aorta, inferior vena cava, renal pedicles, and pancreas - is largely invisible to FAST because the retroperitoneum does not communicate freely with the peritoneal cavity and bowel gas overlying these structures further impairs sonographic penetration [18]. Isolated injuries to solid organ parenchyma without associated free fluid, diaphragmatic lacerations, and hollow viscus perforations with minimal contamination are additional sources of false-negative FAST results [18]. Technical factors that further reduce diagnostic reliability include obesity, subcutaneous emphysema that deflects the ultrasound beam, prior abdominal surgery with adhesions that prevent fluid redistribution to standard interrogation sites, and operator inexperience, since the quality of FAST is inherently user-dependent [18]. For all these reasons, a negative FAST in the context of blunt abdominal trauma should never be interpreted as definitive evidence of absence of injury in the hemodynamically stable patient, and computed tomography must follow in all cases where clinical suspicion persists [1, 5, 18].

Contrast-enhanced computed tomography of the abdomen and pelvis has established itself as the gold standard for the comprehensive imaging evaluation of blunt abdominal trauma in the hemodynamically stable patient, offering simultaneous, high-resolution characterization of all intraperitoneal and retroperitoneal structures [4, 19]. Its role is defined by the hemodynamic condition of the patient: once cardiovascular stability has been confirmed - or provisionally restored through initial resuscitation - computed tomography provides the anatomical detail required to guide decisions about nonoperative management, interventional radiology, and operative planning that would be impossible on the basis of FAST findings alone [4]. Modern multidetector computed tomography systems can complete abdominal and pelvic acquisitions within seconds, with image reconstruction that allows multiplanar reformatting and detection of injuries as small as a few millimeters in solid organ parenchyma, mesenteric vasculature, and retroperitoneal structures [19]. The protocol for blunt abdominal trauma typically includes a portal venous phase acquisition with intravenous iodinated contrast, and frequently an arterial phase acquisition when active vascular hemorrhage is suspected, as the two phases together allow characterization of both parenchymal injury and active bleeding [19].

The diagnostic performance of contrast-enhanced computed tomography for solid organ injury is excellent: for hepatic and splenic lacerations, sensitivity ranges from 92% to 98% and specificity from 95% to 99%, with the American Association for the Surgery of Trauma organ injury scale providing the standardized grading framework upon which management decisions are based [4, 19]. For renal injuries, computed tomography with contrast - including delayed phase acquisitions to detect urinoma or collecting system disruption - is similarly the study of choice, with high sensitivity for parenchymal lacerations, vascular injury, and perirenal hematomas [14]. Active arterial hemorrhage is identified on contrast-enhanced computed tomography by the presence of hyperdense contrast extravasation within or adjacent to the injured organ, with CT attenuation values of active bleeding ranging from 85 to 370 Hounsfield units - substantially higher than the 40–70 HU range of clotted blood - allowing reliable distinction between active hemorrhage requiring urgent angioembolization or operative control, and contained hematoma amenable to expectant management [4]. The identification of active contrast blush on CT directly influences the decision to proceed with angiographic embolization as an alternative or adjunct to operative intervention, particularly for solid organ injuries in hemodynamically stable patients [4].

For injuries of the hollow viscera and mesentery - the most diagnostically challenging category of blunt abdominal injuries - contrast-enhanced CT demonstrates high specificity but more variable and often suboptimal sensitivity, creating a clinically important zone of diagnostic uncertainty [19, 20]. Pathognomonic CT findings for bowel perforation include extraluminal free air within the peritoneal cavity or mesentery, intraluminal contrast extravasation, and direct visualization of a bowel wall defect; these signs achieve specificity approaching 97–98% but are present only in a minority of confirmed injuries [19]. More sensitive but less specific CT signs include mesenteric fat stranding, mesenteric hematoma, focal bowel wall thickening, bowel wall hypoenhancement suggesting ischemia, and unexplained intraperitoneal free fluid in the absence of solid organ injury - the last being a particularly important indirect sign that should prompt repeat evaluation even when no direct injury is identified [19, 20]. A CT-based diagnostic algorithm combining extraluminal gas and absent or reduced bowel wall enhancement achieved 86% sensitivity and 96% specificity for bowel and mesenteric injury in the training cohort, and 92% sensitivity and 88% specificity in the validation cohort, representing the most systematically derived CT decision tool for this injury pattern to date (19). Retroperitoneal injuries - including pancreatic lacerations, duodenal hematomas, and vascular injuries of the aorta and inferior vena cava - are evaluated with high diagnostic accuracy by contrast-enhanced CT when adequate technique and appropriate clinical suspicion are applied [14].

The comparison between FAST ultrasound and contrast-enhanced computed tomography in blunt abdominal trauma is not a direct competition but rather a clinically driven complementarity defined by the hemodynamic status of the patient and the specific diagnostic question being asked at each phase of management [18, 20]. FAST is rapid, portable, repeatable, non-irradiating, and sufficient to guide the decision for emergency laparotomy in the unstable patient; however, it cannot characterize the specific organ injured, grade the severity of the injury, identify retroperitoneal pathology, detect hollow viscus perforation, or detect active contrast extravasation - all of which are critical to planning non-operative management in the stable patient [18, 20]. Computed tomography requires patient transport, takes longer, delivers ionizing radiation, exposes the patient to intravenous contrast with its renal and allergic risks, and is contraindicated in patients who cannot be safely mobilized; but it provides anatomical information of a comprehensiveness and precision that FAST fundamentally cannot match [18, 19]. The standard of care in most high-volume trauma centers accordingly uses these modalities sequentially and complementarily: FAST as the first-line rapid assessment in the resuscitation bay integrated into the primary survey, followed by contrast-enhanced computed tomography in the hemodynamically stable or stabilized patient as the definitive anatomical characterization [1, 4, 18].

The role of serial imaging in blunt abdominal trauma is determined by the well-established phenomenon of delayed clinical manifestation of certain injury patterns, particularly bowel and mesenteric injuries, and by the recognized false-negative rate of both initial FAST and initial computed tomography in patients evaluated within a short interval after the traumatic event [5, 20]. Repeat computed tomography in patients initially managed non-operatively who subsequently develop clinical deterioration - defined as worsening abdominal pain, rising inflammatory markers, increasing leukocytosis, unexplained fever, or hemodynamic instability - has been shown to increase sensitivity from 67% on the initial scan to 100% on the repeat scan, confirming the additive diagnostic value of imaging reassessment over time [5]. Serial FAST examinations during the resuscitation phase can detect the progressive accumulation of intraperitoneal blood that was below the detection threshold on initial evaluation, and a FAST that converts from negative to positive during the observation period has significant management implications even in the absence of a change in vital signs [18]. The appropriate timing of repeat imaging should be guided by clinical reassessment rather than fixed intervals, with imaging triggered by any new clinical finding, unexplained physiologic change, or failure to improve as expected during the observation period [5, 11].

Imaging pitfalls and sources of false-negative findings in blunt abdominal trauma represent a clinically significant challenge that must be explicitly incorporated into the interpretive framework applied to all imaging results in this context [19, 20]. For computed tomography, the most consequential sources of false-negative results include: the timing of the scan relative to the injury, as hollow viscus perforations may produce no free air and minimal free fluid in the first hours after injury before the gastrointestinal contents have accumulated in sufficient quantity to be detectable; pancreatic injuries, which may show only subtle peripancreatic stranding or no abnormality at all on early CT despite significant ductal disruption; diaphragmatic lacerations, which can be as small as a few millimeters and may only become apparent through herniation of abdominal contents hours or days later; and mesenteric vascular injuries with associated intestinal ischemia, where the CT appearance of bowel wall ischemia may lag behind the underlying vascular compromise by several hours [19, 20]. Isolated bowel injuries with partial thickness tears - contusions without full perforation - are particularly difficult to identify on CT, as they lack the pathognomonic signs of free air or contrast extravasation and may produce only nonspecific wall thickening that resolves without intervention or progresses to delayed perforation [20]. For FAST, false-positive results can occur in the presence of pre-existing ascites, pelvic fluid from ovarian rupture or peritoneal dialysis, and perirenal fat deposits that mimic fluid in the hepatorenal space - all of which must be considered in the clinical interpretation of positive findings [18]. The recognition of these limitations demands that imaging results - whether positive or negative - are always interpreted in the full clinical context of the mechanism of injury, the physical examination findings, the laboratory data, and the hemodynamic trajectory of the patient, and that a normal initial imaging study never excludes the possibility of significant intra-abdominal injury that has not yet become radiographically apparent [1, 5, 19].

Injury Patterns and Their Surgical Relevance

Splenic injury is one of the most common findings in blunt abdominal trauma and remains one of the lesions most amenable to non-operative management, particularly in hemodynamically stable patients. Contemporary evidence supports the increasing use of non-operative strategies, including splenic artery embolization, even in high-grade injuries, with favorable outcomes in terms of morbidity and hospital length of stay when compared with open splenectomy [21]. In this setting, splenic artery embolization has emerged as a key adjunct because it is associated with lower mortality and has shown particular utility in patients with Abbreviated Injury Scale scores of 3 to 5. Accordingly, the spleen represents a paradigmatic example of how advances in imaging, monitoring, and interventional radiology have expanded the boundaries of organ-preserving management in trauma care [22].

Hepatic injury frequently accompanies splenic trauma and is likewise often approached non-operatively when the patient remains stable. Recent evidence indicates that non-operative management can be applied in nearly two-thirds of liver injury cases, even in the presence of active bleeding, reflecting the growing confidence in selective conservative treatment under close surveillance. However, important differences exist between splenic and hepatic trauma. Contained vascular injuries such as pseudoaneurysms appear to be more common in splenic lesions, which partly explains why the threshold for embolization or operative intervention may be lower in splenic trauma than in liver injury [23].

By contrast, bowel and mesenteric injuries are substantially less suitable for non-operative management because of the inherent risk of perforation, peritoneal contamination, bowel ischemia, and delayed peritonitis. These lesions often require surgical exploration once suspected or confirmed, especially when clinical deterioration, free intraperitoneal air, or worsening abdominal findings are present. Pancreatic trauma also presents particular challenges because of its retroperitoneal location and the possibility of delayed complications such as fistula, abscess, and necrosis. Surgical intervention is often required in pancreatic injury, especially when the main pancreatic duct is involved [22, 23].

Renal and urinary tract injuries, in contrast, are frequently managed successfully without surgery, provided there is no major hemorrhage or significant urinary extravasation. When those complications are present, selective intervention or operative repair may become necessary. Bladder injury follows a similar principle of selective management: intraperitoneal rupture generally requires surgical repair, whereas many extraperitoneal injuries can be managed conservatively with catheter drainage alone. Retroperitoneal hematomas are also commonly observed, and these are often treated non-operatively unless there is persistent hemorrhage or an associated lesion that mandates surgical exploration. Diaphragmatic injuries, however, usually require repair because of the ongoing risk of visceral herniation and respiratory compromise [1, 24].

From a practical perspective, the findings most strongly associated with operative risk include hemodynamic instability, active bleeding, and high-grade organ injury. Radiologic features such as contrast blush on computed tomography may indicate ongoing vascular extravasation and often justify embolization or surgery, depending on the patient's physiologic condition and the injured organ [24]. Overall, splenic injuries, particularly those with lower injury grades, remain among the lesions most favorable for non-operative management, with splenic artery embolization serving as a critical adjunct in more severe cases [22, 25]. Hepatic injuries with contained bleeding and renal injuries without major hemorrhagic complications are also well suited to conservative treatment, reinforcing the principle that hemodynamic status, injury pattern, and imaging findings should guide the decision between surgery and organ-preserving management [23].

Evidence-Based Surgical Decision-Making

The decision between operative and non-operative management in abdominal trauma is fundamentally determined by the patient's physiologic status, the suspected pattern of injury, and the response to initial resuscitation. Hemodynamic instability remains the most important determinant favoring operative intervention, since unstable patients are more likely to harbor ongoing hemorrhage or injuries that cannot be controlled without surgery. Evidence suggests that operative management is often favored in severe hepatopancreaticobiliary trauma because it may offer lower mortality than delayed or unsuccessful conservative approaches in unstable patients [26]. Likewise, the presence of generalized peritonitis or suspected bowel perforation strongly supports immediate surgical exploration, as delayed recognition of hollow viscus injury substantially increases the risk of sepsis, missed injury, and adverse outcomes [27]. Persistent intra-abdominal hemorrhage, particularly when multiple bleeding sites are present, also shifts management toward surgery, although selective adjuncts such as directed packing may be useful in specific scenarios [28]. Failure of initial resuscitation similarly indicates the need for operative management, as it usually reflects uncontrolled bleeding or another unresolved source of physiologic deterioration that cannot be corrected through supportive measures alone [29].

Immediate laparotomy is therefore indicated when rapid hemorrhage control is essential and when delay would place the patient at substantial risk of death. This is especially relevant in cases of severe bleeding, in which time to intervention is a decisive factor in survival [30]. In the most critically injured patients, damage control surgery has become a central strategy, allowing abbreviated operative intervention focused on hemorrhage control and contamination limitation before definitive repair is attempted once physiologic stabilization has been achieved. This staged approach is particularly valuable in patients with profound shock, coagulopathy, hypothermia, or acidosis, in whom prolonged definitive surgery would further worsen mortality risk [31].

In contrast, non-operative management is supported when the patient is hemodynamically stable or demonstrates adequate response to initial resuscitation. Under these circumstances, selective conservative treatment has become standard for many solid organ injuries, particularly blunt liver trauma, in which transcatheter arterial embolization has proven effective as a minimally invasive alternative with acceptable mortality and good organ-preserving potential [32]. The increasing use of high-quality computed tomography has further strengthened non-operative pathways by improving lesion characterization, identifying active bleeding, and reducing unnecessary or negative laparotomies through more precise surgical indications. Thus, stability, imaging findings, and close monitoring together form the core criteria supporting conservative management [27].

Interventional radiology, especially angioembolization, now plays a pivotal role in bridging the gap between surgery and observation. Transcatheter arterial embolization is considered a first-line treatment for severe blunt liver injuries in hemodynamically stable patients and has expanded the scope of non-operative management in trauma care. Its availability allows targeted hemorrhage control without the morbidity of laparotomy, but it does not replace surgery in unstable patients or in those with peritonitis, bowel injury, or failed resuscitation [32].

Institutional resources and multidisciplinary coordination are also major determinants of management strategy. The feasibility of non-operative treatment depends not only on the patient's condition but also on the availability of interventional radiology, trauma surgery, critical care support, blood products, and continuous monitoring capabilities. In this context, collaboration among trauma surgeons, radiologists, and intensive care specialists is essential to ensure timely escalation or de-escalation of care according to the patient's evolution. Current management algorithms therefore emphasize balanced resuscitation, appropriate patient selection, and rapid transition to surgery when physiologic or radiologic criteria indicate failure of conservative treatment, an approach that has been associated with improved mortality in blunt trauma populations [29, 31].

Conclusions

Blunt abdominal trauma requires a dynamic and evidence-based approach in which hemodynamic status is the principal determinant of management, since unstable patients generally require urgent operative intervention, whereas stable patients can often benefit from selective non-operative strategies supported by imaging and close monitoring.

Advances in computed tomography, FAST ultrasound, and interventional radiology have significantly expanded the role of organ-preserving treatment, particularly for splenic, hepatic, and selected renal injuries, with angioembolization serving as a key adjunct that reduces unnecessary laparotomy in appropriately selected patients.

Despite progress in non-operative management, certain injury patterns—especially bowel, mesenteric, pancreatic, diaphragmatic, and intraperitoneal bladder injuries—continue to carry a high operative risk, making early recognition, serial reassessment, and multidisciplinary coordination essential to prevent delayed diagnosis, complications, and increased mortality.

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