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Retroperitoneal Hematoma: Diagnostic Strategies, Laboratory Evaluation, and Imaging-Guided Management in Acute Clinical Care

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Abstract

Background: Retroperitoneal hematoma, the accumulation of blood in the retroperitoneal space, is a clinically challenging condition associated with high morbidity and mortality. Diagnosis is difficult due to its concealed anatomical location and nonspecific, often delayed symptoms, which can range from vague pain to hemorrhagic shock.

Aim: This review aims to outline the diagnostic strategies, laboratory evaluation, and imaging-guided management approaches for retroperitoneal hematoma in acute clinical care, emphasizing the importance of a systematic and multidisciplinary response.

Methods: A comprehensive synthesis of the literature was performed, integrating data on etiology, clinical presentation, diagnostic modalities, and therapeutic interventions. Key management principles from trauma and interventional radiology guidelines were analyzed.

Results: The etiology is categorized as traumatic (blunt or penetrating) or nontraumatic (iatrogenic or spontaneous). Contrast-enhanced computed tomography (CT) is the diagnostic cornerstone, with near-100% sensitivity for detecting hematoma and identifying active contrast extravasation. Management is dictated by hemodynamic stability and etiology. Hemodynamically stable patients are often managed conservatively with resuscitation, transfusion, and coagulopathy reversal. Unstable patients or those with active bleeding typically require intervention: endovascular angioembolization is first-line for many cases (especially pelvic fractures), while surgical exploration remains crucial for major vascular injuries or penetrating trauma.

Conclusion: Successful management hinges on early suspicion, rapid CT imaging, and a tailored, multidisciplinary approach. Interventional radiology techniques have become pivotal for hemorrhage control, improving outcomes in both traumatic and spontaneous cases.

Keywords: Retroperitoneal hematoma, Hemorrhage, Computed tomography, Angioembolization, Trauma management, Interventional radiology, Anticoagulation.

Introduction

Retroperitoneal hematoma refers to the accumulation of blood within the retroperitoneal space, located posterior to the peritoneal cavity. It represents a clinically challenging and frequently underdiagnosed condition that is associated with considerable morbidity and mortality [1]. A major difficulty in its recognition arises from the often subtle or absent early clinical manifestations. In many instances, patients do not exhibit overt signs or symptoms until a substantial volume of blood has been lost, by which time they may present with hemodynamic instability or even overt hemorrhagic shock attributable to ongoing retroperitoneal bleeding [1]. Consequently, timely identification requires a high index of clinical suspicion, particularly in at-risk

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populations or in the context of trauma, anticoagulation, or invasive procedures. From an anatomic standpoint, the retroperitoneal space is commonly conceptualized using a tripartite zonal framework, which facilitates both diagnostic reasoning and therapeutic decision-making. This schema divides the retroperitoneum into three main zones according to their spatial relationships and contained structures [2]. The central or medial compartment, designated as zone 1, is situated between the two psoas muscles. This region encompasses several critical midline structures, including the abdominal aorta, inferior vena cava, pancreas, and central portions of the duodenum. Hemorrhage arising within this zone is particularly concerning due to the involvement of major vascular elements, and it is often associated with life-threatening hemodynamic compromise [2].

Lateral to the psoas muscles on both sides lies zone 2, also referred to as the perirenal compartment. This zone contains the kidneys, ureters, and segments of the colon, thereby incorporating numerous organs that are vulnerable to both blunt and penetrating trauma, as well as iatrogenic injury [2]. Hematomas in this region may arise from renal parenchymal disruption, vascular injury, or damage to adjacent structures, and their clinical presentation can range from subtle flank discomfort to profound shock, depending on the extent of bleeding and associated injuries. The third region, zone 3, corresponds to the pelvic retroperitoneal space. It contains the urinary bladder and an extensive vascular network, notably the presacral venous plexus and branches of the internal iliac vessels [2]. Hemorrhage in this zone is frequently encountered in association with pelvic fractures and can be particularly challenging to control due to the complexity and density of the pelvic vasculature. Beyond these organ-containing compartments, the retroperitoneum also houses essential components of the musculoskeletal system. Prominent structures in this regard include the psoas muscles, the vertebral bodies, the quadratus lumborum, and the iliacus muscles [2]. In addition, this space provides continuity between the diaphragm and the bony pelvis through fascial and ligamentous connections, contributing to both structural support and the potential spread of hematoma or infection along these planes [2]. Understanding this intricate anatomy is fundamental for interpreting imaging findings, predicting patterns of hemorrhage, and planning appropriate interventions.

Retroperitoneal bleeding is generally classified according to its underlying etiology, most commonly into traumatic and nontraumatic categories. Traumatic retroperitoneal hematomas arise in the context of physical injury and are further subdivided into those resulting from penetrating mechanisms, such as stab and gunshot wounds, and those due to blunt mechanisms, such as motor vehicle collisions, falls, or crush injuries [3]. In contrast, nontraumatic retroperitoneal hematomas are usually categorized as spontaneous or iatrogenic. Spontaneous hematomas may occur in patients receiving anticoagulant or antiplatelet therapy, in those with coagulopathies, or in association with vascular pathologies such as aneurysms or arteriovenous malformations [3]. Iatrogenic hematomas, on the other hand, typically follow invasive diagnostic or therapeutic procedures involving retroperitoneal organs or vessels, including vascular catheterization, endovascular interventions, or surgical operations [3][4]. This etiologic classification has important implications for both diagnostic evaluation and therapeutic strategy. The clinical presentation of retroperitoneal hematoma is highly variable and often nonspecific, making diagnosis particularly challenging even for experienced clinicians. Symptoms may include vague abdominal, flank, back, or groin pain, abdominal distension, or signs of anemia, but these manifestations are frequently absent or mild until the hematoma becomes large or hemodynamically significant [1][3]. Because the retroperitoneal space can accommodate a substantial volume of blood before external signs become evident, patients may first come to medical attention with features of hypovolemic shock, such as tachycardia, hypotension, and altered mental status [1]. Moreover, the specific clinical features are largely determined by the organs or vascular structures affected, so the presentation can mimic a wide array of intra-abdominal, musculoskeletal, or even neurologic conditions [3].

Given this clinical ambiguity, a thorough and systematic evaluation is indispensable. Initial assessment should follow established advanced trauma life support (ATLS) principles, beginning with the evaluation and stabilization of airway, breathing, and circulation [3]. A detailed history focusing on recent trauma, medical comorbidities, anticoagulant use, and recent invasive procedures, combined with a focused physical examination, can provide critical clues. Nevertheless, physical examination findings alone are often insufficient to definitively diagnose retroperitoneal bleeding, necessitating early use of imaging modalities [3][4]. In contemporary practice, computed tomography (CT) with intravenous contrast constitutes the cornerstone of diagnostic evaluation for suspected retroperitoneal hematoma. CT imaging not only confirms the presence and extent of retroperitoneal blood but also frequently identifies the underlying etiology, such as vascular injury, solid organ laceration, or procedure-related complications [3][4]. Furthermore, CT angiography can reveal active contrast extravasation, thereby guiding therapeutic decisions regarding endovascular versus surgical

intervention. In selected unstable patients, however, immediate operative exploration may be required based on clinical judgment and mechanism of injury, especially when imaging is not feasible or would unduly delay hemorrhage control [3][4].

Management strategies for retroperitoneal hematoma are tailored to the patient's hemodynamic status, the source and severity of bleeding, and the underlying cause. Hemodynamically stable patients without evidence of ongoing hemorrhage may be managed conservatively with close monitoring, transfusion support as needed, and serial imaging [3]. In contrast, interventional radiology techniques, such as selective arterial embolization or vascular coiling, have become crucial modalities for controlling hemorrhage in hemodynamically unstable or high-risk patients, particularly when the bleeding source is arterial and anatomically accessible [3][4]. Surgical intervention remains essential in scenarios of uncontrolled hemorrhage, associated intra-abdominal injuries requiring laparotomy, or failure of less invasive measures [3][4]. Because of the complexity and potential severity of retroperitoneal hematomas, optimal outcomes often depend on a multidisciplinary approach involving trauma surgeons, interventional radiologists, intensivists, and other relevant specialists.

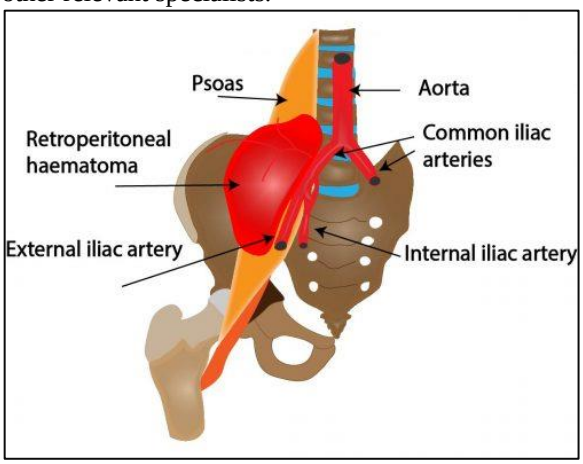

Fig. 1: Retroperitoneal hematoma.

Etiology

The etiological spectrum of retroperitoneal hematoma is classically divided into traumatic and nontraumatic causes, with the former further categorized into blunt and penetrating mechanisms. In the context of traumatic retroperitoneal hematoma, blunt trauma accounts for the majority of cases encountered in clinical practice and is defined by the transfer of kinetic energy from an external force to the patient's body [3][5]. Such forces generate complex patterns of compressive and deceleration stress, predisposing to both crushing and shearing injuries that involve soft tissues as well as arterial and venous structures within the retroperitoneal compartment. Blunt trauma may arise from high-energy mechanisms such as motor vehicle collisions, falls from a height, or crush injuries, but can also result from lower-energy impacts in susceptible individuals. The pathophysiology of blunt retroperitoneal injury is closely related to the fixed and mobile interfaces of retroperitoneal organs and vessels. Rapid deceleration can cause tearing at points where relatively mobile structures, such as portions of the bowel or kidneys, are tethered to more fixed points, such as major vessels or the vertebral column. This explains the occurrence of perirenal hematomas due to renal parenchymal or capsular disruption, pancreatic injuries secondary to compression of the pancreas against the vertebral column, and pelvic retroperitoneal hematomas arising in association with pelvic fractures that disrupt adjacent vascular structures [3][5]. In addition, blunt trauma can produce direct avulsion injuries of retroperitoneal blood vessels, particularly at branching points or areas of relative fixation, resulting in significant hemorrhage that may be initially concealed within the retroperitoneal space. The clinical manifestations of these injuries vary widely, depending on the specific organ involved, the extent of vascular damage, and the volume of blood loss, but all share the potential for rapid clinical deterioration if not promptly recognized.

Penetrating trauma represents the second major traumatic mechanism leading to retroperitoneal hematoma. It most frequently occurs as a consequence of lower- or moderate-energy insults such as stab wounds or gunshot injuries, though the term "lower energy" is relative and depends on trajectory and weapon characteristics [3][5]. The pattern of injury in penetrating trauma is highly dependent on the path traversed by the penetrating object. Organs and vessels along this trajectory may sustain lacerations, perforations, or complete transections. Within the retroperitoneal space, this can result in direct injury to structures such as the kidneys, ureters, pancreas, duodenum, major vessels, or pelvic vasculature. Because the retroperitoneum lies in close anatomic proximity to the intraperitoneal cavity, penetrating injuries that culminate in retroperitoneal hematoma often coexist with intra-abdominal injuries. As a result, clinical presentations may be complex, and management frequently necessitates an integrated assessment of both peritoneal and retroperitoneal involvement [3][5]. Retroperitoneal hematomas arising outside the setting of trauma are broadly categorized as either spontaneous or iatrogenic. Iatrogenic retroperitoneal hematomas occur as complications of medical or surgical interventions, most notably percutaneous and endovascular procedures [6][7][8]. These may include cardiac catheterization, peripheral angiography, endovascular aneurysm repair, or other image-guided interventions that involve vascular access, typically via the femoral or iliac arteries. Although the literature consistently characterizes iatrogenic retroperitoneal hematoma as a relatively rare adverse event, its occurrence is associated with

substantial morbidity and nontrivial mortality [6][7][8]. Advances in technique, imaging guidance, and operator experience have contributed to a decline in incidence over time. For example, a 2018 study reported an incidence of retroperitoneal hematoma of approximately 0.06% following percutaneous interventions, underscoring its rarity [6]. However, this low frequency stands in stark contrast to its clinical impact, as the same study demonstrated a 3.5-fold independent increase in 30-day mortality among affected patients, highlighting the seriousness of this complication [6][7][8].

Several risk factors have been identified that predispose patients to iatrogenic retroperitoneal bleeding after percutaneous procedures. Arterial puncture above the level of the inguinal ligament is a well-recognized technical risk factor, as it may involve the external iliac artery rather than the common femoral artery, increasing the likelihood that bleeding will track into the retroperitoneal space and remain occult [6][7][8]. Female sex has also been identified as an independent risk factor, potentially related to differences in vessel size, body habitus, or anatomical landmarks that complicate accurate puncture site localization [6]. Furthermore, the use of potent antithrombotic and anticoagulant therapies, particularly glycoprotein IIb/IIIa (GPIIb/IIIa) inhibitors and warfarin, significantly augments the risk of retroperitoneal hemorrhage by impairing coagulation and platelet aggregation [6][7][8]. In this context, careful patient selection, meticulous technique, and vigilant post-procedural monitoring are essential to mitigate the risk and promptly identify early signs of bleeding. Spontaneous retroperitoneal hematoma, by contrast, arises in the absence of identifiable external trauma or recent invasive intervention and is considered a rare but serious clinical entity associated with high morbidity and mortality [4][9][10][11]. Much of the available evidence regarding spontaneous cases is derived from case reports, case series, and retrospective cohort studies, which limits the ability to draw definitive epidemiologic conclusions. Nevertheless, consistent trends have emerged from the accumulated data. Spontaneous retroperitoneal hematoma appears to occur more frequently in older adults, likely reflecting both age-related vascular fragility and the higher prevalence of comorbidities necessitating anticoagulant or antiplatelet therapy in this population [4][10]. A strong association has been observed with the use of oral or parenteral anticoagulation, including vitamin K antagonists, heparins, and direct oral anticoagulants, as well as with underlying coagulopathies of hepatic, hematologic, or inherited origin [4][10].

More recently, several reports have documented spontaneous retroperitoneal hematomas in patients with COVID-19, presumably related to the complex coagulopathic and vasculopathic manifestations of severe SARS-CoV-2 infection, as well as the frequent use of therapeutic anticoagulation in this setting [9]. Interestingly, although most patients described in case-based literature are receiving some form of anticoagulation at the time of diagnosis, at least one larger cohort study has shown that approximately 15% of individuals with spontaneous retroperitoneal hematoma were not on any blood-thinning regimen, indicating that anticoagulation, while a major contributor, is not a necessary condition for its development [4][10]. This suggests that other factors, such as structural vascular abnormalities, occult neoplasms, or sudden increases in intra-abdominal or intravascular pressure, may also play significant roles. The underlying structural causes of spontaneous retroperitoneal hematoma are diverse and often related to the rupture of pre-existing lesions within retroperitoneal organs or vessels [11]. Among parenchymal lesions, renal angiomyolipomas are a well-recognized source of spontaneous hemorrhage due to their abnormal vasculature, which is prone to aneurysm formation and rupture. Similarly, cystic lesions and renal cell carcinomas may bleed spontaneously into the perirenal space or broader retroperitoneum [11]. Vascular etiologies include aneurysms and pseudoaneurysms of numerous retroperitoneal arteries, any of which may rupture and result in significant hemorrhage. Case reports have documented involvement of vessels such as the superior gluteal artery, multiple lumbar arteries, the renal arteries, and branches of the pancreaticoduodenal arterial arcade [11]. These events may present with nonspecific pain, hemodynamic instability, or neurologic symptoms due to mass effect, and they often require advanced imaging, such as contrast-enhanced CT or CT angiography, for definitive diagnosis. In summary, the etiology of retroperitoneal hematoma encompasses a broad range of traumatic, iatrogenic, and spontaneous mechanisms, each with distinct pathophysiologic underpinnings and risk profiles. Recognition of these etiologic categories and their associated risk factors is critical for early diagnosis, risk stratification, and the formulation of an appropriate management strategy tailored to the individual patient [3][4][5][6][7][8][9][10][11].

Epidemiology

Traumatic Retroperitoneal Hematoma

The true incidence of retroperitoneal hematoma is challenging to define accurately, largely because the term encompasses a broad and heterogeneous spectrum of injuries involving multiple organs, vascular structures, and mechanisms. Within the subset of traumatic causes, retroperitoneal hematomas arise far more commonly from blunt rather than penetrating mechanisms. Epidemiologic analyses indicate that between 67% and 80% of traumatic retroperitoneal hematomas are

attributable to blunt trauma, whereas penetrating injuries account for approximately 20% to 33% of cases [12]. This distribution reflects both the higher overall frequency of blunt trauma in many trauma systems and the particular vulnerability of retroperitoneal structures to compressive and deceleration forces. Evidence from retrospective clinical series provides further insight into the burden of these injuries. In one study examining a cohort of hemodynamically stable patients with confirmed abdominal trauma, retroperitoneal hematoma was identified in 12% of individuals [12]. Notably, the majority of these patients were found to have renal injuries on computed tomography, underscoring the central role of the kidneys as a common source of retroperitoneal bleeding in the setting of blunt abdominal trauma. Renal involvement is a particularly important consideration in trauma populations, as it is estimated that renal injuries occur in up to 10% of patients with blunt abdominal trauma [12]. This association highlights the need for a high index of suspicion for retroperitoneal hemorrhage whenever renal trauma is suspected or confirmed, even when initial clinical signs are nonspecific. The pattern of vascular involvement differs significantly between blunt and penetrating mechanisms. Vascular injuries are more frequently reported in patients sustaining penetrating trauma than in those with blunt force mechanisms [12]. Penetrating injuries such as gunshot wounds or stab wounds are more likely to cause direct laceration or transection of major or branch vessels, leading to rapid and sometimes catastrophic bleeding into the retroperitoneal space. In contrast, extensive injuries to large-caliber vessels, including direct trauma to the abdominal aorta itself, are rarely the result of blunt force. When blunt trauma does lead to vascular disruption, it more commonly produces avulsion injuries involving smaller aortic branches rather than direct aortic rupture. Such branch vessel injuries may result in centromedial (zone I) retroperitoneal hematomas, which are particularly concerning due to their proximity to major vascular structures and the potential for significant blood loss [12].

Pelvic fractures constitute another critical epidemiologic context for retroperitoneal hematoma. These fractures account for approximately 2% to 8% of all skeletal fractures, yet they are disproportionately associated with severe hemorrhage and high mortality [13]. The pelvic ring houses an extensive network of venous and arterial structures, and disruption of this anatomy during high-energy trauma can lead to massive bleeding confined initially within the pelvic retroperitoneal compartment. Clinical data underscore the gravity of such injuries: in one prospective registry study, patients who underwent angioembolization to control pelvic hemorrhage had a mortality rate of 17.6%, compared with a markedly higher mortality rate of 32.6% in patients who did not undergo embolization [13]. These findings not only emphasize the lethality of pelvic fracture–associated retroperitoneal bleeding but also highlight the importance of timely recognition and definitive hemorrhage control, particularly with endovascular techniques. Blunt injuries involving retroperitoneal organs other than the kidney are relatively rare in comparison but carry a similarly grave prognosis when they occur. The incidence of blunt injury to retroperitoneal organs has been estimated to range between 0.2% and 5%, depending on the specific organ involved, the mechanism of trauma, and the diagnostic methods used [2]. Despite their low frequency, such injuries are associated with mortality rates exceeding 20% [2]. This elevated risk may be attributed to delayed diagnosis, the frequent coexistence of other severe injuries, and the substantial volume of blood that can accumulate within the retroperitoneal space before overt signs of hemorrhage become apparent. Consequently, even though these injuries are infrequent, they occupy an important place in trauma epidemiology due to their disproportionate contribution to morbidity and mortality.

Nontraumatic Retroperitoneal Hematoma

Nontraumatic retroperitoneal hematomas arise either spontaneously or as complications of percutaneous and endovascular procedures. Over recent decades, there has been a notable decline in the incidence of iatrogenic retroperitoneal hematoma associated with cardiac catheterization and related vascular interventions [6][14]. This reduction is multifactorial, reflecting improvements in procedural techniques, better imaging guidance, enhanced operator experience, and, importantly, a gradual shift from femoral to radial artery access in coronary and diagnostic procedures. The radial approach substantially reduces the risk of retroperitoneal bleeding; however, it does not eliminate it entirely, as a small minority of patients may still develop retroperitoneal hematoma even when radial access is employed [6]. Historical data illustrate the evolution in incidence over time. A retrospective study from the early 1990s reported an incidence of approximately 0.5% for retroperitoneal hematoma following cardiac catheterization [14]. Subsequent analyses from more contemporary cohorts demonstrate a considerably lower incidence. In one study spanning the years 2007 to 2014, the incidence of catheterization-associated retroperitoneal hematoma declined from 0.09% at the beginning of the study period to 0.03% by its conclusion, indicating that this complication has become infrequent in the modern era [6]. Despite its rarity, the clinical impact of such hematomas remains profound. Patients who develop retroperitoneal hematoma after cardiac catheterization have been shown to be at significantly increased risk of adverse outcomes. Specifically, the presence of retroperitoneal hemorrhage was associated with an odds ratio of 3.59 for mortality and 5.76 for major

adverse cardiac events [6]. These figures highlight that, although uncommon, iatrogenic retroperitoneal hematoma functions as a marker of severe procedural complication and is associated with substantial short-term risk.

Spontaneous retroperitoneal hematoma represents an even rarer but clinically important category within the epidemiologic spectrum. Available data, largely derived from case reports, small case series, and retrospective cohort studies, suggest a reported incidence of approximately 0.6% [15]. However, determining a precise incidence is inherently difficult because spontaneous retroperitoneal hematomas are both uncommon and heterogeneous in their underlying mechanisms, risk factors, and clinical presentations [15]. Many cases likely go unrecognized or are diagnosed only at advanced stages or postmortem, further complicating epidemiologic assessment. Single-center retrospective studies provide some of the most detailed information on the clinical course and outcomes of patients with spontaneous retroperitoneal hematoma. In one such study, only 89 patients were identified over a 7-year period, emphasizing the rarity of this condition [4]. Within that cohort, the observed mortality was 5.6% during the first week following diagnosis and 19.1% at 6 months, indicating both significant early and intermediate-term mortality. Furthermore, 40% of these patients required admission to an intensive care unit, reflecting the severity of illness and the need for close hemodynamic monitoring and supportive care [4]. Another retrospective analysis that included 100 patients with spontaneous retroperitoneal hematoma reported a mortality rate of 6% directly attributable to the hematoma itself [10]. However, the overall mortality of the cohort was 20%, suggesting that many patients had substantial comorbidities and that spontaneous retroperitoneal hemorrhage often occurred in the context of advanced age, frailty, or complex medical illness [10]. These findings support the observation that spontaneous retroperitoneal hematoma is more prevalent in older adults and typically arises in patients with significant underlying risk factors, such as anticoagulant use, coagulopathy, or vascular disease [4][10][15]. Taken together, the epidemiologic data demonstrate that while retroperitoneal hematoma is relatively uncommon in both traumatic and nontraumatic settings, it is associated with considerable morbidity and mortality across its etiologic spectrum. Traumatic cases are predominantly related to blunt mechanisms and frequently involve renal or pelvic structures, whereas iatrogenic and spontaneous cases, though rare, signal serious underlying pathology or procedural complications. Recognition of these epidemiologic patterns is essential for risk stratification, early diagnosis, and the optimization of clinical outcomes in affected patients [2][4][6][10][12][13][14][15].

History and Physical

Accurate diagnosis of retroperitoneal hematoma depends fundamentally on a high index of clinical suspicion supported by a careful, structured history and thorough physical examination. Because the retroperitoneal space can accommodate a large volume of blood before overt signs appear and because the condition often presents nonspecific symptoms, clinicians must deliberately consider this diagnosis, particularly in high-risk contexts. The clinical manifestations are largely determined by the specific organs and vascular structures involved and may overlap significantly with those of intra-abdominal or musculoskeletal injuries, making differentiation on clinical grounds alone inherently challenging [3][16]. In the setting of trauma, evaluation for a possible retroperitoneal hematoma should be integrated into the standard trauma assessment framework. The diagnostic approach begins with the same initial history and primary survey routinely employed in all trauma cases. Whenever possible, the clinician should elicit detailed information about the mechanism of injury, including the nature of the impact (blunt versus penetrating), the direction and magnitude of forces involved, the presence of deceleration or crush components, and any associated falls, high-speed collisions, or direct blows. This information is critical in estimating the likelihood of retroperitoneal involvement and predicting characteristic injury patterns. For example, high-energy deceleration mechanisms raise suspicion for injuries to retroperitoneal organs and major vessels, whereas penetrating wounds to the flank, back, or lower thorax may indicate potential injury to the kidneys, ureters, or great vessels within the retroperitoneal space [3][16].

In hemodynamically stable, conscious patients who are able to provide a history, common presenting complaints include abdominal pain, flank pain, or back pain. These symptoms may be diffuse, poorly localized, or of variable intensity. However, such complaints are inherently nonspecific and may also be explained by intra-peritoneal injuries, vertebral fractures, paraspinal muscle strain, or other musculoskeletal trauma. Consequently, the presence of these symptoms should prompt consideration, but not assumption, of retroperitoneal hematoma. No historical feature alone is sufficiently sensitive or specific to confirm or exclude the diagnosis, reinforcing the necessity of maintaining persistent clinical suspicion in the appropriate context [3][16]. The physical examination in trauma patients must always begin with systematic assessment of airway, breathing, and circulation, in accordance with advanced trauma life support principles. Life-threatening conditions identified during the primary survey—such as airway compromise, tension pneumothorax, or massive external hemorrhage—

must be addressed immediately, as they may overshadow or coexist with retroperitoneal pathology. Following stabilization, the secondary survey provides an opportunity to identify more subtle clues to occult bleeding, including retroperitoneal hemorrhage [3][16]. Certain examination findings may raise the suspicion of specific retroperitoneal injuries. An unstable pelvis on physical examination, characterized by abnormal movement or crepitus on gentle compression, is highly suggestive of significant pelvic disruption and may be associated with pelvic retroperitoneal hematoma arising from injury to pelvic vessels or presacral veins. Similarly, penetrating wounds located in the flank, back, or lower chest may implicate retroperitoneal structures such as the kidneys, great vessels, or portions of the duodenum and pancreas [3][16]. Classic cutaneous signs of retroperitoneal bleeding—such as flank ecchymosis (Grey Turner sign) or periumbilical ecchymosis (Cullen sign)—are well known in textbooks but are of limited practical value in the acute trauma setting. These signs typically develop hours to days after the onset of hemorrhage and are present in only a small minority of patients, rendering them insensitive indicators for early diagnosis [3][16].

In any trauma patient presenting with hypotensive shock, hemorrhage must be assumed as the primary etiology until proven otherwise. Clinicians should systematically consider all major potential sources of blood loss, including external bleeding, hemothorax, intra-abdominal hemorrhage, long bone fractures, and retroperitoneal bleeding. When obvious sources are not identified on initial assessment and adjuncts such as focused assessment with sonography for trauma (FAST) or chest radiography are unremarkable, retroperitoneal hematoma should be strongly considered as a potential occult cause of hemodynamic instability. Clinical history, mechanism of injury, and suggestive examination findings—such as pelvic instability or flank penetrating wounds—can help prioritize retroperitoneal evaluation in the overall diagnostic strategy [3][16]. In contrast, the clinical presentation of spontaneous retroperitoneal hematoma, as well as hematomas occurring in nontraumatic iatrogenic settings, is frequently more subtle and insidious. Retrospective studies consistently describe presenting symptoms as vague and nonspecific. Abdominal pain is the most frequently reported complaint, occurring in approximately 46% to 67.5% of patients across several series [4][10][17]. This pain may be diffuse or localized, and its character may be dull, aching, or colicky. Other commonly reported symptoms include pain in the back, flank, or hip, reflecting the anatomical distribution of the hematoma and its mass effect on adjacent structures [4][10][17].

In many cases, patients present with nonspecific constitutional symptoms, such as malaise, lightheadedness, or generalized weakness, which may be early manifestations of hypovolemia or anemia secondary to ongoing internal blood loss. Overt signs of hypovolemic shock—tachycardia, hypotension, cool extremities, and delayed capillary refill—are frequently observed in more advanced presentations and signify substantial hemorrhage. In some instances, neurological manifestations, particularly femoral nerve palsy, may be the presenting feature. This occurs when the expanding hematoma compresses the femoral nerve within the iliopsoas compartment, leading to weakness of hip flexion and knee extension, diminished patellar reflex, and sensory changes over the anterior thigh and medial leg [17]. Recognition of this constellation of findings is important, as femoral neuropathy in the appropriate clinical context should prompt consideration of retroperitoneal bleeding. A meticulous physical examination is essential in all patients suspected of harboring a spontaneous or iatrogenic retroperitoneal hematoma. Vital signs should be carefully evaluated for evidence of hypovolemia, and serial measurements are invaluable for detecting dynamic changes. Common findings in ongoing blood loss include tachycardia, hypotension, orthostatic changes, and signs of poor peripheral perfusion such as cool extremities and altered mental status. The abdominal examination may reveal tenderness, fullness, or distension; however, these findings are variable, and the abdomen may be relatively soft and non-tender even in the presence of significant retroperitoneal hemorrhage. Thus, a normal abdominal examination does not exclude the diagnosis. Flank ecchymosis, although classically associated with retroperitoneal bleeding, has been shown to be of very low sensitivity, occurring in only 6.5% of cases in one cohort and 1% in another, further highlighting its limited diagnostic utility [4][10].

In patients who develop retroperitoneal hematoma following percutaneous coronary intervention or other femoral artery–based procedures, the symptom profile and physical findings parallel those seen in spontaneous cases but may be accompanied by local manifestations at the vascular access site. Abdominal, flank, and back pain remain common complaints. One study demonstrated that inguinal tenderness and swelling at or near the femoral puncture site were observed in most patients with catheterization-related retroperitoneal hematoma, suggesting that careful inspection and palpation of the groin region are important components of the post-procedural examination [6][8]. Femoral neuropathy is again a notable finding in this context, likely resulting from compression of the femoral nerve by the expanding hematoma tracking along the iliopsoas muscle from the retroperitoneum toward the inguinal region [6][8]. In summary, the history and physical examination in patients with suspected retroperitoneal hematoma are inherently challenging due to the nonspecific nature

of presenting symptoms and the frequent absence of distinctive signs. Nevertheless, a systematic and vigilant approach—anchored in a detailed understanding of mechanism of injury, risk factors such as anticoagulation or recent vascular intervention, and careful assessment for subtle clues such as pelvic instability, femoral neuropathy, or groin swelling—remains indispensable for raising suspicion and prompting timely imaging and definitive diagnosis [3][4][6][8][10][16][17].

Evaluation

Imaging Studies

Evaluation of retroperitoneal hematoma represents a significant diagnostic challenge due to the inherently concealed location of the retroperitoneal space and the nonspecific, often subtle clinical manifestations associated with bleeding in this region. The occult nature of both traumatic and nontraumatic retroperitoneal hematomas means that reliance on physical examination findings alone is inadequate for diagnosis. Likewise, conventional diagnostic modalities such as plain radiography and ultrasonography frequently fail to detect retroperitoneal bleeding, as these tools lack the sensitivity needed to visualize deep, posterior structures within the abdomen. For this reason, contrast-enhanced computed tomography (CT) has emerged as the diagnostic modality of choice and is considered essential in accurately identifying retroperitoneal hematoma across clinical contexts [1]. In trauma settings, particularly those involving high-energy blunt or penetrating mechanisms, comprehensive CT imaging is routinely performed as part of the initial trauma workup. This includes CT scans of the chest, abdomen, and pelvis with intravenous contrast, collectively offering near-complete evaluation of the retroperitoneal compartment. Studies indicate that the sensitivity of modern CT imaging in detecting retroperitoneal hematomas approaches 100%, making it an indispensable tool for initial diagnosis and for delineating the extent of injury [1]. CT not only confirms the presence of bleeding but also enables clinicians to determine the location, size, and configuration of the hematoma, as well as to identify associated injuries to adjacent organs or vascular structures. Such information plays an essential role in clinical decision-making and in determining the need for operative or endovascular intervention.

By contrast, the focused assessment with sonography for trauma (FAST) examination—widely used for rapid bedside detection of free intraperitoneal fluid—has limited utility in diagnosing retroperitoneal hematomas. The FAST exam primarily evaluates the intraperitoneal and pericardial spaces and has little capacity to detect hemorrhage contained within the retroperitoneum. Consequently, FAST results are often negative even in the presence of significant retroperitoneal bleeding, underscoring its unreliability in this context [2][18]. As a result, clinicians must not be reassured by a negative FAST exam when the mechanism of injury, physical findings, or hemodynamic instability suggests the possibility of retroperitoneal involvement. Diagnostic evaluation becomes even more nuanced in patients without a history of trauma, in whom symptoms may be vague and unrelated to any identifiable injury. In these cases, contrast-enhanced CT of the abdomen and pelvis again serves as the primary diagnostic tool. CT enables precise characterization of spontaneous or iatrogenic hematomas, including assessment of their extent, compartmental location (e.g., perirenal, pelvic, or central), and evolution over time. Particularly important is the detection of intravenous contrast extravasation, which indicates active bleeding. The presence of active contrast extravasation has been shown to be an independent predictor of the need for urgent intervention via interventional radiology or surgery [10][11]. Such findings can guide the multidisciplinary team in determining the urgency of treatment, selecting candidates for angiographic embolization, and assessing the need for critical care monitoring. In addition to identifying active hemorrhage, CT imaging provides valuable information about complications arising from retroperitoneal hematomas, including mass effect on adjacent organs, displacement of retroperitoneal structures, or development of secondary conditions such as hydronephrosis, bowel compression, or neuropathies due to nerve involvement. Thus, CT imaging is indispensable not only for diagnosis but also for guiding ongoing management and monitoring clinical progression.

Laboratory Studies

Beyond imaging, laboratory evaluation plays a crucial supplementary role in the assessment of patients with suspected or confirmed retroperitoneal hematoma. Laboratory findings help establish the severity of bleeding, identify risk factors for ongoing hemorrhage, and detect associated organ dysfunctions that may influence management decisions. A complete blood count is fundamental, as it provides baseline hemoglobin and hematocrit values that can support the suspicion of blood loss and allow for tracking trends over time. However, clinicians must recognize that early laboratory values may not accurately reflect the degree of hemorrhage due to delayed hemodilution and compensatory mechanisms. A comprehensive metabolic panel is equally important, as it offers insight into renal function, electrolyte balance, and metabolic derangements that may accompany hemorrhagic shock or organ compression within the retroperitoneum. In particular, kidney function tests hold diagnostic value in cases where renal injury is suspected, such as in blunt abdominal trauma or in patients presenting with unexplained hematuria.

Renal impairment may signal direct parenchymal injury, ischemia due to vascular compromise, or obstructive processes caused by the hematoma's mass effect. Liver function tests are recommended to assess for hepatic dysfunction, especially given that coagulopathy may be exacerbated in patients with underlying liver disease. Coagulation studies, including prothrombin time, activated partial thromboplastin time, and international normalized ratio, are critical in evaluating patients' bleeding risk. These tests are particularly relevant for individuals receiving anticoagulation therapy, as coagulopathy significantly increases the likelihood of hematoma expansion and complicates management. Prompt correction of reversible coagulopathies may be necessary to stabilize the patient and mitigate further blood loss [3]. Pancreatic enzyme levels, specifically serum amylase, may be elevated in traumatic injuries affecting the pancreas or duodenum, both of which lie partially within the retroperitoneum. While amylase elevation is not specific to retroperitoneal hematoma, it can serve as a clue to coexisting pancreatic injury, particularly in cases of high-energy blunt trauma. Finally, urinalysis may reveal hematuria, which serves as an important indicator of renal or ureteral trauma. Microscopic or gross hematuria, especially in patients with abdominal or flank trauma, strengthens suspicion for retroperitoneal organ involvement and should prompt further evaluation with imaging [3]. Collectively, the combination of detailed imaging and targeted laboratory assessment forms the cornerstone of comprehensive evaluation for retroperitoneal hematoma. Together, these tools enable timely diagnosis, guide management decisions, and facilitate ongoing monitoring essential for optimizing patient outcomes.

Treatment / Management

The management of retroperitoneal hematoma, irrespective of its underlying etiology, is inherently complex and requires a coordinated, interprofessional approach involving trauma surgeons, interventional radiologists, intensivists, anesthesiologists, and nursing staff. Therapeutic strategies must be tailored to the individual patient, taking into account the cause of bleeding, anatomical location of the hematoma, hemodynamic status, comorbid conditions, and radiologic findings. Broadly, the spectrum of management ranges from conservative, nonoperative treatment with close observation and supportive care in hemodynamically stable patients, to urgent angioembolization or operative exploration in those who are unstable or exhibit evidence of ongoing hemorrhage. In all scenarios, prompt and adequate resuscitation using crystalloid fluids and blood products according to standard trauma and massive transfusion protocols forms the cornerstone of early management, with the primary objective of restoring and maintaining hemodynamic stability and organ perfusion. In the context of traumatic retroperitoneal hematoma, the principles of management closely parallel those applied to other forms of abdominal trauma. Any manifestation of overt peritonitis, persistent or refractory hemodynamic instability despite resuscitative efforts, or imaging or clinical evidence of significant free intraperitoneal fluid generally mandates emergent laparotomy. Retroperitoneal injuries frequently coexist with intra-abdominal injuries rather than occurring in isolation, and therapeutic decisions must therefore be based on the overall pattern and severity of trauma rather than on the retroperitoneal component alone. In patients with penetrating abdominal trauma, retroperitoneal hematoma typically develops secondary to direct disruption of solid organs, hollow viscera, or major vascular structures. Because of the high likelihood of significant associated injuries and ongoing bleeding in this setting, operative exploration is commonly recommended to achieve definitive hemostasis and address concomitant intra-abdominal pathology [3].

For patients with blunt abdominal trauma, management decisions are more nuanced and depend heavily on the patient's clinical stability and the ability to delineate the source and severity of bleeding using imaging, particularly contrast-enhanced computed tomography. Persistent hemodynamic instability, failure to respond adequately to resuscitation, or imaging evidence of an expanding or pulsatile retroperitoneal hematoma are strong indicators for surgical intervention. These features suggest an uncontrolled arterial or major venous source of bleeding that is unlikely to resolve with conservative measures alone and may rapidly progress to life-threatening hemorrhagic shock if not addressed surgically [3]. The anatomic location of the retroperitoneal hematoma provides further guidance for the choice between operative and nonoperative approaches, especially in the setting of blunt trauma. Modern CT imaging allows accurate localization of hematomas within recognized retroperitoneal zones, which has important implications for management. Centromedial, or zone I, hematomas are generally considered high risk because they are often associated with injuries to the great vessels or their branches. Consequently, these hematomas are frequently explored surgically, particularly when there is any suggestion of ongoing bleeding or hemodynamic compromise, as nonoperative management may be unsafe in this context [19].

Lateral retroperitoneal hematomas, corresponding to zone II, are most commonly associated with renal injuries. In hemodynamically stable patients with mild to moderate findings on CT, such as contained perirenal hematomas without active contrast extravasation, conservative management is often appropriate. This approach typically includes close hemodynamic monitoring, serial laboratory testing, and repeat imaging as indicated to ensure that the hematoma remains stable or regresses. However,

large hematomas that are expanding, associated with significant renal parenchymal disruption, or demonstrating active contrast extravasation may necessitate more aggressive interventions, including surgical exploration or angiographic embolization of the bleeding vessel [19]. Angioembolization offers a minimally invasive means of achieving hemostasis while preserving as much functional renal tissue as possible. Pelvic retroperitoneal hematomas, generally corresponding to zone III, are most often the consequence of pelvic fractures and are typically due to venous bleeding from the presacral plexus or branches of the internal iliac vessels, though arterial injuries can also occur. These lesions are comparatively less amenable to direct surgical control because of the complex pelvic anatomy and the diffuse nature of the venous bleeding. The initial management strategy in such cases focuses on mechanical stabilization of the pelvic ring, commonly achieved through external pelvic fixation, pelvic binders, or sheets. This external stabilization reduces pelvic volume and promotes tamponade of bleeding vessels. Definitive control of hemorrhage is usually obtained via angiographic embolization, which targets bleeding arterial branches and can substantially reduce mortality and transfusion requirements 13. Thus, endovascular techniques play a central role in the management of pelvic retroperitoneal hematomas associated with high-energy pelvic fractures.

Nontraumatic retroperitoneal hematomas, including both spontaneous and iatrogenic forms, are managed primarily according to the location of the hematoma, the severity and tempo of bleeding, and the presence of active contrast extravasation on CT imaging. Many patients who develop spontaneous retroperitoneal hematoma are receiving anticoagulation therapy for underlying cardiovascular or thromboembolic conditions. In such patients, prompt reversal of anticoagulation is a critical initial step to prevent further bleeding. This may involve administration of vitamin K, prothrombin complex concentrates, fresh frozen plasma, specific reversal agents for direct oral anticoagulants, or platelet transfusions, depending on the pharmacologic agent involved and the degree of coagulopathy. Concurrently, appropriate resuscitative measures, including intravenous fluids and blood product transfusions, should be instituted for patients exhibiting signs of hemodynamic instability or symptomatic anemia. Transfusion decisions are guided by hemoglobin levels, ongoing blood loss, and clinical features such as tachycardia, hypotension, and signs of end-organ hypoperfusion. Definitive management in nontraumatic cases is highly individualized. The presence, location, and extent of bleeding, as well as CT evidence of active contrast extravasation, play decisive roles in determining whether invasive interventions are required. Data from multiple retrospective cohort studies indicate that a substantial proportion of patients with spontaneous or postprocedural retroperitoneal hematomas can be managed successfully with conservative measures, including supportive care, transfusion therapy, and close monitoring, without the need for embolization or surgery. In one series, only 24.7% of patients underwent embolization, and 6.7% required surgical intervention, whereas approximately 75% received blood transfusions, underscoring the predominance of nonoperative management in appropriately selected patients [4]. Another cohort study involving 100 patients with retroperitoneal hematoma reported that the overall rate of invasive management, including interventional radiology procedures and surgery, was only 16% [10]. One of the most significant predictors of the need for invasive therapy in this study was the presence of contrast extravasation on CT imaging, highlighting the importance of radiologic assessment in risk stratification and treatment planning [10]. In summary, the treatment and management of retroperitoneal hematoma require flexible, etiology-specific strategies grounded in careful clinical assessment, detailed imaging evaluation, and multidisciplinary collaboration. Traumatic hematomas often demand rapid decision-making regarding laparotomy, angioembolization, or conservative management based on hemodynamic status and anatomic location, whereas nontraumatic hematomas frequently respond to supportive care and correction of underlying coagulopathies, with invasive interventions reserved for cases with ongoing or uncontrolled bleeding. Across all forms, early recognition, prompt resuscitation, and judicious use of interventional and surgical modalities are essential to optimizing patient outcomes [3][4][10][19].

Differential Diagnosis

The differential diagnosis of retroperitoneal hematoma is broad and encompasses both traumatic and nontraumatic etiologies. In the traumatic context, clinicians must consider acute abdomen, perforated viscus, solid organ injury, major vascular disruption, pelvic fractures, and abdominal compartment syndrome as potential or concurrent diagnoses [20]. In nontraumatic presentations, important alternative or concomitant diagnoses include gastrointestinal bleeding, musculoskeletal pain, appendicitis, cholecystitis, diverticulitis, abdominal aortic aneurysm, pancreatitis, and pyelonephritis [4][10][21]. The prognosis of retroperitoneal hematoma is largely determined by the mechanism, anatomical extent, and specific structures involved. Aortic injuries are associated with substantially higher morbidity and mortality than isolated renal injuries causing retroperitoneal bleeding. In one predominantly blunt trauma cohort, overall mortality reached 6.5%, with approximately 77% of patients

requiring operative management [19]. In contrast, a series primarily involving penetrating trauma reported mortality of 18% [16]. Spontaneous retroperitoneal hematoma carries a particularly poor prognosis, reflecting its predilection for older patients with multiple comorbidities; one retrospective study demonstrated 10% mortality at 30 days and intensive care admission in 40% of cases, indicating that nearly half of spontaneous events are critical [4].

Complications:

Complications of retroperitoneal hematoma include infection or sepsis, symptomatic anemia, and exsanguination with downstream consequences such as myocardial infarction, acute kidney and liver injury, and diffuse cerebral hypoperfusion. Additional sequelae comprise abdominal compartment syndrome and mechanical obstruction of the small bowel or urinary tract [22][23]. Surgical intervention may result in infection, iatrogenic injury to adjacent structures, or exacerbation of hemorrhage. Angioembolization similarly carries risks of infection, vascular damage, worsening bleeding, contrast-induced nephropathy, and ischemia within embolized arterial territories. From an anatomical perspective, the retroperitoneum is a potential space posterior to the peritoneal cavity and is commonly injured in conjunction with other structures following blunt or penetrating trauma. For descriptive and therapeutic purposes, it is divided into three zones. Zone 1, the central retroperitoneum, extends from the diaphragm to the aortic bifurcation and contains the inferior vena cava, origins of the major renal and visceral vessels, duodenum, and pancreas. Zone 2 encompasses the lateral perinephric regions from the renal vessels medially to the lateral reflection of the posterior parietal peritoneum, including the adrenal glands, kidneys, renal vessels, ureters, and ascending and descending colon. Zone 3 lies inferior to the aortic bifurcation and includes the internal and external iliac vessels, distal ureter, distal sigmoid colon, and rectum. Blunt trauma typically results from energy transfer, whereas penetrating trauma directly disrupts tissue planes.

Management strategies range from careful observation to emergent surgical exploration and are dictated by mechanism, zonal location, and severity of organ injury. In penetrating trauma, Zone 1 hematomas warrant exploration because of the high likelihood of major vascular injury, whereas Zone 2 injuries are explored selectively to address active renal bleeding or expanding hematomas and to assess adjacent colon and ureters. Penetrating Zone 3 injuries are generally explored due to the probability of significant pelvic vascular damage. In blunt trauma, Zone 1 hematomas similarly mandate exploration, while Zone 2 injuries are explored when the hematoma is expanding or refractory to measures such as angioembolization; stable, contained Zone 2 hematomas, however, are typically not opened. Blunt Zone 3 hematomas are usually managed nonoperatively with adjunctive hemorrhage control techniques, including preperitoneal pelvic packing or angioembolization. Because retroperitoneal hematomas frequently result from high-energy mechanisms such as motor vehicle collisions, falls, and penetrating violence, prevention centers on broader trauma reduction strategies, including improved public health measures and safety policies. Optimal outcomes depend on an interprofessional, patient-centered approach, as retroperitoneal hematomas are associated with substantial morbidity and mortality and lack a single standardized management pathway. In traumatic cases, radiologic identification of retroperitoneal hematoma should immediately mobilize trauma or general surgery, interventional and diagnostic radiology, orthopedics, and transfusion services, with continuous cross-disciplinary communication to refine the treatment plan [3][24]. In nontraumatic cases, recognition on computed tomography should prompt similarly coordinated involvement of surgery and interventional and diagnostic radiology to determine the most appropriate therapeutic strategy, while maintaining a focus on individualized, patient-centered care [10].

Conclusion:

In conclusion, retroperitoneal hematoma is a serious condition whose management demands a high index of suspicion, rapid diagnostic imaging, and a nuanced, etiology-driven treatment strategy. Contrast-enhanced CT is indispensable for diagnosis, localization, and detecting active hemorrhage, which is a key determinant for intervention. Management is fundamentally guided by the patient's hemodynamic status. Stable patients often benefit from conservative measures, including vigilant monitoring, blood product support, and reversal of anticoagulation. For unstable patients or those with evidence of ongoing bleeding, minimally invasive endovascular angioembolization has emerged as a highly effective first-line therapy, particularly for pelvic fracture-related bleeding and iatrogenic arterial injuries, reducing the need for high-risk surgery. Surgical exploration remains essential for major vascular injuries, penetrating trauma, and cases refractory to less invasive measures. Ultimately, optimal outcomes are achieved through a coordinated, interprofessional approach involving trauma surgeons, interventional radiologists, intensivists, and hematologists. This collaborative model ensures timely decision-making, integrates advanced supportive care with precise procedural intervention, and is critical for reducing the significant morbidity and mortality associated with this complex clinical entity.

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