

Delayed Recognition of AAST Grade IV Blunt Renal Trauma Successfully Managed with Renal Arterial Embolization: A Case Report

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ABSTRACT

Background: High-grade blunt renal trauma may present without hemodynamic instability, gross hematuria, or positive focused abdominal ultrasonography, potentially delaying definitive diagnosis. In stable patients, contrast-enhanced computed tomography and endovascular intervention have become central to contemporary nephron-sparing management. **Case Presentation:** A 25-year-old man sustained blunt multisystem trauma after a bicycle accident. Initial evaluation demonstrated hemodynamic stability, a Glasgow Coma Scale score of 15, negative Focused Assessment with Sonography for Trauma (FAST), and no gross hematuria. He was initially discharged after observation but returned with persistent abdominal pain. Repeat FAST remained negative. Contrast-enhanced abdominal computed tomography subsequently demonstrated an American Association for the Surgery of Trauma Grade IV right renal injury with suspected active bleeding, associated Grade II splenic injury, and hemoperitoneum. Despite the radiological severity of injury, the patient remained hemodynamically stable without peritonitis or another indication for emergency laparotomy. Serial hemoglobin measurements showed a decline from 14.9 to 12.6 g/dL. A kidney-preserving endovascular strategy was therefore selected, and renal arterial coil embolization was performed. Following embolization, the patient remained clinically stable, with controlled pain, preserved urine output of approximately 2.08 mL/kg/h, no gross hematuria, and no immediate requirement for repeat embolization, renal exploration, or nephrectomy. **Conclusion:** This case highlights that negative FAST examinations and absence of gross hematuria do not exclude high-grade renal trauma. Persistent post-traumatic symptoms should prompt definitive cross-sectional imaging. In appropriately selected hemodynamically stable patients with high-grade renal injury and active hemorrhagic features, renal arterial embolization may provide effective hemorrhage control while supporting an organ-preserving management strategy.

Keywords: blunt renal trauma; renal artery embolization; angioembolization; AAST grade IV; nephron-sparing management

INTRODUCTION

Renal trauma represents one of the most frequent forms of genitourinary injury and commonly occurs as part of multisystem blunt trauma. Although most renal injuries are low grade and can be managed conservatively, high-grade injuries remain clinically important because they may involve major parenchymal disruption, collecting-system injury, segmental vascular damage, or active hemorrhage.¹ Historically, severe renal trauma frequently prompted operative exploration; however, advances in cross-sectional imaging, critical care, and interventional radiology have progressively shifted management toward selective non-operative and organ-preserving strategies in appropriately

selected patients. Within this contemporary framework, hemodynamic status has become a more decisive determinant of treatment than anatomical injury grade alone.²

Accurate diagnosis remains fundamental to this approach. The clinical presentation of renal trauma may be deceptively subtle, particularly in hemodynamically stable patients. Gross hematuria, flank ecchymosis, hypotension, and peritoneal signs may be absent even in substantial renal injury, while Focused Assessment with Sonography for Trauma is primarily designed to detect free intraperitoneal fluid and has limited sensitivity for retroperitoneal organ injury.³

Consequently, a negative FAST examination does not reliably exclude clinically significant renal trauma. In stable patients with a suspicious mechanism of injury, persistent abdominal or flank symptoms, unexplained hemoglobin decline, or associated traumatic injuries, contrast-enhanced computed tomography remains essential for defining renal parenchymal and vascular injury, evaluating active contrast extravasation, assessing collecting-system involvement, and identifying concomitant intra-abdominal injuries.⁴

The American Association for the Surgery of Trauma renal injury scale provides a standardized anatomical framework for injury classification and facilitates communication, prognostic assessment, and treatment planning. Nevertheless, management of high-grade renal trauma cannot be determined solely by grade.⁵ Patients with Grade IV injury comprise a heterogeneous population that may include deep parenchymal lacerations, collecting-system disruption, or vascular lesions with ongoing hemorrhage. In the absence of persistent hemodynamic instability or another indication for emergency laparotomy, these injuries may increasingly be managed within a structured non-operative pathway that includes intensive observation, serial laboratory and clinical assessment, and selective escalation to endovascular therapy.⁶

Transarterial renal embolization has emerged as a key component of nephron-sparing management for traumatic renal hemorrhage. By allowing angiographic localization and targeted occlusion of injured arterial branches, embolization may achieve hemostasis while minimizing loss of viable renal parenchyma and avoiding the morbidity associated with open exploration or nephrectomy.⁷ Its role is particularly relevant in hemodynamically stable patients with active arterial extravasation, pseudoaneurysm, arteriovenous fistula, or persistent hemorrhagic findings on imaging. The increasing availability of interventional radiology has therefore expanded the spectrum of high-grade renal injuries that can be treated without immediate surgery.⁸

Despite these advances, delayed or initially unrecognized high-grade renal trauma remains a clinically relevant challenge. Reassuring early physiological parameters, negative bedside ultrasonography, and absent gross hematuria may create false reassurance, particularly when retroperitoneal bleeding remains contained.⁹ Persistent or evolving symptoms after blunt trauma should therefore prompt reassessment and definitive imaging, as delayed recognition may expose patients to ongoing hemorrhage or secondary vascular complications while simultaneously narrowing the window for organ-preserving intervention.¹⁰

We report a case of delayed-recognized AAST Grade IV blunt renal trauma in a hemodynamically stable young adult following a bicycle-related road

traffic accident. Despite repeated negative FAST examinations and the absence of gross hematuria, contrast-enhanced CT subsequently demonstrated high-grade right renal injury with suspected active bleeding and associated hemoperitoneum. The patient was successfully managed with renal arterial coil embolization as part of a non-operative, kidney-preserving strategy. This case highlights the diagnostic limitations of early bedside assessment in renal trauma and underscores the role of selective endovascular embolization in achieving hemorrhage control while avoiding immediate nephrectomy in appropriately selected patients.

CASE-PRESENTATION

A 25-year-old man with no known medical comorbidities, previous surgical history, regular medication use, or documented drug allergies presented following a bicycle-related road traffic accident. The patient had been riding to work when he collided with a dog. He was reportedly wearing a helmet; however, the exact mechanism of impact could not be completely reconstructed because he experienced transient post-traumatic amnesia surrounding the event. He was initially taken to the emergency department of Prof. Dr. I.G.N.G. Ngoerah General Hospital on July 28, 2026, for comprehensive trauma assessment.

On initial evaluation, the patient was hemodynamically stable and neurologically intact, with a Glasgow Coma Scale score of 15. There was no evidence of airway compromise, respiratory failure, or active external hemorrhage. His blood pressure was 125/61 mmHg, heart rate 70 beats/min, respiratory rate 22 breaths/min, peripheral oxygen saturation 98% on room air, and body temperature 36.9°C. Multiple superficial traumatic injuries were identified, including previously sutured wounds over the left temporal and right supraorbital regions and multiple abrasions involving both forearms and the right knee. Despite the multisystem mechanism of injury, there was no initial clinical evidence of circulatory instability or overt abdominal catastrophe.

The initial abdominal examination demonstrated no external abdominal bruising, guarding, or definite peritoneal signs. Focused Assessment with Sonography for Trauma (FAST), performed on July 28, was negative for detectable intraperitoneal free fluid. Initial laboratory investigations showed a hemoglobin concentration of 14.9 g/dL, hematocrit of 43.6%, platelet count of $241 \times 10^3/\mu\text{L}$, and leukocyte count of $13.27 \times 10^3/\mu\text{L}$. Coagulation parameters were within normal limits, with an international normalized ratio of 0.90. Serum creatinine was mildly elevated at 1.50 mg/dL with an estimated glomerular filtration rate of 65.85 mL/min/1.73 m², while blood urea nitrogen was 12.6 mg/dL. After several hours of observation and without evidence of hemodynamic deterioration, the patient was discharged with oral medication.



FIGURE 1: Initial abdominal ultrasonography performed during early trauma evaluation, showing no definite sonographic evidence of significant intra-abdominal free fluid or renal injury.

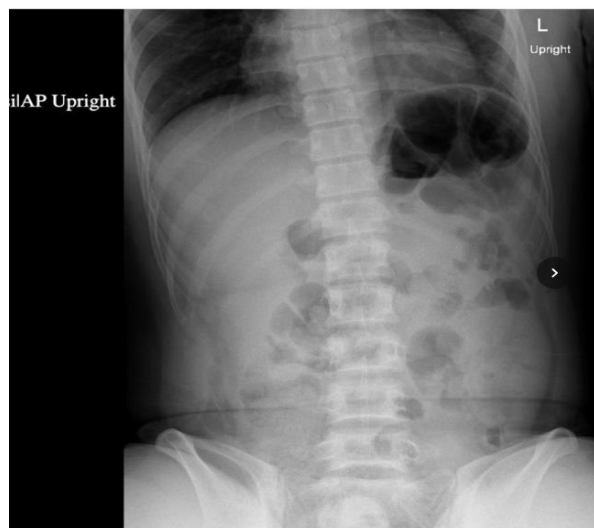


FIGURE 2: Initial upright abdominal radiograph demonstrating features of partial large-bowel obstruction with fecal retention, without radiographic evidence of pneumoperitoneum.

During the following three days, the patient continued to experience persistent abdominal pain that did not adequately respond to analgesic therapy. The pain was described as continuous and stabbing in character and was associated with nausea, without vomiting or fever. He therefore returned for further evaluation. Despite the persistence of symptoms, he remained hemodynamically stable. Abdominal examination demonstrated right lower-quadrant tenderness without muscular guarding or generalized peritoneal irritation. Plain abdominal radiography on July 30 demonstrated partial large-bowel obstruction, fecal retention, and ascites without pneumoperitoneum. A repeat FAST examination on July 31 remained negative.

Given the persistent abdominal symptoms following significant blunt trauma despite repeatedly negative FAST examinations, contrast-enhanced computed tomography of the abdomen was obtained on July 31, 2026. The examination revealed a high-grade traumatic injury of the right kidney classified radiologically as American Association for the Surgery of Trauma (AAST) Grade IV, with findings suspicious for active bleeding. Associated AAST

Grade II splenic injury and hemoperitoneum were also identified. The CT findings represented a marked discrepancy between the severity of the underlying renal injury and the relatively preserved clinical physiology. Importantly, the patient remained normotensive and without tachycardia, generalized peritonitis, or another immediate indication for exploratory laparotomy.



FIGURE 3: Contrast-enhanced coronal CT of the abdomen demonstrating AAST Grade IV right renal injury.



FIGURE 4: Axial contrast-enhanced CT of the abdomen demonstrating AAST Grade IV traumatic injury of the right kidney with parenchymal disruption and associated perirenal hematoma.

Serial laboratory monitoring demonstrated a gradual reduction in hemoglobin concentration from 14.9 g/dL at the initial presentation to 13.0 g/dL on July 31 and 12.6 g/dL on August 2. Serum creatinine remained mildly elevated at 1.59 mg/dL on July 31, with an estimated glomerular filtration rate of 61.40 mL/min/1.73 m². Urinalysis on August 2 demonstrated occult blood of 2+ and three erythrocytes in the urinary sediment, while protein, leukocytes, and nitrites were negative. Notably, gross hematuria was not clinically apparent. Despite the CT evidence of high-grade renal trauma and suspected ongoing bleeding, there was no documented episode of shock or progressive hemodynamic instability.

The combination of radiologically suspected active renal hemorrhage, AAST Grade IV renal injury, and preserved hemodynamic stability prompted a multidisciplinary decision to pursue an endovascular, kidney-preserving strategy rather than immediate open renal exploration. The patient was therefore referred to the interventional radiology service for renal angiography and therapeutic embolization. The rationale for this approach was to achieve targeted hemorrhage control while maximizing preservation of viable renal parenchyma and avoiding the morbidity associated with open surgery or nephrectomy in a physiologically stable patient.

On August 4, 2026, the patient underwent renal arterial embolization for the traumatic right renal injury. Coil embolization was performed by the interventional radiology team. Based on the available clinical documentation, the procedure was undertaken to control the suspected ongoing renal arterial bleeding identified on contrast-enhanced CT. Detailed angiographic information regarding the precise injured arterial branch, presence of angiographically demonstrated contrast extravasation or pseudoaneurysm, microcatheter position, coil specifications, and extent of residual renal perfusion was not available in the records reviewed for this report and was therefore not inferred. Nevertheless, the intervention represented the definitive hemorrhage-control procedure during the admission and allowed continuation of a non-operative renal salvage strategy.

Following embolization, the patient was transferred to a high-dependency setting for close post-procedural observation, with particular attention to recurrent hemorrhage, hemodynamic instability, renal function, urine output, abdominal findings, and potential embolization-related complications. On the first post-embolization day, he remained clinically stable, with a blood pressure of 129/76 mmHg, heart rate of 75 beats/min, respiratory rate of 20 breaths/min, oxygen saturation of 99% on room air, and body temperature of 36.7°C. His Glasgow Coma Scale score remained 15. Post-procedural pain was mild and adequately controlled with analgesic therapy, with a visual analogue scale score of approximately 3/10. He reported no nausea, vomiting, or fever.

Abdominal examination after embolization demonstrated a soft, non-distended abdomen with residual right lower-quadrant tenderness but without guarding or other findings suggestive of evolving peritonitis. There was no clinical evidence of recurrent intra-abdominal hemorrhage. Continued conservative management included bed rest, intravenous fluid therapy, analgesia, supportive treatment, and serial clinical monitoring. The interventional radiology team specifically recommended continued surveillance for bleeding and close monitoring of vital signs after embolization.

Preservation of renal function was a major consideration during the post-embolization period. A urinary catheter documented approximately 2,600 mL of clear yellow urine over 24 hours, corresponding to an estimated urine output of 2.08 mL/kg/h for a body weight of 52 kg. There was no documented oliguria, anuria, or gross hematuria following the procedure. The preserved urine output provided early clinical evidence that hemorrhage control had been achieved without immediate loss of global renal excretory function. The patient also continued to tolerate oral intake, passed flatus, and resumed bowel movements without evidence of progressive abdominal dysfunction.

On the second day after renal embolization, the patient's clinical condition remained stable. His blood pressure was 130/70 mmHg, heart rate 78 beats/min, respiratory rate 20 breaths/min, oxygen saturation 99% on room air, and temperature 36.7°C. Pain remained controlled, and there were no new episodes of nausea, vomiting, fever, or worsening abdominal symptoms. Spontaneous urination was maintained, and no recurrent hemodynamic compromise was documented. No immediate need for repeat embolization, operative renal exploration, or nephrectomy was recorded during the early post-procedural period.



Figure 5: Coronal contrast-enhanced CT demonstrating AAST Grade IV right renal injury (upper panel), with selective right renal angiography demonstrating traumatic involvement of the lower-pole segmental artery prior to embolization (lower panel).



FIGURE 6: Selective right renal angiography before and after coil embolization of the lower-pole segmental artery. Pre-embolization angiography demonstrates focal contrast extravasation from the injured segmental branch (upper panel), while post-embolization angiography demonstrates coil deployment with cessation of contrast extravasation (lower panel).

DISCUSSION

Contemporary Paradigm of High-Grade Renal Trauma Management

The management of high-grade renal trauma has undergone a substantial conceptual transition from injury-grade-driven operative exploration toward physiology-guided, organ-preserving treatment.⁸ Historically, severe renal injuries were frequently managed surgically because of concerns regarding uncontrolled hemorrhage, urinary extravasation, and subsequent deterioration. Contemporary trauma practice, however, increasingly recognizes that anatomical injury severity and the need for operative intervention are not synonymous.⁹ Hemodynamic status has emerged as the principal determinant of the initial therapeutic pathway, while cross-sectional imaging defines injury morphology and identifies features that may require targeted intervention.¹⁰ Current European Association of Urology guidance consequently recommends non-operative management for hemodynamically stable blunt renal trauma and incorporates selective angioembolization as part of a stepwise non-operative strategy when active renal bleeding is present without another indication for immediate abdominal exploration.^{10,11}

The present case illustrates this paradigm particularly well. Despite an AAST Grade IV right renal injury with radiological suspicion of active hemorrhage and associated hemoperitoneum, the patient remained consistently normotensive and was not tachycardic or clinically peritonitic. The

anatomical severity of the renal injury therefore did not, in isolation, mandate laparotomy or nephrectomy. Instead, the combination of preserved physiology, absence of another operative abdominal indication, and a potentially controllable renal bleeding source created an appropriate context for endovascular hemorrhage control. This distinction is central to contemporary renal-trauma decision-making: the clinical objective is no longer simply to control hemorrhage, but to achieve hemostasis while preserving the maximum amount of functional renal parenchyma whenever physiologically feasible.

This approach is particularly relevant in young patients, in whom unnecessary nephron loss may have implications extending well beyond the acute hospitalization. Although unilateral nephrectomy is generally compatible with normal life expectancy in patients with a healthy contralateral kidney, preservation of renal mass remains desirable, particularly when effective minimally invasive alternatives are available.¹²

Large observational datasets increasingly support angioembolization as an important renal-salvage strategy in appropriately selected high-grade injuries. In a large trauma-registry analysis, previous study reported successful angioembolization in 94.2% of Grade IV injuries, with a substantially lower subsequent nephrectomy rate after angioembolization than after surgical repair in Grade IV trauma.^{12,13} Because these data are observational and subject to selection bias, they should not be interpreted as establishing universal superiority of embolization over surgery; nevertheless, they reinforce the feasibility of endovascular renal salvage in selected patients.¹³

Diagnostic Discordance: Negative FAST and the Delayed Recognition of Renal Injury

An important feature of this case is the apparent discordance between an initially reassuring bedside trauma evaluation and the subsequently identified high-grade renal injury.¹⁴ FAST examinations were negative both at initial presentation and during reassessment, yet contrast-enhanced CT ultimately demonstrated Grade IV renal trauma, suspected active bleeding, and hemoperitoneum. This finding should not be viewed as contradictory.¹⁵ FAST was developed primarily as a rapid bedside method for identifying clinically relevant free intraperitoneal fluid in trauma patients; it is neither sufficiently sensitive nor anatomically detailed to exclude renal parenchymal or retroperitoneal injury. The EAU specifically notes that FAST is insensitive, operator-dependent, and inferior to CT for characterization of solid-organ trauma.¹⁶

This limitation is particularly relevant to renal trauma because the kidneys are predominantly retroperitoneal organs. Hemorrhage may initially remain confined within the retroperitoneal compartment or within Gerota's fascia and therefore may not generate sufficient intraperitoneal fluid to produce a positive FAST examination. Even when hemoperitoneum eventually develops, its volume

and distribution may remain below the threshold of reliable sonographic detection.¹⁷ Consequently, a negative FAST should be interpreted as an assessment of detectable free fluid rather than as exclusion of renal injury. In the present patient, persistent abdominal pain following a significant blunt mechanism represented a clinically meaningful discordant feature that ultimately justified definitive cross-sectional imaging despite repeated negative bedside ultrasonography.¹⁸

The case therefore emphasizes the importance of maintaining diagnostic suspicion when the clinical trajectory does not correspond to the initial evaluation. Persistent or progressive abdominal or flank pain following blunt trauma, unexplained decline in hemoglobin, associated significant injuries, or a deceleration mechanism should lower the threshold for CT assessment in hemodynamically stable patients. Current EAU recommendations specifically include rapid deceleration, significant associated injuries, abdominal or flank tenderness, and other clinical features suggestive of renal trauma among indications for multiphase CT.¹⁸ CT remains the diagnostic modality of choice because it can simultaneously characterize renal parenchymal disruption, active contrast extravasation, vascular abnormalities, hematoma distribution, urinary collecting-system injury, contralateral renal anatomy, and associated intra-abdominal trauma.¹⁹

The absence of gross hematuria in this patient represents a second diagnostically important feature. Hematuria remains an important marker of genitourinary trauma, but its severity does not consistently parallel the anatomical severity of renal injury.²⁰ Major renal vascular injury, ureteropelvic junction disruption, and segmental vascular lesions may occur without visible hematuria. The EAU therefore explicitly cautions that significant renal injuries may be present in the absence of hematuria. In this case, urinalysis subsequently demonstrated occult blood and microscopic erythrocyturia, but clinically apparent gross hematuria was not observed. The combination of absent gross hematuria and negative FAST examinations could therefore have provided false reassurance had the persistent clinical symptoms not prompted CT evaluation.²¹

Accordingly, the diagnostic lesson from this case is not that FAST failed, but rather that FAST was being applied within the limitations intrinsic to its intended role. Bedside ultrasonography, urinary findings, physiological parameters, and mechanism of injury should be integrated rather than interpreted in isolation. A stable patient with negative FAST and absent gross hematuria may nevertheless harbor a major renal injury, particularly when symptom persistence or injury mechanism remains concerning.

Importance of CT-Based Characterization and Contemporary AAST Grading

Contrast-enhanced CT represented the decisive investigation in this case because it transformed an otherwise nonspecific post-traumatic abdominal presentation into a defined high-grade renal injury

requiring targeted management.²⁰ Modern CT protocols permit evaluation of vascular, parenchymal, and collecting-system components of renal trauma. The arterial phase is particularly valuable for demonstrating vascular injury and active contrast extravasation, whereas nephrographic imaging delineates parenchymal lacerations and delayed-phase imaging may identify urinary extravasation or ureteropelvic disruption. These anatomical distinctions are not merely descriptive; they influence the probability of spontaneous resolution, requirement for angioembolization, risk of delayed hemorrhage, and need for urinary drainage.²¹

The CT report in this patient classified the renal injury according to the 2025 AAST renal injury scale. The 2025 revision represents an important evolution of the AAST Organ Injury Scale because it incorporates contemporary evidence regarding CT-based injury characterization and the widespread adoption of non-operative renal-trauma management. This evolution is clinically relevant because the traditional relationship between higher anatomical grade and mandatory surgical intervention has progressively weakened. Rather, modern classifications increasingly attempt to distinguish injury features with different prognostic and interventional implications.

Nevertheless, injury grade should remain a framework for risk stratification rather than an isolated therapeutic mandate. Two Grade IV injuries may differ substantially in their dominant pathological mechanism.²² One may primarily involve a collecting-system injury that resolves spontaneously, whereas another may contain active arterial extravasation requiring urgent hemorrhage control. The management consequence therefore depends not only on the assigned grade but also on the specific CT phenotype, hemodynamic behavior, transfusion requirement, evolution of hemoglobin concentration, associated injuries, and institutional capacity for interventional radiology.²³ In the present case, the clinically decisive radiological feature was the suspicion of active renal bleeding in the setting of persistent physiological stability, creating a situation in which renal arterial embolization offered a targeted alternative to open surgery.

Hemodynamic Stability as the Central Determinant of Non-Operative Management

The patient's persistent hemodynamic stability was central to the therapeutic decision. His systolic blood pressure remained approximately 125–130 mmHg, while his heart rate remained between approximately 70 and 78 beats/min without documented episodes of shock. Although the hemoglobin concentration decreased from 14.9 g/dL at initial assessment to 13.0 g/dL and subsequently 12.6 g/dL, this decline was not accompanied by progressive circulatory compromise. The abdominal examination likewise remained without generalized guarding or overt peritonitis. These findings permitted sufficient time for diagnostic characterization and endovascular intervention rather than necessitating immediate damage-control surgery.

This distinction is consistent with current guideline-based management, in which hemodynamic stability constitutes the primary criterion for non-operative treatment.²⁴ Non-operative management should not be interpreted as therapeutic passivity; rather, it represents an active and dynamic treatment strategy involving serial clinical assessment, hemoglobin monitoring, renal-function surveillance, repeat imaging when indicated, and rapid escalation to interventional radiology or surgery when predefined thresholds are reached. The EAU describes this concept as a "package of care," beginning with observation and progressing to angioembolization or operative exploration as necessary.²⁵

In this framework, renal embolization should be regarded as an extension of non-operative management rather than as failure of conservative treatment. This distinction is conceptually important. Traditional dichotomization into "conservative" versus "operative" management may obscure the increasingly central position of interventional radiology.²⁶ A patient may initially undergo observation, subsequently demonstrate a radiological or clinical indication for hemorrhage control, receive targeted embolization, and still remain within an organ-preserving non-operative pathway. The present case followed precisely this trajectory.²⁷

The concomitant Grade II splenic injury also influenced the overall management context. Because there was no clinical evidence that the associated splenic lesion required laparotomy, renal hemorrhage could be addressed independently through an endovascular approach. Had another abdominal injury mandated immediate operative exploration, the threshold for simultaneous renal surgical management might have been different. Therefore, renal-trauma treatment cannot be considered independently of the broader polytrauma phenotype.^{27,28}

Renal Arterial Embolization as Targeted Nephron-Sparing Hemorrhage Control

The most clinically consequential aspect of this case was the use of renal arterial coil embolization to control suspected traumatic renal hemorrhage while avoiding immediate renal exploration or nephrectomy.²⁸ The fundamental advantage of transarterial embolization is its capacity to convert vascular imaging into targeted therapy. Diagnostic angiography can localize the bleeding arterial territory, after which embolic material can be delivered selectively to interrupt pathologic arterial inflow while preserving perfusion to uninvolved renal parenchyma. This differs fundamentally from nephrectomy, in which hemorrhage control is achieved at the cost of complete ipsilateral renal loss, and from more extensive surgical reconstruction, which may be technically difficult in a traumatized retroperitoneum.²⁹

Current EAU guidelines strongly recommend selective angioembolization for active renal

bleeding in the absence of another indication for immediate surgical exploration. The procedure appears particularly valuable in high-grade injuries, and guideline synthesis reports successful non-operative management incorporating selective angioembolization in approximately 89% of Grade IV injuries.³⁰ A systematic review of blunt renal trauma similarly found high success rates for renal angioembolization, particularly among hemodynamically stable Grade III–IV injuries, although substantial heterogeneity exists in patient selection, embolization thresholds, definitions of technical and clinical success, and institutional expertise.³¹

More recent comparative evidence further supports the role of angioembolization in selected high-grade trauma. In a nationwide analysis of 591 patients with high-grade renal trauma, previous study has compared renal angioembolization with operative management and found no adjusted difference in overall morbidity or hospital and intensive-care length of stay, while operative management was associated with higher adjusted mortality.³² Importantly, however, these findings derive from observational trauma-registry data rather than randomized allocation and are vulnerable to confounding by indication, particularly because patients selected for surgery may have had more severe physiological derangement or associated injuries. The study therefore supports the feasibility and potential benefit of angioembolization but does not establish that embolization should replace surgery in patients with uncontrolled instability.³³

Similarly, one of the previous studies has demonstrated high procedural success in Grade IV injuries and a lower likelihood of subsequent nephrectomy following angioembolization compared with surgical repair. In their observational cohort, angioembolization was successful in 94.2% of Grade IV injuries, and nephrectomy occurred less frequently after embolization than after surgical repair.³⁴ These findings are particularly relevant to the present patient because they reinforce the concept that a Grade IV designation does not preclude renal salvage when physiology remains favorable and the hemorrhagic lesion is amenable to endovascular control.³⁵

Coils were used as the embolic agent in the present case. Coil embolization is particularly suited to discrete arterial targets because it provides mechanical vascular occlusion and allows relatively precise deployment. From a nephron-preservation perspective, the conceptual objective is to occlude the smallest arterial territory capable of achieving hemostasis. Excessively proximal embolization may sacrifice a greater volume of functional parenchyma, whereas highly selective embolization may limit ischemia to the injured vascular territory.³⁶ Nevertheless, the degree of selectivity achieved in this patient cannot be reliably established from the available documentation. The procedural note available for the present report confirms renal arterial coil embolization but does not specify the

injured vessel, microcatheter position, presence of angiographically demonstrated extravasation, pseudoaneurysm or arteriovenous fistula, coil dimensions, or post-embolization percentage of preserved renal perfusion.³⁷ For this reason, the procedure should not be described as "superselective embolization" unless the angiographic report or procedural images subsequently confirm that level of catheterization.

The temporal interval between injury and embolization also warrants consideration. The embolization was performed several days after the original traumatic event rather than immediately following injury.³⁵ This course reflects the delayed recognition of the renal lesion and illustrates how clinically important renal bleeding may remain sufficiently contained to permit endovascular treatment despite delayed diagnosis.³⁶ However, the favorable physiological course should not be interpreted as evidence that delayed embolization is preferable to early treatment. Rather, the case demonstrates that persistent symptoms after apparently reassuring initial trauma assessment should prompt reassessment before ongoing bleeding produces hemodynamic deterioration or delayed vascular complications.³⁷

Renal Function After Embolization: Preservation Without Overinterpretation

Renal preservation is one of the major theoretical and clinical advantages of embolization, but assessment of renal outcome requires careful interpretation. Before intervention, the patient already demonstrated mildly impaired biochemical renal function, with serum creatinine values of 1.50–1.59 mg/dL and estimated glomerular filtration rates of approximately 61–66 mL/min/1.73 m². The available data do not establish whether this represented trauma-associated acute kidney dysfunction, transient prerenal physiology, an unrecognized baseline abnormality, or a combination of these factors. Consequently, these values should not be attributed solely to structural renal injury.

The immediate post-embolization course was nevertheless clinically reassuring. Urine output remained approximately 2.08 mL/kg/h, with clear yellow urine and no documented oliguria, anuria, or gross hematuria. This finding suggests preservation of global renal excretory capacity during the early post-intervention period. However, preserved urine volume alone cannot establish preservation of ipsilateral renal parenchymal function because the contralateral kidney can compensate for substantial unilateral functional loss. In the absence of documented post-embolization serum creatinine, follow-up CT, differential renal scintigraphy, or other functional assessment, it would therefore be inappropriate to claim definitive long-term renal functional preservation.³⁸

This distinction should be emphasized in reporting the present case. The available data supports successful early clinical hemorrhage control with preserved overall urine output and avoidance of

nephrectomy, but they do not yet demonstrate quantitative preservation of right renal function. Obtaining post-procedural serum creatinine and longer-term follow-up would substantially strengthen the report.³⁹ Contemporary EAU guidance recommends follow-up after major renal injury with urinalysis, renal-function testing, blood-pressure assessment, and individualized imaging at approximately three months, with continued annual blood-pressure surveillance because post-traumatic renovascular hypertension, although uncommon, may occur.⁴⁰

Post-embolization surveillance is additionally important because successful immediate hemostasis does not eliminate the possibility of delayed complications. Potential complications following high-grade renal trauma include recurrent hemorrhage, urinoma, infection, pseudoaneurysm, arteriovenous fistula, renal infarction, and post-traumatic hypertension⁴⁰. Repeat imaging is particularly warranted when patients develop worsening pain, fever, declining hematocrit, recurrent hematuria, or other evidence of clinical deterioration. Thus, angiographic technical success should be considered one component of a broader renal-salvage pathway rather than the endpoint of care.⁴¹

Clinical Relevance and Lessons from the Present Case

The value of this case lies less in demonstrating that renal artery embolization can be performed for Grade IV trauma, a concept already established in contemporary literature and more in illustrating the sequence of diagnostic and therapeutic decisions required to identify a patient who can benefit from embolization. Three clinically important features converged: persistent post-traumatic abdominal symptoms despite repeated negative FAST examinations, absence of gross hematuria despite high-grade renal injury, and sustained hemodynamic stability despite CT evidence suggesting active hemorrhage. Together, these findings demonstrate why reliance on a single clinical or bedside parameter may be insufficient when evaluating renal trauma.

The first lesson is diagnostic. A negative FAST should not terminate evaluation when the injury mechanism and subsequent clinical course remain concerning. The second is that absence of gross hematuria cannot reliably exclude major renal trauma. The third, and perhaps most important, is therapeutic: high-grade anatomical injury does not automatically require open surgery. In patients whose physiology permits careful evaluation, CT can identify a hemorrhagic phenotype suitable for targeted endovascular treatment. Angioembolization can therefore serve as an intermediate but definitive form of hemorrhage control between observation alone and surgical exploration.

The case also illustrates the importance of multidisciplinary trauma care. Successful renal salvage required integration of emergency assessment, serial

surgical evaluation, radiological characterization, and interventional radiology. The increasing role of endovascular therapy means that institutional resources and timely access to interventional radiology can materially influence the practical management of high-grade renal injury. Contemporary renal-trauma algorithms therefore cannot be entirely divorced from local system capability. A treatment strategy that is safe in a center with continuous interventional radiology availability may require modification in a setting where rapid embolization cannot be provided.

Strengths, Limitations, and Future Considerations

A principal strength of this case is the longitudinal documentation of a clinically stable patient from the initial trauma assessment through delayed CT diagnosis, renal arterial embolization, and early post-intervention recovery. The case also captures an important real-world diagnostic challenge: severe renal injury may coexist with negative FAST examinations, absent gross hematuria, and initially preserved physiology. The subsequent use of embolization provides a clinically relevant example of how contemporary organ-preserving principles can be applied to high-grade renal trauma.

Several limitations should nevertheless temper interpretation. First, the detailed CT description required to define the precise Grade IV phenotype is currently unavailable beyond the radiological impression. Second, the complete interventional radiology procedure report has not been incorporated; therefore, the exact arterial bleeding source, angiographic morphology, degree of catheter selectivity, embolic coil characteristics, and post-embolization residual renal perfusion cannot yet be determined. Third, post-embolization biochemical renal-function measurements and longer-term imaging are not currently available. Consequently, conclusions should be limited to early clinical success, avoidance of immediate surgery, and preserved urine output rather than definitive long-term renal functional preservation. Finally, as with all single-patient reports, this case cannot establish comparative efficacy between embolization, observation, and operative management.

Despite these limitations, the case provides a clinically instructive representation of contemporary renal-trauma management. The successful use of renal arterial coil embolization in a hemodynamically stable patient with delayed-recognized AAST Grade IV blunt renal injury underscores the importance of integrating physiology, CT-defined vascular injury, and minimally invasive hemorrhage-control strategies. Rather than treating injury grade as an automatic indication for surgery, contemporary management seeks to identify the least invasive intervention capable of reliably controlling hemorrhage while preserving viable renal tissue. In appropriately selected patients, renal angioembolization occupies a central position within this nephron-sparing strategy and may allow definitive hemorrhage

control without immediate renal exploration or nephrectomy.

CONCLUSION

High-grade blunt renal trauma may remain clinically occult despite hemodynamic stability, negative FAST examinations, and absence of gross hematuria. This case demonstrates the importance of maintaining clinical suspicion when post-traumatic abdominal symptoms persist and highlights contrast-enhanced CT as the decisive modality for defining renal injury severity and identifying active hemorrhagic features. In a hemodynamically stable patient with AAST Grade IV renal injury and suspected active bleeding, renal arterial embolization provided effective early hemorrhage control while avoiding immediate open exploration or nephrectomy. The favorable post-procedural course, characterized by sustained hemodynamic stability, preserved urine output, and absence of recurrent clinically evident bleeding, supports the role of endovascular embolization as an important component of contemporary nephron-sparing management. Long-term assessment of renal function, blood pressure, and imaging remains necessary to determine the durability of renal preservation after high-grade trauma.

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