



Traumatic Renal Artery Injuries: A Comprehensive Case Study Analysis

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Case Report

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Abstract

Post-traumatic renal artery injury is a rare yet critical complication following trauma, potentially leading to severe renal damage and functional loss. We present three cases of post-traumatic renal artery injury resulting in renal ischemia due to late diagnosis. Of particular note is that the interval between the first patient and the third is only three months, occurring at a time when such lesions are rarely observed. These cases, all involving young male individuals, highlight the challenges of prompt identification and timely intervention in such injuries. Delayed diagnosis hampered attempts at surgical revascularization in all cases, and our hospital lacked resources for percutaneous revascularization procedures. Despite efforts to manage these injuries conservatively, the success rates of surgical revascularization have been limited, leading to recurrent thrombosis. This has prompted the medical community to reconsider the approach to managing these injuries, with emphasis on non-operative methods and less invasive alternatives, particularly in the presence of a functioning contralateral kidney. However, determining the optimal management strategy remains elusive due to insufficient evidence regarding the efficacy of various approaches. Urgent management of renal artery injuries aims to preserve kidney function and mitigate secondary complications, such as renovascular hypertension. Long-term follow-up revealed varying outcomes among these patients, emphasizing the complex nature of managing post-traumatic renal artery injuries.

Keywords: Renal Artery Injury; Trauma; Delayed Diagnosis; Revascularization; Renovascular Hypertension

Abbreviations: GSC: Glasgow Coma Scale; Hb: Hemoglobin; PT: Prothrombin Time; WBC: White Blood Cells.

Introduction

Post-traumatic renal artery injury is a serious complication that can lead to the loss of the renal function by nephrotoxic damage. Thus, rapid resuscitation and restoration of circulating volume are imperative for preventing ongoing renal ischemia. Injuries affecting the

kidneys represent around 1% to 5% of all cases, with the majority attributed to blunt abdominal trauma, accounting for 80% to 90% of these instances [1,2]. Young men, typically engaged in sports, motor vehicle accidents, assaults, or falls (average age of 30), show a higher prevalence of traumatic renal injuries [1,3].

Specific data solely on post-traumatic renal artery injury might be limited, making the precise determination of its incidence challenging. It appears that this incidence varies

between 0.05% and 0.08% [4-6]. Thus, the occurrence of post-traumatic renal artery injury poses a significant concern among trauma patients. Even the kidney's recuperation post open repair ranges widely, from 40% to below 10%, and remains largely unsatisfactory [6], Swift identification and proper intervention play pivotal roles in preserving renal function and avoiding complications especially the risk of renovascular hypertension [5,7].

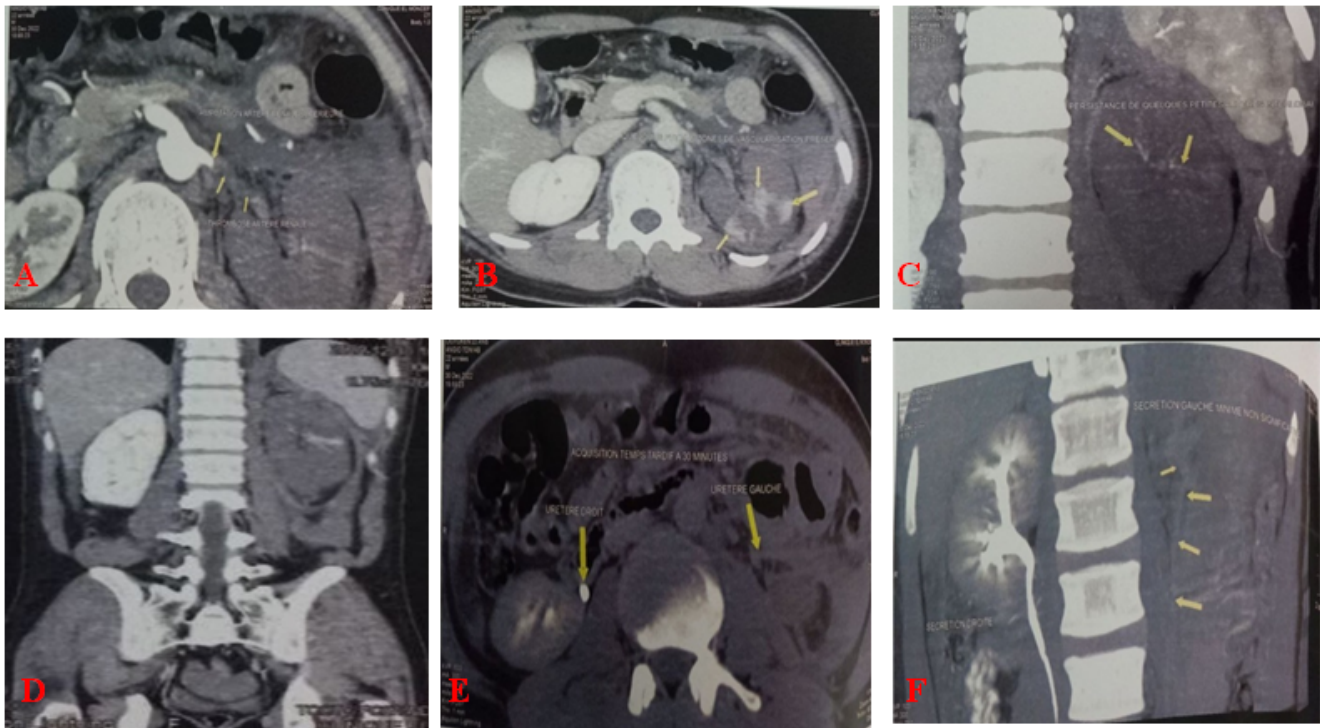
We herein report three cases of renal ischemia due to post-traumatic injury to the main renal artery. Unfortunately, the diagnosis was late, at least 24 hours later. What is anecdotal, is that the interval between the first patient and the third is only three months, at a time when such lesions are rarely seen as described above.

Cases Report

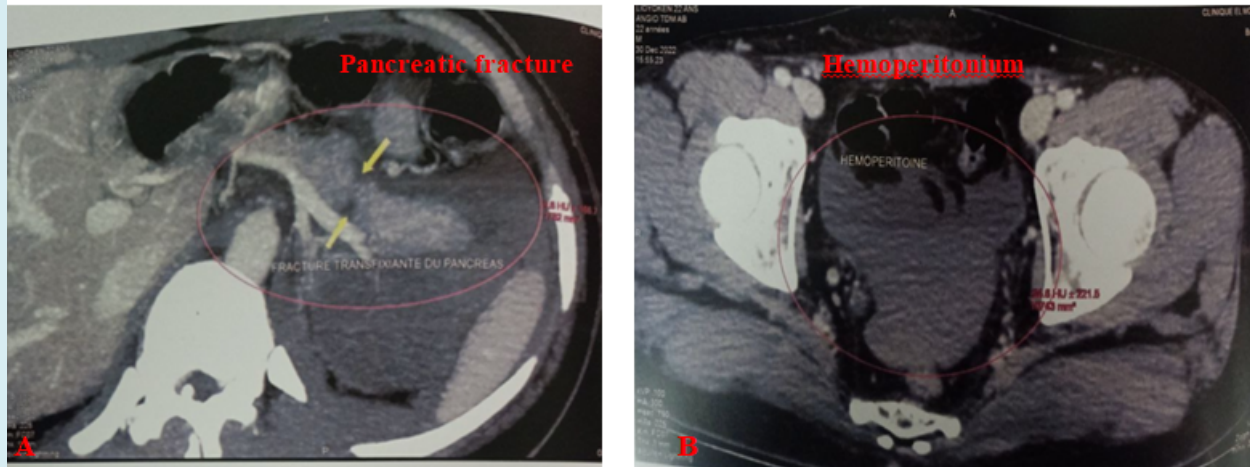
Case 1

The first patient is a man of 22 years old victim of a

workplace accident with the impact point at the lumbar region, resulting in polytrauma. Evacuated to our department 24 hours after the trauma, he was stable hemodynamically with normotensive values (120/65 mmHg). The physical examination revealed well scored patient, 15 on the Glasgow Coma Scale (GSC), with diffuse abdominal sensitivity. The laboratory tests revealed a hemoglobin level of 12.5 g/dL, a white blood cell (WBC) count of 6300 cells/ μ L, a total prothrombin time (PT) of 80%, Platelet count of 314 mm³, Blood urea nitrogen of 0.45 g/L, and serum creatinine of 14.2 g/L. The abdominal contrast-enhanced CT scan done 24 h before, revealed thrombosis in the three left renal arteries from 7 mm of their ostiums (likely occlusive dissection). This led to almost sub-total devascularization of the ipsilateral kidney (some residual upper polar parenchymal areas, approximately 5%, vascularized by small interlobar arteries Figures 1A-D with minimal and insignificant secretion and excretion (Figures 1E & F). In addition, there was pancreatic fracture with a peripancreatic fluid infiltration and low-volume hemoperitoneum (Figures 2A & B).



Figures 1A-D: Thrombosis of the left renal arteries with near-total devascularizaion of the kidney, **E,F:** Weak opacification of the left ureter.



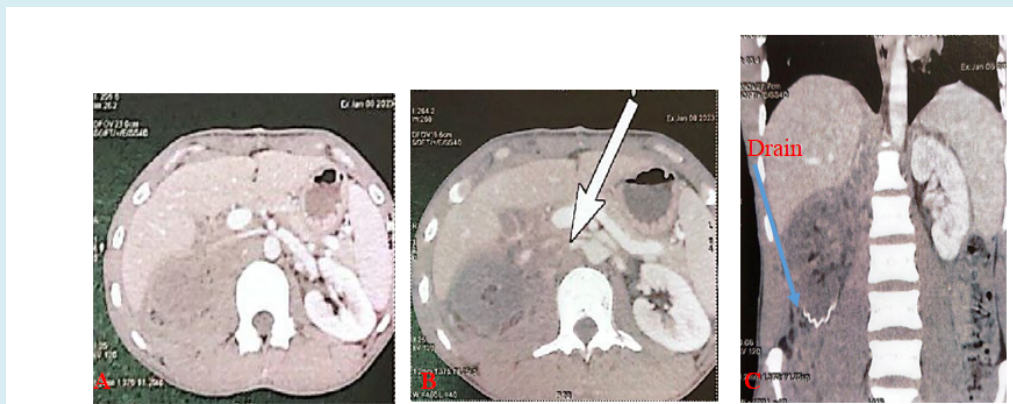
Figures 2A: pancreatic fracture, **B:** Hemoperitoneum.

The patient received an expectant approach for the urological lesion and subsequent drainage for the pancreatic lesion. After discharge, there was no follow-up urology consultation.

Case 2

The second patient, a 27-year-old man, was involved in a work-related accident, leading to the development of crush syndrome. He presented at the emergency department one week after the first patient. At the admission, the patient exhibited hypotension, with a blood pressure reading of 65/40 mmHg. Initial assessment showed a GCS of 15/15 with abdominal sensitivity. Laboratory tests indicated hematocrit level of 30.3%, with a hemoglobin level of 12.2 g/dL, a WBC count of $4.7 \times 10^3 \mu\text{L}$, and platelets at $362 \times 10^3 \text{ mm}^3$. His serum creatinine was $92 \mu\text{mol/L}$. The patient received immediate and aggressive fluid resuscitation. Due to the persistent refractory shock even after resuscitation, an

urgent admission to the operating room became necessary. The exploratory laparotomy revealed a bleeding vessel in the paracolic gutter that was easily manageable. Despite the presence of a retroperitoneal hematoma, the surgeon opted to explore solely the renal pedicle with a straightforward drainage, as the renal vessels appeared intact without evident injury. On the second day post-operation, an abdomen contrast-enhanced CT scan showed total ischemia in the right kidney, indicating what appears to be complete occlusion of the right renal artery (only the proximal portion is visible, while discreet opacification is observed in the renal vein, suggesting a potential vascular injury). Additionally, infiltration of perirenal fat was noted near the vascular pedicle, along the pericaval area, and adjacent to the diaphragmatic pillar (Figures 3A-C). Furthermore, the exam revealed a fracture in the left transverse processes of L1, L2, L3, and L4, along with a mid-portion fracture of the 8th right rib and a minor volume of right-sided pneumoperitoneum.



Figures 3A-C: Infiltration of perirenal fat, the vascular pedicle, the pericaval area, and adjacent to the diaphragmatic pillar.

One month later, another contrast-CT scan with angiography was performed revealing a complete occlusion of the proximal right renal artery (11 mm from the ostium), with devascularized non-functioning kidney. No

retroperitoneal hematoma was observed (Figures 4A-D). He was reviewed at 3 months, 6 months, and then at 9 months with normal blood pressure.

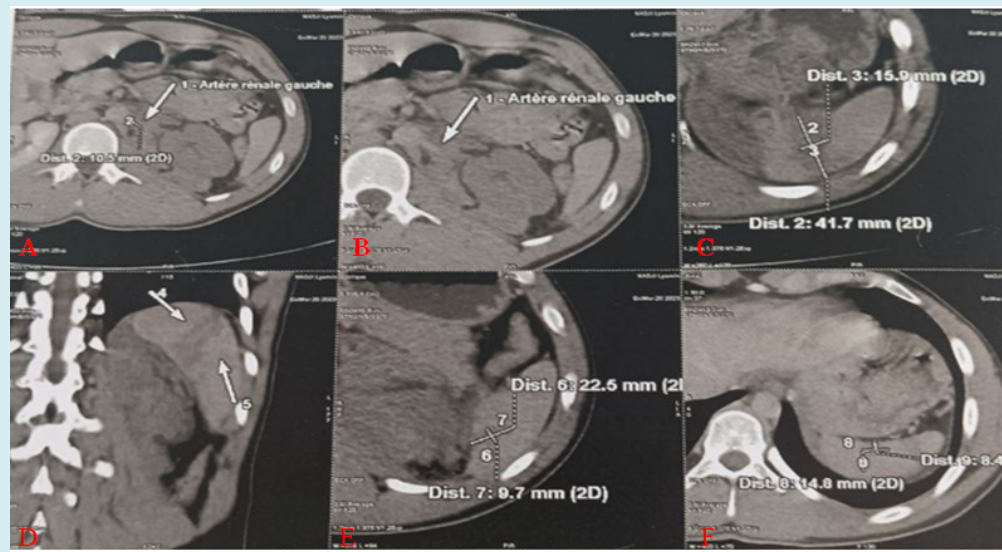


Figures 4A-D: Complete occlusion of the proximal right renal artery, with devascularized non-functioning kidney.

Case 3

The third patient, an 18-year-old male without any medical history, experienced a polytrauma following a road traffic accident and was admitted to our department 48 hours after the incident. Upon admission, the clinical examination indicated a conscious and cooperative patient with a GCS of 15/15. He presented cutaneous-mucosal pallor but

maintained a preserved general condition. Hemodynamically, he presented a normal blood pressure of 120/70 mmHg, with no evident signs of hemorrhagic syndrome. The urinary catheter retrieved 900cc of slightly hematuric urine, with no further abnormalities detected during the remaining clinical examination.

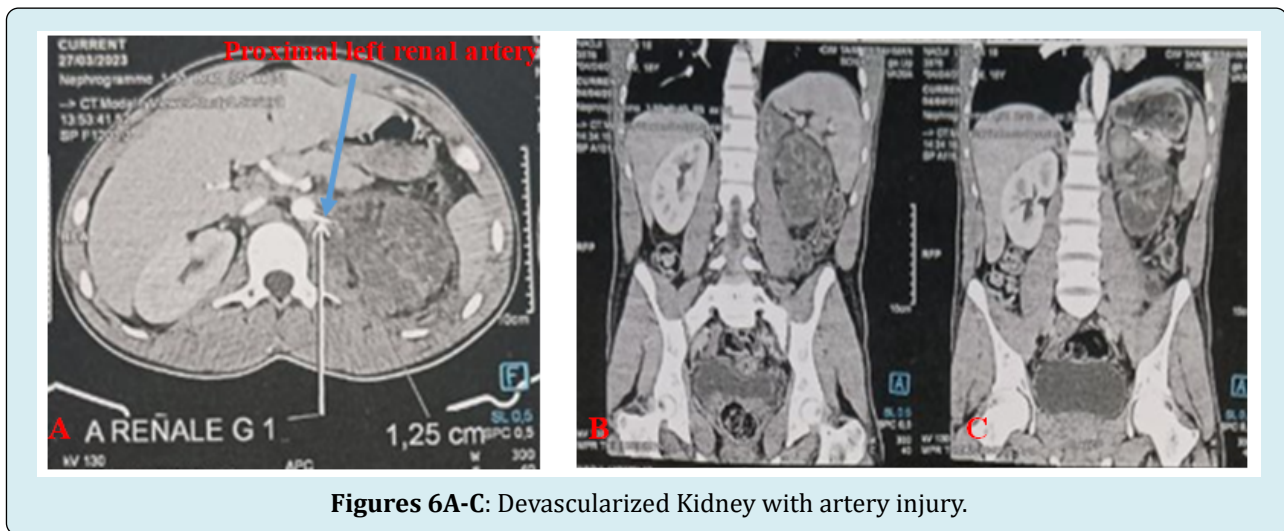


Figures 5A,B: Renal artery injury with devascularized left kidney, C-F: Multiple splenic injuries.

Laboratory investigations found a hemoglobin level of 11.5 g/dL, WBC of 5.1×10^3 , PT of 85.67%. His blood urea nitrogen was 0.48 g/L, serum creatinine 13.2 g/L. The abdominal Contrast-non enhanced CT scan (done 24 h before) revealed an avulsion of the renal hilum (amputation of the renal artery) with a devascularized kidney without active bleeding (Figures 5A,B). Low-volume hemoperitoneum, left adrenal trauma with a non-recognizable adrenal gland submerged in a sizable hematoma extending from the adrenal space to the renal hilum, measuring 93mm*81mm*47mm. Mid-splenic fracture of 42 mm, lower pole laceration of 22 mm, and upper pole contusion focus of 15 mm with a layer

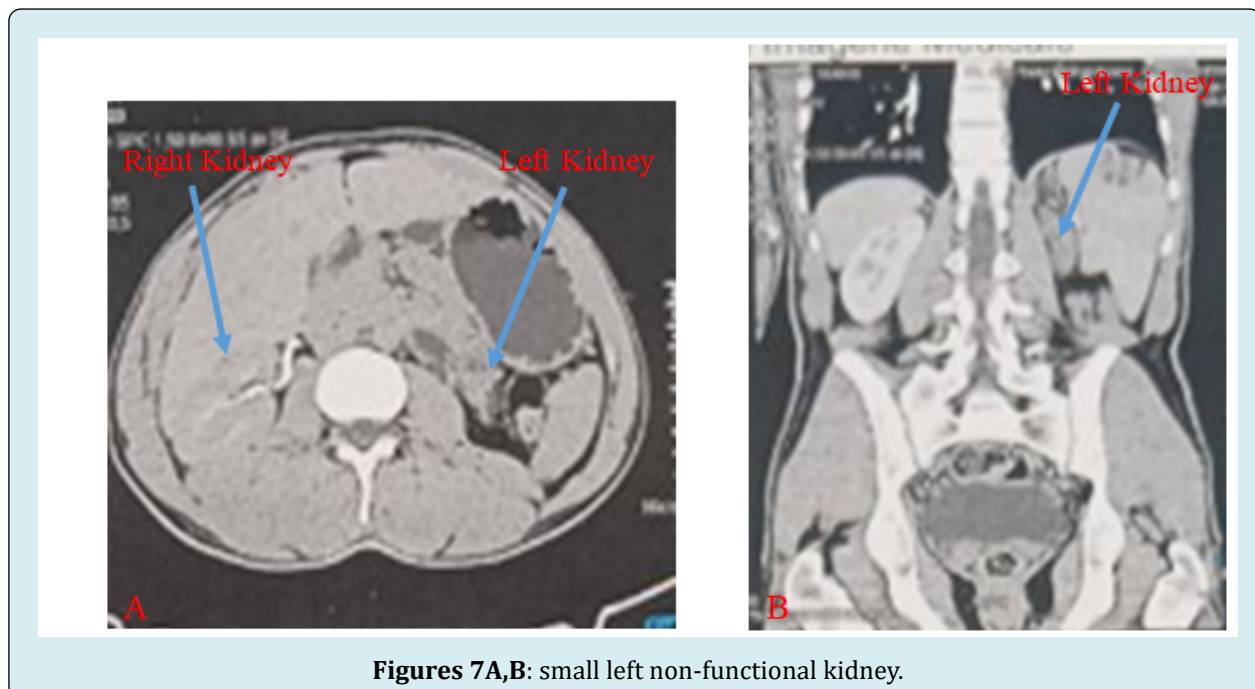
of perisplenic hemoperitoneum (Figures 5C-F). Additionally, non-displaced fractures of the 9th, 10th, and 11th left ribs were identified. Given the absence of immediate indications for laparotomy, the patient, although hemodynamically stable, was admitted to the intensive care unit and received an expectant management.

A subsequent enhanced CT scan, conducted seven days later, showed essentially, no active bleeding (proximal portion of the left renal artery is visible), stabilization of splenic and adrenal gland lesions, with devascularized non-functional kidney (Figures 6A-C).



Seven months later, another CT scan demonstrated the persistence of a non-functional small left kidney (Figures 7A

& B). At the last 9-month follow-up, he maintained a normal blood pressure.



Discussion

Even with renal artery injury, the mortality rate directly linked to kidney injury alone is typically low and often stems from the extensive presence of accompanying injuries. Bergqvist, et al. [8] reported an overall mortality of 6.5%, with a specific mortality rate related to renal injury recorded at 1.7%. Other studies described a total mortality of 0.6% [8,9].

Renal trauma is categorized into five grades, ranging from minor injuries (Grade I) to severe injuries with vascular involvement (Grade V) [9-11]. Hence, we report three cases of renal artery injuries managed in our department within a very short period (a time span of 3 months between the first and third cases), regarding a condition considered rare with an incidence approaching. Although renal trauma is relatively rare, occurring in 1.4% to 3.2% of trauma cases [12,13] and reaching up to 5% in certain series [1,2], arterial injuries, as a subset of these cases, account for 0.05-0.08% of all trauma incidents [4,5].

However, recent series, as indicated by Sangthong, et al. have reported an incidence of BRAI ranging from 1% to 4% among all abdominal injuries, which relies on the criteria used for abdominal CT evaluation [5]. Notably, a surge in the number of BRAI cases became apparent starting in 2005, coinciding with the widespread adoption of the 16-slice CT scanner [14].

All three of our patients were male, with an average age of 22.3 years, consistent with the predominant trend of younger males observed in most reported series. Chow, et al. reported a male-to-female sex ratio of 3.2:1 [14], while Petrone, et al. in their recent systematic review, found 75.3% of the patients to be male, with a mean age of 33 years [9].

Even with only three patients, two of them experienced injuries to the left kidneys. The left kidney is often observed to be slightly more susceptible to injury. Literature suggests a relative injury rate of 1.4:1 to 2:1 in favor of the left side compared to the right. Potential reasons for this include the shielding of the right renal artery by the inferior vena cava and duodenum, as well as its stabilization by the liver and duodenum [15].

It's important to note, that renovascular injuries are frequently linked with concomitant injuries to non-renal organs, as observed in our cases and documented in other similar instances [9,13,15]. In our cases, we did not observe significant hemorrhage, and two cases had no hematuria. This might occur when renal artery injury leads to kidney devascularization through isolated intimal damage, causing thrombosis [15].

All our patients underwent a contrast-enhanced CT scan of the abdomen, which remains the gold standard for diagnosis [1,3,7,15]. However, some authors propose considering contrast-enhanced ultrasound as the initial imaging modality in clinically symptomatic patients with minor blunt trauma and a negative extended focused assessment with sonography for trauma. Contrast-enhanced ultrasound could serve as an initial screening tool before resorting to a CT scan if the results are positive [16]. For hemodynamically unstable patients admitted urgently to the operating room, an intravenous urogram (IVU) might be considered. The objective is to analyze the morphological and functional aspects of both kidneys [17]. Unfortunately, for our patient operated on in an emergency, the IVU could not be performed due to an unsuitable operating table. What prompts the preoperative assessment is that nearly a quarter of post-traumatic renal injuries go unnoticed during emergency laparotomies [18,19]. Moreover, the surgeon resorted to a manual palpation of the renal pedicle, which appeared intact. This is especially prominent in cases of arterial thrombosis, where patients might exhibit minimal or no retroperitoneal hematoma, an intact artery, and solely relying on palpation might lead to a missed diagnosis [20,21].

In two cases, the absence of the cortical rim nephrogram sign, typically visible in devascularized kidneys, might not manifest in the acute setting [15,22]. In our first case, there was approximately 5% of parenchyma, vascularized by small interlobar arteries.

Though CT scans remain the standard for overall renal injuries, arteriography stands as the gold standard for detecting renal artery injuries due to its dual advantage of injury identification and potential for endovascular interventions [23].

In our three cases, unfortunately, the diagnosis was delayed. As recognized, the most crucial aspect in preserving renal function is swiftly restoring blood flow. The ideal timeframe for revascularization remains a topic of debate and lacks clarity. While some authors propose a window spanning 6-12 hours, others have reported a narrower range of 3 to 4 hours [7,15,24], additional authors have suggested an attempt at revascularization before 20 hours of warm ischemia have passed [7,25].

Moreover, even preserving renal function is more likely with a limited warm ischemic time, revascularization within four hours of warm ischemia doesn't always guarantee optimal functional recovery [7,26,27]. Besides the duration until restoring blood flow to the primary renal artery, additional factors may influence renal function preservation. Notably, the presence of multiple thrombi in distal renal arteries. Illustrated in our first case, the estimated incidence

of renal artery thrombosis following renal trauma is approximately 2% [28].

Delayed diagnosis dissuaded surgical revascularization attempts in our three cases, despite its minimal success rates, often resulting in recurrent thrombosis [5,29]. Consequently, many surgeons refrain from this approach, especially when a functioning kidney is present on the opposite side [13,15]. Recent studies have highlighted the potential of percutaneous revascularization using endovascular stenting for stable patients with unilateral renal artery occlusion [15,23]. Unfortunately, our hospital lacks interventional radiologists for these procedures.

Determining the optimal management strategy remains challenging, as evidence is insufficient to identify subsets benefiting from open revascularization, endovascular therapy, or expectant management [23]. In a level 1 trauma center, Chow, et al. employed angiography and embolization in 34.3% of cases [14], while some advocate for open surgery in urgent scenarios.

Current consensus suggests that open revascularization is not recommended if a functioning contralateral kidney exists [4,12-14,27]. Non-operative management remains important due to poor outcomes following urgent surgical revascularization, with an estimated preserved kidney rate of less than 20% [29]. Selective arterial embolization via angiography emerges as a less invasive alternative to laparotomy, boasting a success rate exceeding 90% [30].

Nine months post-injury during the follow-up, two patients did not require antihypertensive medication and had normal blood pressure readings. For the first patient, we did not receive any updates. Indeed, urgent management of renal artery injury is aimed at preserving kidney function and preventing renovascular hypertension, thereby reducing the likelihood of necessitating secondary nephrectomy [5,12,26,29]. Haas, et al. reported Thirty-four out of 105 patients (32%) who did not undergo attempted revascularization experienced the onset of hypertension [12].

Conclusion

Post-traumatic renal artery injuries pose significant challenges in timely diagnosis and appropriate management, particularly given their rarity and potential for severe complications. The cases presented underscore the limitations in prompt identification and intervention, resulting in delayed attempts at surgical revascularization and highlighting the lack of available resources for alternative procedures in our hospital. The limited success rates of surgical revascularization and the associated risk of recurrent

thrombosis have led to a reevaluation of the management approach, with a shift toward non-operative methods and less invasive techniques. However, establishing the optimal management strategy remains a challenge due to inadequate evidence on the effectiveness of different approaches. Urgent management aims to preserve renal function and prevent secondary complications, necessitating further research and standardized protocols to enhance outcomes in these cases. Long-term follow-up revealed varied outcomes, emphasizing the need for comprehensive management and continued monitoring in post-traumatic renal artery injuries.

Declarations

Acknowledgment

Not Applicable

Conflict of Interest

Not Applicable

Ethics Approval and Consent to Participate

Yes

Consent for Publication

Yes

Availability of Data and Materials

Yes

Competing Interests

No

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No

Autours Contributions

NA

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