

## Endovascular salvage of occluded renal artery after >15 hours of ischemic time

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### ABSTRACT

In severe cases of acute traumatic injury to the kidney, immediate intervention is necessary to avoid irreversible ischemic damage. This case involves a 24-year-old woman who presented with signs of right renal devascularization after a high-speed all-terrain vehicle accident. Due to transport from an outside hospital, there was >15-hour delay before evaluation by vascular surgery. Considering her young age, we elected to salvage this patient's kidney via percutaneous endovascular stenting to mitigate any further prolongation of renal artery occlusion and prevent long-term sequelae. After intervention, her acute kidney injury resolved, and her creatinine levels normalized. As illustrated in this case, recovery of the renal parenchyma remains a possibility despite an extended warm ischemic time, providing evidence for future young patients to be considered for renal salvage. (*J Vasc Surg Cases Innov Tech* 2024;10:101511.)

**Keywords:** Acute kidney injury; Blunt trauma; Endovascular repair; Renal ischemia

Renal artery injury secondary to a blunt traumatic event is an extremely rare occurrence, with a previously reported incidence between 0.05% and 0.08%.<sup>1,2</sup> Hemorrhage resulting from avulsion or laceration of this vessel can be emergently managed via arterial embolization or open intervention, especially in cases of hemodynamic instability. Patients can also present as hemodynamically stable; however, if their underlying etiology involves thrombotic occlusion or stenosis of this vessel.<sup>3</sup> Acute occlusive incidents in the setting of trauma provide a reason to consider renal salvage techniques. The success rates of surgical revascularization in post-traumatic renal injury are reported to lie between 25% and 50%.<sup>4</sup> These underwhelming outcomes have limited the widespread embracement of renal salvage after periods of ischemia >20 to 30 minutes. Nonoperative treatments, however, are also associated with complications such as acute kidney injury or renal hypertension, with an incidence of 19% to 43%.<sup>5</sup> Although small animal experiments have observed pathological changes outside this ischemic window, prior human studies demonstrate no clinically significant decline in renal function at >30 minutes of

renal ischemia, providing evidence for attempting salvage in patients capable of tolerating intervention.<sup>6-8</sup> We report our successful endovascular management of a blunt renal artery injury with >15 hours since ischemic onset with restoration of renal arterial perfusion and no subsequent complications. The patient provided written informed consent for the patient report of her case details and imaging studies.

### CASE REPORT

A 24-year-old morbidly obese (body mass index, 42 kg/m<sup>2</sup>) woman presented to an outside hospital as a level 1 trauma activation with a right radial fracture, right clavicular fracture, and multiple bilateral rib fractures with an associated left pneumothorax after an all-terrain vehicle accident. At the outside hospital, computed tomography identified findings concerning for a high-grade blunt injury to the right renal artery and possible renal devascularization. The patient was accepted as an emergent transfer to our facility without receiving any anticoagulant therapy from the external institution. Computed tomography angiography of the abdomen and pelvis demonstrated total occlusion of the right renal artery approximately 1.5 cm from its origin. The kidney retained minimal perfusion from a partially occluded right accessory renal artery. The patient presented with a blood urea nitrogen of 12 mg/dL and a creatinine of 1.05 mg/dL on arrival and reported significant right flank pain without hematuria. The estimated glomerular filtration rate (eGFR) just before the intervention was 67 mL/min/1.73 m<sup>2</sup> with an associated creatinine of 1.17 mg/dL. Given her relatively young age, vascular surgery was consulted for the possibility of salvage therapy preceding a planned right nephrectomy. Of note, >15 hours of renal warm ischemic time had passed at the time of the initial vascular surgery consultation.

We elected to attempt endovascular salvage of the patient's right kidney. The right common femoral artery was accessed

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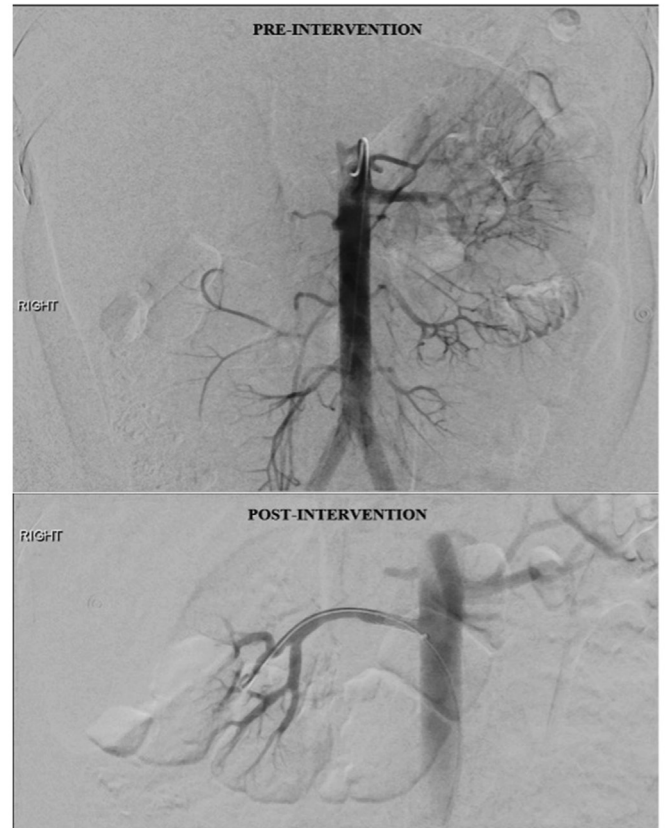
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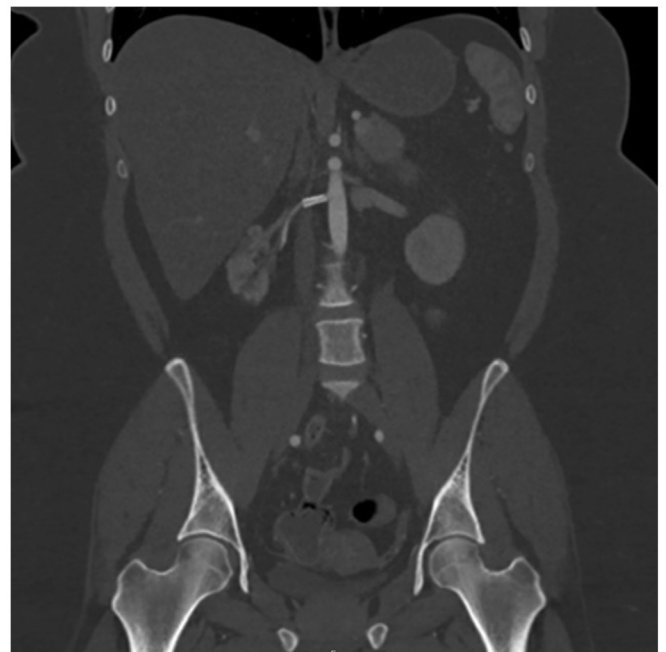


**Fig 1.** Preoperative computed tomography scan demonstrating total occlusion of the right renal artery, with an accessory inferior renal branch present providing minimal perfusion.

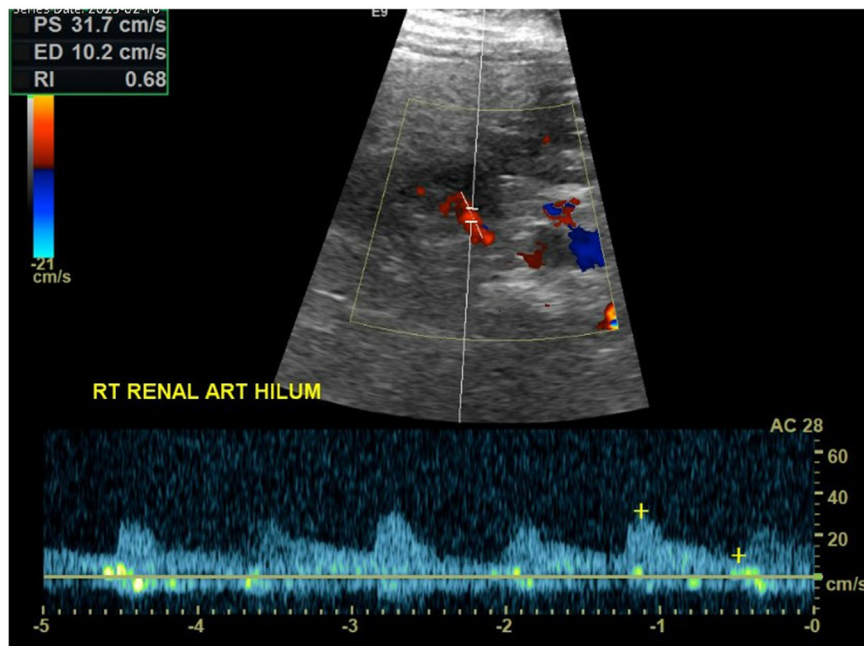


**Fig 2. Top,** Initial angiogram showing the right renal artery occlusion. **Bottom,** Successful endovascular revascularization of the right kidney.

via micropuncture, with subsequent aortography revealing complete occlusion of the right renal artery (Fig 1). The right renal artery was successfully cannulated using an Omni catheter and a soft Glidewire (Terumo Interventional Systems). Following heparinization, a 6F, 45-cm Ansel guiding sheath (Cook Medical) was advanced into the right renal artery over a Rosen J tip wire (Cook Medical), and a 5 × 16-mm iCAST covered stent (Getinge) was deployed within the focal dissection. Selection of the iCAST stent was predicated on its availability within our inventory and its flexibility and low profile, rendering it particularly suitable for visceral vasculature intervention. Mild vasospasm of the artery was responsive to nitroglycerin administration. Angiography after intervention demonstrated satisfactory stent patency and restored perfusion to the right kidney (Fig 2). Hemostasis was obtained, and the patient was transferred to recovery in stable condition. The patient experienced an uncomplicated postoperative course with resolution of her acute kidney injury and a return of serum creatinine to baseline. Her creatinine levels peaked at 1.36 mg/dL immediately after intervention, with a steady downward trend to 1.16 mg/dL at 10 hours postoperatively, and the blood urea nitrogen levels remained stable at 11 mg/dL. Her eGFR at 10 hours postoperatively was 56 mL/min/1.73 m<sup>2</sup>. The patient reported complete resolution of her right flank pain and had no evidence of hematuria. She was discharged with a 3-month course of daily clopidogrel. Computed tomography angiography at 5 months after the procedure demonstrated maintained patency of the renal



**Fig 3.** Computed tomography angiography at 5 months after intervention demonstrating renal stent patency and renal arterial perfusion with some small regions of chronic infarcts.



**Fig 4.** Postoperative duplex ultrasound at 7 months after intervention with Doppler ultrasound illustrating patency of the right renal artery at the renal hilum.

artery stent and perfusion of the right kidney, with some small regions of chronic infarcts from the prolonged ischemic time (Fig 3). The eGFR was measured at 69 mL/min/1.73 m<sup>2</sup> and 87 mL/min/1.73 m<sup>2</sup> at 5 months and 1 year postoperatively, respectively. Her creatinine levels had decreased to 1.14 mg/dL at 5 months before reaching 0.93 mg/dL by 1 year. The right kidney measured 8.9 × 3.1 × 5.0 cm and left kidney measured 12.6 × 6.0 × 5.1 cm on the 5-month ultrasound scan with sufficient renal perfusion demonstrated bilaterally. Surveillance duplex ultrasound imaging demonstrated a normal resistive index of 0.6, with unimpeded flow through the right renal artery and no evidence of stenosis at 1 month or 7 months of follow-up (Fig 4). At her last follow-up, she remains at her baseline creatinine level.

## DISCUSSION

Although uncommon, blunt trauma can cause injury to the renal artery, resulting in arterial occlusion without damaging the local organ parenchyma. Proposed mechanisms for such an injury include either direct compression of the renal vessel against the vertebral column or acceleration–deceleration forces that indirectly induce mechanical damage and can create a dissection flap capable of thrombosing the artery. These blunt forces are particularly likely to precipitate renovascular trauma around 2 cm from their origin, such as in our patient, given that these organs are held in place via the vascular pedicle and ureter.<sup>9,10</sup> Unlike our patient, however, the right renal artery is less susceptible to insult than its left counterpart at a rate of 1.4:2.1 within the literature. Although the right artery is stabilized by its proximity to the inferior vena cava and duodenum, the left renal

artery is shorter and more acutely angled, leaving it vulnerable to the effects of blunt trauma.<sup>10-12</sup> Although we previously described our satisfactory post-traumatic revascularization of the renal artery, we acknowledge that such success could be limited to patients without contraindications to heparin administration or concomitant life-threatening injuries requiring immediate intervention.

The paramount consideration when attempting renal revascularization is the maximal ischemic time before irreversible parenchymal injury occurs, because the high vascularity of the kidneys renders them extremely vulnerable to prolonged warm ischemia. Specifically, Thompson et al<sup>13</sup> found that patients with >25 minutes of renal cross-clamping during partial nephrectomy were four times as likely to experience additional renal damage. Additionally, the risk of renal failure in these patients increased by 5% for each minute beyond 25 minutes.<sup>13</sup> The ischemic susceptibility of the kidneys is further compounded by their limited accessory blood supply, thereby elevating the risk of end-organ ischemia in cases of acute renal artery injury or occlusion. Sequelae such as renovascular hypertension and acute nephropathy can also develop rapidly when primary arterial perfusion is constrained.<sup>14</sup> In our patient, however, the presence of collateral flow from a patent accessory renal artery might have mitigated the ischemia severity at the point of intervention, thus allowing more time for definitive revascularization.

Although no specific guidelines exist for revascularization of patients with an occluded renal artery, prior

investigations have noted the onset of ischemic changes at between 1 and 2 hours after injury and attempted to ascertain an optimal window to preserve organ function.<sup>10</sup> Spirnack and Resnick<sup>15</sup> previously documented success within 6 to 12 hours from the initial insult. In contrast, studies by Flye et al<sup>16</sup> and Cass<sup>11</sup> have delineated an ideal timeframe of operative intervention of within 3 to 4 hours after injury.<sup>10</sup> Although most successful revascularization attempts might occur within these reported intervals, our patient demonstrated restoration of renal function despite treatment occurring beyond the 12-hour upper limit for irreversible tubular damage. In their investigation of seven patients undergoing fenestrated-branched endovascular aneurysm repair, Heidemann et al<sup>17</sup> also demonstrate successful delayed revascularization of nine acute renal artery occlusions with a mean ischemic time of 24 hours and no permanent dialysis necessary. Similarly, Weise et al<sup>18</sup> describe a successful return to baseline in three patients receiving delayed intervention well outside the reported parameters, thereby underscoring the efficacy of endovascular stenting in protracted ischemia.

Our patient has not yet required any reintervention and there are no current plans for additional procedures. If concerns regarding right renal function were to develop during future surveillance, we would consider renal scintigraphy to delineate renal function. If she were to develop in-stent restenosis, we would likely consider an endovascular-first approach to preserve stent patency.

## CONCLUSIONS

Whether considering open surgical or endovascular therapy for the treatment of an obstructed renal artery, care must be taken to minimize the duration of ischemic time and prevent chronic kidney injury. We report the case of a 24-year-old woman with an acutely occluded right renal artery following blunt trauma to the abdomen. Although instances of blunt renal artery injury remain rare, this case is additionally unique because the patient presented with an extended warm ischemic time of >15 hours. We demonstrate the successful cannulation and stent placement of the occluded renal artery without any postoperative complications and resuscitation of renal perfusion. We suggest that vascular interventionalists consider renal artery revascularization after blunt trauma even with a prolonged warm ischemic time for select patients such as our young patient in this case.

## DISCLOSURES

None.

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