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Role of Intervention Radiology in Renal Vascular Injuries

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ABSTRACT
Background: Trans-catheter renal artery embolization has a role in the management of iatrogenic and traumatic renal vascular injuries. **Objective:** To assess the technical success and short term clinical efficacy of renal artery Embolization in patients with iatrogenic and traumatic renal vascular injuries. **Methodology:** All cases were done at interventional radiology unit Ain Shams University. **Conclusion:** Renal artery embolization plays a great role in the management and treatment of renal vascular injuries either traumatic or iatrogenic.
Keywords: Renal vascular injuries, Renal artery embolization (RAE), Renal Pseudo-aneurysm, Renal Arterio-venous fistula (AVF).

INTRODUCTION

The kidney is the third most common abdominal organ to sustain injury, with renal trauma evident in approximately 1–5% of all trauma cases. Trauma is either blunt representing almost 80% of traumatic renal injuries such as motor vehicle accident, falls and sports accidents or penetrating trauma due to stab wounds and gunshot wounds [(1)]. The prevalence of iatrogenic vascular injuries following renal interventions such asrenal biopsy, placement of a percutaneous nephrostomy tube, or laparoscopic or open surgical procedures reaches 8.0%, with less than 2.0% patients requiring intervention [(1)].

Aim of The Work The aim of this work was to assess the technical success and short term clinical efficacy of trans-catheter renal artery embolization as a treatment for renal vascular injuries. The study was approved by the Ethics Board of Ain Shams University.

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Anatomy of the renal vasculature (Fig. 1)

Arterial supply consist of a single renal artery arising bilaterally from the lateral aspect of the abdominal aorta just inferior to the origin of the superior mesenteric artery at level of L1/L2in 75% of cases. In 25% of cases there are duplicate renal arteries which are more common on the right side. The right renal artery usually has a long downward course towards the inferior position of the right kidney and it passes posterior to the inferior vena cava (IVC) and is usually postero-superior to the right and left renal veins. The renal artery is subdivided outside the renal hilum into an anterior and posterior division, carrying 75% and 25% of the blood supply respectively [(2)].

The arterial divisions are further divided into five segmental arteries where an apical, upper, middle and lower segmental arteries arise from the anterior division, and a posterior segmental artery arises from the posterior division. Segmental arteries branch at the level of the fornix to form interlobar arteries, which continue in the interlobar septae between the pyramids. Each interlobar artery branches at the cortico -medullary junction into 5-7 arcuate arteries, which then branch into interlobular arteries. These Interlobular arteries give supply to the afferent glomerular arteries and capsular perforating arteries [(3)]. The venous system begins with the peritubular capillary venous plexus draining into the arcuate veins through the venae rectae which in turn drain into the interlobular veins leading to arcuate veins and then interlobar veins which forms multiple trunks (2 in 50%, 3 in 30% of cases) that ultimately unite as the renal vein located anteriorly to the renal pelvis. The right renal vein drains directly into the IVC with no tributaries while the left renal vein is longer than the right one with multiple tributaries draining into it [(3)].

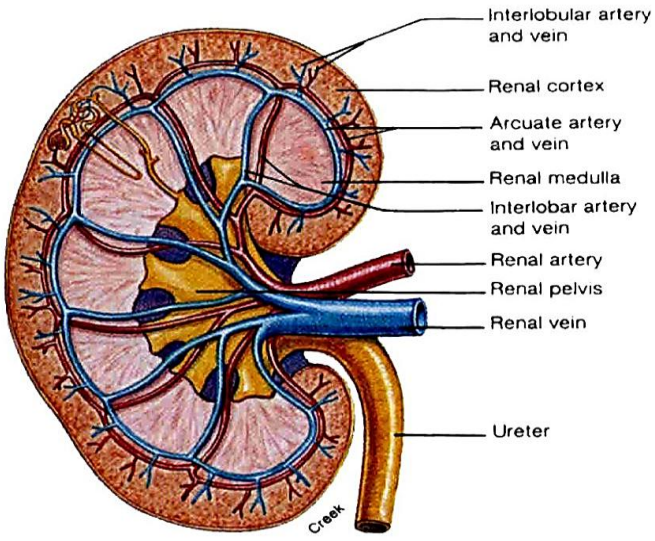

Fig. 1: Image showing renal vascular supply **(Quoted from Fox)** [(4)].

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Pathology of renal vascular injuries

Patients with pre-existing renal anomalies are at more risk for injury [(5)]. The main mechanism in blunt trauma is the exertion of a deceleration force on the renal parenchymal tissue, major renal blood vessels and renal collecting system [(6)] which thrusts the kidney against the vertebral column or rib cage causing contusion, laceration, hemorrhage or avulsion of the renal pedicle [(7)]. Penetrating trauma lead to crush of tissue struck by the bullet/knife (the permanent cavity) with associated stretch of the surrounding tissue (the temporary cavity). High velocity bullets result in much more tissue damage owing to blast effect to the surrounding tissue [(8)]. Iatrogenic trauma e.g renal biopsy can cause arteriovenous fistula by injuring an artery and a vein together creating an abnormal communication between them [(1)]. Traumatic renal injuries should be classified according to AAST (American Association for the Surgery of Trauma) organ injury severity scale [(8)].

Grade	Type	Description
I	Contusion	Microscopic or gross hematuria.
	Hematoma	Subcapsular , non-expanding with no parecnhymal laceration .
II	Hematoma	Non expanding peri-renal hematoma
	Laceration	Less than 1 cm of parenchymal depth with no collecting system injury or urine extravasation .
III	Laceration	More than 1 cm of parenchymal depth with no collecting system injury or urine extravasation .
IV	Laceration	Parenchymal laceration involving renal cortex , medulla and reaching collecting system.
	Vascular	Main renal artery or vein injury.
V	Laceration	Complete shattered kidney.
	Laceration	Avulsion of renal hilum with subsequent devascularization of the kidney
Advance grade by one for bilateral injuries up to grade III.		

Diagnosis of Renal Vascular injuries

Clinical presentation

In patients with abdominal trauma, the most common presenting sign is hematuria, but the amount of bleeding is a poor indicator to the severity of trauma. Patients with arterio-venous fistula often present with hematuria, hypertension, abdominal bruit, renal insufficiency and high output cardiac failure while those with pseudo-aneurysm are asymptomatic most of the time because most pseudo-aneurysms are small and spontaneously thrombose. Large pseudo-aneurysms are symptomatic and may present with flank pain, pulsatile mass in the loin, hemorrhage due to rupture or renal insufficiency 2ry to compression of artery branches [(9)].

Most cases of vascular injuries post nephrostomy tube placement or renal biopsy heal spontaneously without treatment, however if hematuria persist longer than 3 days further investigations are done [(1)].

Imaging Diagnosis of Renal vascular injuries

Abdominal ultrasound (US) and computed tomography (CT) scan are usually the first imaging modalities in the evaluation of patients with suspected renal vascular injuries. CT scan provides information similar to that of renal US yet with more detail owing to its high spatial resolution [(1)].

The advantage of computed tomography and magnetic resonance imaging over US is the ability to provide a more comprehensive assessment of the renal vascular anatomy with multiplanar imaging and reconstruction, which is non-operator dependent [(1)].

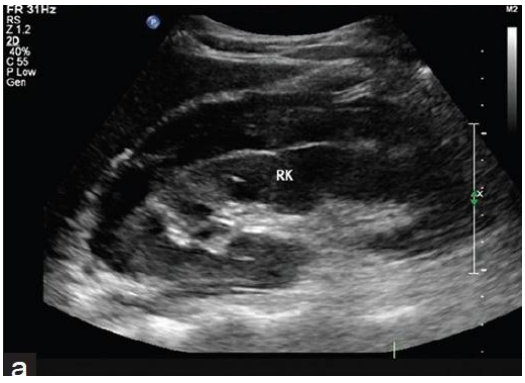

Fig.2 Right renal perinephric hematoma shown on US as variable sized hypoechoic fluid collection surrounding part or all of the kidney (Quoted from Qu and Hu) [(10)]

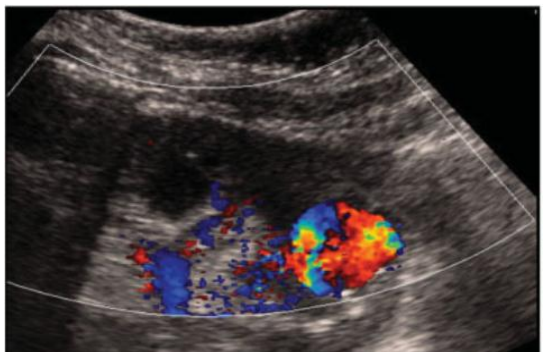

Fig.3 Pseudo-aneurysm on US appear as focal dilatation of the renal artery or one of its branches, with a yin-yang (Quoted from Sauk and Zuckerman) [(9)].

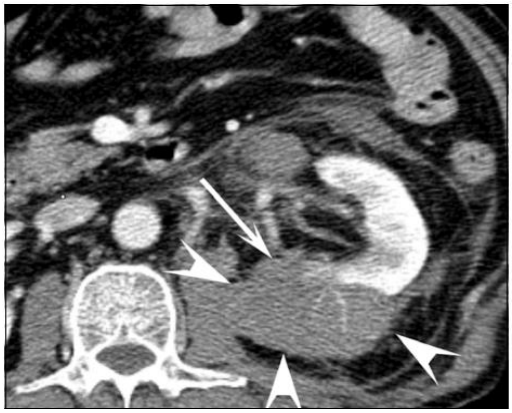

Fig.4 CT Grade II renal injury. Contrast enhanced CT study at corticomedullary phase showing cortical laceration (arrow) along with perinephric hematoma (arrowhead) (Quoted form **Park et al.**)[11]

Fig 5 Renal angiogram shows an arteriovenous fistula. The arrowhead points to venous filling extending towards the IVC during the arterial phase as the parenchyma are just beginning to enhance (Quoted from Schwartz et al.) [13].

Fig 6 Left renal arteriogram showing a lower polar lobular pseudoaneurysm appearing as localized segment of arterial dilatation (Quoted from Sauk and Zuckerman) [9] .

Fig 7 Renal angiogram showing active bleeding from an interlobar artery of the left kidney (Quoted Muller and Rouvière) [1] .

Renal angiography still remains the gold standard in imaging of renal vasculature, however it is rarely performed solely in a diagnostic context due to its invasive nature so. It is reserved mainly to cases aimed with therapeutic goal in mind or in cases with query diagnosis [12].

Technique of renal artery Embolization

The technique of trans-catheter renal artery embolization is usually straight forward. The renal artery is catheterized using a femoral approach. A 6 French (6F) vascular sheath is placed in the desired vein using modified Sledinger technique and a 4 or 5 F C2 Cobra catheter is inserted in renal artery directly or after doing flush aortography to reveal the origin of the renal vein in difficult cases. Super-selection of the targeted vascular lesion can be achieved using micro catheters [1].

The vascular lesion is then embolized using different embolic agents, each suited to a different type of vascular pathology where vascular coils are used in pseudoaneurysms and in proximal occlusion of extravasating arteries as well as AV fistulae at the arterial side. Permanent particles (PVA) are used to embolize vascular lesions with multiple collateral arterioles and vascular beds especially with tumors. Gelatin sponge "Gel Foam" pledges are used with small temporary iatrogenic bleeders, it also can be used when other agents are not available and on emergency basis [1].

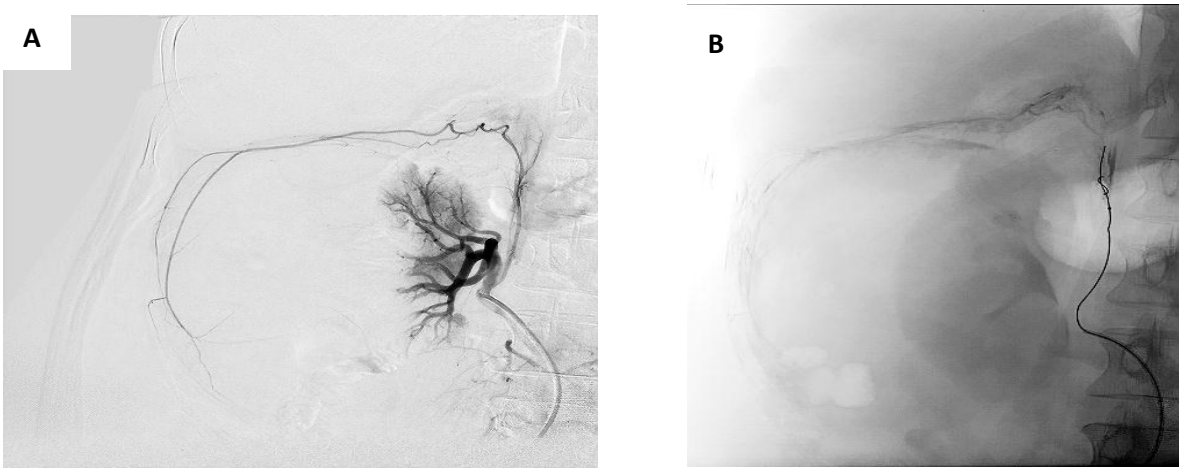

Fig. 8 : A case Done at interventional radiology unit Ain Shams University.
A Digital subtraction angiography of right renal artery revealing capsular artery bleeder.
B Control angiography after micro coil insertion.

COMPLICATIONS [9]

- Venous puncture related e.g. Hematoma at the puncture site.
- Post embolization syndrome is the most common adverse effect with an incidence of more than 90% of patients. Usually present by variable degrees of loin pain, nausea, vomiting, fever, paralytic ileus for 1-3 days following the procedure. Symptoms are relieved by conservative treatment.
- Hematuria. Moderate hematuria may occur following procedure and usually resolves spontaneously within 1-2 days and is related to hemorrhagic infarction of part of the parenchyma.
- Non target embolization and Coil migration.
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CONCLUSION

Renal vascular injuries are common problem encountered in medical practice either iatrogenic or traumatic in origin and pose significant morbidity and mortality despite the kidney's relatively protected site within the retro-peritoneum. Surgical procedures mostly fail at repair of the vascular injury and usually end with nephrectomy carrying the risk of loss of renal function and high morbidity and mortality rates. RAE is an established alternative to surgical intervention with the main goal to preserve renal tissue as much as possible. Improvements in catheter and embolic agents have played a large role in the increasingly successful implementation and high technical success of RAE.

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