Endovascular Management of Various renal vascular pathologies

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Learning objectives

• To make the reader familiar with basic principle of endovascular renal intervention.
• To briefly discuss indications for various transarterial interventions.
• To attain confidence in optimum selection and execution of procedure.
Background

Percutaneous endovascular renal artery interventions are minimally invasive procedure and directed towards dealing with vascular narrowing or vascular pathologies needing embolization. Selection of the appropriate technique depends on nature of lesion(s) targeted which is best revealed by preprocedural imaging. The preprocedural imaging includes doppler, computed tomography and magnetic resonance imaging. Doppler is highly useful in emergency conditions. The cross sectional imaging answers many unrevealed characters of lesion left by ultrasound. Diagnostic arteriography remains the first step of every endovascular procedure.

For almost all endovascular intervention vascular access is achieved via transfemoral approach (usually right side; common femoral artery for arterial access and common femoral vein for venous access). It is followed by selective catheterization of renal artery with the preshaped catheter 4 French (F) or 5 French (F). We frequently use 5F renal double catheter for diagnostic mapping of renal artery and its distal branches.

For pathologies needing embolization, superselective catheterization is achieved with coaxial microcatheter system (usually 2.7F). The selection of embolic materials temporary (gel foam) or permanent (solid - PVA particle, coil or liquid - alcohol, endocryl) primarily depends upon the diagnostic arteriographic picture of lesion (location, parent vessel and dynamics of flow). Clinical aim of intervention (preoperative in RCC, palliative in end stage renal disease, therapeutic in actively bleeding vascular lesion) and operator experience keeping in view to preserve as much renal parenchyma as possible also guides the interventionist in optimum selection and end point of procedure. The most common side effect is post-embolization syndrome (nausea, vomiting, fever and abdominal pain). Superselective catheterization avoids another potential complication of non target embolization (1).

For pathologies leading to hemodynamically significant renal artery narrowing, the dilatation (angioplasty) is carried out with an appropriate sized balloon catheter (Usually 8 mm x 4 cm) over a stiff guidewire (usually 0.035 inch) after advancing it across the narrowed segment. The renal artery stenting is useful adjunctive to angioplasty in case of post angioplasty residual/recurrent stenosis, dissection and primarily in atherosclerotic / ostial narrowing.

There are no absolute primary contraindication to these procedures. Caution is taken with patient having renal dysfunction or with single kidney (1,2).
Findings and procedure details

We here briefly describe how the procedure is generally approached in different renal diseases at most of the institutes (after the extensive search on medline) and providing examples of cases treated at our institution.

Renal cell carcinoma: Renal cell carcinoma (RCC) is tenth most common cancer worldwide, accounting for about 2%-3% of all malignancies. Indication for embolization include preoperative devascularization to ease resection and decrease blood loss during its definitive surgery, palliative therapy in patients with unresectable tumor or who are not surgical candidates. The tumor vascular bed should be completely occluded. The vascular supply to tumor should be embolized as distal as possible to preserve as much normal renal parenchyma as possible and to provide optimum length of arterial stump during its follow up surgical ligature in resectable tumor [1,3-8] (Figure 1).

Renal Artery Stenosis - Renal artery stenosis (RAS) is the most common cause of secondary hypertension. The frequently encountered etiologies are atherosclerosis and fibromuscular dysplasia (FMD), along with non specific aorto-arteritis, radiation and trauma as other encountered factor [9]. Presently percutaneous transluminal renal angioplasty (PTRA) is considered the first line of treatment [10].

After advancement of balloon catheter (guided by radioopaque marker) across the narrowed arterial segment over stiff guidewire, balloon is inflated under fluoroscopic guidance. Post angioplasty less than 30% stenosis and pressure gradient less than 20 mm Hg is considered objective indicator of angioplasty success. Dissection (if encountered during angioplasty), significant residual stenosis or restenosis can be successfully treated with stenting. [9,11]. Angioplasty per se has been less successful in treating atherosclerotic narrowing and ostial lesion as compared to FMD and truncal lesion respectively (Figure 2).

Traumatic or iatrogenic injury related lesions:- The overall incidence of renal injury in patients with abdominal trauma is 1.2% to 3.25%. The potential of arterial injury is very high in penetrating injury like gunshot, stab, biopsy and nephrostomy [12-14]. The spectrum of vascular injury comprises of arteriovenous fistula (AVF), pseudoaneurysm, dissection, thrombosis and tear. Criteria for embolization are post traumatic hematuria, dropping hematocrit and/or large intra/perirenal hematoma, extravasation, pseudoaneurysm and arterio-venous fistula (AVF) on CT. DSA is performed in multiple projection to pinpoint the exact source of bleeding and to plan a route [15]. Superselective catheterization (frequently with coaxial microcatheter system) is essential to reduce degree of renal infarction and non target embolization (Figure 3,4).
Fistula and aneurysm of non traumatic origin (as in congenital AVF, pseudoaneurysm in angiomyolipoma) are dealt in the similar way [9,16].

**End Stage Renal Disease (ESRD):** Indication for embolization in end stage renal disease as an alternative to surgery are uncontrolled hypertension even with 4 drug treatment regime, nephrotic syndrome, irreversibly rejected renal allograft and end stage hydronephrosis with moderate hypertension, pain and recurrent urinary tract infection (Figure 1). There must be no viable parenchyma as it would compromise the result, and particularly with regard to arterial hypertension. Ethanol with or without lipiodol is most frequently employed embolizing agent under antibiotic cover using a balloon occlusion catheter to prevent reflux and subsequent non target embolization [17].
Fig. 1: Figure 1. Incidental detection of renal cell carcinoma in 64 year old male patient presenting with chronic debilitating loin pain and uncontrolled hematuria. A,B: CT showing grossly hydronephrotic left kidney with exophytic heterogenously enhancing solid tumor (arrow). C-D: Selective renal arteriogram: depicting vascular tumor blush (single arrow) in perihilar region of left kidney with faint enlarged parenchymal blush (double arrow) indicating renomeagly due to hydrenephrosis as seen on CT. E,F: Embolization of distal most main renal artery using radiopaque n- Butyl cyanoacrylate/Lipiodol mixture (1:3) was carried out achieving almost complete obliteration of tumoral bed and parenchymal blush leaving optimum length of main renal artery pedicle for its ligature during follow up surgery. The glue cast (curved arrow) in occluded vessel is well appreciated.

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**Fig. 2:** Figure 2: Failure of percutaneous angioplasty at renal artery ostial narrowing. A-C: Mid aortic narrowing with tight ostial stenosis at left renal artery origin (arrow in A). Angioplasty was attempted with 8 mm x 4 cm balloon catheter (curved arrow in B). The radiopaque marker (as seen in B) at both ends of inflated balloon guides in positioning of the balloon. Post dilatation significant residual stenosis at left renal artery origin noted (double arrow in C).

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**Fig. 3:** Figure 3: Post renal biopsy persistent hematuria in 38 year old male patient: A: Arteriography: Diagnostic run depicting small AVF at lower pole of left kidney (single arrow) with early venous drainage (double arrow). B: Superselective transcatheter embolization of the AVF deploying microcoil (curved arrow) through coaxial microcatheter assembly.

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Fig. 4: Emergency embolization of post partial nephrectomy pseudoaneurysm in 22 year old female presenting with hematuria: A-C: Ultrasound of right kidney showing well defined anechoic lesion (arrow in A) at upper pole (A) with mixed colour filling on colour Doppler (arrow in B) and Yin Yang pattern (arrow in C) in spectral analysis.

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Conclusion

The endovascular treatment provides good alternative to more traditional mode of treatment in diverse renal conditions. The commonly performed procedures include transarterial embolization, renal artery angioplasty and stenting. Being the less invasive nature as compared to surgery, endovascular intervention patient has less morbidity and shorter hospital stay. It is safe in hands of experienced vascular interventionist as long as the patients are appropriately selected, nature of primary disease is well elucidated beforehand (with help of diagnostic imaging) and basic principles of intervention technique are strictly followed.
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