



THE ROLE OF INTERVENTIONAL RADIOLOGISTS IN THE TREATMENT OF COMPLICATIONS IN UROLOGIC PATIENTS

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SUMMARY – Higher turnaround of urologic patients in the tertiary clinical center can lead to more accompanying complications, ranging from 1% to 55% for various procedures, with the incidence of vascular injuries varying from 0.43% up to 9.5%. In patients with impaired renal function, it is imperative to prevent the loss of normal kidney function and potential hemodialysis. Being minimally invasive, endovascular procedures such as renal artery embolization (RAE) can treat major and life-threatening complications, but good and prompt communication between urologists and interventional radiologist is necessary for fast and effective treatment. Absolute contraindications for RAE are the presence of acute infection and previously known anaphylactic reaction to the iodine contrast media, while previous mild or moderate allergic reactions to iodine contrast media are not contraindications for RAE. Currently used embolic agents can be divided into temporary and permanent embolization agents. While the temporary embolization agent available is a gelatin sponge that could be used as complementary material or stand-alone, for permanent embolization interventional radiologists use microparticles, microspheres, liquid embolic agents, coils, and microcoils. RAE procedures are considered to be safe with a low incidence of complications, with non-target embolization being the most serious one. Postembolization syndrome is considered to be the most common adverse effect and it involves around 90% of patients. The overall results show that RAE is a safe, minimally invasive procedure that can effectively treat significant complications caused by other urologic procedures, with the reported success rates of 87%-100%.

Key words: Urologic procedures, complications; Iatrogenic kidney injuries; Endovascular procedures; Renal artery embolization

Introduction

Managing the higher number of urologic patients in a tertiary clinical center can lead to a higher number of accompanying complications. Minimally inva-

sive diagnostic procedures such as biopsies of renal masses and percutaneous nephrostomy placement, as well as invasive procedures such as partial or radical nephrectomies can cause complications with a variety of symptoms, ranging from mild to severe cases of rapid patient deterioration or even death¹⁻¹⁰. The reported incidence of such adverse events varies from 1% to 55% for different procedures^{3,4,6,7,11}. The incidence of vascular injuries including retroperitoneal hemorrhage, formation of pseudoaneurysm and arteriovenous fistulas

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also varies among reports, ranging from 0.43% up to 9.5%^{1,3-9,11}. Although rare, there are several reports of spontaneous perirenal (retroperitoneal) hemorrhage related to benign and malignant renal tumors such as angiomyolipomas or renal cell carcinomas^{9,12}.

Urology patients often have impaired renal function, and some patients have solitary kidneys^{10,13}. In those groups of patients, it is imperative to prevent the loss of normal kidney function and potential hemodialysis. With minimally invasive, endovascular procedures such as renal artery embolization (RAE) it is possible to treat major and life-threatening complications like active retroperitoneal hemorrhage, and clinicians, especially urologists, should be familiar with the possibilities offered by interventional radiology. Good and prompt communication between urologists and interventional radiologists is necessary for fast and effective treatment.

Technique

Embolization of the renal artery could be total or selective. Total embolization of the renal artery is usually reserved for the cases of total devascularization such as grade 5 renal trauma (shattered kidney), palliative treatment for nonsurgical candidates with renal cell carcinoma, etc. Selective RAE is reserved for all other cases when preservation of the healthy and functional renal tissue is desired, as in post-interventional complications resulting in hemorrhage.

Absolute contraindications for RAE are the presence of acute infection to prevent superimposed infection of the devascularized tissue and previous known anaphylactic reaction to the organic part of the molecule in iodine contrast media. In those cases, surgery should be the treatment of choice. Previous mild or moderate allergic reactions to iodine contrast media are no contraindication for RAE if appropriate prophylactic therapy is administered prior to the procedure.

Before the RAE procedure, it is recommended to perform a multiphase computed tomography (CT) scan of the abdomen and by examining the arterial phase, interventional radiologists get an insight into the vascular bed anatomy and the origin of the contrast blood extravasation or the possible other associated pathology (pseudoaneurysm, arteriovenous fistula)^{1,14,15}.

In most cases, renal arteries (RA) originate at the level of the lower half of the TH12 to the L1-L2 ver-

tebra and exit the aorta at the right angle^{15,16}. Anatomy is variable and sometimes the origin of RA forms an acute angle with the aorta, and some patients have accessory and aberrant renal arteries the branches of which can also be the origin of retroperitoneal hemorrhage¹⁴⁻¹⁶. Awareness of these details is necessary for planning and better preparation for the procedure, including the choice of materials to be used.

The following laboratory parameters should be obtained: white blood cell count, hemoglobin, hematocrit, coagulation parameters, and creatinine or estimated glomerular filtration rate (eGFR)¹⁵. If there is a significant deviation from the reference values, it should be corrected, but the RAE procedure should not be delayed.

Antibiotic prophylaxis is applied to prevent infection of the infarcted renal tissue.

Renal artery embolization is performed under local anesthesia at the vascular access site. Mild or moderate sedation could be applied. The most common vascular access site is the common femoral artery (CFA), preferably right, but the contralateral side can also be used. If there is a severe atherosclerotic disease of the iliac arteries, such as occlusion of the vascular lumen, or there is an unfavorable angle of the renal artery origin, other access sites could be obtained such as the brachial or radial artery. Applying the modified Seldinger technique, a micropuncture needle is used for vessel puncture under ultrasound guidance. If there is no ultrasound machine available, vessel puncture could be performed using manual palpation of the CFA pulse or under the fluoroscopy guidance. A short, 4-6 F vascular access sheath or long 5-6 F guiding sheath could be placed at the puncture site for coaxial technique. Depending on the operator preferences, diagnostic aortography at the presumed level of the renal artery origin could be performed for artery visualization. If there is a CT angiography study performed before the RAE procedure and especially if the patient has already impaired renal function, diagnostic aortography could be omitted and immediate selective catheterization of the RAs could be performed. Newer angio-suites are equipped with software add-ons that can help navigate and selectively catheterize arterial branches, reducing the contrast burden on the kidney¹⁷. Depending on the angle of the renal artery origin, for horizontally directed renal arteries, pre-shaped end-hole catheters, perpendicular to the aortic wall such as the Cobra catheter could be used, as shown in Figure 1c. If the origin

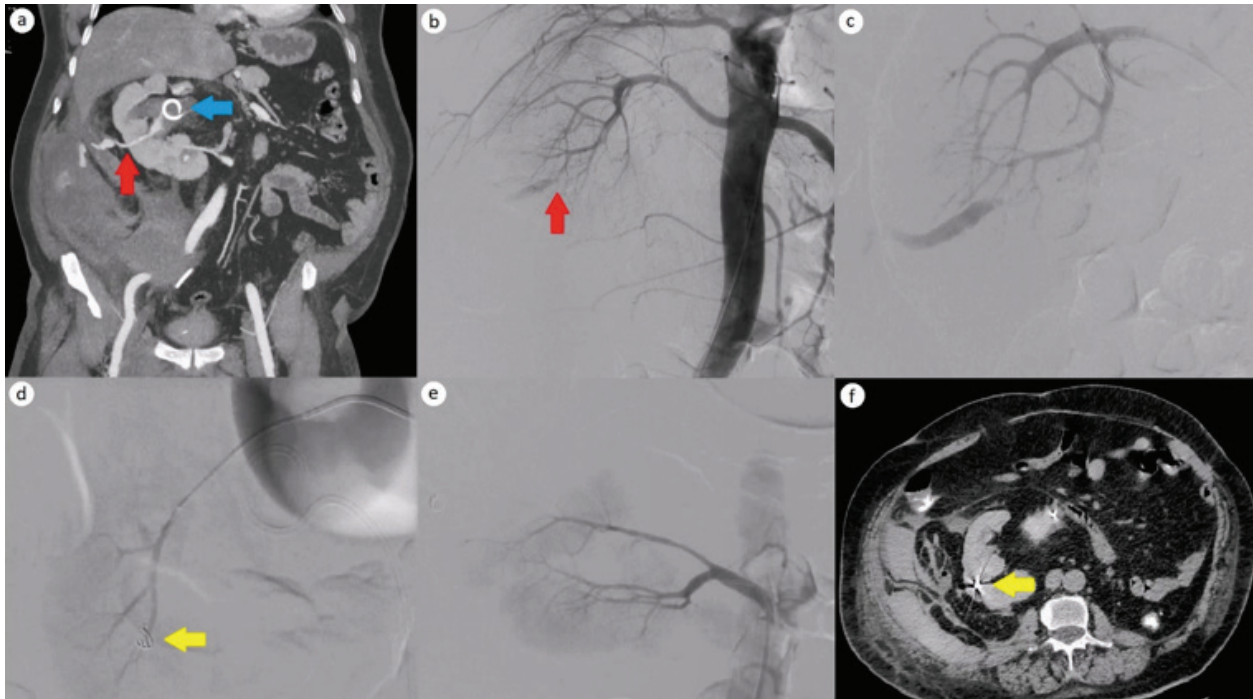


Fig. 1. (a) Maximum intensity projection coronal reconstruction of the computed tomography (CT) scan showing active contrast blood extravasation (red arrow) in an elderly patient after mini percutaneous nephrolithotomy of the right kidney; blue arrow shows the proximal end of the JJ stent; (b) digital subtraction angiography in the same patient showing active contrast extravasation from one of the arcuate arteries of the right kidney middle third (red arrow); (c) magnified view of the extravasation after selective catheterization of the right kidney segmental branch; (d) control angiogram with super-selective catheterization of the interlobar arteries after embolization with the pushable coil (yellow arrow) showing successful embolization without active bleeding; (e) selective catheterization and control angiogram of the aberrant right renal artery showing there is no additional vascular injury present; (f) control postcontrast CT scan showing metal coil in place (yellow arrow) and initial regression in the size of retroperitoneal hematoma; the patient was stable after the procedure and was soon discharged from the hospital.

of renal arteries has an acute angle to the aorta, and has a caudal direction, reversed directed tip catheters such as Simmons could be used for selective catheterization. For superselective catheterization of the segmental and interlobar arteries, coaxial technique with microcatheters and microguidewires are being used, as shown in Figure 1d.

Embolic agents used for RAE could be divided into two groups, i.e., agents that cause temporary embolization and agents used for permanent embolization. For temporary embolization, gelatin sponge (Gelfoam, Pharmacia and Upjohn Company LLC, Lake Forest, USA; Spongostan, Johnson & Johnson, New Brunswick, New Jersey, USA) is being used alone or as a complementary embolic material to other permanent embolic agents. Several types of embolic agents are

available for permanent embolization. Microparticles such as polyvinyl alcohol (PVA) particles have been widely used but their properties can be unpredictable¹⁴. Microspheres such as trisacryl-gelatin microspheres (Embosphere, Guerbet, Villepinte, France) produce better results than non-spherical PVA particles because they better adapt to vessel lumen as they come in different sizes. More recently, calibrated PVA-based microspheres have been developed. Because of their ease of use, microspheres have become the embolic agent of choice for selective embolization of the renal artery branches.

Besides microspheres, liquid embolic agents are available and include glue, such as N-2-cyanoacrylate (Histoacry, Aesculap Inc., Center Valley, USA; Glubran 2, GEM S.r.l., Viareggio, Italy), which are mixed

with iodized oil (Lipiodol, Guerbet, Villepinte, France) to become radio-opaque, and they polymerize when in contact with blood. Onyx (Medtronic plc, Dublin, Ireland) is another liquid agent composed of ethylene vinyl alcohol (EVOH) dissolved in dimethyl sulfoxide mixed with tantalum for radio-opacity. Liquid agents are suitable for embolization of arteriovenous fistulas, as opposed to microspheres, but their handling can be cumbersome.

Another type of embolic agents available for permanent embolization are coils and microcoils (Fig. 1d). They come in various diameters and lengths when formed that suit targeted vessel diameters. Coils can be pushable or detachable; the latter ones are being used when precision deployment is necessary.

Different embolic agents could be combined to achieve better ischemia.

Discussion and Conclusion

As in all medical branches, performing various invasive procedures on urologic patients could have serious complications. Managing them surgically, especially in patients with already impaired renal function, could lead to unnecessary loss of healthy renal tissue, leaving the patient hemodialysis dependent. RAE procedures are considered to be safe with a low incidence of complications, especially compared to surgical treatment^{14,18}. Complications may be associated with vessel access site and include hematoma or forming pseudoaneurysm due to inappropriate hemostasis, arteriovenous fistula, and occlusion of the vessel (thrombosis or dissection)¹⁹. The most serious complication is 'non-target' embolization due to migration of the embolic material like coils or reflux ('backflow') of the microspheres, which can cause ischemia to other tissues and organs or even pulmonary embolism.

Postembolization syndrome is considered to be the most common adverse effect and it affects around 90% of patients¹⁸. Patients often report mild flank pain, nausea, fever, vomiting, and have leukocytosis for several days after the procedure. Supportive care is needed, and symptoms are treated with analgesics, antipyretics, and antiemetics for a few days.

The overall results show that RAE is a safe minimally invasive procedure that can effectively treat major complications caused by other urologic procedures with reported success rates of 87%-100%^{1,10,13,18-20}. Having this in mind, referring clinicians, i.e., urologists, should undoubtedly consider RAE as the treat-

ment of choice when dealing with post-interventional vascular complications such as active bleeding, pseudoaneurysm, or arteriovenous fistulas.

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Sažetak

ULOGA INTERVENCIJSKOG RADIOLOGA U LIJEČENJU KOMPLIKACIJA UROLOŠKIH BOLESNIKA

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Veći broj liječenih uroloških bolesnika u tercijarnom kliničkom centru može dovesti i do većeg broja popratnih komplikacija, u rasponu od 1% do 55% za različite zahvate, s incidencijom vaskularnih ozljeda od 0,43% do 9,5%. U bolesnika s oštećenom funkcijom bubrega nužno je spriječiti gubitak zdravog parenhima bubrega i moguću hemodijalizu. Minimalno invazivni, endovaskularni zahvati poput embolizacije bubrežne arterije (*renal artery embolization*, RAE) mogu liječiti velike i za život opasne komplikacije, no za brzo i učinkovito liječenje neophodna je dobra i brza komunikacija između urologa i interventnog radiologa. Apsolutne kontraindikacije za RAE su prisutnost akutne infekcije i prethodno poznata anafilaksijska reakcija na jedna kontrastna sredstva, dok prethodne blage ili umjerene alergijske reakcije na jedna kontrastna sredstva nisu kontraindikacija za RAE. Sredstva za embolizaciju koja se rabe mogu se podijeliti na sredstva za privremenu i trajnu embolizaciju. Dok je dostupno sredstvo za privremenu embolizaciju želatinska spužva koja se može rabiti kao dodatni materijal ili samostalno, za trajnu embolizaciju interventni radiolozi upotrebljavaju mikročestice, mikrosfere, tekuća sredstva za emboliju, zavojnice i mikrozavojnice. Postupci RAE smatraju se sigurnima s niskom učestalošću komplikacija, pri čemu je *non-target* embolizacija najozbiljnija. Postembolizacijski sindrom se smatra najčešćom nuspojavom i pogađa oko 90% bolesnika. Ukupni rezultati pokazuju da je RAE siguran, minimalno invazivan postupak koji može učinkovito liječiti značajne komplikacije uzrokovane drugim urološkim zahvatima s prijavljenim stopama uspjeha u rasponu od 87% do 100%.

Ključne riječi: *Komplikacije uroloških zahvata; Jatrogene ozljede bubrega; Endovaskularni zahvati; Embolizacija bubrežne arterije*