Endovascular Urology Techniques

Editors:

Kyle D. Wood, MD

Authors:

Jonathan Fainberg, MD, MPH; Timothy McClure, MD

Last Updated:

Wednesday, March 8, 2023

Key Words:

Endovascular techniques; interventional radiology; embolization; interventional urology

Summary:

In this AUA University series, we present a review of endovascular Techniques utilized in the emerging field of Interventional Urology. We seek to educate the reader on the variety of disease processes that have overlap between urology and interventional radiology. We will review the diseases, the workup and treatments, with specific interest in the interventional procedures that treat these diseases. We discuss embolization and its utilities in the genitourinary tract, small renal mass diagnosis and management and varicocele embolization. By the end of this update, the reader should be familiar with basic endovascular techniques and have a broader understanding of the field of interventional urology.

1. Introduction

The overlap between interventional radiology (IR) and other surgical subspecialties continue to grow. Urology is no exception and in modern practice, many urologic diseases and malignancies are now treated in conjunction with a trained interventionalist. Still, many urologists are unfamiliar with the procedures done by IR or the data/techniques utilized. This review will outline a variety of urologic disease processes and the interventional techniques utilized to treat them.

2. Transcatheter Embolization

Transcatheter embolization is a minimally invasive procedure in which interventional radiologists access peripheral arteries under image guidance to selectively occlude the blood supply of target tissues. The first documented case of successful transcather arterial embolization was performed in 1970 at the Oregon Health Science Center in order to control upper gastrointestinal bleeding and since that time, a variety of endovascular techniques to treat an array of medical issues has become commonplace. While initially these endovascular techniques were used as a last resort to control bleeding, over the five decades since their initiation they have become guideline-based therapy in the diagnosis and treatment of an array of medical problems, across varying subspecialties.

Transcatheter embolization is a sterile procedure and is performed with the same precautions and sterile technique as any other operative procedure, which includes the use of pre-procedure antibiotic prophylaxis.[1] Continuous cardiac monitoring is required throughout the duration of the procedure, as well as intravenous access for the infusion of fluids and medication.[1] Patients can be placed under conscious sedation, monitored anesthesia care, or general anesthesia depending on the degree of invasiveness, duration of the procedure, and overall health of the patient.

While image guidance and medical devices have improved outcomes and enabled newer procedures, the basic technique utilized in the earliest descriptions is still the foundation of the current approach to all transcather arterial embolization. The first step in arterial embolization is obtaining vascular access, which is typically achieved via the femoral artery due to its location and caliber.[2] More recently, other arteries such as the radial artery are increasingly being used.[3] Currently, it is recommended that initial arterial access be obtained under ultrasound guidance.[3] After access has been obtained, digital subtraction angiography (DSA), a form of fluoroscopy, is performed to both confirm correct placement as well as to identify target arterial anatomy, anatomical variants, or sites of vascular injury.[2]

Once placement has been confirmed, a guidewire is utilized to reach the embolization target. The chosen embolization agent can then be delivered to the target and employed via various proprietary devices specific to the chosen embolic agent.

The choice of embolization agent is also an important point of consideration. Factors that determine which embolic agent is most appropriate include target vessel caliber, permanent vs temporary agent, and desire for target tissue death vs continued viability.[4] Temporary agents include: Gelfoam (PHARMACIA & Upjohn, Kalamazoo, MI) , collagen, and thrombin while permanent agents include drug eluting particles, embolic spheres, Polyvinyl Alcohol, coils, plugs, detachable balloons, and liquid agents, which include glue, Onyx and alcohol.[5] The smaller the particles of the agent are the more distally they embolize relative to where they are delivered, and as such, are more likely it is to cause tissue ischemia.[4] Particle or device size must be chosen appropriately to embolize the vessel which provides clinical improvement while minimizing unnecessary tissue ischemia.

At the end of any angiographic or embolization procedure, obtaining femoral artery hemostasis is mandatory and it typically accomplished by either applying manual pressure or using a vascular closure devise. This is followed by a period of bed rest, during which the puncture site is monitored for hematoma formation, in addition to standard postoperative measurements of intake and output, pain, and cardiac symptoms. [1] Vascular examinations of extremities distal to the access site should also be performed to confirm adequate perfusion.[1]

Transcatheter arterial embolization can be utilized to treat a number of disease entities including: aneurysm, pseudoaneurysm, arteriovenous fistula, arteriovenous malformation, hemangioma, acute/recurrent hemorrhage.[6] Within the field of urology, transcatheter arterial embolization may be utilized to perform renal artery embolization, varicocele embolization, penile embolization, pelvic embolization for bleeds, and prostate artery embolization.

3. Renal Trauma

Renal injury is a relatively common consequence of trauma (1-5%).[7] Blunt renal trauma is more common than penetrating renal trauma (65 versus 35%). Clinicians must be suspicious of renal trauma if a patient presents with an appropriate mechanism of injury, hemodynamic instability, and/or hematuria. In stable patients, renal injury can be diagnosed by cross sectional imaging. For unstable trauma patients who require immediate laparotomy, diagnosis of a renal injury is performed intraoperatively via direct exploration in the setting of an expanding retroperitoneal hematoma or via one-shot intravenous pyelography. While in an unstable patient immediate surgical exploration is mandated, in most hemodynamically stable patients management is typically supportive.

Selective embolization is indicated for renal injury or laceration when persistent bleed is suspected and confirmed on angiography. Angiography is indicated for continued bleeding in hemodynamically stable patients who require continual resuscitation or transfusion. If bleeding is diagnosed on angiography, it should be selectively embolized with permanent embolic agents such as coils or glue. Typically, these embolizations are successful at achieving hemostasis; however if unsuccessful the treatment is either repeat angiography and embolization or surgery. According to one retrospective analysis of a large trauma database, 78% and 83% of patients with grade IV and grade V renal lacerations respectively retained their kidneys.[8] However, 16.5% of patients who are managed nonoperatively with angiogram, with or without embolization, ultimately required surgical intervention. [9] Patients with renal injury treated with embolization should be monitored for continued signs of bleeding and should be resuscitated as needed. Renal

function should be monitored, and patients should be given appropriate follow up with a nephrologist if renal function is impaired. These patients also require repeat cross sectional imaging such as a contrast-enhanced CT.

4. Angiomyolipoma

Angiomyolipomas (AMLs) are benign highly vascular tumors which can be sporadic or associated with tuberous sclerosis complex (TSC). AMLs may be diagnosed with ultrasound, CT, or MRI. MRI is the study of choice for diagnosing lipid-poor AMLs. [10] Sporadic AMLs are twice as likely to be diagnosed in women and are associated with hemorrhage (0.4%). While benign, these tumors tend to grow over time and as they grow the risk of spontaneous hemorrhage rises. Classically, AMLs are observed until they reach 4 cm in size or greater based on retrospective data which suggests that the likelihood of hemorrhage is higher in lesions greater than 4 cm. The rationale being that 64-74% of hemorrhages present in patients with an AML larger than 6 cm, 17-26% between 4-6 cm, and 9% < 4 cm.[11] Patients with sporadic AMLs may benefit from active surveillance, which can avoid treatment in up to 65% of patients. [12] Patients with AMLs smaller than 4 cm may be observed unless symptomatic. [13] AML size > 5 cm was associated with hemorrhage retrospectively and is therefore an indication for prophylactic embolization. [14] However, there is no level 1 data for prophylactic embolization for AMLs and therefore treatment decisions related to sporadic AMLs are largely determined by patient and provider preference and judgement.

The mainstay of treatment of sporadic AML in both prophylactic and acute hemorrhagic setting is selective embolization. Evidence supports the use of an mTOR inhibitor to reduce the size of the AML in patients with TSC however once the mTOR inhibitor is discontinued the AMLs will regrow. The literature on various embolization materials for AML embolization remains unclear. A meta-analysis published in 2015 found that 50% of patients with AML > 8 cm and 25% with AML < 8 cm required retreatment after embolization at 5 years follow up. In another meta-analysis in 2019 of 30 studies including 653 patients treated with selective embolization 32% were treated urgently for hemorrhage and the rest were elective. They found that here was no change in renal function after treatment based on creatinine and eGFR. Major complications occurred in 4.4%, including renal abscesses, femoral artery pseudoaneurysms, urinary tract infections, renal insufficiency, acute respiratory distress, and pleural effusions. There was one mortality attributed to treatment. The average decline in tumor size was 32%, though 11% of patients had no change or an increase in tumor size on follow up.[15] Urbano et al. in 2017 published a series of 22 consecutive patients (37% urgent and 63% elective) with symptomatic AMLs or AMLs larger than 4 cm with 6% ethylene vinyl alcohol and found that, at a median follow up of 37.5 months, 18.5% percent of patients had experienced post-embolization syndrome and that masses had shrunk on average 45.7%.[15] Minor complications occurred in 7-11% and no major complications (including change in renal function or rebleeding) occurred in this setting. [15] Recent reports suggest embolization of AMLs is possible using radial access. [16-17]

5. Renal Artery Pseudoaneurysm

Renal artery pseudoaneurysms can be a devastating problem post procedure and patients can present with hemorrhage (with or without shock), flank pain, or a pulsatile mass. These pseudoaneurysms typically occur after an intervention such as a renal biopsy, partial nephrectomy, percutaneous nephrolithotomy (in approximately 0.3-1.4% of interventions), or damage to the kidney from renal trauma.[18] Early diagnosis is crucial and is typically made on cross sectional imaging. First-line management is selective embolization with coils rather than foam to avoid passage into the venous circulation.[19]

6. Renal Arteriovenous Fistula

Much like a pseudoaneurysm, renal arteriovenous fistulae (AVF) typically result from operative interventions or trauma. Presenting signs include hematuria, renal failure or high output heart failure, and abdominal bruit. First line management is selective embolization with coils rather than foam, as with renal artery pseudoaneurysm, to avoid passage into the venous circulation.[19]

7. Renal Artery Aneurysm.

Renal artery aneurysm is a rare condition, affecting approximately 0.1% of the general population. As expected, this number rises when analyzing patients getting angiography for other reasons.[20] Patients typically present in the sixth decade with variable symptoms; most patients have hypertension, but can also have renal insufficiency, renal bruit, abdominal/flank pain, or an abdominal mass.[20] Typical indications for intervention are a renal artery aneurysm found in a woman of childbearing age (due to the risk of rupture with the hormonal changes of pregnany), a symptomatic aneurysm or an aneurysm greater than 2cm. This size cut-off was chosen as it corresponded to approximately 0.3% chance of rupture over 10 years[20-21] Repair can be either through an open approach or by transarterial intervention (i.e. coiling). In a recent meta-analysis, both had similar short-term and long-term mortality rates, but the open approach was associated with more cardiac (2.2% vs 0.6%, p = 0.001) and peripheral vascular complications (0.6% vs 0.0%, p=0.01). Although re-intervention rates were higher in the endovascular group this was not found to be statistically significant.[22] Endovascular repair, however, was associated with a coil migration rate of 29% (95% CI 4-71%) and a post-embolic syndrome rate of 9% (95% CI 9%-52%). [22]

8. Renal Cell Carcinoma

Background. Renal cell carcinoma (RCC) occurs in 74,000 men and women in the United States annually. [23] With the adoption of more widespread cross sectional imaging, an increasing proportion of these masses are being detected at earlier stages, with a shift towards T1a kidney lesions, also known as small renal masses (SRMs).[24] As such, management options have increased for these patients, including active surveillance and renal mass biopsy vs. ablation, in addition to the gold standard surgical treatment of partial and radical nephrectomy.[25] Treatment decisions are made based on variable such as tumor size and location, experience of the surgeon or interventionalist, and risk tolerance of the patient for repeat imaging examinations post-ablation.[26]

9. Renal Mass Biopsy

Renal mass biopsy (RMB) remains an underutilized tool in the armamentarium in the workup and treatment of SRMs. These masses range from oncocytoma (benign) to chromophobe and papillary type 1 (indolent) to clear cell, and papillary type 2 (aggressive). It is also known that the cancer biology changes based on the subtype of renal mass and currently the size of the mass is used as a correlate for malignancy: for renal cortical tumors less than 3 cm, 24% are benign tumors based on both historic nephrectomy data and more recent RMB studies.[27] While knowledge of histologic subtype may affect management considerations including when to proceed with surgery, RMB is not a traditional prerequisite to treatment, as it is in many other cancer subtypes. It has been suggested that only 7% of small renal masses undergo biopsy despite the high rate of specificity for diagnosing the histologic subtype.[28]

10. Preoperative Embolization prior to Nephrectomy

Performing radical nephrectomy for a large locally advanced tumor is a challenging operation, often with a difficult dissection, and an increased risk of bleeding. Providers may elect to embolize the kidney before radical nephrectomy in order to reduce the risk of bleeding and to allow surgeons to ligate the renal vein immediately upon identification rather than after identification and control of the renal artery. Alternatively, for patients with large unresectable symptomatic tumors, some patients may elect for palliative embolization of the renal artery to improve symptoms and quality of life.[29] The studies that are available are retrospective in nature, and have variable results regarding the benefit of embolization for preventing blood loss and complications in this setting.[30] Older studies have mixed outcomes in terms of survival.[31-32] In the largest comparison study, embolization was associated with increased blood loss and transfusion requirement. However, this study was not controlled, and the cohort that received embolization had higher stage of disease and greater anesthetic risk scores. [33] Consensus opinion suggests that the optimal timing of nephrectomy after embolization is 24-72 hours. [29] If preoperative embolization is attempted, access may be achieved via the femoral, radial, or brachial artery with a 5 or 6-French sheath; the renal artery is identified via angiography. Embolization may per performed with various materials including either permanent or temporary embolics. Patients may experience post embolization syndrome (pain, fever, nausea) [33] however other complications, such as bleeding, non-target embolization or contrast nephropathy, are rare.[29]

Palliative renal artery embolization is indicated in patients with hematuria or flank pain who have large, unresectable tumors. Multiple studies have shown that up to 75% of patients will experience an improvement in symptoms following embolization in this setting and that this effect can be potentiated by adding doxorubicin.[34,35]

11. Embolization/Ablation

Ablation of renal masses is considered a first line therapy for small renal masses with many studies demonstrating durable long term oncologic control. However, vascular supply surrounding the mass may create a heat sink which can be detrimental to the effectiveness of ablative techniques.[36] Selective embolization prior to ablation has the potential to counteract this effect while also providing larger margins and decreasing the risk of pre- or post-procedure bleeding.[19]

12. Prostate Artery Embolization

Transurethral resection of prostate (TURP) is one of the most commonly performed procedures by urologists and has become the gold standard therapy for benign prostatic hyperplasia (BPH) due to durable results with long-term follow-up.[24] More recently, the repertoire of BPH therapies has come to include novel minimally invasive surgical therapies (MIST) such as prostatic urethral lift (Urolift System), convective water vapor energy (Rezum), and aqua-ablation (AQUABEAM System).[25] One of the newer techniques in the armamentarium for a proceduralist in the treatment of BPH is the use of prostate artery embolization (PAE), which is performed by an interventional radiologist, often under local anesthesia and monitored anesthesia care (MAC) via common femoral artery access.

PAE was first reported for the treatment of BPH in 2010 and since that time has generated excitement within the IR and urology communities.[26] Prior to this, PAE had only been used in the treatment of refractory hematuria. In May of 2019, the Society of Interventional Radiology (SIR) officially released an updated position statement, reporting that current evidence is adequate to support the use of PAE for the treatment of BPH in appropriately selected patients.[37] In addition, the National Institute for Health and Care Excellence (NICE), located within the United Kingdom, has stated that there is enough evidence for the safety and efficacy of PAE in BPH.[28] In contrast, the American Urological Association (AUA), stated in the 2019 amendment to the 2018 BPH guidelines, that due to the heterogeneity within the available literature and concerns for procedural side effects, PAE should only be performed in the context of a clinical trial until more rigorously performed studies are available.[37]

The goal of PAE is to induce a decrease in prostate size through the use of superselective embolization and thus reduce symptoms associated with BPH. PAE is achieved via obtaining femoral artery access, performing selective catheterization of the bilateral prostatic arteries and embolizing with the injection of microspheres. In general, the most commonly utilized microcatheters range in size from 2.0 to 2.4 French. The two embolic agents approved by the Food and Drug Administration (FDA) are Embosphere and Embozene.[38,39]

Importantly, anatomical variants should be considered. Adjustments must be made depending on the location of the prostatic artery, which most commonly originates from the internal pudendal artery and the common gluteal-pudendal trunk, but may vary in its origin. In one study, two separate vascular pedicles were found in approximately one-fourth of pelvices.[40]

The entirety of the procedure can be performed under fluoroscopy and/or cone-beam computed tomography (CT) for additional delineation of vascular anatomy. Specific preoperative and peri-procedural practices differ between institutions. In general, perioperative antibiotics are administered, and patients are discharged on combination of steroids, non-steroidal anti-inflammatory drugs, and phenazopyridine for discomfort. Alpha-blockers and 5-alpha reductase inhibitors can be discontinued post-operatively and patients are seen in clinic to re-evaluate their symptoms and urinary parameters.

In general, the randomized-controlled trials included patients experiencing LUTS with prostate size no larger than 100 cm^3 and evidence of obstruction (eg. peak flow rate < 15 mL/seconds).[27] The first randomized controlled trial (N=114, 57 PAE, 57 TURP) found that TURP resulted in better functional outcomes at 1 and 3 months, but was then found equivalent to PAE at 12 and 24 months as measured by IPSS, quality of life (QOL), peak flow, and post-void residual (PVR).[41] The second, a prospective randomized controlled trial (N=30, 15 PAE, 15 TURP) demonstrated that TURP resulted in greater improvement of IPSS, QOL and peak flow rates when compared to PAE at 1 year. A second group of non-randomized patients (N=15) underwent a specialized proximal and distal embolization technique, which demonstrated equivalent IPSS improvement to the patients randomized to TURP (N=15) at 1 year.[42] Finally, the third randomized-controlled trial (N= 99, 51 PAE, 48 TURP) showed that at 3 month symptomatic scores (IPSS, QOL) frequency, and nocturia, were similar, but showed significantly greater improvement of peak flow and PVR in the TURP group.[43]

When evaluating sexual function using the International Index of Erectile Function score (IIEF-5), the included randomized-controlled trials and meta-analyses showed no significant change from baseline.[27] Cases of reduced ejaculation, but not retrograde ejaculation, were reported.[27] In the first two RCTs, no major complications were experienced within the PAE groups, and in the third trial, TURP was associated with twice as many adverse events as PAE, including greater blood loss, length of stay, and rate of bladder catheterization.[27] In the literature, PAE has been associated with postembolization syndrome (pelvic pain, dysuria, transient worsening LUTS), which often lasts approximately 1 week, and is treated only with symptomatic management.[44] More severe adverse events such as bladder necrosis, rectal ulcers, and ischemic balanitis have been reported, and are believed to be secondary due to technical error/aberrant embolization.[44]

PAE is a minimally invasive option for treating BPH, which may be a reasonable alternative for patients who are poor surgical candidates, want to avoid general anesthesia, and/or a transurethral approach. The AUA advises caution when interpreting the above data as the highest level presented data, the three randomized-controlled trials, have substantial heterogeneity between patient groups (I^2=90%), as well as significantly different duration of follow-up (12 weeks to 12 months to 2 years).[45] However, given the improvement in symptom scores, and limited incidence of major complications, it is necessary to conduct additional long-term randomized-controlled trials, which utilize standard inclusion/exclusion criteria.

13. Embolization for Refractory Hematuria

Transcatheter arterial embolization of bladder or prostate for intractable hematuria secondary to hemorrhagic cystitis, TURP, cancer, and/or coagulopathy has been reported in the setting of patients who do not improve with continuous bladder irrigation, fulguration, resuscitation and transfusions. The limited data available suggests success rate of 80 to 100% when used in this setting.[46,47,45,48] This appears to be a feasible strategy that can be added to the urologist's repertoire of procedures for hematuria management.

14. Embolization for Arterioureteral Fistula

While incredibly rare, areterioureteral fistulas (AUF) can be devastating, with a reported acute mortality of 2.1-7.7% in recent literature.[49,50] Common predisposing factors to development of an AUF are pelvic radiation, prior pelvic or vascular surgery, chemotherapy, and chronic indwelling ureteral stent.[49,50,51] All patients have presented with gross hematuria, with many others also experiencing flank pain, abdominal pain, or acute urinary retention.[49,50,51] A major risk factor development of an AUF is presence of a chronic ureteral stent and often the initial diagnosis of an AUF is made on routine stent exchange when pulsatile blood is visualized via the ureteral orifice. At such point, the stent should be replaced and interventional radiology contacted on an emergent basis. CT is not indicated as it has low sensitivity for AUFs (39.1% in one series) and the presence of which is often seen at the time of angiography with provocative maneuvers.[50] Treatment is either by placement of an endovascular stent graft, embolization of the fistula or an aneurysm if present, or both, with a technical success rate of 91.3%. In one small series, at a median follow up of 8 months only 7.5% of patients treated endovascularly had rebled.[49,50] While rare (15-17%), complications have included retroperitoneal abscess, stent thrombosis, urosepsis, and native artery thrombosis.[49,50]

15. Embolization of Penis

Priapism is a persistent penile erection lasting 4 hours or greater unrelated to sexual stimulation. The majority (>95%) of cases are low-flow priapism (LFP; i.e. ischemic or veno-occlusive priapism) while a smaller group are categorized as high-flow priapism (HFP; i.e. non-ischemic priapism). While not in the treatment algorhythm for LFP, arterial embolization is the intervention of choice in the treatment of HFP.[43,44] HFP is characterized by a pathological increase in arterial blood into the corpora cavernosa which escapes the veno-occlusive mechanism of the penis. Typically, HFP is caused by blunt perineal trauma and the development of an arteriocavernosal fistula (ACF).[43,45] The diagnosis of HFP is made based on history and physical exam, and can be supported by cavernosal blood gas.[43,44] Initial management of HFP is observation as up to 62% of cases will resolve spontaneously. However, in the case of no resolution, selective cavernosal artery embolization is the initial treatment of choice.[43,44] Prior to embolization, the penile vasculature is imaged to aid in planning. While penile doppler ultrasonography can be used to confirm the presence of an ACF (near 100% sensitivity), CT-angiography can show a characteristic “blush” at the location of the ACF and contrast-enhanced magnetic resonance angiography (MRA) may help in localization of the ACF.[52,48,49,50] MRA in particular can provide elevated detail of the segmental arteries. At the time of embolization, bilateral pudendal arteriography is performed to delineate the anatomy.[44] Success rates of superselective angioemolization for HFP are up to 89% in most series and nearly all have been successfully treated with 3 or less embolization sessions.[44,47,50,53] However, recurrence rates range from 30-40%, requiring re-embolization.[44,50,53] Severe complications (e.g. erectile dysfunction, gluteal ischemia, penile gangrene) are rare and mostly theoretical in the era of SSAE. In one series, 27% had bruising and slight pain at the needle insertion site and none experienced leg numbness, bleeding, claudication, or embolic symptoms.[54] 15-20% of patients have erectile dysfunction after SSAE, lower than the average 50-90% for surgical intervention, and many respond to oral PDE5-inhibitors.[45,53,54]

16. Varicocele Embolization:

A varicocele consists of abnormally dilated and tortuous vessels within the pampiniform plexus of the spermatic cord. Varicoceles are common, affecting approximately 15% of all men. This number rises to 35% of men treated for primary infertility and up to 80% of men with secondary infertility.[55] Varicocele also likely leads to a continued decline in testicular function including worsening semen parameters and possibly decreased serum testosterone. Conventional treatment is with inguinal or subinguinal varicocelectomy, with careful avoidance of the testicular artery. Laparoscopic varicocelectomy is also utilized to ligate the internal spermatic veins proximally.[56] Percutaneous embolization is the least invasive of the surgical options and can be performed under local sedation or MAC. Venography enables the precise identification of the internal spermatic veins in addition to any collateral blood supply and is typically accessed thru the right common femoral vein.[57] The choice of embolic agent is typically coils, vascular plugs or liquid embolic agent and depends on operator preference. Left sided varicocele is more common and easier to treat with success rates close to 100%. However, right sided varicocele proves much more difficult, with one study reporting failure rates as high as 49% for right sided varicoceles.[58] Regarding recurrence rates, the literature has a wide variation with postembolization recurrences ranging from 0-24%. This should be compared to the gold-standard microsurgical varicocelectomy which boasts lower recurrence rates, ranging from 0-3%. [59]

17. Conclusion

Endovascular techniques are increasingly being utilized in the treatment of urologic diseases. These range from arterial embolization to renal mass biopsy/ablation and many conditions in between. As the interdisciplinary field of interventional urology continues to grow, urologic diseases will increasingly be managed by both urologists and intervention radiologists. Arterial embolization can both complement and aid urologic interventions (i.e. renal embolization prior to radical nephrectomy or embolization/ablation of SRMs) or offer a minimally invasive method as an alternative to surgery (e.g. PAE, embolization for HFP, traumatic renal bleed, refractive hematuria, AUF, AML). While some techniques are currently only recommended by the AUA in the setting of a trial (i.e. PAE), many are well established. The increasing diffusion and efficacy of these interventions make it important for the practicing urologist to know their indications to allow for better patient counseling, and to accomplish an interdisciplinary approach to patient care.

18. Abbreviations:

ACF Arteriocavernosal fistula
AML Angiomyolipoma
AUA American Urologic Association
AUF Arterio-ureteral fistula
BPH Benign Prostatic Hyperplasia
DSA Digital subtraction angiography
HFP High flow priapism
IR Interventional radiology
NICE National Institute for Health and Care Excellence
MAC Monitored Anesthetia Care
PAE Prostate artery embolization
TSC Tuberous sclerosis complex

Videos

Endovascular Urology Techniques 2022 Video PPT

Presentations

Endovascular Urology Techniques Presentation 1

References

1 Spies JB, Bakal CW, Burke DR, et al: Standard for Diagnostic Arteriography in Adults. J. Vasc. Interv. Radiol. 1993; 4: 385–395.

2 Bauer JR and Ray CE: Transcatheter Arterial Embolization in the Trauma Patient: A Review. Semin. Interv. Radiol. 2004; 21: 11–22.

3 Anon: AIUM practice guideline for the use of ultrasound to guide vascular access procedures. J. Ultrasound Med. Off. J. Am. Inst. Ultrasound Med. 2013; 32: 191–215.

4 Lubarsky M, Ray CE and Funaki B: Embolization Agents—Which One Should Be Used When? Part 1: Large-Vessel Embolization. Semin. Interv. Radiol. 2009; 26: 352–357.

5 Vaidya S, Tozer KR and Chen J: An Overview of Embolic Agents. Semin. Interv. Radiol. 2008; 25: 204–215.

6 Drooz AT, Lewis CA, Allen TE, et al: Quality Improvement Guidelines for Percutaneous Transcatheter Embolization. J. Vasc. Interv. Radiol. 2003; 14: S237–S242.

7 Lee YJ, Oh SN, Rha SE, et al: Renal Trauma. Radiol. Clin. North Am. 2007; 45

8 ☆ Hotaling JM, Sorensen MD, Smith TG, et al: Analysis of diagnostic angiography and angioembolization in the acute management of renal trauma using a national data set. J. Urol. 2011; 185: 1316–1320.

9 Menaker J, Joseph B, Stein DM, et al: Angiointervention: high rates of failure following blunt renal injuries. World J. Surg. 2011; 35: 520–527.

10 Krueger DA, Northrup H and International Tuberous Sclerosis Complex Consensus Group: Tuberous sclerosis complex surveillance and management: recommendations of the 2012 International Tuberous Sclerosis Complex Consensus Conference. Pediatr. Neurol. 2013; 49: 255–265.

11 Kuusk T, Biancari F, Lane B, et al: Treatment of renal angiomyolipoma: pooled analysis of individual patient data. BMC Urol. 2015; 15: 123.

12 Ouzaid I, Autorino R, Fatica R, et al: Active surveillance for renal angiomyolipoma: outcomes and factors predictive of delayed intervention. BJU Int. 2014; 114: 412–417.

13 Ryan JW, Farrelly C and Geoghegan T: What Are the Indications for Prophylactic Embolization of Renal Angiomyolipomas? A Review of the Current Evidence in the Literature. Can. Assoc. Radiol. J. 2018; 69: 236–239.

14 Yamakado K, Tanaka N, Nakagawa T, et al: Renal angiomyolipoma: relationships between tumor size, aneurysm formation, and rupture. Radiology 2002; 225: 78–82.

15 Urbano J, Paul L, Cabrera M, et al: Elective and Emergency Renal Angiomyolipoma Embolization with Ethylene Vinyl Alcohol Copolymer: Feasibility and Initial Experience. J. Vasc. Interv. Radiol. JVIR 2017; 28: 832–839.

16 Scharf Z, Momah-Ukeh I and Kim AY: Trans-Radial Embolization of Bleeding Renal Angiomyolipoma in Pregnant 30-Year-Old Female - A Case Report. J. Radiol. Case Rep. 2019; 13: 34–42.

17 Matsumoto T, Hasebe T, Kamei S, et al: Snuff box radial access in transcatheter arterial embolization for unruptured renal angiomyolipoma. Minim. Invasive Ther. Allied Technol. MITAT Off. J. Soc. Minim. Invasive Ther. 2019: 1–6.

18 Inci K, Cil B, Yazici S, et al: Renal Artery Pseudoaneurysm: Complication of Minimally Invasive Kidney Surgery. J. Endourol. 2010; 24: 149–154.

19 Ramaswamy RS and Darcy MD: Arterial Embolization for the Treatment of Renal Masses and Traumatic Renal Injuries. Tech. Vasc. Interv. Radiol. 2016; 19: 203–210.

20 Coleman DM and Stanley JC: Renal artery aneurysms. J. Vasc. Surg. 2015; 62

21 Klausner JQ, Lawrence PF, Harlander-Locke MP, et al: The contemporary management of renal artery aneurysms. J. Vasc. Surg. 2015; 61: 978-984.e1.

22 Barrionuevo P, Malas MB, Nejim B, et al: A systematic review and meta-analysis of the management of visceral artery aneurysms. J. Vasc. Surg. 2019; 70: 1694–1699.

23 Siegel RL, Miller KD and Jemal A: Cancer statistics, 2019. CA. Cancer J. Clin. 2019; 69: 7–34.

24 Leão RR, Ahmad AE, Richard PO. Should small renal masses be biopsied? Curr Urol Rep. 2017;18:7

25 Richard PO, Jewett MAS, Bhatt JR, et al. Renal tumor biopsy for small renal masses: a single-center 13-year experience. Eur Urol. 2015;68:1007–1013

26 Lobo JM, Clements MB, Bitner DP, Mikula MD, Noona SW, Sultan MI, Cathro HP, Lambert DL, Schenkman NS, Krupski TL. Does renal mass biopsy influence multidisciplinary treatment recommendations? Scand J Urol. 2020 Feb;54(1):27-32.

27 Reich O, Gratzke C and Stief CG: Techniques and long-term results of surgical procedures for BPH. Eur Urol 2006; 49: 970–8; discussion 978.

28 Chung ASJ and Woo HH: Update on minimally invasive surgery and benign prostatic hyperplasia. Asian J Urol 2018; 5: 22–27.

29 Ramaswamy RS, Akinwande O and Tiwari T: Renal Embolization: Current Recommendations and Rationale for Clinical Practice. Curr. Urol. Rep. 2018; 19: 5.

30 Zargar H, Addison B, McCall J, et al: Renal artery embolization prior to nephrectomy for locally advanced renal cell carcinoma. ANZ J. Surg. 2014; 84: 564–567.

31 Zielinski H, Szmigielski S and Petrovich Z: Comparison of Preoperative Embolization Followed by Radical Nephrectomy with Radical Nephrectomy Alone for Renal Cell Carcinoma: Am. J. Clin. Oncol. Cancer Clin. Trials 2000; 23: 6–12.

32 May M, Brookman-Amissah S, Pflanz S, et al: Pre-operative renal arterial embolisation does not provide survival benefit in patients with radical nephrectomy for renal cell carcinoma. Br. J. Radiol. 2009; 82: 724–731.

33 Subramanian VS, Stephenson AJ, Goldfarb DA, et al: Utility of preoperative renal artery embolization for management of renal tumors with inferior vena caval thrombi. Urology 2009; 74: 154–159.

34 Onishi T, Oishi Y, Suzuki Y, et al: Prognostic evaluation of transcatheter arterial embolization for unresectable renal cell carcinoma with distant metastasis. BJU Int. 2001; 87: 312–315.

35 Karalli A, Ghaffarpour R, Axelsson R, et al: Transarterial Chemoembolization of Renal Cell Carcinoma: A Prospective Controlled Trial. J. Vasc. Interv. Radiol. 2017; 28: 1664–1672.

36 Goldberg SN, Hahn PF, Tanabe KK, et al: Percutaneous Radiofrequency Tissue Ablation: Does Perfusion-mediated Tissue Cooling Limit Coagulation Necrosis? J. Vasc. Interv. Radiol. 1998; 9: 101–111.

37 Carnevale FC, Antunes AA, da Motta Leal Filho JM, et al: Prostatic Artery Embolization as a Primary Treatment for Benign Prostatic Hyperplasia: Preliminary Results in Two Patients. Cardiovasc. Intervent. Radiol. 2010; 33: 355–361.

38 Herrera-Caceres JO, Finelli A, Jewett M. Renal tumor biopsy: indicators, technique, safety, accuracy results, and impact on treatment decision management. World J Urol. 2019;37:437–443

39 Tomaszewski JJ, Uzzo RG, Smaldone MC. Heterogeneity and renal mass biopsy: a review of its role and reliability. Cancer Biol Med. 2014;11:162–172

40 McWilliams JP, Bilhim TA, Carnevale FC, et al: Society of Interventional Radiology Multisociety Consensus Position Statement on Prostatic Artery Embolization for Treatment of Lower Urinary Tract Symptoms Attributed to Benign Prostatic Hyperplasia: From the Society of Interventional Radiology, the Cardiovascular and Interventional Radiological Society of Europe, Societe Francaise de Radiologie, and the British Society of Interventional Radiology: Endorsed by the Asia Pacific Society of Cardiovascular and Interventional Radiology, Canadian Association for Interventional Radiology, Chinese College of Interventionalists, Interventional Radiology Society of Australasia, Japanese Society of Interventional Radiology, and Korean Society of Interventional Radiology. J Vasc Interv Radiol 2019; 30: 627-637 e1.

41 Anon: NICE Guidance - Prostate artery embolisation for lower urinary tract symptoms caused by benign prostatic hyperplasia: (c) NICE (2018) Prostate artery embolisation for lower urinary tract symptoms caused by benign prostatic hyperplasia. BJU Int 2018; 122: 11–12.

42 ☆ Foster HE, Dahm P, Kohler TS, et al: Surgical Management of Lower Urinary Tract Symptoms Attributed to Benign Prostatic Hyperplasia: AUA Guideline Amendment 2019. J Urol 2019; 202: 592–598.

43 Food and Drug Administration: De Novo Classification Request for Embosphere Microspheres. 2016. Available at: https://www.accessdata.fda.gov/cdrh_docs/reviews/DEN160040.pdf, accessed November 10, 2019.

44 Boston Scientific: Embozene PAE Letter for Customers. 2018. Available at: https://www.bostonscientific.com/content/dam/bostonscientific/pi/portfolio-group/embolization/Microspheres/Embozene/Embozene-PAE-Indication-Letter-For-Customers-PI-546911-AA.pdf, accessed November 10, 2019.

45 Carnevale FC, Iscaife A, Yoshinaga EM, et al: Transurethral Resection of the Prostate (TURP) Versus Original and PErFecTED Prostate Artery Embolization (PAE) Due to Benign Prostatic Hyperplasia (BPH): Preliminary Results of a Single Center, Prospective, Urodynamic-Controlled Analysis. Cardiovasc. Intervent. Radiol. 2016; 39: 44–52.

46 Bilhim T, Pisco JM, Furtado A, et al: Prostatic arterial supply: demonstration by multirow detector angio CT and catheter angiography. Eur Radiol 2011; 21: 1119–26.

47 Gao Y, Huang Y, Zhang R, et al: Benign Prostatic Hyperplasia: Prostatic Arterial Embolization versus Transurethral Resection of the Prostate—A Prospective, Randomized, and Controlled Clinical Trial. Radiology 2013; 270: 920–928.

48 Abt D, Hechelhammer L, Müllhaupt G, et al: Comparison of prostatic artery embolisation (PAE) versus transurethral resection of the prostate (TURP) for benign prostatic hyperplasia: randomised, open label, non-inferiority trial. BMJ 2018; 361: k2338.

49 Moreira AM, de Assis AM, Carnevale FC, et al: A Review of Adverse Events Related to Prostatic Artery Embolization for Treatment of Bladder Outlet Obstruction Due to BPH. Cardiovasc Interv. Radiol 2017; 40: 1490–1500.

50 Loffroy R, Pottecher P, Cherblanc V, et al: Current role of transcatheter arterial embolization for bladder and prostate hemorrhage. Diagn Interv Imaging 2014; 95: 1027–34.

51 ☆ Delgal A, Cercueil JP, Koutlidis N, et al: Outcome of transcatheter arterial embolization for bladder and prostate hemorrhage. J Urol 2010; 183: 1947–53.

53 Liguori G, Amodeo A, Mucelli FP, et al: Intractable haematuria: long-term results after selective embolization of the internal iliac arteries. BJU Int 2010; 106: 500–3.

54 Subiela JD, Balla A, Bollo J, et al: Endovascular Management of Ureteroarterial Fistula: Single Institution Experience and Systematic Literature Review. Vasc. Endovascular Surg. 2018; 52: 275–286.

55 Halpern J, Mittal S, Pereira K, Bhatia S, Ramasamy R. Percutaneous embolization of varicocele: technique, indications, relative contraindications, and complications. Asian J Androl [serial online] 2016 [cited 2021 Sep 2];18:234-8.

56 Tanrikut C, McQuaid JW, Goldstein M. The impact of varicocele and varicocele repair on serum testosterone. Curr Opin Obstet Gynecol 2011; 23: 227-31.

57 Wadhwa V, Kashanian JA, Schiffman M, McClure TD. Varicocele Embolization: Patient Selection: Preprocedure Workup, and Technical Considerations. Semin Intervent Radiol. 2021 Jun;38(2):176-181. doi: 10.1055/s-0041-1727105. Epub 2021 Jun 3. PMID: 34108803; PMCID: PMC8175113.

58 Iaccarino V, Venetucci P. Interventional radiology of male varicocele: current status. Cardiovasc Intervent Radiol 2012; 35: 1263-80

59 Cayan S, Shavakhabov S, Kadioglu A. Treatment of palpable varicocele in infertile men: a meta-analysis to define the best technique. J Androl 2009; 30: 33-40.