Prostatic Artery Embolization for Benign Prostatic Hyperplasia: Patient Evaluation, Anatomy, and Technique for Successful Treatment

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Jeffrey S. Klein, MD  Hi. I’m Jeff Klein, Editor of RadioGraphics and today I am pleased to have with us Dr. Andrew Picel currently from the Stanford University Medical Center Department of Radiology, previously at the University of California, San Diego Department of Radiology who is first author of one of our featured papers in the current September 2019 issue of RadioGraphics. His paper is entitled “Essentials of Prostate Artery Embolization for Benign Prostatic Hyperplasia: Understanding Patient Evaluation, Anatomy, and Technique for Successful and Safe Outcomes.” Dr. Picel welcome to our first September 2019 author podcast.

Andrew C. Picel, MD  Thank you for the invitation. My coauthors and I appreciate the recognition and hope readers enjoy the paper and podcast.

JSK  Terrific. Thanks so much. So Andrew, your paper addresses the role of image guided arterial embolization of the prostate for BPH. Following an introduction to the topic your paper describes the evaluation of patients for possible prostate artery embolization which we’ll call PAE for short. Can you tell us how one identifies patients with true bladder outlet obstruction due to BPH for whom PAE might be an appropriate treatment option?

ACP  Well it’s important to note that patient evaluation and treatment should be multidisciplinary. All patients should be evaluated by a urologist or primary care who’s familiar with the evaluation and treatment of patients with PBH. A patient may present to interventional radiology from urology as an outpatient or inpatient consult in the standard workflow we’re familiar with, but with this procedure in particular patients tend to directly refer and present to IR. Patients may come to the office having previously undergone very little evaluation. In these cases it is important to have a urology colleague that you can refer to to assist with the workload. This is not to say we shouldn’t see the patients and participate in the evaluation, but BPH is a complex disease process and patient outcomes are optimized with a complete evaluation that requires the multidisciplinary approach. Interventional radiologists should however understand that urologic evaluation and the medical and surgical options for treatment. In general, the evaluation consists of symptom scores, the most commonly reported score is the International Prostate Symptom Score Score, but there are others. Prostate size measurement should be obtained with imaging, and the urine flow rate should be measured. A moderately elevated IPSS score of at least 13 and a prostate size of 40 mL or larger with a maximum urinary flow of less than 12 mL/s is typically recommended for treatment. The urologist will help determine if patients require additional evaluation to exclude those with lower urine tract symptoms from causes that may be other than the prostate.

JSK  Great. So Andrew what imaging is needed prior to anticipated treatment for BPH? Specifically, do all patients with BPH require cancer screening prior to treatment?

ACP  Well the imaging prior to treatment, the imaging requirements are changing as we become more experienced with the procedure. In general, operators should have an imaging measurement of prostate size. This is important to confirm that the prostate’s enlarged and to also provide a baseline that will later be used to measure the prostate size change after treatment. This can be a transrectal ultrasound measurement, a CT, or MR. When first performing the procedure it can be very helpful to obtain CT angiography before intervention. This allows identification of prostatic arteries which can be seen in greater than 90% of CT angiography cases. This helps operators learn where to look for the prostatic arteries and reduces fluoroscopy and procedure time during the actual intervention. As we gain more experience with the procedure, we’re finding that the pretreatment CTA may not be necessary and eliminating the study can save radiation dose and extra visits for patients. With modern angiography equipment cone-beam CT angiography can be performed at the time of intervention and provides a similar evaluation to the pretreatment CTA. For the cancer screening part, cancer screening is recommended prior to PAE. This is mostly because the effects of embolization of prostate cancer remain largely unknown as most of the studies are focused on patient cohorts without cancer. We do know that PAE alters the PSA levels and changes the cancer screening part, cancer screening is recommended prior to PAE. This is mostly because the effects of embolization of prostate cancer remain largely unknown as most of the studies are focused on patient cohorts without cancer. We do know that PAE alters the PSA levels and changes the therapy remains uncertain.

ACP  The therapy remains uncertain.

JSK  Great. So Dr. Picel the article reviews the treatment options for patients with symptomatic BPH including medical and surgical therapies. Focusing on standard and min-
The treatment of BPH is actually quite complex with multiple different treatment options. The best treatment often depends on the patient preference and the surgeon's experience as well. Treatment typically starts with medical therapy which consists of alpha blockers which decrease smooth muscle tone with medications such as tamsulosin and alfuzosin. There's then five alpha reductase inhibitors which decrease cell proliferation and decrease the prostate size by affecting testosterone conversion; and there's also PDE-5 inhibitors such as Cialis which also appear to have a positive effect on the lower urinary tract symptoms. In terms of surgery, TURP is the most commonly performed procedure and considered the surgical gold standard. It's done for prostates that are up to a maximum size of 80 to 100 mL. Larger prostates would typically undergo open prostatectomy when it's over 100, but that procedure is not really commonly performed anymore. There's also a large number of minimally invasive surgical therapies which are each designed and provide relief with a simpler procedure and fewer side-effects than TURP. There's really multiple different procedures and different versions of these procedures. The more common ones are the laser procedures such as HoLEP and some new procedures called UroLift and Rezum. The HoLEP procedure refers to laser enucleation of the prostate. It has shorter catheterization time and hospitalization than TURP and has fewer serious complications. And it can be performed on prostates that are larger than 100 mL. Most interventionalists performing PAE will likely be asked questions about the UroLift and Rezum as many patients are also considering these treatments. During UroLift the prostatic implants are placed through the urethra, hope that will open a channel in the prostate. That's a simple procedure that could be performed in the urologist's office. It's typically done for procedures less than 80 mL. That was originally contraindicated for patients with obstructing median lobes, but has since been approved for this indication. Not all urologists perform the procedure, however not all insurances will reimburse the procedure. Rezum is another new transurethral procedure that uses water vapor to thermal ablative and destroy hyperplastic tissue. It's also an office based procedure for prostates less than 80 mL in size.

Well thanks for that. So moving on to the main focus of your paper, let's discuss the use of PAE in this particular setting. The section on indications for embolization is accompanied by a flow chart which is Appendix B. We'll put that chart up as you review the process by which interventional radiology assesses patients for possible prostate artery embolization.

The indications for embolization are evolving as we learn more about the procedure. Initially operators may choose to treat patients that are more severely symptomatic and those with larger prostates. These are likely easier cases as the larger prostates have larger prostatic arteries. Others, and those with more experience, may start to treat more mild symptoms than smaller prostates. Successful outcomes have been shown with a range of prostate sizes and initial symptoms scores. It's generally agreed that prostate size should be greater than 40 mL and patients should have moderate to severe lower urinary tract symptoms. Initial trials are performed with an IPSS greater than or equal to 18 with a quality of life score of greater than or equal to 3, but now many operators are treating those with lower scores. So an IPSS greater than or equal to 13 or sometimes even less is acceptable if there's a strong suspicion that the bladder outlet obstruction is caused by an enlarged prostate. There should be evidence of decreased urinary flow. This is abbreviated as Qmax. So the maximal flow should be less than 12-15 mL/s. If there is concern for urethral stricture, then cystoscopy should be considered for further evaluation. This often determined by a urologist. If the urinary flow is not depressed, there should be suspicion that another process other than BPH is causing the symptoms. In this case, the urologist may recommend invasive urodynamics which can help confirm diagnosis. And as we previously discussed patients should be screened for prostate cancer. Again relying on the urologist for this evaluation, but in general when the PSA is greater than 2.5 this should raise some suspicion and consideration should be made for MRI or prostate biopsy.

So let's go on to discuss the internal iliac and prostatic arterial anatomy. We'll put up Figures 1A through C which is the Yamaki classification for internal iliac artery branching. We'll then have you review the variability of prostatic arterial origin which you illustrate in Figures 3 A through H. As you detail the prostatic arterial anatomy can you discuss one anatomic variant in particular which is the prostato-rectal tract and why this is important to recognize? This variant is shown in Figure 4 which we'll put up at the end of your discussion.

A detailed understanding of the pelvic arterial anatomy is needed to safely and effectively perform prostatic embolization. The internal iliac artery branching pattern is highly variable. There are several different classification schemes. The Yamaki classification provides a simple to understand scheme based on the three major branch vessels. The most common variation shown in Figure 1A, in this
configuration the internal iliac artery divides into this gluteal artery and a gluteal-pudendal trunk. These are the anterior and posterior divisions. The gluteal-pudendal trunk then divides into arterial pudendal artery and the inferior gluteal artery. It’s not important to really memorize all the different classifications and the different schemes, but more to identify the major branches in each case. The superior gluteal artery for example is often the larger branch exiting the greater sciatic foramen and supplying the musculature. And the inferior gluteal artery exits the inferior aspect of the sciatic foramen again to remaining muscular branches. While the internal pudendal artery seen adjacent to the inferior gluteal artery in the sciatic foramen has a characteristic of 90-degree curvature. So recognizing these patterns helps you identify these arteries both on the pre-procedure imaging and during the procedure itself. The prostatic arteries themselves are also highly variable in their size, appearance, and origin. Several radiographic and anatomic studies have described most common origins. There is some variability in the findings. The paper we highlighted by Assis et al evaluated 286 pelvic sides and classified the origins as following and showing in the figure. The most common, 31.1% of the time was an origin from the internal pudendal artery. Then the superior vesical artery and 28.7% and obturator artery at 18.9%. The gluteal-pudendal trunk occurred in 14.7%, and then there was a list of other less common origins. The prostate arteries themselves give off inferior vesicle arteries and then seminal vesicles arteries as they course towards the prostate they then typically terminate in two pedicles. There’s a superior pedicle, which is also called anterolateral pedicle based on the CT appearance. This supplies the central gland and is a primary target for embolization. The inferior pedicle also called posterolateral pedicle supplies the peripheral and the apex of the gland. Both divisions may supply the BPH nodules and should be embolized if it’s determined to be safe. And that is determined based on the anastomose and collaterals that are seen during the procedure. It’s important for anastomose to identify include the middle rectal artery and the accessory internal pudendal arteries. These are thought to be present in a large number of patients, likely at least 30 to 40% of cases. The middle rectal arteries can arise from the prostate artery itself and they kind of course in the posterior vertical orientation to supply the rectal wall. These vessels should be identified and avoided if possible. This may be done with microcatheter positioning. If a safe position cannot be obtained then the vessel itself may be selected and coil embolized to prevent from nontarget embolization which would itself result in ischemic rectitus and other complications. The accessory internal pudendal artery is the other vessel that’s frequently demonstrated and needs to be identified before embolization. These vessels communicate with distal internal pudendal artery to supply the penile arteries. Embolization of these vessels can result in severe complications and there are cases of penile pain and skin loons reported after prostatic embolization.

**JSK** Great. Now let’s talk about the PAE technique itself. You mentioned in the paper the use of cone-beam CT to obtain a pre-procedure prostatic arteriogram and then you detail the embolization technique itself. Can you discuss the perfected technique for delivering the embolization particles and the use of a balloon-occlusion catheter to prevent inadvertent non-target embolization? And we’ll show Figure 10 as you speak which illustrates this later concept.

**ACP** Yes the perfected technique was pioneered by Dr. Carnevale in Brazil. It stands for proximal embolization first then embolize distally. In this technique, the microcatheter is positioned in a safe area to treat, typically in the mid prostatic artery, and a slow embolization is performed with diluted small particles. This is done until near stasis is obtained in the vessel and at this point the microcatheter is advanced distally as far as possible towards the prostate. Embolization is then performed from the distal position and it’s been shown that with this technique 30 – 50% more embolic material can be given and Dr. Carnevale has demonstrated improved clinical outcomes compared to conventional technique. Another advanced technique you mentioned is the balloon-occlusion microcatheter technique. This is another tool that can potentially improve the embolization process. It’s a catheter with a small balloon that’s inflated before embolization. The catheter and the technique are still being investigated, but it’s thought that the catheter can reduce the risk of non-target embolization, allowing for more complete treatment that would improve outcomes and safety. The microcatheter is advanced into the prostatic artery, the balloon’s inflated, and then this balloon protects from reflux along the catheter to prevent particles from entering proximal non-target branches. But it’s also thought that the balloon has an effect distally in the prostatic arterial bed. Once the balloons are inflated, there’s decreased pressure distally and it’s thought that this decreased pressure could then reverse flow within small collateral arteries. So you get an effect where there’s reversed flow in small collaterals now coming towards the prostate. So it’s thought this may provide a second mechanism to prevent non-target embolization during treatment.

**JSK** Great. After discussion post-procedure MRI, the article provides and extensive discussion of the outcomes following PAE. Do you want to highlight any of the studies that have been published that look specifically at post PAE results?

**ACP** Sure. There’s several studies published within the past few years reporting good success after PAE with few complications. Very recently, a multi society consensus statement was published in JBIR. Authors concluded that PAE provides the least invasive procedure for LUTS with mean IPS improvement of 10.8 to 18 points and fewer than .5% have major complications. This paper concludes that evidence is adequate to support PAE as a clinical treatment option for lower urinary tract symptoms due to PBH in the appropriately selected patients. PAE is useful for large prostates and for patients with urinary retention who may not be surgical candidates. It’s also recommended for patients who wish to avoid surgery due to concern or worsening erectile and ejaculatory function after surgery. The paper also provides a comprehensive review of the published PAE literature and I refer listeners to this paper for more detail.
It provides several excellent tables comparing published results. In general, there’s three randomized controlled trials comparing PAE to TURP and six made analysis reporting the PAE outcomes. The results of over 2,000 patients have now been published in the literature. In general the randomized trials show improvement and symptom scores of both techniques and really not a significant difference in the scores themselves between the PAE and TURP groups. TURP does show greater improvements in peak urinary flow, but it comes with a greater rate of complications during the procedure. A more important comparison may be in the future maybe between PAE and minimally invasive surgical therapies as both offer outpatient treatments with shorter recoveries and fewer complications. Compared to these procedures, PAE is thought to be available to more patients as there’s no upper size, prostate size, for treatment. It’s thought that it likely has fewer complications due to not requiring bladder catheterization. But there’s still few studies currently that directly compare PAE to minimally invasive surgeries. And I think this is something that’s important to explain to patients. It’s also good to mention that PAE doesn’t limit treatment options, and after treatment with PAE or surgery, if symptoms recur patients still have the option of repeat procedures.

JSK  Terrific. So Andrew in the final section of the article, you discuss the building of a successful PAE practice. Any words of wisdom for our interventional radiologist out there who are listening and would like to consider offering this particular procedure and service at their institution?

ACP  Yes. I found the procedure is becoming a lot more common, but it’s still largely unknown to many referring physicians and even urologists. So it’s important to provide education to referring physicians. It’s also important to provide information directly to patients regarding the procedure and their treatment options. Collaboration should be sought out in urology as a multidisciplinary evaluation will be required to safely treat these patients. The procedure should be presented as an alternate treatment option for patients interested in minimally invasive therapies to offer treatment with fewer sexual side effects, reduced pain, and without hospitalization. I don’t think the procedure has to be presented as a research procedure at this time, but it’s still important to let patients know that it is a new alternative. It offers some benefits over traditional treatments, but the long term risks and the long term outcomes are still relatively unknown. But working together, a PAE program can increase the business to both the interventional radiology and urology clinics, and with easy access to information on the internet and social media, patients are learning more about their treatment options. They’re looking for those with less risk and they’re looking for programs that can discuss these procedures with them. Patients may present directly to IR clinics so this model allows us to market directly to patients as well. And I think once patients learn that your IR program is providing a comprehensive service including the option of surgical therapies and you demonstrate successful outcomes after PAE, I think you’ll find that patients begin to present directly to IR for evaluation and the service will quickly grow.

JSK  Well terrific. Dr. Andrew Picel, I want to thank you for taking the time today to discuss your paper on prostate artery embolization for benign prostatic hyperplasia which can be found in the current September 2019 issue of *RadioGraphics*. Andrew thanks so much for your time today.

ACP  Thank you.