American College of Radiology
ACR Appropriateness Criteria®

Clinical Condition: **Obstructive Voiding Symptoms Secondary to Prostate Disease**

Variant 1: **Normal renal function.**

Radiologic Procedure	Rating	Comments	RRL*
US pelvis (bladder and prostate) transabdominal	7	Postvoid to measure residual urine. If there is significant residual, evaluation of upper tracts is indicated. Gives estimate of prostate size.	None
US kidney retroperitoneal	3	Appropriateness rating could be higher if significant residual urine were present. Evaluate for hydronephrosis.	None
X-ray intravenous urography	3	Appropriateness rating could be higher if significant residual urine is present. In patients with stones, hematuria, or atypical history, the study may be warranted. CT urography has replaced IVU in some centers.	Med
MRI pelvis without and with contrast	2		None
X-ray voiding cystourethrography	2	Consider in men younger than 50 with symptoms.	Low
X-ray abdomen	2	Other imaging studies more useful.	Med
US pelvis (prostate) transrectal	2	Resistive indices (RI) have been shown to be elevated in BPH and to decrease after transurethral vaporization of the prostate, suggesting that RI can be used to evaluate severity of BPH and monitor therapy.	None
X-ray retrograde urethrography	2	Does not assess prostate size.	Med
CT abdomen and pelvis without and with contrast	1	Not indicated.	High
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Clinical Condition: **Obstructive Voiding Symptoms Secondary to Prostate Disease**

Variant 2: **Increased blood urea nitrogen (BUN) and/or creatinine. (Refer to ACR Appropriateness Criteria® for *Renal Failure*.)**

Radiologic Procedure	Rating	Comments	RRL*
US pelvis (bladder and prostate) transabdominal	8	To evaluate for residual urine and prostate size.	None
US kidney retroperitoneal	8	To evaluate for hydronephrosis.	None
X-ray abdomen	3	To exclude calculi. Can be used in association with US.	Med
US pelvis (prostate) transrectal	2	Can assess prostate size by transabdominal US. Resistive indices (RI) have been shown to be elevated in BPH and to decrease after transurethral vaporization of the prostate, suggesting that RI can be used to evaluate severity of BPH and to monitor therapy.	None
X-ray intravenous urography	2	Other studies better for evaluating same structures.	Med
X-ray retrograde urethrography	2	Does not assess prostate size.	Med
MRI pelvis without contrast	2		None
X-ray voiding cystourethrography	2	Consider in men younger than 50 with symptoms.	Low
CT abdomen and pelvis without contrast	1	Not indicated.	High
Rating Scale: **1=Least appropriate, 9=Most appropriate**			***Relative Radiation Level**

Expert Panel on Urologic Imaging: Edward I. Bluth, MD[1]; Isaac R. Francis, MD[2]; Deborah A. Baumgarten, MD[3]; William H. Bush, Jr., MD[4]; David D. Casalino, MD[5]; Nancy S. Curry, MD[6]; Gary M. Israel, MD[7]; S. Zafar H. Jafri, MD[8]; Akira Kawashima, MD[9]; Nicholas Papanicolaou, MD[10]; Erick M. Remer, MD[11]; Carl M. Sandler, MD[12]; David B. Spring, MD[13]; Pat Fulgham, MD.[14]

Summary of Literature Review

Obstructive voiding symptoms secondary to prostate disease include hesitancy, decreased force of stream, terminal dribbling, postvoid fullness, and double voiding [1,2]. Benign prostatic hypertrophy (BPH) is the most common cause of prostate enlargement requiring intervention. It is estimated that by 80 years of age, 75% of men have developed BPH [1]. It has been hypothesized that age related impairment of blood supply to the lower urinary tract is important in the development of BPH [3]. It has also been estimated that 10% of all males older than age 40 will have BPH requiring surgery before reaching age 80 [4]. Other causes of bladder outlet obstruction include urethral stricture, prostate cancer, bladder neck contracture, and neurogenic disease.

Numerous imaging studies have been used in evaluating patients with symptoms of bladder outlet obstruction. These include radiographs, intravenous pyelography (IVP), urethrography, both transabdominal and transrectal ultrasonography, computed tomography (CT), and magnetic resonance imaging (MRI) [1,4-21]. With the coming re-engineering of health care, selective use of these modalities will be required in order to decrease costs and practice efficient, effective medicine [16].

Radiography cannot be used to visualize the prostate directly. A distended bladder can be visualized as a pelvic mass, but unless information is available regarding when the patient last voided, this finding is of uncertain value. Prostatic calcifications can be visualized and always indicate glandular enlargement if they extend above the pubic symphysis [19]. Bladder calculi can also be easily identified. In patients with prostate cancer and bone metastases, radiographs are a valuable and inexpensive diagnostic tool. Eighty percent of bone metastases are osteoblastic, and mixed osteoblastic and osteolytic lesions are seen in another 15% of patients [19]. However, bone scintigraphy is far more sensitive in identifying bone metastases at an early stage [19].

The routine use of IVP is not recommended [5,7,10,16,19-22]. In patients who have stones on radiographs, hematuria, or an atypical history, however, IVP may be warranted [19,20]. There is no evidence that patients with BPH have a higher incidence of asymptomatic renal cancers than the general population in the same age group; therefore, an IVP to search for occult neoplasms is unwarranted [7,22]. In a prospective study of 502 patients, Wasserman et al [21] found benign renal cysts in 10%, renal cancers in less than 1%, and significant upper urinary tract obstruction in 2.6%. When patients have obstructive symptoms and renal insufficiency, ultrasound (US) rather than IVP is recommended to evaluate for hydronephrosis [19,22]. In patients with severe hydronephrosis, azotemia is almost always present, and US is indicated. In summary, while not routinely recommended, upper urinary tract imaging is indicated in patients with BPH and either hematuria (including asymptomatic microscopic), laboratory evidence of renal insufficiency, history of urinary tract infection, urolithiasis, previous urinary tract surgery, or congenital or acquired renal disease [22].

Retrograde urethrography is valuable to exclude urethral strictures but does not accurately assess the size of the prostate gland. As such, it is not part of the routine evaluation of patients with prostatism [19]. Voiding cystourethrography should be considered only for men younger than age 50 with outflow obstruction symptoms [19].

Sonography can be used to evaluate the prostate transabdominally (through a distended bladder) or transrectally (TRUS). TRUS is preferred by urologists [22]. The US pattern is still too nonspecific to differentiate benign from malignant prostate lesions. A particular problem is the difficulty in identifying isoechoic lesions. Recently the use of resistive index (RI) in prostate disease has been proposed as helpful. RI measured during TRUS has been found to be elevated in the transition zone of patients with BPH, but not in the peripheral or central zones and not in normal patients or those with prostate cancer [3]. RI has also been shown to decrease after transurethral vaporization of the prostate, suggesting that RI can be used to evaluate severity of BPH [23] and monitor the outcomes of therapy [24]. TRUS is, however, used to guide lesion-directed and systematic biopsies of the prostate [22]. It has been suggested that US contrast agents will make tumors more conspicuous, thus improving the detection rate of

[1]Principal Author, Ochsner Foundation Hospital, New Orleans, La; [2]Panel Chair, University of Michigan, Ann Arbor, Mich; [3]Emory University Hospital, Atlanta, Ga; [4]University of Washington Medical Center, Seattle, Wash; [5]Northwestern University, Chicago, Ill; [6]Medical University of South Carolina, Charleston, SC; [7]New York University Medical Center, New York, NY; [8]William Beaumont Hospital, Royal Oak, Mich; [9]Mayo Clinic, Rochester, Minn; [10]Hospital of University of Pennsylvania, Philadelphia, Pa; [11]Cleveland Clinic Foundation, Cleveland, Ohio; [12]UT MD Anderson Cancer Center, Houston, Texas; [13]Kaiser Permanente Medical Center, Oakland, Calif; [14]Urology Clinics of North America, Dallas, Texas, American Urological Association.

Reprint requests to: Department of Quality & Safety, American College of Radiology, 1891 Preston White Drive, Reston, VA 20191-4397.

malignancy in contrast-enhanced targeted cases compared to sextant cases [25]. Three-dimensional (3D) US may prove to be of value in the future [26].

Secondary changes of bladder outlet obstruction, such as bladder wall thickening, are better seen with US than IVP with [8]. The size of the enlarged prostate can be detected accurately by TRUS and MRI, but inaccuracies arise when using transabdominal US [8,14,22]. TRUS and MR imaging have an advantage in that the internal prostatic anatomy is better seen and the ratio of glandular to stromal tissue in the prostate can be determined, although to date this information has not proven clinically useful [22,27]. Identifying the size of the prostate is important since it helps determine the type of therapy indicated. Abdominal (suprapubic) US may be used to accurately (plus or minus 15%) measure residual urine volume in 90% of patients [6,11]. However, catheterization is probably the least expensive method to accurately assess residual urine in the bladder.

In patients with azotemia, the collecting system of the kidneys should be imaged for dilatation. In patients with normal renal function, this may not be necessary. However, in a study of 128 patients, de Lacey et al [10] reported that hydronephrosis can be present with normal biochemical results.

The Clinical Practice Guideline of the Agency for Health Care Policy and Research (AHCPR) states that imaging of the upper urinary tracts by US or IVP is "not recommended unless patients have one or more of the following: hematuria, urinary tract infection, renal insufficiency (excluding IVP), history of urolithiasis, or history of urinary tract surgery" [28].

CT has not proven to be of much value in evaluating the benign, enlarged prostate [18]. There are reports of the value of MRI in evaluating the prostate gland [13,17]. MRI is also useful in evaluating prostate size, although other less costly procedures, such as US, are preferred.

Summary

In summary, in patients who have normal renal function but suffer the symptoms of prostatism, a radiographic workup should be minimal. US is occasionally desirable for estimating prostate size prior to surgery. If azotemia is present, the upper urinary tracts should definitely be evaluated with US for the presence of hydronephrosis.

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document.

Relative Radiation Level Designations	
Relative Radiation Level	**Effective Dose Estimate Range**
None	0
Minimal	< 0.1 mSv
Low	0.1-1 mSv
Medium	1-10 mSv
High	10-100 mSv

References

1. O'Brien WM. Benign prostatic hypertrophy. *Am Fam Physician* 1991; 44(1):162-171.
2. Takeda M, Araki I, Kamiyama M, Takihana Y, Komuro M, Furuya Y. Diagnosis and treatment of voiding symptoms. *Urology* 2003; 62(5 Suppl 2):11-19.
3. Berger AP, Horninger W, Bektic J, et al. Vascular resistance in the prostate evaluated by colour Doppler ultrasonography: is benign prostatic hyperplasia a vascular disease? *BJU Int* 2006; 98(3):587-590.
4. Kuo HC, Chang SC, Hsu T. Predictive factors for successful surgical outcome of benign prostatic hypertrophy. *Eur Urol* 1993; 24(1):12-19.
5. Andersen JT, Jacobsen O, Standgaard L. The diagnostic value of intravenous pyelography in infravesical obstruction in males. *Scand J Urol Nephrol* 1977; 11(3):225-230.
6. Beacock CJ, Roberts EE, Rees RW, Buck AC. Ultrasound assessment of residual urine. A quantitative method. *Br J Urol* 1985; 57(4):410-413.
7. Brooks AP. Prostatism, intravenous urography and asymptomatic renal cancer. *Br J Urol* 1988; 62(1):1-3.
8. Cascione CJ, Bartone FF, Hussain MB. Transabdominal ultrasound versus excretory urography in preoperative evaluation of patients with prostatism. *J Urol* 1987; 137(5):883-885.
9. Chancellor MB, VanAppledorn CA. Value of transrectal prostate ultrasonography pre-transurethral prostatectomy in screening for occult prostate carcinoma. *Urology* 1993; 41(6):590-593.
10. de Lacey G, Johnson S, Mee D. Prostatism: how useful is routine imaging of the urinary tract? *Br Med J (Clin Res Ed)* 1988; 296(6627):965-967.
11. Griffiths CJ, Murray A, Ramsden PD. Accuracy and repeatability of bladder volume measurement using ultrasonic imaging. *J Urol* 1986; 136(4):808-812.
12. Henneberry M, Carter MF, Neiman HL. Estimation of prostatic size by suprapubic ultrasonography. *J Urol* 1979; 121(5):615-616.
13. Hricak H, Jeffrey RB, Dooms GC, Tanagho EA. Evaluation of prostate size: a comparison of ultrasound and magnetic resonance imaging. *Urol Radiol* 1987; 9(1):1-8.
14. Roehrborn CG, Chinn HK, Fulgham PF, Simpkins KL, Peters PC. The role of transabdominal ultrasound in the preoperative evaluation of patients with benign prostatic hypertrophy. *J Urol* 1986; 135(6):1190-1193.
15. Roehrborn CG, Peters PC. Can transabdominal ultrasound estimation of postvoiding residual (PVR) replace catheterization? *Urology* 1988; 31(5):445-449.
16. Sage WM, Kessler R, Sommers LS, Silverman JF. Physician-generated cost containment in transurethral prostatectomy. *J Urol* 1988; 140(2):311-315.
17. Schiebler ML, Tomaszewski JE, Bezzi M, et al. Prostatic carcinoma and benign prostatic hyperplasia: correlation of high-

resolution MR and histopathologic findings. *Radiology* 1989; 172(1):131-137.
18. Sukov RJ, Scardino PT, Sample WF, Winter J, Confer DJ. Computed tomography and transabdominal ultrasound in the evaluation of the prostate. *J Comput Assist Tomogr* 1977; 1(3):281-289.
19. Talner LB. Specific causes of obstruction. In: Pollack HM ed. Clinical urography. Philadelphia, Pa. *WB Saunders*; 990:chapter 56.
20. Talner LB. Routine urography in men with prostatism. *AJR* 1986; 147(5):960-961.
21. Wasserman NF, Lapointe S, Eckmann DR, Rosel PR. Assessment of prostatism: role of intravenous urography. *Radiology* 1987; 165(3):831-835.
22. Grossfeld GD, Coakley FV. Benign prostatic hyperplasia: clinical overview and value of diagnostic imaging. *Radiol Clin North Am* 2000; 38(1):31-47.
23. Tsuru N, Kurita Y, Suzuki K, Fujita K. Resistance index in benign prostatic hyperplasia using power Doppler imaging and clinical outcomes after transurethral vaporization of the prostate. *Int J Urol* 2005; 12(3):264-269.
24. Amiel GE, Slawin KM. Newer modalities of ultrasound imaging and treatment of the prostate. *Urol Clin North Am* 2006; 33(3):329-337.
25. Halpern EJ, Ramey JR, Strup SE, Frauscher F, McCue P, Gomella LG. Detection of prostate carcinoma with contrast-enhanced sonography using intermittent harmonic imaging. *Cancer* 2005; 104(11):2373-2383.
26. Hamper UM, Trapanotto V, DeJong MR, Sheth S, Caskey CI. Three-dimensional US of the prostate: early experience. *Radiology* 1999; 212(3):719-723.
27. Liney GP, Turnbull LW, Knowles AJ. In vivo magnetic resonance spectroscopy and dynamic contrast enhanced imaging of the prostate gland. *NMR Biomed* 1999; 12(1):39-44.
28. McConnell JD, Barry MJ, Bruskewitz RC. Benign prostatic hyperplasia: diagnosis and treatment. Agency for Health Care Policy and Research. *Clin Pract Guidel Quick Ref Guide Clin* 1994; (8):1-17.