American College of Radiology
ACR Appropriateness Criteria®

Clinical Condition: **Suspected Lower Urinary Tract Trauma**

Variant 1: **Penetrating trauma, lower abdomen/pelvis.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray retrograde cystography	8		☢ ☢ ☢
CT pelvis with bladder contrast (CT cystography)	8	CT cystogram and retrograde cystogram are equivalent. If doing CT, do CT cystogram.	☢ ☢ ☢ ☢
CT pelvis with contrast	5	Routine enhanced CT by itself is inadequate to evaluate lower urinary tract for trauma. If needed to evaluate extraurinary pelvic organs.	☢ ☢ ☢
X-ray abdomen	5	If any question of foreign body (eg, bullet).	☢ ☢ ☢
Arteriography with possible embolization abdomen and pelvis	3	For persistent bleeding preliminary to embolotherapy.	NS
X-ray intravenous urography	2	Inadequate for lower urinary tract trauma.	☢ ☢ ☢
X-ray retrograde urethrography	2	Unless suspected urethral injury (eg, trajectory of knife or bullet).	☢ ☢ ☢
US pelvis (bladder and urethra)	2	US is usually not definitive.	O
MRI pelvis without and with contrast	1	Not applicable to acute trauma.	O
Tc-99m MAG3 scan kidney	1	Not applicable to acute trauma.	☢ ☢ ☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Variant 2: **Blunt trauma, lower abdomen/pelvis.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray abdomen	9		☢ ☢ ☢
X-ray retrograde cystography	8		☢ ☢ ☢
CT pelvis with bladder contrast (CT cystography)	8	CT cystogram and retrograde cystogram are equivalent. If doing CT, do CT cystogram.	☢ ☢ ☢ ☢
X-ray retrograde urethrography	5	Necessary if pelvic fracture present.	☢ ☢ ☢
CT pelvis with contrast	5	Routine enhanced CT by itself is inadequate to evaluate lower urinary tract for trauma. If needed to evaluate extraurinary pelvic organs.	☢ ☢ ☢
Arteriography with possible embolization abdomen and pelvis	3	For persistent bleeding preliminary to embolotherapy.	NS
X-ray intravenous urography	3	Inadequate for lower urinary tract trauma.	☢ ☢ ☢
US pelvis (bladder and urethra)	2	US is usually not definitive.	O
MRI pelvis without and with contrast	1	Not applicable to acute trauma.	O
Tc-99m MAG3 scan kidney	1	Not applicable to acute trauma.	☢ ☢ ☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Clinical Condition: **Suspected Lower Urinary Tract Trauma**

Variant 3: **Blunt perineal trauma in the male (straddle injury).**

Radiologic Procedure	Rating	Comments	RRL*
X-ray retrograde urethrography	9		☢☢☢
X-ray abdomen	5	Necessary if strong suspicion of pelvic fracture present.	☢☢☢
CT pelvis with contrast	2	To look for hematoma.	☢☢☢
CT pelvis without contrast	1		☢☢☢
X-ray intravenous urography	1	Inadequate for lower urinary tract trauma.	☢☢☢
MRI pelvis without and with contrast	1	Not applicable to acute trauma.	O
Arteriography with possible embolization abdomen and pelvis	1	For persistent bleeding preliminary to embolotherapy.	NS
US pelvis (bladder and urethra)	1	Transabdominal US not definitive.	O
X-ray retrograde cystography	1		☢☢☢
Tc-99m MAG3 scan kidney	1	Not applicable to acute trauma.	☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Expert Panel on Urologic Imaging: Ronald S. Arellano, MD[1]; Isaac R. Francis, MD[2]; David D. Casalino, MD[3]; Deborah A. Baumgarten, MD, MPH[4]; Nancy S. Curry, MD[5]; Manjiri Dighe, MD[6]; Pat Fulgham, MD[7]; Gary M. Israel, MD[8]; John R. Leyendecker, MD[9]; Nicholas Papanicolaou, MD[10]; Srinivasa Prasad, MD[11]; Parvati Ramchandani, MD[12]; Erick M. Remer, MD[13]; Sheila Sheth, MD.[14]

Summary of Literature Review

Lower urinary tract injury may be from blunt, penetrating, or iatrogenic trauma. Injuries to the urologic system occur in 10%-20% of patients who experience major trauma and may be the result of either blunt or penetrating injuries [1]. Up to 85% of patients with pelvic fractures due to trauma will have associated bladder injuries [2] and an average of 2.9 other injuries in multiple organ systems [3]. Approximately 30% of patients with pelvic fractures will have some bladder rupture, including bladder contusion [4]. Major bladder injury occurs in about 10% of patients suffering from an anterior arch pelvic fracture [5]. However, 25% of intraperitoneal bladder ruptures occur in patients without pelvic fracture [6]; however, pelvic fractures alone does not always predict the type of lower urinary tract injury [7]. Simultaneous bladder ruptures from external trauma occur in 10%-29% of male patients with traumatic rupture of the prostatomembranous urethra, with an average of 3.1 associated injuries per patient [7,8].

The degree of distension of the bladder with urine determines its shape and to some degree the injury it may sustain. Even relatively minor trauma may rupture the fully distended bladder [9], but the empty bladder is seldom injured except by crushing or penetrating wounds. Pelvic scars or pre-existing pelvic pathology modify the situation [10].

Gross hematuria indicates urologic trauma. Presence of gross blood at the urethral meatus strongly suggests urethral injury. A Foley catheter should not be inserted without first doing a retrograde urethrogram to ensure urethral integrity [11]. While grossly clear urine in a trauma patient without a pelvic fracture virtually eliminates the possibility of a bladder rupture, up to 2% of patients with bladder rupture may have only microhematuria [1].

Exactly how much blood in the urine necessitates investigation is a point of controversy in the literature. Recently published data suggest that bladder imaging is not necessary for patients who on initial presentation have less than 50 RBC/hpf and that no cases of bladder injury were missed when patients had more than 50 RBC/hpf [12].

Fuhrman et al [13] believe that cystography in blunt trauma should be restricted to those patients with gross hematuria, which they define as more than 200 RBC/hpf. They also feel that a retrograde urethrogram should be done first in males with a pelvic fracture. Hochberg and Stone [14] concluded that since 90% of patients in their series of 103 patients with pelvic fracture did not have a bladder rupture, cystography may be safely reserved for those patients with pelvic fracture who are considered to be at high risk for such an injury. They limit cystography in pelvic fracture to patients with significant pubic arch involvement, gross hematuria, and/or hemodynamic instability.

Bladder Injury

The Consensus Panel of the Société Internationale D'Urologie has classified bladder injury into four categories [15]:

- Type I: Bladder contusion.
- Type II: Intraperitoneal rupture.
- Type III: Extraperitoneal rupture.
- Type IV: Combined injury.

Bladder contusion (Type I) represents an incomplete tear of the bladder mucosa following blunt injury. The results of cystography are normal. The diagnosis of bladder contusion is usually established by exclusion in patients with hematuria following blunt pelvic trauma for which no other cause is found. While bladder contusion is generally regarded as the most common form of bladder injury following blunt trauma, it is not considered to be a major injury.

Intraperitoneal rupture (Type II) occurs when there is a sudden rise in intravesicle pressure as a result of a blow to the lower abdomen in a patient with a distended bladder. The increased intravesicle pressure results in rupture of the weakest portion of the bladder, the dome, where the bladder is in contact with the peritoneal surface. Intraperitoneal rupture accounts for approximately one-third of major bladder injuries. Approximately 25% of such injuries occur in patients without pelvic fracture. On cystography, contrast material extravasation into the paracolic gutters and outlining loops of small bowel will be present.

[1]Principal Author, Massachusetts General Hospital, Boston, Massachusetts.
[2]Panel Chair, University of Michigan, Ann Arbor, Michigan.
[3]Panel Vice-chair, Northwestern University, Chicago, Illinois.
[4]Emory University Hospital, Atlanta, Georgia.
[5]Medical University of South Carolina, Charleston, South Carolina.
[6]University of Washington Medical Center, Seattle, Washington.
[7]Presbyterian Hospital of Dallas, Dallas, Texas, American Urological Association.
[8]Yale University School of Medicine, New Haven, Connecticut.
[9]Wake Forest University School of Medicine, Winston Salem, North Carolina.
[10]Hospital of University of Pennsylvania, Philadelphia, Pennsylvania.
[11]University of Texas Health Science Center, San Antonio, Texas.
[12]University of Pennsylvania Hospital, Philadelphia, Pennsylvania.
[13]Cleveland Clinic Foundation, Cleveland, Ohio.
[14]Johns Hopkins Hospital, Baltimore, Maryland.

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

The classically described mechanism for *extraperitoneal bladder rupture* (Type III) is laceration of the bladder by a bone spicule in association with an anterior pelvic arch fracture. Recent data, however, have shown that cystograms in such patients often demonstrate that the site of contrast material extravasation is far removed from the site of fracture, and thus the validity of this mechanism has been questioned.

Extraperitoneal rupture represents approximately 60% of major bladder injuries. Sandler et al [16] further subdivided extraperioneal rupture into two groups. With *simple* extraperitoneal rupture, contrast extravasation is limited to the pelvic extraperitoneal space. With *complex* extraperitoneal rupture, contrast material extravasation may extend into the anterior abdominal wall, the penis, the scrotum, and the perineum. The presence of a complex extraperitoneal injury implies that the fascial boundaries of the pelvis have been disrupted by the injury. Such findings should not be mistaken as evidence of a coexisting urethral injury.

Combined bladder injury (Type IV) results when both intraperitoneal and extraperitoneal bladder injuries are present. This happens in approximately 5% of major bladder injuries [17].

Urethral Injury

Injuries to the male urethra can be classified into two main categories according to their mechanism of injury: 1) those associated with a fracture of the anterior pelvic arch (usually involving the membranous urethra), and 2) those occurring as the result of a straddle injury (usually involving the bulbous urethra). Any female urethral injury is rare and usually associated with pelvic disruption and/or vaginal laceration [18]. The incidence of urethral injury with pelvic fracture ranges from zero to 6% in women, in contrast to about 10% in men. This is due to the relatively short length and anatomic position of the female urethra, which is hidden behind the osseous pubic arch, and the fact that it is more mobile without significant attachment to the pubic bone [18-20].

Some form of urethral injury occurs in about 5% of men who sustain a pelvic fracture when the prostate is sheared from its connection to the urogenital diaphragm as the puboprostatic ligaments are ruptured. The urethral injury is due to disruption of the soft tissues, rather than to a laceration by a bony spicule. A hematoma forms in the retropubic and perivesical spaces [21].

Straddle injuries occur as the result of a direct blow to the perineum when the urethra and corpus spongiosa are compressed between a hard object and the inferior aspect of the symphysis pubis. In most cases there is no pelvic fracture. Straddle injuries result in either partial or complete rupture of the bulbous urethra [21].

Male urethral trauma has been classified by Colapinto and McCallum [22] based on the appearance of the retrograde urethrogram. This classification has been expanded to include all urethral trauma [23,24].

Urethral injuries associated with pelvic fracture [22-24] include:

- Type I: Posterior urethra stretched but intact.
- Type II: Urethra disrupted at the membranoprostatic junction above the urogenital diaphragm.
- Type III: Membranous urethra disrupted, with extension to proximal bulbous urethra and/or disruption of the urogenital diaphragm (most common).
- Type IV: Bladder neck injury with extension into the urethra.
- Type IVa: Injury of the base of the bladder with periurethral extravasation simulating a true Type IV urethral injury.
- Type V: Partial or complete pure anterior urethral injury.

Urethrography has improved our understanding of the mechanism of such injuries. In the past, the diagnosis of acute urethral injury often was based loosely on the clinical triad of 1) blood at the urethral meatus, 2) inability of the patient to void, and 3) a palpable urinary bladder. An inability to pass the catheter into the bladder also was considered diagnostic of a posterior urethral injury. It is now well established, however, that diagnostic catheterization is to be condemned since it may convert a partial injury into a complete one [5]. Because posterior urethral injuries are also seen with pelvic fractures, a retrograde urethrogram should be performed before inserting a catheter [23-26]. Lack of pelvic and suprapubic tenderness; absence of penile, scrotal, or perineal hematoma; and a normal rectal examination support the integrity of the urethra [11].

Retrograde Urethrography

Patients with penetrating trauma should undergo retrograde urethrography (RUG) as the primary diagnostic procedure [5].

Cystography

The diagnosis of bladder rupture is usually made easily on cystography when the injected contrast is identified outside the bladder. Retrograde cystography in evaluation of bladder trauma is called “procedure of choice” [27], “mandatory” [28], “the only way” [29], “examination of choice” [5], “keystone” [4], “mainstay” [4], and “absolute indication” [2].

Adequate distention of the urinary bladder is crucial to finding a perforation, especially in instances of penetrating trauma, since most instances of a false-negative retrograde cystogram were found in this situation [28].

Cystography requires plain film, filled film, and postdrainage film at a minimum. Half-filled film and obliques are optional. Bladder injury may be identified only on the postdrainage film in approximately 10% of cases [6]. Cystography has an accuracy rate of 85%-100% for detecting bladder injury [30]. Only a properly

performed cystogram should be used to exclude bladder injury [5].

Intravenous Urography

An intravenous urography (IVU) is inadequate for evaluating the bladder and urethra after trauma because of dilution of the contrast material within the bladder and because resting intravesical pressure is simply too low to demonstrate a small tear [10,31]. IVU has a low accuracy, on the order of 15%-25% [32]. In only 5 of 23 patients (22%) studied was the diagnosis of bladder rupture made with IVU [33]. Carroll and McAninch [21] found only 5 of 32 (16%), and Werkman et al [34] found only 4 of 11 (36%).

Ultrasound

Transabdominal ultrasound (US) findings in bladder rupture and urethral evaluation with an endorectal probe have been described [10], but US has not been routinely used for evaluating the trauma patient. It is unlikely that a patient with significant posterior urethral or bladder rupture would tolerate evaluation with an endorectal probe. On the other hand, most or all serious trauma patients will likely be evaluated with computed tomography (CT) because of the speed and accuracy of evaluation.

US can exclude associated visceral lesions such as solid or hollow organ rupture and nonspecific peritoneal fluid [10,35]. The detection of peritoneal fluid in the presence of normal viscera or failure to visualize the bladder after the transurethral introduction of saline is considered highly suggestive of bladder rupture [10]. As a practical matter, US is not definitive in bladder or urethral trauma and is almost never used.

Computed Tomography

CT cystography refers to the retrograde instillation of a minimum of 300-350 cc of diluted contrast media into the bladder followed by axial CT images of the pelvis [17,36]. Deck et al [37,38] reported sensitivities of 95% overall but only 78% for intraperitoneal rupture. Routine CT, using excreted contrast only, cannot be relied upon entirely to diagnose bladder rupture, even with a urethral catheter inserted and clamped [8,10,39]. CT performed with excreted contrast only may demonstrate intraperitoneal or extraperitoneal fluid but cannot differentiate urine from ascites. The absence of pelvic ascites is strong evidence against bladder rupture [40]. As with IVU, the bladder is usually inadequately distended to cause extravasation through a bladder laceration or perforation during routine abdominal and pelvic studies. A negative study cannot be entirely trusted [41].

Horstman et al [42] reviewed the cystograms and CT examinations of 25 patients who had both studies as the initial evaluation of blunt abdominal trauma. Five of them had bladder rupture, three extraperitoneal and two intraperitoneal. All injuries were detected by both studies. The authors felt that delayed imaging or contrast instillation can provide the adequate bladder distention needed to demonstrate contrast extravasation from the injury site during CT. They continue to perform cystography in patients with compelling evidence of bladder injury but no extravasation demonstrated on CT. Schneider [11] stated that either retrograde cystography or CT is the diagnostic procedure of choice for suspected bladder injury.

The literature suggests that conventional and CT cystography are equivalent, with physician preference and diagnostic protocols generally defining which is used [6,42,43]. Quagliano et al [44] prospectively compared CT cystography and conventional cystography in patients with blunt abdominal trauma and found equally high sensitivity (95%) and specificity (100%) for both studies. Although CT is not the technique of choice for urethral injuries, it is performed so frequently that urethral injuries are inevitably identified on CT performed for pelvic trauma. Findings can include displacement of the prostate and bladder, extravasation of contrast media, and hematomas [45]. Recently, Chou et al [46] described preliminary results of CT voiding urethrography using 16-multidetector CT and found high correlation between results of conventional retrograde urethrography and CT voiding urethrography [46] for evaluating urethral injuries [19].

Angiography

Angiography can be useful in identifying an occult source of bleeding and can guide its subsequent therapeutic embolization [10].

Nuclear Imaging

Because of its low resolution, nuclear imaging has not been applied to lower urinary tract injuries.

Magnetic Resonance Imaging

Because of the difficulty of monitoring a seriously injured patient in a strong magnetic field, magnetic resonance imaging (MRI) currently has little place in the evaluation of acute bladder and/or urethral trauma [10]. Use of MRI has been described for later evaluation of urethral injury as an adjunctive tool for assessing complex urethral anatomic derangements [47,48].

Summary

- CT of the pelvis with bladder contrast (CT cystography) is the recommended imaging study for suspected lower urinary tract injury due to penetrating trauma of the lower abdomen or pelvis. Because CT scans of the abdomen and pelvis are frequently obtained for penetrating trauma to the abdomen or pelvis, a pelvic CT with bladder contrast (CT cystography) is recommended as the study of choice in this setting to assess for bladder injury. Routine unenhanced CT scans of the abdomen or pelvis alone may be inadequate to assess for penetrating injuries to the lower urinary tract system. When a CT scan of the abdomen or pelvis in the trauma patient is not obtained, then x-ray retrograde cystography is recommended to assess for bladder injury.

- X-ray retrograde cystography or pelvic CT with bladder contrast (CT cystography) are the recommended imaging studies for suspected lower urinary tract injury due to blunt trauma of the lower abdomen or pelvis. Retrograde urethrography should be considered to exclude urethral injury when pelvic fracture is present. Retrograde urethrography should be performed in the setting of gross hematuria to exclude a urethral injury before bladder catheterization.
- X-ray retrograde urethrography is the examination of choice for suspected blunt perineal trauma in the male (straddle injury).

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. Patients in the pediatric age group are at inherently higher risk from exposure, both because of organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared to those specified for adults (see Table below). 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*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
☢	<0.1 mSv	<0.03 mSv
☢ ☢	0.1-1 mSv	0.03-0.3 mSv
☢ ☢ ☢	1-10 mSv	0.3-3 mSv
☢ ☢ ☢ ☢	10-30 mSv	3-10 mSv
☢ ☢ ☢ ☢ ☢	30-100 mSv	10-30 mSv

*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as NS (not specified).

Supporting Document(s)

- ACR Appropriateness Criteria® Overview
- Procedure Information
- Evidence Table

References

1. Dreitlein DA, Suner S, Basler J. Genitourinary trauma. *Emerg Med Clin North Am* 2001; 19(3):569-590.
2. Morey AF, Iverson AJ, Swan A, et al. Bladder rupture after blunt trauma: guidelines for diagnostic imaging. *J Trauma* 2001; 51(4):683-686.
3. Flancbaum L, Morgan AS, Fleisher M, Cox EF. Blunt bladder trauma: manifestation of severe injury. *Urology* 1988; 31(3):220-222.
4. Rehm CG, Mure AJ, O'Malley KF, Ross SE. Blunt traumatic bladder rupture: the role of retrograde cystogram. *Ann Emerg Med* 1991; 20(8):845-847.
5. Jankowski JT, Spirnak JP. Current recommendations for imaging in the management of urologic traumas. *Urol Clin North Am* 2006; 33(3):365-376.
6. Corriere JN, Jr., Sandler CM. Diagnosis and management of bladder injuries. *Urol Clin North Am* 2006; 33(1):67-71, vi.
7. Andrich DE, Day AC, Mundy AR. Proposed mechanisms of lower urinary tract injury in fractures of the pelvic ring. *BJU Int* 2007; 100(3):567-573.
8. Cass AS. Diagnostic studies in bladder rupture. Indications and techniques. *Urol Clin North Am* 1989; 16(2):267-273.
9. Sezhian N, Rimal D, Suresh G. Isolated intraperitoneal bladder rupture following minor trauma after alcohol ingestion. *South Med J* 2005; 98(5):573-574.
10. Bigongiari LR, Zarnow H. Traumatic, inflammatory, neoplastic and miscellaneous lesions of the bladder. *In: Medical radiology of the lower urinary tract.* Lang EK ed. Berlin: Springer-Verlag. 1994:70-147.
11. Schneider RE. Genitourinary trauma. *Emerg Med Clin North Am* 1993; 11(1):137-145.
12. Brewer ME, Wilmoth RJ, Enderson BL, Daley BJ. Prospective comparison of microscopic and gross hematuria as predictors of bladder injury in blunt trauma. *Urology* 2007; 69(6):1086-1089.
13. Fuhrman GM, Simmons GT, Davidson BS, Buerk CA. The single indication for cystography in blunt trauma. *Am Surg* 1993; 59(6):335-337.
14. Hochberg E, Stone NN. Bladder rupture associated with pelvic fracture due to blunt trauma. *Urology* 1993; 41(6):531-533.
15. Gomez RG, Ceballos L, Coburn M, et al. Consensus statement on bladder injuries. *BJU Int* 2004; 94(1):27-32.
16. Sandler CM, Hall JT, Rodriguez MB, Corriere JN, Jr. Bladder injury in blunt pelvic trauma. *Radiology* 1986; 158(3):633-638.
17. Vaccaro JP, Brody JM. CT cystography in the evaluation of major bladder trauma. *Radiographics* 2000; 20(5):1373-1381.
18. Chapple CR. Urethral injury. *BJU Int* 2000; 86(3):318-326.
19. Hemal AK, Dorairajan LN, Gupta NP. Posttraumatic complete and partial loss of urethra with pelvic fracture in girls: an appraisal of management. *J Urol* 2000; 163(1):282-287.
20. Venn SN, Greenwell TJ, Mundy AR. Pelvic fracture injuries of the female urethra. *BJU Int* 1999; 83(6):626-630.
21. Ingram MD, Watson SG, Skippage PL, Patel U. Urethral injuries after pelvic trauma: evaluation with urethrography. *Radiographics* 2008; 28(6):1631-1643.
22. Colapinto V, McCallum RW. Injury to the male posterior urethra in fractured pelvis: a new classification. *J Urol* 1977; 118(4):575-580.
23. Goldman SM, Sandler CM, Corriere JN, Jr., McGuire EJ. Blunt urethral trauma: a unified, anatomical mechanical classification. *J Urol* 1997; 157(1):85-89.
24. Sandler CM, Goldman SM, Kawashima A. Lower urinary tract trauma. *World J Urol* 1998; 16(1):69-75.
25. Corriere JN, Jr., Sandler CM. Management of the ruptured bladder: seven years of experience with 111 cases. *J Trauma* 1986; 26(9):830-833.
26. Sandler CM, McCallum RW. Injuries of the urethra. *In: Clinical Urology*. Pollack HW, ed. Philadelphia, Pa: Saunders Company. Volume 2:1522-1534.

27. Stine RJ, Avila JA, Lemons MF, Sickorez GJ. Diagnostic and therapeutic urologic procedures. *Emerg Med Clin North Am* 1988; 6(3):547-578.
28. Baniel J, Schein M. The management of penetrating trauma to the urinary tract. *J Am Coll Surg* 1994; 178(4):417-425.
29. Corriere JN, Jr., Sandler CM. Management of extraperitoneal bladder rupture. *Urol Clin North Am* 1989; 16(2):275-277.
30. Carroll PR, McAninch JW. Major bladder trauma: the accuracy of cystography. *J Urol* 1983; 130(5):887-888.
31. Festini G, Gregorutti S, Reina G, Bellis GB. Isolated intraperitoneal bladder rupture in patients with alcohol intoxication and minor abdominal trauma. *Ann Emerg Med* 1991; 20(12):1371-1372.
32. MacMahon R, Hosking D, Ramsey EW. Management of blunt injury to the lower urinary tract. *Can J Surg* 1983; 26(5):415-418.
33. Bonavita JA, Pollack HM. Trauma of the adult bladder and urethra. *Semin Roentgenol* 1983; 18(4):299-306.
34. Werkman HA, Jansen C, Klein JP, Ten Duis HJ. Urinary tract injuries in multiply-injured patients: a rational guideline for the initial assessment. *Injury* 1991; 22(6):471-474.
35. Goletti O, Ghiselli G, Lippolis PV, et al. The role of ultrasonography in blunt abdominal trauma: results in 250 consecutive cases. *J Trauma* 1994; 36(2):178-181.
36. Power N, Ryan S, Hamilton P. Computed tomographic cystography in bladder trauma: pictorial essay. *Can Assoc Radiol J* 2004; 55(5):304-308.
37. Deck AJ, Shaves S, Talner L, Porter JR. Computerized tomography cystography for the diagnosis of traumatic bladder rupture. *J Urol* 2000; 164(1):43-46.
38. Deck AJ, Shaves S, Talner L, Porter JR. Current experience with computed tomographic cystography and blunt trauma. *World J Surg* 2001; 25(12):1592-1596.
39. Mee SL, McAninch JW, Federle MP. Computerized tomography in bladder rupture: diagnostic limitations. *J Urol* 1987; 137(2):207-209.
40. Pao DM, Ellis JH, Cohan RH, Korobkin M. Utility of routine trauma CT in the detection of bladder rupture. *Acad Radiol* 2000; 7(5):317-324.
41. Hsieh CH, Chen RJ, Fang JF, et al. Diagnosis and management of bladder injury by trauma surgeons. *Am J Surg* 2002; 184(2):143-147.
42. Horstman WG, McClennan BL, Heiken JP. Comparison of computed tomography and conventional cystography for detection of traumatic bladder rupture. *Urol Radiol* 1991; 12(4):188-193.
43. Lis LE, Cohen AJ. CT cystography in the evaluation of bladder trauma. *J Comput Assist Tomogr* 1990; 14(3):386-389.
44. Quagliano PV, Delair SM, Malhotra AK. Diagnosis of blunt bladder injury: A prospective comparative study of computed tomography cystography and conventional retrograde cystography. *J Trauma* 2006; 61(2):410-421; discussion 421-412.
45. Ali M, Safriel Y, Sclafani SJ, Schulze R. CT signs of urethral injury. *Radiographics* 2003; 23(4):951-963; discussion 963-956.
46. Chou CP, Huang JS, Wu MT, et al. CT voiding urethrography and virtual urethroscopy: preliminary study with 16-MDCT. *AJR* 2005; 184(6):1882-1888.
47. Kim B, Kawashima A, LeRoy AJ. Imaging of the male urethra. *Semin Ultrasound CT MR* 2007; 28(4):258-273.
48. Koraitim MM, Reda IS. Role of magnetic resonance imaging in assessment of posterior urethral distraction defects. *Urology* 2007; 70(3):403-406.