PRACTICE MANAGEMENT GUIDELINES FOR THE EVALUATION OF GENITOURINARY TRAUMA

The EAST Practice Management Guidelines Work Group

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I. STATEMENT OF THE PROBLEM

Injury to the genitourinary tract is a common occurrence after both blunt and penetrating trauma. Delayed recognition of these injuries may have the unique complication of urinary extravasation. To avoid the subsequent morbidity, a high index of suspicion must be maintained, and the appropriate radiographic evaluation performed. The indications, timing, and method of diagnostic imaging performed in patients with suspected urinary tract injury have been controversial. Additionally, improved imaging techniques have led to re-evaluation of methods of diagnosing potential urinary tract injury.

We initiated our review by converting the need for information about diagnosis of urinary tract trauma into several answerable questions:

1) What are the indications for preoperative imaging of the kidneys in blunt trauma? In penetrating trauma?
2) What renal imaging study should be used for blunt trauma? Penetrating trauma?
3) What are the indications for imaging of the bladder in blunt trauma? In penetrating trauma?
4) What imaging study should be used to visualize the bladder?
5) What are the indications for imaging of the urethra after blunt trauma? After penetrating trauma?
6) What are the indications for imaging of the renal vessels in blunt trauma? In penetrating trauma?
7) What imaging study should be used to visualize the renal vessels?

II. PROCESS

A. IDENTIFICATION OF REFERENCES

A computerized search was undertaken using Medline with citations published between the years of 1966 and 2001. Using the search words “genitourinary”, “renal”, “kidney”, “urethra”, “renovascular”, “trauma”, “wounds”, and “injury”, and by limiting the search to citations dealing with human subjects and published in the English language, we identified over 3,200 articles. From this initial search, case reports, review articles, editorials, letters to the editor, pediatric series, and meta-analyses were excluded prior to formal review. Additional references, selected by the individual subcommittee members, were then included to compile the master reference list of 123 citations.

Articles were distributed among the subcommittee members for formal review. A data sheet was completed for each article reviewed which summarized the purpose of the study, hypothesis, methods, main results, and conclusions. The

reviewers classified each reference by the methodology established by the Agency for Health Care Policy and Research (AHCPR) of the U.S. Department of Health and Human Services.

B. QUALITY OF THE REFERENCES

Class I: Prospective randomized controlled trials, **(0 references)**
Class II: Clinical studies in which the data was collected prospectively, and retrospective analyses which were based on clearly reliable data. Types of studies so classified include: observational studies, cohort studies, prevalence studies, and case control studies. **(23 references)**
Class III: Studies based on retrospectively collected data. Evidence used in this class includes clinical series and database or registry review. **(100 references)**

An evidentiary table was constructed using the remaining 136 references. Recommendations were based on studies included in the evidentiary tables.

III. RECOMMENDATIONS

A. RENAL TRAUMA

1. Level I

There is insufficient Class I and Class II data to support any standards regarding evaluation of renal trauma.

2. Level II

1) Patients who require urologic imaging after blunt trauma include those with gross hematuria and those with microscopic hematuria in the face of hemodynamic instability. Microscopic hematuria can be reliably detected using urine dipstick, although different brands of dipstick may have different levels of sensitivity and specificity.
2) CT has a higher sensitivity and specificity in the evaluation of blunt renal trauma as compared to IVP and is the diagnostic modality of choice in imaging patients with suspected blunt renal trauma.
3) MRI equals CT in correctly grading blunt renal injuries and detecting the presence and size of perirenal hematomas. MRI differentiates intrarenal hematoma from perirenal hematoma more accurately and is able to determine recent bleeding in the hematoma by regional differences in signal intensity. Although MRI can replace CT in patients with iodine allergy and may be helpful in patients with equivocal findings on CT, it should be reserved for selected patients, due to increased cost and increased imaging time.

3. Level III

1) There is a correlation between degree of hematuria in blunt trauma and likelihood of significant intra-abdominal injury not related to the genitourinary system.
2) Negative ultrasound does not exclude renal injury.
3) There is no correlation between presence and amount of hematuria and extent of renal injury after penetrating trauma.
4) Limited one-shot IVP is of no significant value in assessing penetrating abdominal trauma patients prior to laparotomy, other than to determine the presence of a second kidney prior to nephrectomy.
5) CT should be the primary diagnostic study in penetrating trauma at risk for renal trauma. Renal hematoma area: total body area may be helpful in determining the grade of renal injury.
6) In penetrating renal trauma, after IVP or CT, renal angiogram is the second study of choice because it reliably stages significant injuries and offers the possibility of embolization.

B. URETERAL TRAUMA

1. Level I

There is insufficient Class I and Class II data to support any standards regarding evaluation of ureteral trauma.

2. Level II

There is insufficient Class II data to support any recommendations regarding evaluation of ureteral trauma.

3. Level III

1) Urinalysis, IVP, and operative exploration may miss ureteral injuries, requiring a high index of suspicion during celiotomy.
2) Delaying spiral CT for 5-8 minutes after contrast infusion may increase the sensitivity in detecting ureteral disruption from blunt trauma.

C. BLADDER TRAUMA

1. Level I

There is insufficient Class I and Class II data to support any standards regarding evaluation of bladder trauma.

2. Level II

a. Routine Ct of the abdomen alone (without cystography) is inadequate to detect bladder rupture, even when the foley is clamped and bladder distended.
b. CT cystography is as accurate as conventional cystography in the detecting bladder rupture and may be used interchangeably with conventional cystography.
c. Gross hematuria, pelvic fluid, pelvic fractures (other than acetabular fractures) on CT should prompt conventional cystography or CT cystography. Drainage films and adequate distension of the bladder with contrast medium increases the sensitivity of cystography in the detection of bladder injuries.

2. Level III

There are no Level III recommendations for the evaluation of bladder trauma.

D. URETHRAL TRAUMA

1. Level I

There is insufficient Class I and Class II data to support any standards regarding evaluation of urethral trauma.

2. Level II

Urethral injury should be suspected when a pubic arch fracture exists and an urethrogram performed. The risk of urethral injury is increased when there is involvement of both the anterior and posterior pelvic arch.

3. Level III

a. Although blood at the urethral meatus, gross hematuria, and displacement of the prostate are signs of disruption and should prompt urologic work-up, their absence does not exclude urethral injury. Successful passage of a foley does not exclude a small urethral perforation.
b. Although the female urethra is relatively resistant to injury, it should be suspected in patients with either vaginal bleeding or external genitalia injury or with severe pelvic fractures and incontinence problems.

E. RENOVASCULAR TRAUMA

1. Level I

There is insufficient Class I and Class II data to support any standards regarding evaluation of renovascular trauma.

2. Level II

There is insufficient Class II data to support any recommendations regarding of renovascular trauma.

3. Level III

There is insufficient Class III data to support any recommendations regarding evaluation of renovascular trauma.

IV. SCIENTIFIC FOUNDATIONS

A. RENAL TRAUMA

The kidney is the most frequently injured urologic organ, with 70% to 80% being a consequence of blunt trauma. Although few urologic injuries are immediately life threatening, they do account for some of the more frequent complications of trauma. Renal injuries are diagnosed by combining clinical, laboratory, and radiographic modalities. Hematuria, defined as greater than five red blood cells per high-power field, is the single best primary indicator of renal injury and is present in 90% of renal injuries. Microscopic hematuria can be reliably detected using urine dipstick, although different brands of dipstick may have different levels of sensitivity and specificity 44, 48.

In the adult, patients with clinically significant renal injuries usually demonstrate either gross hematuria or microscopic hematuria with hemodynamic instability 20, 33, 36, 37, 38, 52 although the absence of hematuria does not exclude a vascular injury 110 . . . Hardeman et al prospectively studied 406 consecutive patients with suspected blunt renal trauma and found of the 365 patients with microscopic hematuria without hemodynamic ins7ability, only one patient had a renal injury sufficiently severe to warrant further study 51. Furthermore, 21 of 25 patients with documented renal injury in demonstrated gross hematuria. In a prospective study of 996 patients with suspected renal trauma, the 4.4% who sustained significant blunt renal injury had either gross hematuria (>50 red blood cels per high-power field) or microscopic hematuria accompanied by hemodynamic instability 91. Thus, the patients who require urologic imaging after blunt trauma include those with gross hematuria and those with microscopic hematuria in the face of hemodynamic instability.

Penetrating flank wounds have generally been explored in the past to determine the extent of injury, but more recently, the extension of nonoperative therapy has been extended to these injuries, as well. Although clinical examination can determine the need for exploration in up to 90% of patients, the remainder may have clinically significant but occult injuries. Unfortunately, there is no correlation between presence and amount of hematuria and extent of renal injury after penetrating trauma 30, 48, 24. In a retrospective review of 244 consecutive patients with renal proximity stab wounds, significant renal injury was found in 5 of 184 without hematuria, 24 of 46 with microscopic hematuria and all 14 patients with gross hematuria 30. Similarly, Federele et

al found that 13 of 41 patients explored for penetrating flank and back trauma had renal pedicle injuries in the absence of hematuria. In a retrospective series of 101 patients with penetrating renal injuries, Wilson et al found that 12% lacked hematuria, and 45% of those with renal pedicle injuries had a normal urinalysis 52.

Traditionally, a one-shot IVP has been performed in patients with penetrating trauma prior to laparotomy. IVP is unreliable with a high false-negative rate for patients with penetrating trauma. Urinary extravasion and nonfunction, generally considered to be relatively reliable indications of renal injury, are seen in less than 50% of patients with major or vascular injuries 115, 160. In a retrospective review of 40 patients with penetrating renal trauma, Patel et al found the IVP to have false-negative rate of 75% 76. Thus, limited one-shot IVP is of no significant value in assessing penetrating abdominal prior trauma patients to laparotomy 28, 56, 66, 73, 92. Whether IVP should be performed to confirm the presence of a contralateral functioning kidney has not been addressed. Delaying definitive therapy to obtain a preoperative IVP in an unstable pt is not warranted 28.

A number of imaging modes are available, including intravenous pyelography (IVP), computerized tomography (CT), ultrasonography (USG), and magnetic resonance imaging (MRI). The choice of modality depends on both the sensitivity and specificity of the technique, as well as it's availability. Although IVP is the oldest and most widely available technique, CT appears to be more sensitive and specific in the diagnosis of renal trauma 36, 49, 54. In a prospective study of 60 patients with blunt renal trauma, Halsell found five injuries detected on CT in patients with negative IVPs, all of which were managed nonoperatively 49. In a prospective series of 22 patients, Cass et al compared IVP and CT findings. IVP was indeterminate in 82%, whereas CT provided determinate diagnoses in all the cases of severe renal injury 54.

CT provides precise anatomic and functional renal information, while also simultaneously detecting other coexisting intra-and extraperitoneal injuries. In a 15 year review of 55 patients with blunt renal trauma, Ichigi et al found the renal hematoma area to total body area ratio to be helpful in grading renal injuries, facilitating selection for intervention 27. Therefore, if CT is available, it should be the initial diagnostic modality of choice for the stable patient in the evaluation of suspected renal injury 48.

Despite the popularity of USG for the rapid diagnosis of intra-abdominal injury, it has not been found to be accurate in the evaluation of renal injury. In a prospective study of 32 patients with known renal injuries, 78% of those with isolated renal injuries had negative renal sonograms7. McGahan et al, whose retrospective series of 20 patients with isolated renal trauma demonstrated renal parenchymal abnormalities in 22% and free fluid in only 35%, supported these findings 26. Although sonography may be used in triage of patients with abdominal trauma and possible renal injury, a negative USG does not exclude renal injury and is not the definitive modality of choice.

Although MRI has not been widely used in renal trauma because of the expense, the length of the examination, and the comparative accuracy of other techniques, it may be

valuable in selected patients. MRI equals CT in correctly grading blunt renal injuries and detecting the presence and size of perirenal hematomas 81, 86. MRI differentiates intrarenal hematoma from perirenal hematoma more accurately than CT, and is able to determine recent bleeding in the hematoma by regional differences in signal intensity. MRI can replace CT in patients with iodine allergy and may be helpful in patients with equivocal findings on CT. It should be limited to selective patients, however, due to increased cost and imaging time 86.

The evolution of high-resolution CT has reduced the necessity for angiographic staging of renal injuries. CT will reliably detect renal artery injury 110, 111. Occlusion is demonstrated by lack of renal enhancement with a normal renal contour. Cortical rim enhancement takes a minimum of eight hours after injury to become apparent on CT scan 76. If CT identifies thrombosis of the renal artery and revascularization is indicated, surgical repair can be undertaken without angiography. In the stable patient with persistent bleeding, angiography may allow selective arterial embolization, obviating the need for operative exploration 120.

B. URETERAL TRAUMA

Ureteral injuries from external trauma constitute less than 1% of all urinary tract injuries. 95% result from gunshot wounds. The early diagnosis of a ureteral injury is primarily based on 30% of patients with ureteral injuries 121, 122, 123. Neither CT nor IVP acutely has been found to be reliable in the detection of ureteral injuries. In a retrospective review of five patients with ureteral injuries secondary to blunt trauma, 80% of injuries were missed on initial CT and detected only on delayed CT 24 hours later 15. These findings were confirmed by Brown et al in a similar study, who recommended delaying spiral CT for five to eight minutes after contrast infusion to increase the sensitivity in detecting ureteropelvic junction disruption from blunt trauma 12.

In a review of 118 patients with penetrating ureteral injury, Perez-Brayfield et al found a false-negative rate of IVP of 33%86. In Azimuddin's review of 20 patients with penetrating ureteral injury, only one of seven patients demonstrated injury on preoperative or intraoperative IVP 123. In another recent report on 12 ureteral injuries, the IVP missed the ureteral injury in all nine cases in which it was used 121. In this series, four of 20 injuries were missed at initial operation. These authors concluded that since ureteral injuries are infrequent and few surgeons have significant experience with their management, a high index of suspicion is required during celiotomy 17. When inspection is inconclusive, intraoperative recognition may be facilitated by the intravenous or intraureteral injection of indigo carmine or methylene blue.

C. BLADDER TRAUMA

Blunt trauma accounts for 60% to 80% of all bladder injuries. Although only 10% to 15% of patients with pelvic fractures sustain bladder injuries, greater than 70% of bladder injuries are associated with pelvic fractures. In a recent retrospective review of 53 patients with bladder rupture from blunt trauma, Morey et al found that 85% of patients

had pelvic fractures and all of the patients had gross hematuria 89. In a prospective study of 157 patients with hematuria suspected to have bladder injury, Morgan et al identified 12 patients with bladder rupture2. Pelvic fractures were present in 75%, but isolated acetabular fractures were not correlated with rupture. 67% of patients with bladder rupture had gross hematuria, and 100% demonstrated pelvic fluid on standard contrast-enhanced CT. Gross hematuria or pelvic fluid in patients with pelvic fractures other than acetabular fractures should prompt cystography 1, 2, 224, 94, 109. Existing data do not support diagnostic imaging for patients with either pelvic fractures or hematuria alone 22.

IVP or conventional CT of the abdomen may demonstrate extravasated contrast material from a ruptured bladder, but there are many false-negatives, and they are not a substitute for cystography. In a retrospective series of 54 patients with clinically suspected bladder rupture by Pao et al, contrast extravasation was identified in only four of the eight patients with bladder rupture in whom contrast had been excreted into the bladder at the time of CT. In two of the four patients without extravasation, the bladder was distended at the time of CT 3. In a similar study by Haas et al, conventional abdominal CT identified only nine of 15 bladder ruptures which were diagnosed with CT cystography 25. Therefore, routine IVP or CT of the abdomen (without cystography) is inadequate to detect bladder rupture even when the foley is clamped and the bladder distended 3, 25, 579, 82.

CT cystography is as accurate as conventional cystography in the detection of bladder rupture and may be used interchangeably with conventional cystography. In a prospective series, Peng et al screened 55 patients with hematuria and blunt abdominal trauma with CT cystograms, identifying five patients with bladder rupture1. The injuries in these five patients were confirmed intraoperatively. The 50 patients with negative CT cystograms underwent conventional cystography, and no other bladder rupture, CT cystography identified the rupture in 42 for an overall sensitivity and specificity of 95% and 100%, respectively. For intraperitoneal rupture, sensitivity was 78% and specificity was 99% 10. if CT scanning is being performed for abdominal evaluation, CT cystography may be performed; if not, conventional cystography is preferred.

D. URETHRAL TRAUMA

Urethral injuries are most often associated with pelvic fractures, especially anterior arch fractures with displacement 77. Lowe et al found that the combining injuries of the sacro-iliac joint with pubic rami injuries had a positive predictive value of 86% and a negative predictive value of 73% in identifying patients with urethral injury 40. In a prospective study of 203 male patients with pelvic fracture, Koraitim et al found the incidence of urethral injury was 24 times greater in patients with a straddle fracture when combined with diastasis of the sacro-iliac joint as compared to other pelvic fractures 77.

Although blood at the urethral meatus, gross hematuria, and displacement of the prostate are signs of urethral disruption, their absence does not exclude urethral injury. In a retrospective review of 405 patients with pelvic fracture, Lowe et al identified 21 patients with urethral injury. Of these 21, only 12 demonstrated blood at the urethral meatus,

high-riding prostate, or perineal hematoma 39. They determined that patients with urethral injuries examined less than one hour after injury may not show physical findings of urethral disruption. In addition, the successful passage of a foley does not exclude a small urethral perforation 72.

Female urethral injuries are rare but do occur and are frequently overlooked, leading to added patient morbidity 16, 18, 35. Peng et al published a retrospective review of 130 females with pelvic fractures; six (4.5%) of these patients were found to have an associated urethral injury. All six patients had vaginal bleeding associated with severe pelvic fractures and public diastasis. 50% had a delayed diagnosis. In a similar review of twelve women with pelvic fractures and urethral injuries, Venn et al found that mild injuries present as incontinence, requiring a high index of suspicion 16.

V. SUMMARY

The urinary tract may be damaged by a variety of blunt or penetrating trauma to the abdomen. Urinary system injuries occur in approximately 4% of trauma patients. Although some of the more frequent complications occurring after trauma involve the urinary tract, few GU injuries are immediately life threatening. The appropriate indications, timing, and methods of diagnostic imaging remain controversial, partially due to a paucity of Class I and II studies in the literature.

VI. FUTURE INVESTIGATIONS

There is a paucity of Class I data analyzing the various methods of evaluation of genitourinary tract trauma, as evidenced by the complete lack of Level I recommendations for the evaluation of these injuries. Future investigations should be carried out in a prospective, randomized manner with a sufficient number of patients to enable clinicians to draw valid, concrete conclusions as to the optimal methods of evaluating these patients. Given the relative infrequency of some of these injuries, especially renovascular trauma, this will likely require large-scale multi-institutional projects.

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Ref	Title	First Author	Data Class	Methods	Main Results	Conclusions
1	CT cystography versus conventional cystography in evaluation of bladder injury. Am J Roent. 1999;173:1269-72	Peng	II	prospective series of 55 patients with hematuria after blunt abdominal trauma who underwent CT cystography; negative CT cystograms were followed by conventional cystograms	5 bladder ruptures were identified in the 55 patients screened. CT cystography did not miss any bladder injuries	CT cystography is as accurate as conventional cytography in trauma
2	CT cystography: radiographic and clinical predictors of bladder rupture. Am J Roent. 2000;174:89-95.	Morgan	II	prospective series	Gross hematuria, pelvic fluid, pelvic fractures were predictors of bladder rupture	Gross hematuria, pelvic fluid, pelvic fractures on CT should prompt cystography
3	Utility of routine trauma CT in the detection of bladder rupture. Acad Radiol. 2000;7:317-24.	Pao	III	retrospective review	Conventional CT missed over 50% of 8 bladder ruptures in which contrast was excreted into the bladder at the time of CT, all patients with bladder rupture had pelvic fluid	Routine CT is not adequate to detect bladder rupture and CT or conventional cystography should be done if it is suspected, pelvic fluid suggests the diagnosis.
4	Causes and outcome of bladder injuries in Durban. E African Med J 1999;76:676-9.	Madiba	III	retrospective review	Extraperitoneal injuries do well with drainage only; isolated bladder injuries carry a low mortality	Routine CT is not adequate to detect bladder rupture and CT or conventional cystography should be done if it is suspected, pelvic fluid suggests the diagnosis.
5	Traumatic renal artery occlusion: a review of the literature. Tech Urol 1998;4:1-11.	Haas	III	retrospective review	Of bilateral RA occasional, 56% salvaged; of unilateral RA occasional, 26% successful (of these 67% had reduced renal function and 12% developed HTN at mean 3.1 years; 32% who did not have attempt at revascularization had HTN by mean of 97 days	Revascularization in unilateral RA occlusion is only very rarely successful; patients should be followed long term for hypertension.

6	Significance of hematoma size for evaluating the grade of blunt renal trauma. Intern J Urol 1999;6:502-8.	Ichigi	III	Retrospective15 year review of 55 pts with blunt renal trauma. Group I no intervention, Group II transcatheter embolization, Group III surgery. Comparison of hematoma area (H) to body area (B) in same CT plane	Group I 20 pts, H/B ration 0.123, Group II and III 13 pts, H/B 0.2. The ratio of hematoma to body area (amount of bleeding) correlated with prior decisions to observe, embolize, or operate.	Patients with H/B ratio >0.15 should be managed as high-grade injury requiring intervention.
7	Use of ultrasonography in the patient with acute renal trauma. J Ultrasound Med 1999;18:207-15.	McGahan	II	prospective study	37 renal injuries in 32 patients were evaluated by US; isolated injuries were frequently associated with normal renal sonograms (78%) and absent free fluid	US is not accurate in the evaluation of renal injury
8	Value of computed tomography in the evaluation of retroperitoneal organ injury in blunt abdominal trauma. Am J Emer Med 1998;16:225-7.	Porter	III	retrospective review	466 stable patients who underwent CT had films and operative findings and clinical course correlated; Ct was accurate for renal injury, but missed some duodenal injuries	CT is accurate in the evaluation of renal trauma
9	Urban free falls and patterns of renal injury: a 20-year experience with 396 cases. J Trauma 1999;47:643-9.	Brandes	III	retrospective review	423 patients with renal injuries sustained in falls were reviewed; degree of hematuria did not predict extent of renal injury; 29% of grade 2 to 4 injuries would have been missed if patients without hematuria had not been imaged	The absence of hematuria or flank hematoma should not exclude patients sustaining significant falls from renal imaging

10	Computerized tomography cystography for the diagnosis of traumatic bladder rupture. J Urology 2000;164:43-6.	Deck	III	Retrospective review	316 patients underwent CT cystography as part of the evaluation for trauma; CT and operative findings and clinical course were compared; sensitivity and specificity of CT cystography were 95% and 100% respectively. Of the 44 patients with the ultimate diagnosis of bladder rupture CT cystography revealed bladder rupture in 42. In the 316 patients CT cystography detected bladder rupture with an overall sensitivity and specificity of 95% and 100%, respectively. For intraperitoneal rupture sensitivity was 78% and specificity was 99%.	CT cystography is accurate and useful
11	Limitations of routine spiral computerized tomography in the evaluation of bladder trauma. J Urol 1999;162:51-2.	Haas	III	Retrospective review	24 patients with bladder injury who had both spiral CT (with IV contrast and bladder clamping) and retrograde cystography were reviewed; CT diagnosed only 60% of bladder ruptures.	Spiral CT (with IV contrast and bladder clamping) will miss many clinically important bladder injuries; retrograde cystograms should be done if bladder injury is suspected.
12	Limitations of routine spiral computerized tomography in the evaluation of blunt renal trauma. J Urol 1998;160:1979-81.	Brown	III	Retrospective review	35 patients with blunt renal injury had spiral CT with IV contrast; 3 or 35 (8.6%) of the injuries would have been missed if delayed scans (days later) had not been performed for other reasons (such as flank pain)	Some renal collecting system injuries may not be apparent on the initial CT; the authors recommend routine delayed scans, especially if symptoms persist in the face of known renal parenchymal injury.

13	Urethrography and cavernosography imaging in a small series of penile fractures: a comparison with surgical findings. Urol 1998;51:616-9.	Mydlo	III	Retrospective review	7 patients with penile fracture were reviewed. 2 patients who presented with blood at the meatus had intact urethras, whereas 2 of the 3 patients who had urethral lacerations did not have a bloody meatus. In 2 cases the urethrogram and cavernosogram revealed lacerations that were not initially detected surgically. However, in another 2 cases, the urethrogram and cavernosogram were falsely negative.	Both blood at the meatus and imaging missed some urethral lacerations associated with penile fracture; all penile fractures should be explored in such a way that the urethra can be evaluated intraoperatively
14	The higher injury risk of abnormal kidneys in blunt renal trauma. Scand J Urol & Nephr 1998;32:388-92.	Schmidlin	III	Retrospective review	120 patients with blunt renal injury were reviewed; 23 (19%) had preexisting renal abnormalities; these patients tended to have lower ISS.	Abnormal kidneys have a higher rate of injury for a given mechanism than normal kidneys.
15	Ureteropelvic Junction Disruption Secondary to Blunt Trauma: Excretory Phase Imaging (Delayed Films) should help prevent a missed diagnosis. J Urol 1998;159:67-70.	Mulligan	III	Retrospective chart review of 5 patients	80% of diagnoses were delayed at least 24 hours and not shown on initial contrast spiral CT.	Spiral CT may not be giving the contrast enough time for excretion, therefore missing the diagnosis of UP junction injury. Recommend that scanning be delayed by 5-8 minutes after contrast infusion.
16	Pelvic fracture injuries of the female urethra. Br J Urol 1999;83:626-30.	Venn	III	Retrospective chart review of 12 females	Mild injuries present as incontinence, severe injuries result in a longitudinal urethral tear or complete avulsion.	The female urethra is relatively resistant to injury but may be injured in association with severe pelvic fractures.
17	Penetrating ureteric injuries. Injury 1998;29:363-7.	Azimuddin	III	Retrospective chart review of 20 patients.	33% had macroscopic hematuria, 33% had microscopic hematuria. Only 1 of 7 pre- or intra-operative excretory urograms demonstrated an injury.	A high index of suspicion is necessary in patients with a penetrating wound to the retroperitoneum. It is important to thoroughly examine the ureteric bed intraoperatively.

18	Traumatic Injuries of the Female external genitalia and their association with urological injuries. J Urol 1998;159:956-9.	Goldman	III	Retrospective chart review of 20 female with trauma to the external genitalia not due to parturition.	11 patients had direct external trauma not related to intercourse. 6 of these patients had an associated urologic injury, primarily to the bladder or urethra.	Whenever trauma to the female external genitalia is noted, it is crucial to rule out an associated injury to the bladder or urethra.
19	Injuries Associated with Fractures of the Transverse Processes of the Thoracic and Lumbar Vertebrae. J Trauma 1984;24:597-9.	Sturm	III	Retrospective chart review of 92 patients with transverse process fractures of the thoracic or lumbar vertebrae.	11% of patients with transverse process fractures had an associated urologic injury. 55% of patients with a fracture had hematuria which was gross in 24%: 42% of patients with gross hematuria had a urologic injury. 13% of patients with microscopic hematuria had a urologic injury. No patient without hematuria had a urologic injury.	The presence of hematuria in a patient with a transverse process fracture should alert the physician to rule out a urologic injury.
20	Hematuria after blunt trauma: when is pyelography useful? J Trauma 1983;23:305-11.	Guice K	III	Retrospective review of 156 IVP's over 1 year period	13/56 IVPs were abnormal. 5/13 required interventions, all of whom had gross or 4+ microscopic hematuria.	IVP is indicated in blunt trauma patients with gross hematuria or 4+ microscopic hematuria.
21	Computerized tomography cystography for the diagnosis of traumatic bladder rupture. J Urol 2000;164:43-6.	Deck AJ	III	Retrospective review of 316 blunt trauma pts undergoing CT cystography	42/44 bladder ruptures diagnosed by CT cystography. Overall sensitivity 95%, specificity 100%	CT cystography is recommended over plain film cystography for diagnosis of blunt bladder rupture.
22	Utility of routine trauma CT in the detection of bladder rupture. Acad Rad 2000;7:317-24.	Pao DM	III	Retrospective review of 54 abdominal and pelvic CT in whom bladder rupture was clinically suspected	Cystograms depicted bladder rupture in 10 patients. All had extravesical fluid, but so did 32/44 pts without bladder rupture	Routine abdominal/pelvis trauma CT is unreliable in the diagnosis of bladder rupture.
23	CT cystography: radiographic and clinical predictors of bladder rupture. Am J Roent. 2000;174:89-95.	Morgan DM	II	18 month prospective study of 154 trauma pts with hematuria referred for abdominal CT	12/157 with bladder rupture, 9/12 with pelvic fx, 8/12 gross hematuria, 12/12 with pelvic fluid on trauma CT	Gross hematuria, pelvic fluid, pelvic fx other than acetabular fx are associated with bladder rupture.

24	Penetrating ureteral trauma at an urban trauma center: 10 year experience. Urol 1999;54:34-6.	Palmer LS	III	Retrospective 10 year review of 20 pts with penetrating ureteral trauma	8/12 pts with isolated ureter injury had hematuria. 1/4 IVP's abnormal. 15/20 injuries noted intraoperatively, 4/20 missed at initial operation	Uninalysis and preoperative IVP may miss ureteral injury requiring a high index of suspicion during operative exploration.
25	Limitations of routine spiral computerized tomography in the evaluation of bladder trauma. J Urol 1999;162:51-2.	Haas CA	III	Retrospective review of 15 pts undergoing both retrograde cystography and spiral CT of abdomen/pelvis	15/15 diagnosed by retrograde cystography; 9/15 identified on spiral CT	Spiral CT without CT cystography is not accurate in diagnosis of bladder rupture
26	Use of ultrasonography in the patient with acute renal trauma. J Ultrasound Med 1999;18:207-13.	McGahan JP	III	retrospective 3 year review of 32 pts with 37 renal injuries who had undergone ultrasound at admission	eliminated pts with concomitant intra-abdominal injury. 7/20 pts with renal injury had free fluid; 8/20 had parenchymal injuries noted in US; 11/32 had normal ultrasound exams	A negative ultrasound exam does not exclude renal injury.
27	Intravenous pyelography in penetrating trauma. Am Surg 1994;60:384-6.	Tang E	III	7 month review of 67 IVP's in patients with penetrating injury	0/34 (19 stabs, 15 GSW) patients without hematuria demonstrated renal injury requiring intervention.	IVP is not required in penetrating trauma patients without hematuria.
28	The "One-Shot" Intravenous Pyelogram. Is It Indicated In Unstable Trauma Patients Before Celiotomy. J Trauma 1994;36:828-34.	Stevenson	III	retrospective review of 239 pre-operative "one-shot" ivp's in patients for whom evaluation in the radiology suite was felt to be unsafe.	Allergic reactions occurred in 3/239(1.3%). 31 pts (13%) required renal exploration. No solitary kidneys were identified. The IVP was abnormal in 53 pts (22%) - 5 bilateral non-visualization and 15 unilateral non-visualization. 87% of pts with normal IVP findings had renal injuries not detected by "one-shot" IVP and normal and 26% of pts with abnormal IVP'S had no evidence of renal injury.	Delaying definitive therapy to obtain a preoperative IVP in an unstable pt is not warranted.

29	Urological evaluation and management of renal proximity stab wounds. J Urol 1993;150:1771-3.	Eastham	III	Retrospective review of 244 consecutive pts with renal proximity stab wounds. Stable pts with hematuria &/or suspected injury due to proximity of entrance wound to the kidney were assessed with an IVP; 34 were subsequently evaluated with CT and/or angiography	Renal injury was found in 5/184 without hematuria, 24/46 with microscopic hematuria and all 14 with gross hematuria .IVP was 96% accurate in establishing the presence or lack of injury.	The absence of hemturia does not preclude renal injury. .IVP is an acceptable first-line study. Renal angiogram is the second study of choice because it reliably stages significant injuries and offers the possibility of iembolization. Most renal stab wounds when accurately staged can be managed nonoperatively.
30	Ureteropelvic junction disruption following blunt abdominal trauma. J Urol 1993;150:33-6.	Boone	III	Retrospective review of 8 cases (7 pts) as well as an extensive literature review	Delay in diagnosis in 4 patients was greater than 36 hrs. 3/4 patients with missed injuries lacked hematuria and were in hypovolemic shock unresponsive to fluid resuscitation. All patients were emergently explored without imaging studies due to hemodynamic instability. Retroperitoneal findings at operation failed to reveal evidence of a perinephric hematoma. The kidneys were palpably normal and, therefore, they were not directly examined. Despite these negative retroperitoneal findings the patients sustained disruption of the ureteropelvic junction.	The majority (45/47) of pts with ureteropelvic junction disruption present with a substantial history of rapid deceleration injury and the presence of at least 1 of 4 associated findings: microscopic hematuria with shock, gross hematuria, direct flank tenderness/ecchymosis or multisystem failure. However, a negative exploratory laparotomy without direct visualization of the kidney should not exclude radiographic evaluations for retroperitoneal injuries.

31	The single indication for cystography in blunt trauma. Am Surg 1993;59:335-7.	Fuhrman	IIII	Retrospective review. First, a 15-month retrospective evaluation revealed 26 patients with bladder trauma. All 26 patients presented with gross hematuria. This was followed by a randomized prospective study of all patients with blunt trauma. Patients were randomized to be evaluated with cystography for any degree of hematuria or the diagnosis of pelvic fracture versus those to be evaluated only for the presence of gross hematuria.	Eleven patients had pelvic fractures and no hematuria. One hundred nine patients had microscopic hematuria and a 39 per cent incidence of coexistent pelvic fractures. Thirty-one patients had gross hematuria and a 26 per cent incidence of pelvic fracture. Bladder injuries were seen only in this latter group.	Cystographic evaluation in blunt trauma should only be done in the presence of gross hematuria.
32	Hematuria as a Predictor of Abdominal Injury after blunt trauma. Am J Surg 1992;164:482-5.	Knudson	III	Retrospective review of 160 pts with blunt trauma and extrarenal injury	Incidence of abdominal injury in patients with microscopic hematuria and shock=29% vs patients with gross hematuria and shock=>65%.	All pts with gross hematuria alone and all with microhematuria with shock should be evaluated for both renal and non renal abdominal injuries.
33	Radiographic Assessment of Adult patients with Blunt Renal Trauma. J Urol 1992;148:266-7.	Eastham	III	Retrospective review 337 pts with blunt trauma microscopic hematuria) and no shock	30/337 (9%) had abnormal IVP =greater 28 contusions UPJ disruption 1-absent kid…only 1 significant injury would have been missed (0.37%)	GU evaluation is indicated in pts with suspected intra-abdominal injury, those in major deceleration accidents and those with shock, gross hematuria or both. Additional staging not indicated in patients with microhematuria without shock.
34	Increasing Role of Angiography and Segmental Artery Embolization in the Management of Renal Stab Wounds. J Urol 1992;147:1231-4.	Heyns	III	Retrospective review of 93 pts. 79 were initially evaluated and treated at the authors' hospital (Group I) and 14 were referred with complications (Group II). In Group I, 26 pts (33%) were selected for surgery on the basis of signs of severe blood loss or associated intra-abdominal injury, or major	At operation a major renal injury and/or associated intra-abdominal laceration was found in 23 patients (88%) and nephrectomy was required in 7 (27%) of them. Nonoperative management was selected in 53 patients (67%) in group 1 and secondary hemorrhage occurred in 8 (15%). Of the patients in group 2, 4 had undergone an operation elsewhere and 10 had	Angiography and selective arterial embolization can be effectively used to treat vascular complications in pts being managed non-operatively.

				abnormality on the excretory urogram.	been managed nonoperatively. Renal arteriography was performed in 14 patients who had been managed nonoperatively (6 from group 1 and 8 from group 2) and demonstrated a traumatic pseudoaneurysm in 6, an arteriovenous fistula in 5 and no large vessel injury in 3. Selective embolization of the involved segmental artery was successful in 9 of 11 patients (82%) when angiography showed a vascular lesion.	
35	Urethral injuries in female subjects following pelvic fractures. J Urol 1992;147:139-43.	Perry	III	Retrospective review of 130 female pts with pelvic fracture 6/30 (4.5%) had associated urethral injury	3/6 had delayed diagnosis. All 6 had vaginal bleeding associated with severe pelvic fractures and pubic diastases..	Urethral injury is rare in female trauma pts but should be considered in pts with pelvic fractures, pubic diastasis and vaginal bleeding. Urethrography will be diagnostic.
36	Evaluation and Treatment of blunt renal trauma. J Urol 1991;146:274-7.	Herschorn	III	Retrospective review of 126 pts with blunt renal trauma	All patients who had microscopic hematuria without shock had minor injuries. Excretory urograms (IVPs) were normal in 74% and 39% of the patients when performed for minor and moderate renal injuries, respectively. Computerized tomography (CT) was abnormal in all cases when performed, and was more sensitive and specific than an IVP.	Radiologic evaluation is not needed in patients with microscopic hematuria and no shock. If XRays are indicated, CT is imaging study of choice.

37	Hematuria following Blunt Abdominal Trauma the Utility of Intravenous Pyelography. Arch Surg 1988;123:1173-7.	Klein	III	Retrospective review of 134 pts who had IVPs and tomograms over a one yr period. The XRay findings were correlated with the degree of hematuria, associated injuries, management & outcome.	0/62 patients with 0-10 rbc's/hpf had an abnormal IVP. 2/19 patients with 10-30 rbc's/hpf had renal contusions only, which were observed. 25/53 patients with greater than 30 rbc's/hpf had renal injuries: 17 (contusions), 3(major lacerations),5(bladder injuries).	Patients without penetrating or significant associated injuries and less than 30 rbc's/hpf on urinalysis can be managed without IVP.
38	The Value of Sonography in the Diagnosis and Follow-up of Patients with Blunt Renal Trauma. Br J Urol 1988;62:110-6.	Furtschegger	III	Retrospective review of 88 patients with blunt renal trauma who received renal ultrasound; IVP was performed in 79.	41 pts had kidney rupture of which 34 were confirmed at surgery. 45 patients had renal contusion. A renal artery lesion was found in 2 patients, both of whom had a normal renal ultrasound.	Sonography is useful in follow patients after surgery as well as those patients being managed conservatively.
39	Risk factors for urethral injuries in men with traumatic pelvic fractures. J Urol 1988;140:506-7.	Lowe	III	Retrospective review of 405 pts with pelvic fracture	21 injuries were identified (4.7%). 14/21 (67%) had combined injuries of SI joint and pubic rami. The Positive predictive value of these pelvic fractures was 86%; the negative predictive value was 73%. There were no physical signs (blood at meatus, perirectal or scrotal hematoma). 9 men had examination findings & urethral injuries (2 scrotal swelling alone, 3 high-riding prostate or nonpalpable prostate and blood at the meatus, and 1 had all 3 physical findings. 12/21 men with urethral injuries lacked any of these 3 physical signs.	Retrograde urethrogram should be performed in all pts with fracture of sacroiliac joint and pubic ramus in addition to perirectal or scrotal hematoma, blood at the meatus, and/or high riding prostate. Patients with urethral injuries examined less than 1 hour after injury may not show physical findings.

40	Hematuria and Clinical Findings as Indications for Intravenous Pyelography in Pediatric Blunt Renal Trauma. Pediatrics 1988;82:216-22.	Lieu	III	Retrospective review of 78 consecutive patients who had an IVP to evaluate blunt trauma	52/78 (67%) had a normal IVP. 13/78 (17%) had an abnormal IVP. 8/13 of these patients had renal contusion(66%). There were no fractures or pedicle injuries. 4/13 had lacerations with extravasation. 1/13 had bladder rupture identified on IVP. The IVP results did not lead to surgery in any patient.	IVP is indicated in patients with red blood cells too numerous to count. If it is important to identify renal contusions, IVP is indicated if greater than 20 rbc's/hpf . IVP or CT should be performed in patients with lesser hematuria and extremity fractures.
41	Urinary Lactic Dehydrogenase as a Marker of Renal Injury in Blunt Trauma Patients with Hematuria. Ann Emer Med 1988;17:797-800.	Henneman	III	Retrospective review of 36 blunt trauma patients with hematuria . All had IVP and urine and serum LDH levels		LDH is a nonspecific marker of cellular disruption anywhere along the GU tract and is not useful as a screening test for renal injury
42	Detection and significance of microscopic hematuria in patients with blunt renal trauma. J Urol 1988;140:16-8.	Chandhoke	II	339 pts Prospective consecutive pts; Patients were initially evaluated with urine dipstick, followed by urinalysis and subsequent imaging.	>80% of 50-100 RBC/hpf correspond to 3+ dipstick; microscopic hematuria was detected reliably, high sensitivity and specificity by dipstick	Hematuria can be detected reliably with a high degree of sensitivity and specificity by urine dipstick. The brand of dipstick may make a difference.
43	The Role of IVP in Blunt Trauma. J Trauma 1988;28:502-4.	Wong L	III	139 IVP pts Retrospective 21 clinical parameters applied	No combination of 21 clinical parameters were found to predict IVP abnormalities	Clinical parameters which determine need for operation 90% of the time include blood at urinary meatus, degree of hematuria, age, ISS, number of ribs fractured.
44	Dipstick Evaluation of Hematuria in Abdominal Trauma. Am J Clin Path 1988;89:538-42.	Daum GS	II	178 pts Prospective consecutive pts; Random urine sample with dipstick evaluation	>5-10 RBC/hpf indicates need for IVP. Sensitivity for dipstick for microscopic hematuria was 100%, specificity 58.6%; increases to 90% if proteinuria is added. There is a poor correlation of positive dipstick with degree of microscopic hematuria.	Negative urine dipstick does not require further testing. There is a poor correlation of positive urine dipstick with the degree of microscopic hematuria. The dipstick brand may make a difference.

45	Blunt Urethral Injury: Results of Initial Management. Am Surg 1988;54:181-4.	Malangoni MA	III	14 pts Retrospective Chart review	13/14 pts had pelvic fracture of the anterior ring. Urethral disruption in assoc with prostate displacement occurred in 10/12.	Displacement of the prostate is a highly reliable sign of urethral disruption. The absence of blood at the urinary meatus and gross hematuria are not reliable alone to rule out urethral injury. Retrograde urethrography should be performed if classic signs and symptoms are found in association with anterior pelvic fracture on x-ray. Suprapubic catheterization is required. If the patient has a partial tear, a foley may be placed by the urologist.
46	Burn and Trauma associated proteinuria: the role of lipid peroxidation, rennin, and myoglobin. Ann Clin Biochem 1988;25:53-9.	Gosling P	II	Prospective study of 10 trauma patients and 13 burn patients	In burn patients, maximum proteinuria occurs within -4-8hr; serum lipid peroxides increase maximally within 2-8hr. In trauma patients, maximum proteinuria occurs within 4hr; serum lipid peroxides increase after 12hr and peak between 16hr and 7d In both burn and trauma patients, recurrent protein leaks 2-5d post-injury generally are associated with sepsis No association with myoglobinuria or increased renin activity.	Proteinuria suggests a rapid and reversible change in glomerular filtration after burn or an acute inflammatory response.
47	Blunt Bladder Trauma: Manifestation of Severe Injury. Urol 1988;31:220-2.	Flancbaum L	III	29 pts Retrospective chart review of patients requiring operative management	Hypotension and gross hematuria occurred in 68 and 97% respectively, pelvic fracture in 93%; intraabdominal injury in 48%. The majority of ruptures were intraperitoneal (72%). Mortality was due to associated injuries at 34%. Urethral injury occurred in 33% of males.	All pts with bladder injury had either pelvic fracture or gross hematuria. Recommend retrograde urethrogram followed by cystogram in pts with hematuria and/or pelvic fracture. Eliminate cystography if the patient has no gross hematuria or pelvic fracture, or if evaluation of the upper urinary tract (CT or IVP) demonstrates bladder extravasation.

48	Penetrating Renal Trauma. J Comp Assist Tomog 1987;121:1026-30.	Federle MP	III	27 pts Retrospective Stab wounds Ct if clinically stable Risk for renal injury - flank or back wound, hematuria, abnormal IVP	Most patients with penetrating renal injuries do not require exploration. Angiography may be used as an adjunct to CT if vascular injury is suspected.	There was no correlation between the presence and amount of hematuria and extent of renal injury. The combination of clinical exam and CT allows for non-operative management CT should be the primary diagnostic study in penetrating back trauma at risk for renal trauma
49	The reliability of excretory urography as a screening examination for blunt renal trauma. Ann Emerg Med 1987;16:1236-9.	Halsell RD	II	60 pts Prospective Blunt criteria: blunt abdominal trauma, hematuria >5RBC/hpf, low rib fractures, T12-L3 transverse process fractures, fall >10', flank mass, tender flank. Workup consisted of urinalysis, followed by IVP, followed by CT.	5 renal injury on CT not seen on EU; all managed nonoperatively; CT did not change management 93% pts with hematuria, no demonstrable renal damage; microscopic hematuria alone has low specificity as indicator of renal injury CT more sensitive than EU; majority of trauma pts with clinical or lab indications for injury have either no injury or insignificant injury	Normal IVP in blunt trauma successfully excludes clinically significant injury.
50	Features of 164 bladder ruptures. J Urol 1987;138:743-5.	Cass AS	III	Retrospective study of 164 patients	High incidence of associated injuries (89%) leading to a mortality rate of 22% . The most common associated injury was pelvic fracture. There was no significant relationship between the type of pelvic fracture and the type of bladder rupture.	Retrograde cystography is sufficient for diagnosis if using 400ml contrast; false negatives occur with 250ml.

51	Blunt Urinary Tract Trauma. J Urol 1987; 138:99-101.	Hardeman SW	II	506 pts Prospective Consecutive, non-randomized patients. Initially, IVP and Cystography were performed. These were followed by CT, arteriography, retrograde urethrography and intraoperative findings to confirm initial impression	365 patients had microscopic hematuria but no shock - 3 urinary tract injuries; if used as a criteria for no further study, only one severe injury would have been missed Absence of major associated injury and microscopic hematuria without shock indicate patients who do not require further GU study. This protocol will result in a less than 1% chance of missing a severe renal injury .	Gross hematuria or microscopic hematuria with shock indicate further study and likely renal injury.
52	Diagnostic and treatment problems in renal injuries. Am Surg 1987;53:399-402.	Wilson RF	III	112 pts Retrospective	74% PENETRATING GSW with another 16% STAB; 10% blunt Preop evaluation - UA, IVP except in life threatening injury Degree of hematuria does not correlate with degree of renal trauma Absence of hematuria does not rule out renal injury 12% normal UA for all injury; 45% normal UA for pedicle injury 27% false negative IVP; Small cortical laceration or contusion - lends well to conservative management Shattered kidney, renal artery or vein, large expanding or pulsatile retroperitoneal hematoma require surgery	Extravasation and nonvisualization indicate major injury. Suspect injury in the OR if extravasation or nonvisualization on IVP if unable to obtain arteriogram or CT; severe shock not responding to resuscitation and in spite of other control of bleeding

53	Intravenous pyelogram results in association with renal pathology and therapy in trauma patients. J Trauma 1987;27:515-8.	Bergren CT	III	127 pts Retrospective Penetrating vs nonpenetrating	Hematuria should indicate the need for further study No correlation between site of injury and type of renal injury No correlation between microscopic hematuria or gross hematuria with the severity of renal injury PENETRATING - IVP unreliable (high false negative rate) BLUNT - IVP effective in r/o serious renal injury Determine presence of 2nd kidney before nephrectomy	IVP - extravasation and nonvisualizualization are significant for major renal injury; delayed filling or incomplete filing are nonspecific findings requiring further evaluation.
54	Comparison of IVP and CT findings in patients with suspected severe renal injuries. Urol 1987;29:484-7.	Cass AS	II	22 pts Prospective non-operative management exclude - nonvisualization on IVP; pelvis fracture, norm IVP and hematuria due to bladder injury	IVP not definitive diagnosis in 5% contusion, 50% renal laceration, 29% renal pedicle CT definitive diagnosis in all	CT provides a definitive diagnosis in all types of renal injury.
55	Renal trauma and the intravenous urogram. J Royal Soc Med 1987;80:21-2.	Oakland CD	III	Retrospective review of 81 patients with blunt trauma	Incidence of abnormal IVP with Microscopic hematuria was low . Microscopic hematuria occurs after minor renal trauma and clears within 7 days - IVP noncontributory. Gross hematuria is evidence of injury.	IVP should be performed n abdominal trauma prior to laparotomy and in those hemodynamically unstable with expanding loin mass, gross hematuria, and prolonged microscopic hematuria.

56	Selective diagnostic uroradiography for trauma. J Urol 1987;137:449-51.	Peterson NE	III	Retrospective review of 157 penetrating; 225 blunt pts Workup consisted of IVP, retrograde cysto-urethrography; occasional arteriography and CT.	PENETRATING INJURY - most often localized; Rarely simultaneous tract injury and usually indicates severe injury with high mortality from assoc injuries	Selective evaluation should be performed in pts with associated injuries - lower rib fractures or lumbar transverse process fracture (upper renal injury) and pelvic fracture, urethral bleeding, prostate displacement, rectal injury (lower GU injury). Use IVP or CT for upper; retrograde urethrography or cystography o for lower to save money and time. Exceptions are massive injury; angle of entry for penetrating. There is no need for comprehensive study if the clinical picture is limited to upper or lower GU and the initial study is compatible with the clinical impression.
57	Computerized tomography in bladder rupture: diagnostic limitations. J Urol 1987;137:207-9.	Mee SL	III	Two patients with blunt trauma and gross hematuria or with blunt trauma, pelvic fracture, and microscopic hematuria, CT was performed first followed by retrograde cystography.	CT scan was negative or equivocal for evidence of bladder rupture in the first two patients studied.	Routine abdominopelvic CT is not a reliable method of evaluating bladder rupture. Retrograde cystography remains the most accurate diagnostic technique.

58	Demonstration of Residual Contrast Medium in Renal Parenchyma Using Computerized Tomography. J Urol 1987;137:11-4.	Braedel HU	III	11 patients 6 with renal trauma, 1 with intrarenal abscesses, 2 with pyelonephritis, 1 with renal tumor embolization, and 1 with a solitary renal cyst were inadvertently found to have increased residual contrast medium present after CT. This search was initiated after a solitary patient with transitional cell carcinoma and several patients with renal failure were found to have persistence of contrast medium at other institutions. CTs were performed at initial evaluation (@referral hospital or the study center without times indicated) and in 24 to 48 hrs. Preferable demonstration of retention was by performing CT approximately 1 hr after contrast injection.	Of the 6 renal trauma patients (blunt vs. penetrating was never specified), 5 of the initial CT scans revealed residual contrast medium on the injured side with reduced contrast enhancement of the renal parenchyma. In only one patient, did the CT demonstrate increased uptake of contrast medium at the site of injury.	Protracted residual contrast medium in damaged renal tissue leads to density changes which are highly evident on CT examination. If there is clinical suspicion of renal parenchymal damage in cases of trauma, infection, or vascular disturbance a CT scan should be deferred for at least 1 hr after intravenous contrast medium administration

59	Clinical Indications for Radiologic Evaluation of Blunt Renal Trauma. J Urol 1986;136:370-1.	Cass AS	III	847 consecutive patients with hematuria following blunt external trauma admitted to the hospital were reviewed. 16 patients were excluded due to assoc. urinary tract injuries which could cause hematuria. Clinical findings recorded on initial evaluation were the degree of hematuria found on UA, shock (SBP <100mmHg), and all assoc injuries including intra-abdominal. injuries that were found at admission laparotomy. Radiographic evaluation. consisted of and initial IVP followed by a repeat IVP, CT, or arteriography if the IVP was indeterminate or nonvisualized. Renal injuries were classified as renal contusion, laceration, rupture, and pedicle injury. Follow-up 3 months after injury included clinical evaluation, BP, and IVP or CT.	Microscopic hematuria without shock was noted in 160 of 241 patients without and 334 of 590 with associated injuries. Of the former 160 patients 159 had renal contusion and 1 had a renal laceration, while of the latter 334 patients 329 had renal contusion, 3 had renal laceration, 1 had renal rupture and 1 had a pedicle injury. Most patients with microscopic hematuria and no shock after blunt renal trauma had a renal contusion, especially those with no associated injury.	Most patients with microhematuria and no shock after blunt renal trauma had a renal contusion and experienced no complications with nonoperative management, but a small number with this clinical presentation had severe renal injuries that would have been missed without radiographic evaluation.

60	Computerized Tomographic Staging of Renal Trauma: 85 Consecutive Cases. J Urol 1986;136:561-5.	Bretan PN	II	466 consecutive patients btw. Ages 3 and 84 yrs were evaluation. At San Fran Gen. Hosp. Evaluation was based on the presence of microhematuria or gross hematuria with normal lower genitourinary tract assessment (pelvic fractures. And bladder ruptures excluded), rapid deceleration injury, flank tenderness, or ecchymosis or entrance wound in the vicinity of the kidneys, or retroperitoneal hematoma discovered during CT staging and/or laparotomy for assoc. abdominal. injuries. 85 patients with renal trauma were staged with CT (87.1% blunt and 12.9% penetrating. Surgical exploration was required in 33 patients (38.8%) with findings on CT verified in all patients.	Of their selected study group of 33 patients, CT had a 100% specificity and 100% sensitivity for staging renal trauma. There were no false negative or false positive findings on CT. By direct comparison with IVP and renal arteriography, CT is much more accurate in staging renal trauma.	CT is a more sensitive and specific staging technique than IVP or nephromotography and in many cases arteriography. It differentiates minor from major lacerations, and assesses associated chest and abdominal injuries precisely.

61	Renal Trauma in 125 Cases of Blunt Abdominal Trauma. Cent Afr J Med 1986;32:16-20.	Gordon JA	III	Retrospective review	Of 125 cases of blunt abdominal trauma, 38 cases had an IVP (criteria for IVP not stated) and 14 of these cases showed some abnormality. The latter 14 were divided into two groups 5 cases with macroscopic hematuria and 7 with microscopic hematuria with 2 cases which had no hematuria. The macroscopic hematuria cases all had IVP followed by US ,and/or Radionucleotide scan, or arteriography. Only one case went to the OR after IVP and arteriography. The microscopic cases underwent IVP followed by Radionucleotide scan, US, and or Aortogram with no surgical intervention.	IVP is used to demonstrate the presence of both kidneys which is vital should surgery be performed. Second, IVP may be normal in the presence of renal injury and other studies should be considered if clinical suspicion is high including radionucleotide scanning.
62	Diagnosis of Renal Injury with Computed Tomography. Minn Med 1986;69:207-9.	Vieira J	III	Retrospective review with review of the literature	IVP findings are often indeterminate with major renal injuries while CT clearly defines renal parenchymal injuries, hematoma formation, and extravasation of urine with dye.	CT gives a definitive diagnosis in almost all cases of renal injury with the exception of renal artery injury and should be the initial radiographic study. If there is no parenchymal perfusion or enhancement on CT proceed to renal arteriogram

63	Pathogenesis and Management of Ureteric Injuries. So Afr Med J 1985;68:811-4.	Grizic AM	II	Retrospective review for 5 years and prospective for 2 years. Histories were reviewed with regard to etiology, mode of presentation, management of the injury, and result as determined by the clinic F/U notes. 68 patients with 72 ureteric injuries were included. 53 of these injuries were due to operative trauma and 19 were secondary to external violence. Of the external trauma cases, 7 were blunt and 12 penetrating (9 knife and 3 gunshot)	Injuries of the ureter are of two main types occurring most frequently during intra-abdominal and pelvic surgery while a minority are caused by external trauma. The first type is typically accidental. Excretory urography is the single most valuable diagnostic tool and is accurate in over 90% of cases. In cases of suspected ureteric injury due to external trauma, urography is essential before exploratory laparotomy. US, renal isotope studies and CT can be employed to aid the diagnosis. No further comments are made in the decision process of using the latter.	Most ureteric injuries are due to operative damage and many of these are caused by personnel unfamiliar with the surgery they are performing. The diagnosis is difficult and a high index of suspicion is essential when operating in the vicinity of the ureter and in all cases of blunt or penetrating abdominal trauma.
64	Diagnosis and Management of Bladder Trauma. J Trauma 1973;13:687-94.	Brosman SA	III	90 patients with traumatic bladder injuries were classified according to type of injury: contusion, extraperitoneal rupture, intraperitoneal rupture, and combined injuries.	78 of these patients had sustained blunt injury, and 12 had penetrating injuries. The diagnosis was made by cystography (indications not stated). In patients with blunt trauma, contusions were found in 45%, extraperitoneal lacerations in 28%, intraperitoneal lacerations in 13%, and combined injuries in 14%	Early diagnosis and therapy are necessary to reduce the morbidity and mortality due to traumatic bladder injury. Every patient with pelvic fracture should be suspected of having a bladder injury and should be studied.

65	Urinary Tract Lesions Associated with Fractures of the Pelvis. Acta Chir Scand 1973;139:201-7.	Iversen HG	III	275 patients were admitted with a diagnosis of pelvic fracture over a 10 year period. Cases fell into three groups of trauma stratification: road accidents, accidents at work, and miscellaneous, the latter which was comprised primarily of simple falls at home or on the street. Group I comprises 59 patients with fractures not involving the whole of any part of the pelvic ring. Group II comprises 143 patients with single complete pelvic ring fractures. Group II comprises 73 patients with double fractures , both complete, or a single pelvic ring fracture associated with symphysis rupture or sacro-iliac dislocation.	8 patients were identified with urinary tract ruptures over a 10 year period. A number of cases were missed or treated late. Insufficient attention was give to the possibility of urinary tract lesions in many pelvic fracture patients. Urine microscopy was inconsistently undertaken in all groups and urographic studies were not routine even in group III patients. With the demonstration of hematuria, x-ray studies were conducted in only half the total cases and may have included urography, cystography, or urethrography or a combination of the above.	Routine urographic studies should be undertaken in cases of pelvic injuries. No specific recommendations are made for GU radiographic evaluation.
66	The Management of Renal Injuries coincident with penetrating wounds of the abdomen. J Trauma 1973;13:502-8.	Tynberg PL	III	Review of 60 patients with penetrating renal injuries	Hematuria was present in 83%. IVP was normal in 35%. All contralateral kidneys were normal in location and function	Absence of hematuria or presence of psoas shadow does not rule out renal injury

67	Bladder Trauma Associated with Pelvic Fractures in Severely Injured Patients. J Trauma 1973;13:205-12.	Cass AS	III	73 patients with bladder rupture were admitted to St. Paul-Ramsey Hospital over an 11 year period. Etiology of injury was blunt in 68 patients and penetrating in 7 (3 gunshot wounds and 2 knife wounds). Retrograde cystogram was performed whether microscopic or macroscopic hematuria was present. Pelvic Ring Fractures included were: Anterior (unilateral/bilateral), Anterior and Posterior (unilateral/bilateral), Protrusio acetabulum, Symphysis separation n, Combined Prot. acetabular/sym separation, Ant/Post., Others (not specified)	Cystograms revealed no extravasation in 31 patients with bladder contusion, Intraperitoneal extravasation was present in 17 patients with intraperitoneal rupture of the bladder. The remaining 6 patients did not have cystograms. The diagnosis was made at the time of immediate laparotomy in 4 cases and in 2 at autopsy. Extravasation occurred in 13 patients with extraperitoneal rupture. Three patients did not have cystograms with diagnosis at immediate laparotomy and 2 at autopsy. Normal cystograms were present in 3 patients with extraperitoneal rupture. In these 3 cases, cystograms performed with only 250cc of dye and there was only 1 post-washout film was performed.	A cystogram with a post-washout film performed in the severely injured patient diagnosed bladder injury. False negatives do occur with penetrating wounds and extraperitoneal rupture, making bladder distention with 400 cc of dye mandatory.
68	Comparison of the conservative and surgical management of the more severe degrees of renal trauma in multiple injured patients. J Urol 1973;109:8-10.	Cass AS	II	Retrospective review	Delayed operation was needed in 37.5% of survivors managed non-operatively and an additional 25% were discharged with unilateral non-function. Hospital stay was 45 percent longer. Surgical treatment had less morbidity but loss of the kidney was 3 times more frequent.	A cystogram with a post-washout film performed in the severely injured patient diagnosed bladder injury. False negatives do occur with penetrating wounds and extraperitoneal rupture, making bladder distention with 400 cc of dye mandatory.

69	Management of bladder and urethral injury in conjunction with the immediate surgical treatment of the acute severe trauma patient. J Urol 1972;108:581-5.	Del Villar	III	Retrospective review	Collected data without sufficient details to allow a critical analysis of the 51 patients with bladder injuries or 24 patients with urethral injuries.	Radiologic evaluation with a cystogram and post-wash out film and a retrograde urethrogram allow immediate diagnosis of bladder and urethral injury.
70	Evaluation of renal trauma by infusion urography. J Urol 1971;105:620-2.	Smalley	III	Retrospective review	40 patients with rapid infusion (150 ml maximum) of contrast. 83% were diagnostic. 6 true positive, 0 false positive, 34 true negative, unknown number of false negative.	Infusion urography increases the number of diagnostic studies without risk to the patient and gives pathological significance to non-visualization of all or part of a kidney
71	Renal trauma. J Urol 1970;104:649-53.	Morrow	III	Retrospective review	Diagnostic value of high dose pyelography confirmed by correlation (87%) with selective angiography.	Infusion urography increases the number of diagnostic studies without risk to the patient and gives pathological significance to non-visualization of all or part of a kidney
72	Management of Urethral Injuries in War Casualties. Mil Med 1970;135:748-51.	Rohner TJ	III	49 patients (9 blunt, 40 penetrating) Injury locations: penile 24, bulbous 4, prostatomembranous 12 [penetrating] Prostatomembranous 9 [blunt]	Urethrograms were not done to evaluate either penetrating penile or perineal wounds. Operative management: 1.Bulbous and penile urethra (Penetrating) primary repair w/tissue loss up to 3 centimeters. 2. Membranous Urethra (Blunt) Suprapubic cystostomy and Foley catheter traction for 3 weeks. 3. Prostatic Membranous (Penetrating) Suprapubic cystostomy and splinting urethral catheter w/traction for 3 weeks. Six patients under went primary approximation of the urethra to the bladder, poor results. 4. Penile Wounds. Primary skin closure when there is no urethral involvement	Successful passage of a foley do not exclude a small urethral perforation.

73	The Role of "One-Shot" Intravenous Pyelogram in Evaluation of Penetrating Abdominal Trauma. Am Surg 1997;63:350-3.	Patel VG	III	Retrospective review of 40 patients. Technique was 1.5 ML per KG non ionic contrast IV injection. Portable films were obtained 5-10 minutes following the injection.	19 patients (47.5%) were hypotensive (BP = 90 mm Hg. Before this, 19 patients put in 36 gunshot wounds, 4 stab wounds. Two of 10 patients with urologic injuries had positive IVPs; 7 renal injuries and 3 bladder injuries with no ureteric injuries. Two of the 7 renal injuries had a positive IVP. Nine patients had gross hematuria and only 2 positive IVPs. Nine patients with microscopic hematuria had 3 positive IVPs and only 2 injuries. Of 18 patients with 5 positive IVPs, only 1 patient had a urologic injury. Eighty percent of normal one-shot IVPs had renal injuries identified at laparotomy. Twenty percent of patients with abnormal IVP findings had no intraoperative evidence of a renal injury.	Limited one-shot IVP is of no significant value in assessing penetrating abdominal trauma patients prior to laparotomy.

74	Gunshot Wounds to the Male Genitalia. J Trauma 1995;38:855-8.	Monga M	III	Retrospective review of 50 cases of gunshot wounds to the male genitalia	Distribution of injuries: penis (14), scrotum (26), penis & scrotum (10). Fifty percent of patients had associated injuries. All 36 penile wounds were evaluated with retrograde urethrograms and demonstrated anterior urethral injuries in 8 patients. Five injuries involved the pendulous urethra and 3 the bulbous urethra. Six of 8 partial transections of the urethra underwent primary repair. Two underwent staged procedures with an initial suprapubic cystostomy. Ten corpora cavernosal injuries were primarily repaired. Penile injuries were also repaired primarily. Five of 17 testicular injuries were salvaged with drainage of hematomas and primary repair of the tunica albuginea and/or partial orchiectomy. Follow up for all patients was very limited.	Algorithms with nice systematic steps for diagnosis and management which led to good functional integrity
75	Ureteropelvic Junction Injuries Secondary to Blunt Abdominal Trauma. Radiology 1997;205:487-92.	Kawashima A	III	Retrospective review of 10 patients (2 pediatric, 8 adults). Imaging studies included CT, excretory urography and retrograde pyelography.	CT and urography played complimentary roles in diagnosis. UPJ avulsion (N=4), UPJ laceration (N=6). All 10 patients had medial perirenal contrast extravasation. This did not differentiate avulsion from laceration. A distinctive pattern of contrast material extravasation at CT termed "circumrenal urinoma" was present in 5 patients and specific for UPJ injury.	Medial perinephric contrast material extravasation was highly suggestive of UPJ injury. Demonstration of ureteral filling differentiated UPJ laceration from avulsion.

76	Assessment of the Cortical Rim Sign in Posttraumatic Renal Infarction. J Comp Asst Tom 1996;20:803-6.	Kamel IR	III	Retrospective review of 20 patients diagnosed by dynamic CT scan to have post injury focal or global infarcts. CT scans were reviewed to evaluate the size of the infarction presence and appearance of the rim sign.	Twelve patients had a single CT scan while 8 patients had multiple CT examinations. Fourteen cases demonstrated a rim sign, 8 of which had more than 1 CT. The earliest appearance of the rim sign was 8 hours. Six cases without any rim sign were evaluated within 10 hours of injury with a median time of 4 hours.	In spite of the presence of renal collateral circulation, it takes a minimum period of 8 hours after injury for the collateral circulation to expand and become apparent on CT scan. CT demonstrated a rim sign on all cases performed 1 week after injury.
77	Risk factors and mechanism of urethral injury in pelvic fractures. Br J Urol 1996;77:876-80.	Koraitim MM	II	Prospective study of 203 consecutive male patients with pelvic fracture. Data included clinical examination, radiographic studies of the pelvis, excretory urography and retrograde urethrography.	Thirty nine patients (19%) had a urethral injury. Five patients (2.5%) had a bladder injury and 12 patients (6%) had combined urethral and bladder injuries. Urethral injuries included 13 stretching and 13 (25.5%) partial rupture and 13 (25%) and complete rupture in 25 (49%). Urethral injury was consistently associated with pubic arch fractures. The risk of urethral injury was increased when there is involvement of the anterior and posterior pelvic arch.	The highest risk of urethral injury was associated with a straddle fracture when combined with diastasis of the SI joint (24 x more than the rest of the pelvic fractures). This is straddle fracture alone (3.85 x) and Malgaigne's fracture (3.4 x).
78	The Use of Computed Tomography in Blunt Abdominal Injuries. Am Surg 1996;62:56-9.	Odekwu PO	III	A retrospective review of 256 patients (Total = 2,047) undergoing CT scans. Sixty two (24.2%) were positive for visceral injury. Injury-specific sensitivities were lowest for pancreas (0%), intestinal tract (41.6%), and bladder (50%). False negative scans occurred in 1.9%. No deaths or major complications attributable to delay in diagnosis.	Sensitivity of with visceral injury was 92.4%, specificity was 99.5% and overall accuracy was 97.6%. Urine dipsticks and urinalysis performed poorly as predictors of either significant urologic injury or intra-abdominal injury in general.	Yield for patients scanned with obtundation as an isolated indication was diminished. Cost of CT exceeds that of DPL, but lower procedure-related risk and lower estimated rate of nontherapeutic laparotomy leads to clinical favor of CT scan.

79	The Role of Haematuria in the Diagnosis of Blunt Renal Trauma. Scan J Urol & Nephro 1995;172;99-101.	Moller CM	III	Retrospective review of 114 patients during a ten year period.	Thirteen of 14 patients with major renal trauma had macroscopic hematuria. Three of the 13 patients were in shock and required an acute operation for stabilization. One major renal lesion was diagnosed by acute IVP before urinalysis.	Microscopic hematuria in a hemodynamically stable patient does not require radiographic imaging of the GU system in adults. In contrast, all children should have radiographic evaluation after blunt renal trauma.
80	Diagnostic difficulties in patients with a ruptured bladder. Br J Surg 1995;82:69-70.	Mokoena T	III	Retrospective review of blunt urinary bladder patients diagnosed with blunt urinary bladder rupture. Patients without pelvic fracture, whose only intra-abdominal injury was bladder rupture formed the basis of this report.	Macroscopic hematuria was present in 7/44 patients. A definitive diagnosis was made by voiding cystourethrography in 36/44 patients. Five were diagnosed at laparotomy which was performed for acute abdomen. Three were diagnosed by aspiration of urine ascites. All had cupola lacerations. Thirty six bladder injuries were intraperitoneal and 8 extraperitoneal. Serum urea and creatinine were not diagnostic.	None stated.
81	Comparison of High-Field Magnetic Resonance Imaging with Computed Tomography in the Evaluation of Blunt Renal Trauma. J Trauma 1995;38:420-7.	Leppaniemi A	II	A prospective study of 14 patients who underwent CT and high-field (1.0 T) MRI.	MRI equaled CT in correctly grading the renal injury. MRI images were helpful in determining the extent the renal parenchymal lesion. Both methods were accurate in finding perirenal hematomas, assessing the viability of renal fragments and detecting preexisting renal abnormalities but failed to visualize urinary extravasation on initial examination.	MRI imaging can compliment the gold standard CT in patients with severe renal injury, preexisting renal abnormalities, equivocal CT findings or when repeat radiographic follow up is required. MRI could replace CT in patients with iodine allergy and be used for initial staging if CT is not available.

82	Utility of routine trauma CT in the detection of bladder rupture. Acad Radiol 2000;7:317-24.	Pao DM	III	Retrospective review of 108 patients with blunt pelvic trauma, 10 of whom had bladder ruptures, who underwent both standard abdominal/pelvic CT and conventional cystography	10/10 bladder ruptures were identified by conventional cystography. Extravasation of bladder contrast was noted in only 4/10 patients on abdominal/pelvic CT. 9/10 patients with bladder rupture had extraperitoneal pelvic fluid on abdominal/pelvic CT.	The absence of pelvic fluid on abdominal/pelvic CT indicates that bladder rupture is unlikely. Bladder injury may be present despite absence of contrast material extravasation of abdominal/pelvic CT
83	Severe blunt renal trauma: a 7-year retrospective review from a provincial trauma center. Can J Urol 2001;8:1372-6.	Baverstock R	III	Retrospective review of 227 patients with renal injuries, blunt 93.4%, penetrating 6.6%	Of Grade III, IV, or V injuries, 80% had gross hematuria and 80% had associated trauma. Management was conservative in 87.5% of Grade III and 77.7% of Grade IV; 90.9% of Grade V injuries underwent immediate surgery. No outpatient follow-up.	Blunt renal trauma managed conservatively is associated with few intrahospital complications in the hemodynamically stable patients. Grade V injuries result in a nephrectomy rate of 90.9% due to hemodynamic instability
84	The role of interventional radiology in the management of blunt renal injury: a practical protocol. J Trauma 2001;51:526-31.	Hagiware A	III	Retrospective review of 28 patients with blunt renal artery injury	The incidence of diagnosis of blunt renal artery injury was 0.08% which increased over time	At this institution the incidence of blunt renal artery injury diagnosis is increasing which is attributed to the increased use of CT scan.
85	Blunt Renal Artery Injury: Incidence, Diagnosis, and Management. Am Surg 2001;67:550-6.	Bruce LM	III	Retrospective review of 28 patients with blunt renal artery injury	Most renal artery injuries were diagnosed by CT scans (93%) with seven confirmatory angiograms.	The frequency of diagnosis of blunt renal artery injury is increasing at this institution

86	Is there a role of magnetic resonance imaging in renal trauma? Int J Urol 2001;8:261-7.	Ku JH	II	Prospective study of 12 patients with blunt renal trauma who underwent contrast-enhanced CT followed by MRI	There was no difference on staging of renal injury between Ct and MRI. MRI could delineate intrarenal hematoma from perirenal hematoma and between hematoma and renal parenchyma more accurately than CT. Both CT and MRI were accurate in diagnosing renal infarction in 3 patients.	The presence and size of perirenal hematoma could be detected by both CT and MRI, and both techniques accurately graded renal injury. MRI was able to determine recent bleeding in hematomas, differentiated intrarenal from perirenal hematoma. MRI should be limited to carefully selected patients, such as those with severe renal injury or equivocal findings on CT, as it requires longer imaging time and increases the cost.
87	Gunshot wounds to the ureter: a 40-year experience at Grady Memorial Hospital. J Urol 2001;166:119-21.	Perez-Brayfield MRI	III	Retrospective review of 118 patients with GSW to the ureter	33% false negative IVP	Preoperative testing is of poor reliability
88	Computerized tomography cystography for the diagnosis of traumatic bladder rupture. J Urol 2000;164:43-6.	Deck AJ	III	Retrospective review of 316 blunt trauma patients who underwent CT cystography	CT cystography detected bladder rupture with a sensitivity of 95% and specificity of 100%. CT cystography detected intraperitoneal bladder rupture with a sensitivity of 78% and specificity of 99%	CT cystography rather than plain film cystography should be performed in patients who are already undergoing CT for other injuries
89	Bladder rupture after blunt trauma: guidelines for diagnostic imaging. J Trauma 2001;51:683-6.	Morey AF	III	Retrospective review of 53 patient with blunt bladder rupture from four institutions	100% had gross hematuria and 85% had pelvic fracture	Pelvic fracture with gross hematuria is an indication for cystography in blunt trauma patients

90	Preoperative radiographic staging for ureteral injuries is not warranted in patients undergoing celiotomy for trauma. Am Surg 2001;67:969-73.	DiGiacomo JC	III	Retrospective review of 27 patients with ureteral injury due to penetrating trauma	13/23 patients had documentation of urine appearance preoperatively: 5 gross hematuria, 3 dipstick positive, 5 dipstick negative. 2/23 patients had preoperative IVP, 1/2 demonstrated a transected ureter, 1/2 failed to visualize ureter or kidney on the injured side. All 23 patients underwent operative exploration and there were no missed ureteral injuries.	Preoperative radiographic staging for ureteral injuries is not warranted in patients undergoing celiotomy for trauma
91	Radiographic assessment of renal trauma: a 10-year prospective study of patient selection. J Urol 1989;141:1095-8.	Mee SL	II	Prospective study of 996 patients with suspected renal trauma, 140 penetrating and 856 blunt. All patients with blunt trauma and macroscopic hematuria +/- shock or microscopic hematuria + shock were imaged radiographically; all patients with penetrating renal trauma were imaged radiographically. 404 of the 812 patients with blunt trauma, microscopic hematuria without shock were radiographically imaged	Significant renal injuries were found in 44 patients with blunt trauma, gross hematuria +/- shock or microscopic hematuria + shock. No significant renal injuries occurred in the 812 patients with blunt trauma and microscopic hematuria without shock. Significant renal injuries were found in 63% of patients with penetrating trauma to the flank or abdomen.	Patients with blunt trauma, microscopic hematuria and no shock who do not have associated major intra-abdominal injuries can be managed safely without excretory urography. Complete radiographic staging is mandatory in patients with penetrating trauma to the flank or abdomen.
92	Renal trauma: re-evaluation of the indications for radiographic assessment. J Urol 1985;133:183-7.	Nicolaisen GS	II	Prospective study of 359 consecutive patients with blunt (306) or penetrating (53) renal trauma	No combination of parameters (degree of hematuria, presence of shock, associated injuries) in patients with penetrating trauma was able to predict a severe injury. All blunt trauma patients with microscopic hematuria but no shock had renal contusions and were successfully managed nonoperatively.	Excretory urography is indicated in patients with blunt renal trauma and either macroscopic hematuria +/- shock or microscopic hematuria + shock, and also in penetrating trauma; it is not indicated in patients with microscopic hematuria but no shock after blunt renal trauma

93	Blunt urinary tract trauma: identifying those patients who require radiological diagnostic studies. J Urol 1987;138:99-101.	Hardeman SW	II	Prospective study of 506 consecutive patients with blunt trauma and hematuria	25/506 patients had urinary tract injuries. 21 of these 25 presented with gross hematuria. 1/25 with microscopic hematuria was in shock. The remaining 3 patients with microhematuria without shock were successfully managed conservatively.	Radiographic imaging is indicated in patients with blunt renal trauma and macroscopic hematuria +/- shock or microscopic hematuria + shock, but not microscopic hematuria without shock.
94	Urological injury and assessment in patients with fractured pelvis. J Urol 1984;13:712-4.	Fallon B	III	Retrospective study of 200 patients with pelvic fractures, 32 of whom had urologic injury.	29 of 31 patients with pelvic fracture and urologic injury had gross hematuria; urine specimen was not obtained in 1. 1/77 patients with microscopic hematuria had serious urologic injury.	Urethrography and cystography is not indicated in all patients with pelvic fractures. It is indicated in patients with gross hematuria or when other clinical signs indicate a high likelihood of bladder or urethral trauma
95	Clinical indications for radiographic evaluation of blunt renal trauma. J Urol 1986;136:370.	Cass AS	III	Retrospective review of 831 patients with hematuria and blunt trauma.	160/241 patients with microscopic hematuria but without shock had associated injuries; 334/590 patients had microscopic hematuria without shock and lacked associated injuries. 1/160 had a renal laceration; 3/334 had a renal laceration, 1/334 had renal rupture, 1/334 had a pedicle injury. Only 7 patients with significant injuries had microscopic hematuria alone.	Radiographic evaluation in patients with blunt renal trauma plus microhematuria and no shock will miss a few cases of severe renal injury
96	Significance of hematuria after trauma. J Urol 1978;120:455-6.	Bright TC	II	Prospective study of 142 consecutive patients with hematuria (120 blunt & 22 penetrating)	19 patients had GU injuries, 8/19 required an operation. The degree of hematuria did not correlate with the severity of injury.	The degree of hematuria does not correlate with the severity of injury in patients.

97	The role of computed tomography in renal trauma. Radiology 1981;141:455-60.	Federle MP	II	Prospective study of 15 patients suspected of having renal trauma who received CT & IVP	Ct demonstrated extravasation of urine not detected by urography. Parenchymal injuries & extrarenal hematomas were depicted more accurately by CT, differentiating minor from major/catastrophic injuries.	CT is more accurate than IVP
98	Evaluation of renal injuries with computerized tomography. J Urol 1982;128:456-60.	McAninch JW	II	Prospective study of 24 patients suspected of renal injury who received CT and IVP, and/or nephrotomography	CT demonstrated extravasation not seen on IVP in 4 patients. Renal lacerations, perirenal and intrarenal hematomas were defined more clearly on CT. CT detected liver, spleen or pancreas injuries in 4 patients.	CT is more accurate than IVP
99	Penetrating renal trauma: CT evaluation. J Comp Asst Tomo 1987;11:1026-30.	Federle MP	III	Retrospective study of 27 consecutive patients with SW of the flank	22 patients received CT, 11 IVP, 3 angiogram. IVP underestimated, overestimated, or was indeterminate in many cases. Angio was rarely required to better define renal vascular injuries. CT was accurate. 20 patients were managed nonoperative.	No correlation was found between the presence and amount of hematuria and the extent of renal injury in penetrating trauma patients. IVP was of little use; CT should be the primary diagnostic study in patients with penetrating back or flank trauma judged to be at risk for renal or other retroperitoneal injury.
100	Renal trauma: radiological studies; comparison of urography, computed tomography, angiography, and radionuclide studies. Radiology 1985;154:1-6.	Lang EK	III	Retrospective study of 388 patients with renal trauma. Some patients received IVP, radionuclide urography, angio, conventional or dynamic CT.	IVP excluded renal injury with an accuracy of 87%. Dynamic CT established the correct diagnosis in 129/130 compared to 116/130 for conventional CT. Angio correctly diagnosed 43 renal artery injuries.	CT is more accurate than IVP.

101	Bladder injury in blunt pelvic trauma. Radiology 1986;158:633-8.	Sandler CM	III	Retrospective study of 97 patients with bladder injury secondary to blunt trauma	44 patients had extraperitoneal bladder rupture; 35 had intraperitoneal rupture; 2 had insterstitial bladder injury; 5 had combined intraperitoneal & extraperitoneal bladder rupture. Of 61 patients with film studies available, 2 with intraperitoneal rupture had false-negative cystograms. In 2 other cases, the diagnosis was missed with urography but demonstrated on cystography.	Cystography is more accurate in the diagnosis of bladder injuries than IVP.
102	Major bladder trauma: the accuracy of cystography. J Urol 1983;130:887-8.	Carroll PR	III	Retrospective review of 51 patients with blunt bladder rupture	Extravasation was noted in all 32 cases for which retrograde cystograms were available. Of 32 cystograms found, 4 showed rupture on the drainage film only.	Drainage films and adequate distension of the bladder with contrast medium increases the sensitivity of cystography in the detection of bladder injuries.
103	Major bladder trauma: mechanisms of injury and a unified method of diagnosis and repair. J Urol 1984;132:154-7.	Caroll PR	III	Retrospective review of 51 patients with bladder trauma; 32 blunt, 13 penetrating, 1 spontaneous & 5 iatrogenic injuries.	Extraperitoneal rupture was noted in 32, intraperitoneal rupture in 13, combined intraperitoneal & extraperitoneal rupture in 6. 30/31 with blunt trauma had pelvic fractures. Associated organ injuries were found in 62% with penetrating and 93% with nonpenetrating injuries.	Drainage films and adequate distension of the bladder with contrast medium increases the sensitivity of cystography in the detection of bladder injuries.
104	Indications for emergency intravenous pyelography (IVP) in blunt abdominal trauma: a reappraisal. J Trauma 1986;26:1086-9.	Kisa E	III	Retrospective review of 50 consecutive patients undergoing IVP for blunt trauma.	Significantly abnormal IVP was found in 6/7 patients with gross hematuria. No patient of 43 with microscopic hematuria had a clinically significant abnormality.	Patients with post-traumatic microscopic hematuria alone do not require radiographic imaging. Radiographic imaging is indicated in patients with post-traumatic gross hematuria.

105	Microscopic hematuria after blunt trauma. Is pyelography necessary? Am Surg 1989;55:145-50.	Thomason RB	III	Retrospective review of 102 consecutive patients undergoing IVP after blunt trauma.	26 patients had gross hematuria; of these, 7 had abnormal IVPs, and 2 of those required surgery. 76 patients had microscopic hematuria; of these, none required urologic surgery.	Microscopic hematuria alone is not an indication for radiographic imaging after blunt trauma. Imaging is indicated in the presence of gross hematuria.
106	Renal trauma: evaluation by computerized tomography. J Urol 1985;133:946-9.	Erturk E	III	Retrospective review of 22 patients suspected of major renal trauma	17 were successfully managed nonoperatively; 5 were surgically explored. CT provided precise anatomical detail of the renal injuries and only 2 required angiography for further detail.	CT should be the primary diagnostic modality in patients suspected of sustaining major renal injury and/or other organ injuries.
107	Renal artery and vein injury following blunt trauma. Ann Surg 1975;182:606-8.	Sturm JT	III	Retrospective review of 15 patients with blunt renal vascular trauma	Diagnosis was made immediately in 6 patients, delayed in 5, and at autopsy in 3. The diagnosis was suggested by IVP.	An IVP should be mandatory following severe blunt trauma, especially when hematuria is present. Angiography is indicated when distortion of calyces, extravasation or nonfunction is seen on IVP and allows a definitive diagnosis of renal vessel injury to be made.
108	Evaluation and Treatment of blunt renal trauma. J Urol 1991;146:274-7.	Herschorn S	III	Retrospective review of 126 patients with blunt renal trauma	86 patients had gross hematuria; 37 had microscopic hematuria. All patients with microscopic hematuria without shock had minor injuries. 2 patients had pedicle injuries; both had gross hematuria.	Radiological investigations are not needed in those patients with microscopic hematuria and no shock. When radiologic investigations are indicated, CT scan is the imaging study of choice.
109	Management of Genitourinary Injuries in Patients with pelvic fractures. Ann Surg 1979;189:717-23.	Weems WL	III	Retrospective review of 282 male patients with pelvic fractures.	80 patients had urologic injuries; there were 19 bladder injuries, 20 urethral injuries, & 9 renal injuries. Hematuria occurred in 38 patients.	Hematuria was the only evidence of injury in 38/80 patients with urologic injuries.

110	Computerized tomography cystography for Computed tomographic evaluation of blunt renal injuries. Radiology 1981;141:461-6.	Sandler CM	III	Retrospective review of 10 patients with blunt renal injuries	CT demonstrated the renal injury in 9/10 patients.	CT is valuable in providing definition of urologic injuries and in avoiding angiography.
111	Renovascular trauma: risk assessment, surgical management, and outcome. J Trauma 1990;30:547-54.	Carroll PR	III	Retrospective review of 36 patients (23 penetrating and 13 blunt) with 37 renovascular injuries	The renal artery alone was injured in 9 kidneys, the renal vein alone in 12, and both renal artery and vein in 6. Segmental vessel injuries alone were found in 10 kidneys. Gross hematuria was present in 16 patients, microscopic hematuria in 10, no hematuria in 7, and unrecorded in 3. Only 4 patients had isolated renal injuries. IVP was performed in 11, angio in 5, and CT in 6. IVP demonstrated unilateral nonfunction in 7 patients and urinary extravasation in 1. Nonspecific findings (delayed opacification) were noted in 3. Angiography accurately identified renovascular injury in all 5 cases in which it was performed. CT showed the presence of vascular injury in the 6 patients in whom it was performed.	Although hematuria is usually present, it may be absent despite renovascular trauma. Renal nonfuction is not specific for renovascular injury. CT may accurately stage renal pedicle injuries without angiography.

112	Arteriography in the assessment of renal trauma. J Trauma 1975;15:553-66.	Lang EK	III	Retrospective review of 190 patients with renal trauma (51 penetrating, 139 blunt).	Arteriograms were performed in 176 patients; the remaining patients were clinically unstable. The decision to manage surgically vs nonoperatively was based on angiogram. 113/139 patients with blunt trauma were managed nonoperatively; 25/51 patients with penetrating renal trauma were managed nonoperatively. Complications developed in 3% of patients managed nonoperatively.	Angiography may allow triage of patients with renal trauma into nonoperatively and operatively managed groups.
113	Renal pedicle injury in the multiple injured patient. J Trauma 1985;25:892-6.	Cass AS	III	Retrospective review of 31 patients (25 blunt, 6 penetrating) with renal pedicle injuries	Gross hematuria was found in 13, microscopic hematuria in 5, no hematuria in 12, and unknown in 1. A nonfunctioning kidney was found in 18/21 patients who underwent IVP. Of the remaining 5 patients, 2 had extravasation and 3 had incomplete filling, requiring arteriography in 1 and laparotomy in 2 for the diagnosis. 8 patients did not undergo IVP and the diagnosis was made at laparotomy in 6 and at autopsy in 2.	Hematuria, both macroscopic and microscopic, was absent in 40% of the renal pedicle injuries, requiring a high index of suspicion based on mechanism of injury.
114	Renal vascular injuries. Am Surg 1986;52:30-6.	Meacham PW	III	Retrospective review of 17 patients (6 blunt, 9 penetrating) with renal vascular injuries	Gross hematuria was present in 6 patients and microscopic hematuria found in 5. IVP was abnormal in 4/5 patients with renal artery injury and 1/1 patients with renal vein injury. Arteriogram was abnormal in 5/5 patients with renal artery injury.	None stated.

115	Traumatic renal artery occlusion: a 15-year review. J Trauma 1998;45:557-61.	Haas CA	III	Retrospective review of 12 patients with blunt renal artery injury.	7/8 patients had hematuria, results unknown for 4 patients. CT established the diagnosis in 9/9 patients who underwent this test.	Diagnosis requires a high index of suspicion. Hematuria was absent in 12.5% of patients.
116	Accuracy of computed tomography in diagnosing renal artery injuries. Urology 1989;34:249-51.	Cass AS	III	Retrospective study of 7 patients with renal artery injury.	All 7 patients were diagnosed successfully by CT demonstration of lack of opacification or lack of enhancement of kidney	CT is accurate in the diagnosis of renal artery injury.
117	Renal trauma: reevaluation of indications for radiographic assessment. J Urol 1985;133:183-7.	Nicolaisen GS	II	Prospective study of 369 consecutive patients with renal trauma (306 blunt, 53 penetrating)	In patients with penetrating injuries, neither hematuria, shock, or associated injuries could predict the presence/extent of renal trauma. Patients with microscopic hematuria without shock did not require operation and therefore should not be worked up urographically. Only patients with penetrating injuries or blunt injury with gross hematuria or blunt injury with microscopic hematuria should undergo evaluation.	Blunt trauma patients with microscopic hematuria without shock should not undergo urographic evaluation. This should be reserved for patients with penetrating injuries or blunt trauma patients with either gross hematuria +/- shock or microscopic hematuria + shock.
118	CT diagnosis of renal pedicle injury. Urol Radiol 1985;7:63-8.	Sclafani SJ	III	Retrospective review of 6 patients with renal vascular injury.	The most specific CT signs of renal vascular injury included nonexcretion, "rim" enhancement, and abrupt termination of an enhanced renal artery. Nonspecific CT signs included central retroperitoneal hematoma associated with limited perinephric hematoma.	CT allowed for differentiation of causes of absent or poor urographic nephrogram after trauma and may obviate the need for time-consuming angiography. CT should replace IVP for the evaluation of polytrauma.
119	The CT appearance of renal pedicle injury. J Urol 1984;132:1163-4.	Steinberg DL	III	Retrospective review of 2 patients with traumatic renal artery occlusion, with an additional review of 60 cases of renal trauma without renal artery injury.	CT demonstrated nonfunctioning, normal-sized kidney with minimal or no contrast enhancement in both patients.	These CT findings appear to be specific for occlusion of the renal pedicle

120	Management of traumatic hematuria by selective renal artery embolization. J Urol 1984;132:662-7.	Uflacker R	III	Retrospective review of 17 patients with renal injury and hematuria who underwent angiography and selective renal arterial embolization	8/17 patients had urinary extravasation, 6/17 had traumatic AV fistulas, 5/17 had pseudoaneurysm.	Angiography and embolization should be performed in patients with renal trauma and uncontrolled hematuria before any surgical attempt is made.
121	Ureteral and renal pelvic injuries from external trauma: diagnosis and management. J Trauma 1989;29:370-4.	Presti JC	III	Retrospective review of 18 patients with 19 collecting system injuries (16 penetrating, 3 blunt)	IVP was diagnostic of ureteral injury in 3/8. Retrograde pyelography was diagnostic in 1/1 patients.	IVP & initial urinalysis may be unreliable indicators of ureteral and renal pelvic injury, and high suspicion mandates exploration.
122	Ureteral injuries from penetrating trauma. J Trauma 1994;36:766-9.	Brandes SB	III	Retrospective review of 12 patients with penetrating ureteral injuries who underwent exploratory laparotomy upon admission	11/12 injuries were diagnosed at surgery. Diagnosis was delayed in one patient for 2 weeks, when CT demonstrated a urinoma. High-dose IVP was nondiagnostic in 9/9 patients. Hematuria was absent in 5/11 patients.	Urinalysis and high-dose IVP are not reliable for detecting penetrating ureteral injury. In addition, 1/12 ureteral injuries was not initially identified, despite routine surgical exploration, urinalysis, and IVP. A high index of suspicion is required to diagnose ureteral injury.
123	Penetrating ureteric injuries. Injury 1998;29:363-7.	Azimuddin K	III	Retrospective chart review of 20 patients.	33% had macroscopic hematuria, 33% had microscopic hematuria. Only 1 of 7 pre- or intra-operative excretory urograms demonstrated an injury. All operative repairs were stented with a double-J stent. 3 patients had a urinary leak post-operatively.	A high index of suspicion is necessary in patients with a penetrating wound to the retroperitoneum. It is important to thoroughly examine the ureteric bed intraoperatively. A double-J stent should be used for all repairs.