Hematuria—Child
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Strength of Evidence
1. Feld LG, Waz WR, Perez LM, Joseph DB. Hematuria. An integrated medical and surgical approach. *Pediatr Clin North Am* 1997; 44(5):1191-1210.	12	N/A	To review microscopic and gross hematuria and define an approach to evaluation of hematuria.	The initial evaluation of gross or macroscopic hematuria may require only a urine culture, urine calcium-to-creatinine ratio, and renal and bladder US or a very detailed evaluation for renal parenchymal disease, stones, tumors, or anatomic abnormalities. Consultation with a pediatric nephrologist, urologist, or both is necessary in these instances.	4
2. Gordon C, Stapleton FB. Hematuria in adolescents. *Adolesc Med Clin* 2005; 16(1):229-239.	12	N/A	To review causes and methods of evaluating hematuria in adolescents.	Renal US has little risk and is helpful in diagnosing many of the conditions requiring intervention. Serum studies offer little useful information in the evaluation of microscopic hematuria.	4
3. Patel HP, Bissler JJ. Hematuria in children. *Pediatr Clin North Am* 2001; 48(6):1519-1537.	12	N/A	To review causes and evaluation of pediatric hematuria.	Complete urinalysis with a microscopic examination is the only test uniformly required for children with various presentations of hematuria. The rest of the evaluation is tailored according to the pertinent history, physical examination, and other abnormalities on the urinalysis.	4
4. Benbassat J, Gergawi M, Offringa M, Drukker A. Symptomless microhaematuria in schoolchildren: causes for variable management strategies. *Qjm* 1996; 89(11):845-854.	12	N/A	Review published data on frequency of underlying disorder in school children with microscopic or gross isolated hematuria (IH).	Authors found 5 reports of microscopic IH in screened asymptomatic schoolchildren, 3 reports of microscopic IH detected by case-finding and 5 surveys of kidney biopsies in referred children with microscopic and gross IH. The combined prevalence of 5 disorders was 0%-7.2% in children with microscopic IH detected by screening, and 3.3%-13.6% in those with microscopic IH detected by case-finding.	3
5. Cilento BG, Jr., Stock JA, Kaplan GW. Hematuria in children. A practical approach. *Urol Clin North Am* 1995; 22(1):43-55.	12	N/A	To review causes of hematuria in childhood and present a diagnostic strategy.	Microscopic examination of the urinary sediment is important in evaluating hematuria. Genitourinary (GU) imaging should be tailored to each clinical situation.	4
6. Fitzwater DS, Wyatt RJ. Hematuria. *Pediatr Rev* 1994; 15(3):102-108; quiz 109.	12	N/A	To outline a plan for the evaluation of pediatric patient with hematuria.	The most important differentiating feature in differential diagnosis for hematuria is the presence or absence of proteinuria. Those with significant proteinuria deserve a rapid evaluation and early referral to a nephrologist while those with no proteinuria should be followed and a step-wise evaluation performed.	4

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7. Hisano S, Kwano M, Hatae K, et al. Asymptomatic isolated microhaematuria: natural history of 136 children. *Pediatr Nephrol* 1991; 5(5):578-581.	13	136	To evaluate the natural history of asymptomatic isolated microhematuria (ASH) detected by mass screening.	Study suggests prognosis of ASH is good. Renal biopsy is not indicated for children with ASH.	3
8. Lieu TA, Grasmeder HM, 3rd, Kaplan BS. An approach to the evaluation and treatment of microscopic hematuria. *Pediatr Clin North Am* 1991; 38(3):579-592.	12	N/A	To review an approach to the evaluation and treatment of microscopic or symptomatic hematuria in children.	Initial evaluation of microscopic hematuria in a healthy child involves looking for signs of life-threatening causes of hematuria. If signs are absent, a stepwise evaluation (includes microscopic examination of the urine for red blood cell casts, a test for proteinuria, serum creatinine, and serial follow-up) is recommended. Although renal biopsy may establish a diagnosis it seldom changes the treatment in a child with ASH.	4
9. Osegbe DN. Haematuria and sickle cell disease. A report of 12 cases and review of the literature. *Trop Geogr Med* 1990; 42(1):22-27.	12	12	To review the pathophysiology of sickle cell-induced haematuria, its incidence rate, its diagnostic criteria and available modalities of treatment.	Study suggests that diagnosis of sickle cell induced haematuria should be based on identifiable features and not merely by exclusion of other lesions.	3
10. Tarry WF, Duckett JW, Jr., Snyder HM, 3rd. Urological complications of sickle cell disease in a pediatric population. *J Urol* 1987; 138(3):592-594.	15	321	Survey patients and review literature to define urologic complications of sickle cell disease in a pediatric population.	Urological problems realized are hematuria, urinary tract infection and priapism. Study found that priapism responds most often to nonsurgical therapy and rarely results in impotence in young sickle cell patients.	3
11. Meyers KE. Evaluation of hematuria in children. *Urol Clin North Am* 2004; 31(3):559-573, x.	12	N/A	To review diagnosis and management of macrohematuria and microhematuria in children.	For macrohematuria, US is needed to exclude malignancy or cystic renal disease. For microhematuria, US yield remains unproven but the value of a normal renal US examination in terms of reassurance may justify its cost and time.	3
12. Park YH, Choi JY, Chung HS, et al. Hematuria and proteinuria in a mass school urine screening test. *Pediatr Nephrol* 2005; 20(8):1126-1130.	13	1044	To evaluate the significance of mass screening test in children with hematuria and proteinuria. Patient's history, physical examination, laboratory tests, kidney US and Doppler US were used.	Mass screening can detect chronic renal disease in its early stage.	2

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13. Greenfield SP, Williot P, Kaplan D. Gross hematuria in children: a ten-year review. *Urology* 2007; 69(1):166-169.	13	342 (272 boys (80%) and 70 girls (20%))	Review patients' charts to characterize the clinical presentation and diagnosis of gross hematuria.	• Of the 272 boys, 52 (19%) had benign urethrorrhagia; 48 (14%) had trauma; and 48 (14%) had a urinary tract infection, and 10 of those also had urologic anomalies. • Of the 342 patients, 45 (13%) had one or more congenital urologic anomalies. Of these, 45 patients, 20 boys and 2 girls had vesicoureteral reflux, 10 boys had posterior urethral valves, 7 boys and 1 girl had ureteropelvic junction obstruction, 7 boys had proximal hypospadias, 2 boys and 1 girl had ureterovesical junction obstruction, 2 boys and 1 girl had ureterocele, and 1 boy had caliceal diverticulum. • Voiding cystourethrography is useful in those with suspicious US findings, urinary tract infection, or voiding symptoms. Cystoscopy should be reserved for the minority in whom hematuria persists or those with ambiguous imaging study findings.	2
14. Shin JI, Park JM, Lee JS, Kim MJ. Effect of renal Doppler ultrasound on the detection of nutcracker syndrome in children with hematuria. *Eur J Pediatr* 2007; 166(5):399-404.	10	248 (216 with hematuria and 32 healthy)	To determine the accuracy of renal Doppler US in detecting nutcracker syndrome in children with hematuria.	• The peak velocity (PV) at the aortomesenteric portion (P=0.003) and the PV ratios of the left renal vein (LRV) (P=0.003) were significantly higher in children with hematuria than in normal children, while the PV at the hilar portion was not different. • Renal Doppler US has an effect on the detection of nutcracker syndrome.	2
15. Gleason PE, Kramer SA. Genitourinary polyps in children. *Urology* 1994; 44(1):106-109.	13	16	Retrospective review of presenting complaints, diagnostic evaluation, treatment, and natural history of children with GU polyps seen at a clinic.	GU polyps in children can be diagnosed with excretory urography, with voiding cystourethrography, or endoscopically. The biologic activity of these polyps is uniformly benign, and there have been no recurrences following complete excision.	3

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16. Lee CC, Lin JT, Deng HH, Lin ST. Hematuria due to nutcracker phenomenon of left renal vein: report of a case. *J Formos Med Assoc* 1993; 92(3):291-293.	14	1	To report the diagnosis of LRV compression by a nutcracker phenomenon in an 11-year-old patient with 2-year history of recurrent painless hematuria.	Renal US study, selective left renal angiography and retrograde left renal venography showed evidence of compression of the LRV where it crossed between the aorta and the superior mesenteric artery (SMA). A needle biopsy of the right kidney revealed no abnormal histologic change.	4
17. Takahashi Y, Akaishi K, Sano A, Kuroda Y. Intra-arterial digital subtraction angiography for children with idiopathic renal bleeding: a diagnosis of nutcracker phenomenon. *Clin Nephrol* 1988; 30(3):134-140.	13	28	To review the diagnosis of the nutcracker phenomenon in children with nonglomerular idiopathic renal bleeding.	In 22/28 cases, digital subtraction angiography (DSA) showed the entrapment of the LRV, or nutcracker phenomenon. Study suggests most nutcracker phenomenon should be diagnosed on US but notes that intra-arterial DSA is an important tool to establish the disease entity and ultrasonic criteria.	3
18. Mishra VC, Rowe E, Rao AR, et al. Role of i.v. urography in patients with haematuria. *Scand J Urol Nephrol* 2004; 38(3):236-239.	9	1,211	Retrospective study to evaluate the impact of the omission of i.v. urography (IVU) on the diagnosis of renal tract malignancies and other non-malignant but significant conditions. Diagnostic yields of IVU and US were compared.	US combined with a MAG III renogram could be considered as a first-line investigation instead of IVU. This is likely to result in maximum detection of malignant and non-malignant conditions, while reducing the radiation exposure to the patient.	2
19. Hogg RJ, Silva FG, Berry PL, Wenz JE. Glomerular lesions in adolescents with gross hematuria or the nephrotic syndrome. Report of the Southwest Pediatric Nephrology Study Group. *Pediatr Nephrol* 1993; 7(1):27-31.	13	121 56 with gross hematuria and 65 with idiopathic nephrotic syndrome (INS).	Retrospective study to define the specific glomerular lesions in adolescents with gross hematuria or idiopathic nephrotic syndrome.	IgA nephropathy is the most frequent findings on renal biopsy in adolescents with gross hematuria.	3
20. Fitoz S, Ekim M, Ozcakar ZB, Elhan AH, Yalcinkaya F. Nutcracker syndrome in children: the role of upright position examination and superior mesenteric artery angle measurement in the diagnosis. *J Ultrasound Med* 2007; 26(5):573-580.	9	49	To evaluate the pathophysiology characteristics of nutcracker syndrome and to assess the role of upright position imaging and SMA angle measurement in the diagnosis.	The SMA angle measurement had sensitivity and specificity of 69.6% and 61.5%, respectively, in the supine position and 87.0% and 76.9% in the upright position when the cutoff values were set to less than 41 degrees and 21 degrees, respectively.	2

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21. Fu WJ, Hong BF, Gao JP, et al. Nutcracker phenomenon: a new diagnostic method of multislice computed tomography angiography. *Int J Urol* 2006; 13(7):870-873.	10	4 with nutcracker phenomenon 10 healthy controls	To evaluate the role of 3D CTA in the diagnosis of nutcracker phenomenon and its importance in postoperative follow-up.	• The angles and distances between the SMA and the aorta were 39.3 ± 4.3 degrees and 3.1 ± 0.2 mm in the patient groups and 90 ± 10 degrees and 12 ± 1.8 mm in the control groups, respectively. • Since 3D CTA revealed that unusual hematuria was due to compression of the LRV, it may be a useful alternative imaging technique instead of conventional examinations. The non-invasive 3D CTA may be a useful tool in the diagnosis of the nutcracker phenomenon and follow-up testing.	3
22. Shin JI, Park JM, Lee JS, Kim MJ. Doppler ultrasonographic indices in diagnosing nutcracker syndrome in children. *Pediatr Nephrol* 2007; 22(3):409-413.	10	30	Analysis of Doppler spectral findings to explain the Doppler US cut-off value of nutcracker syndrome causing hematuria in children.	When the cut-off values for nutcracker syndrome was set at the mean+/-2 SD (mean: 2.95+/-0.92, range: 1.60-5.02) of 30 controls (normal children and relieved nutcracker without hematuria), the calculated cut-off value was 4.8, and the sensitivity and specificity were 100% and 93%, respectively.	2
23. Shin JI, Park JM, Lee SM, et al. Factors affecting spontaneous resolution of hematuria in childhood nutcracker syndrome. *Pediatr Nephrol* 2005; 20(5):609-613.	13	20	Retrospective analysis of patients to identify factors affecting spontaneous resolution of hematuria in children with nutcracker syndrome.	The PV ratios of the LRV at the follow-up US decreased significantly when compared to the first US examination (7.74+/-2.64 vs 3.50+/-1.09, p<0.0001), and height (147.4+/-20.1 vs 152.3+/-18.8 cm) and weight (36.1+/-10.9 vs 42.3+/-12.7 kg) increased (p<0.0001). Changes in the PV ratios of the LRV correlated positively with changes in the PV at the aortomesenteric portion (r=0.569, p=0.009). Changes in the PV at the aortomesenteric portion correlated negatively with changes in body mass index (BMI) (r=-0.543, p=0.013).	3

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24. Jequier S, Cramer B, Petitjeanroget T. Ultrasonographic screening of childhood hematuria. *Can Assoc Radiol J* 1987; 38(3):170-176.	9	184	To define the value of US on pediatric patients with hematuria. Compared US and IVU results.	• US and IVU were in agreement in 83% of patients. • US gave additional information in 44 patients (40%) with 56 findings not detected using IVU. • In six patients (5.5%), lesions were missed using US but detected using IVU. In the remaining 58 patients, IVU and US were equally informative. • US is an excellent screening method for use in childhood hematuria and can replace IVU in patients with minor posttraumatic hematuria and in most with glomerular disease.	2
25. Stapleton FB. Hematuria associated with hypercalciuria and hyperuricosuria: a practical approach *Pediatr Nephrol* 1994; 8(6):756-761.	12	N/A	To review diagnostic criteria of excessive urinary excretion of calcium and uric acid. Emphasis is placed on differences in urinary calcium and uric acid excretion between infants and older children.	Few long-term consequences from hypercalciuria or hyperuricosuria have been identified, although some debate exists concerning the effect of chronic hypercalciuria upon bone mineralization.	4
26. Strouse PJ, Bates DG, Bloom DA, Goodsitt MM. Non-contrast thin-section helical CT of urinary tract calculi in children. *Pediatr Radiol* 2002; 32(5):326-332.	13	113 (137 CT exams)	To determine if non-contrast thin section helical CT is useful for the diagnosis of urinary tract calculi in children. Radiology databases at three pediatric institutions were searched to identify all pediatric patients evaluated by "renal stone" protocol CT scans.	CT is a useful method to diagnose urinary tract calculi in children. Radiation dose in this retrospective study may exceed the lowest possible radiation dose for diagnostic accuracy.	2
27. Levine JA, Neitlich J, Verga M, Dalrymple N, Smith RC. Ureteral calculi in patients with flank pain: correlation of plain radiography with unenhanced helical CT. *Radiology* 1997; 204(1):27-31.	10	178	To compare retrospectively the accuracy of radiographs for ureteral calculi using CT as a gold standard.	For detection of ureteral calculi: • Original reading (before the patient underwent CT) was 45% for sensitivity and 77% for specificity. • Blinded reading was 59% for sensitivity and 71% for specificity. • Unblinded reading was 59% sensitivity (95%, CI: 47%-70%).	1

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28. Oner S, Oto A, Tekgul S, et al. Comparison of spiral CT and US in the evaluation of pediatric urolithiasis. *Jbr-Btr* 2004; 87(5):219-223.	9	29	To determine the value of spiral CT in detecting pediatric urolithiasis and compare its value with US.	• Spiral CT detected 57 stones (45 renal and 12 ureteral). US detected 34 stones (59.6%) in 18 (78.2%) patients. • US localized 31 stones (68.8%) in 21 kidneys (75%) and 3 stones (25%) in 11 ureters (27.2%). • Spiral CT is very effective in the diagnosis of pediatric urolithiasis and is more efficient than US in imaging pediatric patients with symptoms and signs of urolithiasis, when KUB is inconclusive.	2
29. Palmer JS, Donaher ER, O'Riordan MA, Dell KM. Diagnosis of pediatric urolithiasis: role of ultrasound and computerized tomography. *J Urol* 2005; 174(4 Pt 1):1413-1416.	9	75	Retrospective review of children's (ages 0 to 18 years) charts to describe the presenting features and radiographic evaluation of pediatric urolithiasis, and to determine the accuracy of US and unenhanced CT in detecting urolithiasis.	• 39 CT: accurate in detecting calculi in children with urolithiasis symptoms (96%-100%) and in those without symptoms (100%). • 36 US: more variable accuracy in children with urolithiasis symptoms (33%-100%) vs those without symptoms (89%). • US failed to detect urolithiasis in 41% of the patients with urolithiasis symptoms, compared to 5% with CT. • CT was highly accurate regardless of calculus location (89%-100%), whereas US was again more variable (kidney 90%, kidney and ureter 75%, ureter alone 38%).	2
30. O'Connor OJ, McSweeney SE, Maher MM. Imaging of hematuria. *Radiol Clin North Am* 2008; 46(1):113-132, vii.	12	N/A	To review current status of imaging of patients suspected of having urologic causes of hematuria and role of modalities used in the evaluation of these patients. Focus on MD-CTA.	Most recent data validate use of MD-CTA in the evaluation of the urothelium for neoplasms. Future studies must concentrate on radiation dose optimization and radiation dose reduction.	4
31. Potretzke AM, Monga M. Imaging modalities for urolithiasis: impact on management. *Curr Opin Urol* 2008; 18(2):199-204.	12	N/A	To review imaging modalities used for the diagnosis of calculi and its impact on management.	CT has become a common diagnostic modality for urolithiasis and may provide prognostic information regarding the success of specific management strategies for urolithiasis.	4
32. Ulusan S, Koc Z, Tokmak N. Accuracy of sonography for detecting renal stone: comparison with CT. *J Clin Ultrasound* 2007; 35(5):256-261.	10	50	To determine accuracy of US in the detection of renal stones. Noncontrast CT is used as the gold standard. Also correlated the accuracy of US with stone size, kidney affected (right vs. left) and body mass index (BMI).	• Sensitivity of US was 52%-57% for the right kidney and 32%-39% for the left kidney. • The overall accuracy of US in detecting a stone in the right kidney by radiologists 1 and 2 was 67% and 77%, respectively. The corresponding accuracy values for the left kidney were 53% and 54%, respectively.	2

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33. Lee JY, Kim SH, Cho JY, Han D. Color and power Doppler twinkling artifacts from urinary stones: clinical observations and phantom studies. *AJR* 2001; 176(6):1441-1445.	13	32	Prospective study to determine how often urinary stones show twinkling artifacts on Doppler US. Gray-scale images and color, power, and spectral Doppler images were obtained in all patients.	• 30/36 (83%) urinary stones showed color and power Doppler twinkling artifacts. • 22/30 stones with the twinkling artifacts showed strong intensity artifacts. • Spectra with saturated amplitude were obtained from all 30 stones showing color Doppler artifacts. • Color Doppler twinkling artifacts may be useful in determining the presence of urinary stones.	3
34. Turrin A, Minola P, Costa F, Cerati L, Andrulli S, Trinchieri A. Diagnostic value of colour Doppler twinkling artefact in sites negative for stones on B mode renal sonography. *Urol Res* 2007; 35(6):313-317.	10	67 with urinary stone 67 control	To determine the diagnostic value of color Doppler twinkling artifact in sites negative for stones on B-mode renal US.	• Twinkling artifact was frequent in patients with stone disease (95.5%) compared to controls (9.0%) ($P<0.001$). • Twinkling artifact was highly associated to renal stone disease and present in renal areas where a stone was undetected with B-mode approach suggesting its diagnostic role although further studies are needed to confirm its accuracy.	2
35. McAleer IM, Kaplan GW. Pediatric genitourinary trauma. *Urol Clin North Am* 1995; 22(1):177-188.	12	N/A	To review GU trauma in children.	CT is the preferred diagnostic imaging modality. Cystography and urethrography are essential in diagnosing bladder and ureteral injuries.	4
36. Stalker HP, Kaufman RA, Stedje K. The significance of hematuria in children after blunt abdominal trauma. *AJR Am J Roentgenol* 1990; 154(3):569-571.	13	256	Review and analyze medical records and CT examinations of children to assess the significance of hematuria after blunt abdominal trauma.	Direct relationship between the amount of hematuria and the severity of renal injury. No normotensive child with fewer than 50 red blood cells (RBC) per high-power field had a significant renal injury, and conversely, all children with significant renal injuries had either large amounts of hematuria or shock.	2

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37. Brown SL, Haas C, Dinchman KH, Elder JS, Spirnak JP. Radiologic evaluation of pediatric blunt renal trauma in patients with microscopic hematuria. *World J Surg* 2001; 25(12):1557-1560.	13	1,200	Retrospective review of medical records to determine if radiographic evaluation is required in children with microscopic hematuria and blunt renal trauma.	• 65 patients had microscopic hematuria. 3/65 had significant renal injury while 32 had normal findings. • The degree of hematuria did not correlate with the grade of renal injury. Pediatric patients with blunt trauma, microscopic hematuria, and no associated injuries do not require radiologic evaluation, as significant renal injuries are unlikely, but children with associated injuries and microscopic hematuria after blunt trauma may have significant renal injuries and should undergo radiologic evaluation.	2
38. Chopra P, St-Vil D, Yazbeck S. Blunt renal trauma-blessing in disguise? *J Pediatr Surg* 2002; 37(5):779-782.	13	103	Retrospective review of medical records to quantify pathologic lesions of the kidney found incidentally during the workup of a blunt renal trauma. Patients had US, Doppler of renal vessels. CT, cystography, or nuclear medicine functional studies were performed as indicated.	• Coexisting urogenital lesions were identified in 13/103 (12.6%). Stenosis of the uretero-pelvic junction was the most frequent diagnosis (n=7): 3 patients required uretero-pyeloplasty, and 3 required nephrectomy. • 2 heterogeneous renal masses were discovered; elective resection and open biopsy were performed. • The diagnoses of multicystic kidney and solitary cyst with complex hematoma, respectively, were confirmed on pathology.	3
39. Levy JB, Baskin LS, Ewalt DH, et al. Nonoperative management of blunt pediatric major renal trauma. *Urology* 1993; 42(4):418-424.	13	61	Retrospective review to determine which patients with blunt renal trauma and hematuria required imaging, and the best way of managing major renal injuries.	Gross hematuria (n=10) was a significant predictor of major renal injury (n=5) ($p<0.001$). All 3 patients with microscopic hematuria and a major renal injury also had evidence of multisystem trauma. Admission blood pressure, hemoglobin, and trauma score were not predictors of major renal trauma.	2
40. Morey AF, Bruce JE, McAninch JW. Efficacy of radiographic imaging in pediatric blunt renal trauma. *J Urol* 1996; 156(6):2014-2018.	13	180	Review records to determine the accuracy of radiographic imaging in detecting renal injuries in children with blunt trauma with no significant hematuria.	• Of 33 patients with gross hematuria, renal injuries were found in 9, including 3 who required immediate surgical repair of a major renal laceration or vascular injury. • Combining results with other reported series showed significant renal injuries in 11/548 children (2%) with less than 50 RBC per high power field on presenting urinalysis after blunt abdominal trauma.	3

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41. Nguyen MM, Das S. Pediatric renal trauma. *Urology* 2002; 59(5):762-766; discussion 766-767.	13	61	Analyze medical records to determine the appropriate indications for imaging and operative intervention in pediatric renal trauma.	To make the decision for renal imaging for the diagnosis and grading of renal injuries, clinical status, history, injury mechanism must be considered in addition to urinalysis.	3
42. Santucci RA, Langenburg SE, Zachareas MJ. Traumatic hematuria in children can be evaluated as in adults. *J Urol* 2004; 171(2 Pt 1):822-825.	13	720	Retrospective review to evaluate whether the criteria for imaging the renal parenchyma in adult blunt trauma victims apply to the pediatric population.	334/720 patients had imaging and 59 renal injures were identified. It is appropriate to image pediatric trauma cases based on the adult criteria of gross hematuria, shock and significant deceleration injury.	2
43. Nance ML, Lutz N, Carr MC, Canning DA, Stafford PW. Blunt renal injuries in children can be managed nonoperatively: outcome in a consecutive series of patients. *J Trauma* 2004; 57(3):474-478; discussion 478.	15	101	Review management and outcome data of consecutive series of children with blunt renal injury to determine whether pediatric renal injuries can be managed nonoperatively.	Nonoperative management strategy was useful and successful in pediatric blunt renal injuries (94.7% successful nonoperative rate, 98.9% renal salvage rate). Adjunctive urologic procedures (eg, ureteral stenting) were useful in selected cases.	3
44. Taylor GA, Eichelberger MR, Potter BM. Hematuria. A marker of abdominal injury in children after blunt trauma. *Ann Surg* 1988; 208(6):688-693.	13	378	To examine the significance of hematuria.in children with blunt abdominal trauma in order to define its diagnostic role and outline a rationale for use of CT.	Asymptomatic hematuria is a low-yield indication for abdominal CT. When in association with other suggestive clinical signs and symptoms, the presence and severity of hematuria can be useful markers of underlying abdominal injury.	3
45. Abou-Jaoude WA, Sugarman JM, Fallat ME, Casale AJ. Indicators of genitourinary tract injury or anomaly in cases of pediatric blunt trauma. *J Pediatr Surg* 1996; 31(1):86-89; discussion 90.	13	100	Retrospective review: • To determine whether a certain threshold of microscopic hematuria was associated with GU tract injury, and • To identify additional factors warranting evaluation of the GU. • All but one study patient had an intravenous pyelogram and/or CT.	• A threshold of ≥20 RBCs/HPF as an indication for radiographic evaluation would have missed 28% of cases with GU tract injuries or occult anomalies. • Pelvic fractures and abdominal/chest injuries help to identify patients who require evaluation of the GU tract.	2
46. Perez-Brayfield MR, Gatti JM, Smith EA, et al. Blunt traumatic hematuria in children. Is a simplified algorithm justified? *J Urol* 2002; 167(6):2543-2546; discussion 2546-2547.	13	110	Retrospective review to determine if radiographic evaluation is indicated in all children with traumatic hematuria.	Radiological evaluation (abdominal and pelvic CT) should be performed only in patients with ≥50 RBC on urinalysis, hypotension at presentation to the emergency room or based on the severity of mechanism of injury.	3
47. Rathaus V, Pomeranz A, Shapiro-Feinberg M, Zissin R. Isolated severe renal injuries after minimal blunt trauma to the upper abdomen and flank: CT findings. *Emerg Radiol* 2004; 10(4):190-192.	14	6	To describe renal injuries in patients with major isolated renal injuries resulting from minimal blunt trauma to the upper abdomen and/or the flank.	Major kidney insult can occur after a minimal blunt trauma localized to the flank or upper abdomen. Abdominal CT is recommended when clinical findings suggest renal injury.	4

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48. Filiatrault D, Longpre D, Patriquin H, et al. Investigation of childhood blunt abdominal trauma: a practical approach using ultrasound as the initial diagnostic modality. *Pediatr Radiol* 1987; 17(5):373-379.	9	170	Retrospective study to examine childhood blunt abdominal trauma with IVU, US and scintigraphy.	US became the first line screening tool, and was combined with IVU in suspected renal trauma.	2
49. Sirlin CB, Brown MA, Deutsch R, et al. Screening US for blunt abdominal trauma: objective predictors of false-negative findings and missed injuries. *Radiology* 2003; 229(3):766-774.	13	3,679	Retrospective review to determine the risk for missed injury in patients with blunt abdominal trauma and negative findings at screening US and with coexistent hematuria or fracture of the sixth through 12th ribs, lumbar spine, or pelvis.	Patients with hematuria, lower rib fractures, and pelvic fractures are at much higher risk for having a false-negative FAST (focused assessment with US in trauma) scan (including having missed renal injury), and should undergo CT.	2
50. Korner M, Krotz MM, Degenhart C, Pfeifer KJ, Reiser MF, Linsenmaier U. Current Role of Emergency US in Patients with Major Trauma. *Radiographics* 2008; 28(1):225-242.	12	N/A	To review the current role of US in patients with major trauma.	US is usually the initial imaging examination for major trauma patients, but because of its poor sensitivity for the detection of most solid organs, the initial survey with US is often performed with a FAST protocol. FAST may be used also to exclude injuries to the heart and pericardium.	4
51. McGahan JP, Horton S, Gerscovich EO, et al. Appearance of solid organ injury with contrast-enhanced sonography in blunt abdominal trauma: preliminary experience. *AJR* 2006; 187(3):658-666.	9	22 injuries	Prospective study to compare the detection rate of injury and differentiate imaging findings of contrast-enhanced US and non-contrast-enhanced US. Contrast-enhanced CT was used to identify hepatic, splenic, and renal injuries.	• CT detected 22 injuries in 20 patients. Non-contrast-enhanced US revealed 11/22 (50%) injuries, while contrast-enhanced US depicted 20/22 (91%) injuries. • The average conspicuity grade for the splenic injuries increased from 0.67 for non-contrast-enhanced US to 2.33 for contrast-enhanced US. With regard to liver injuries, the conspicuity scale increased from 1.0 for non-contrast-enhanced US to 2.2 for contrast-enhanced.	2
52. Valentino M, Serra C, Pavlica P, et al. Blunt abdominal trauma: diagnostic performance of contrast-enhanced US in children--initial experience. *Radiology* 2008; 246(3):903-909.	9	27	To prospectively compare the sensitivity and specificity of US with those of contrast-enhanced US in detecting solid organ injuries in children with blunt abdominal trauma, with contrast-enhanced CT as the reference standard.	• Contrast-enhanced US: Sensitivity 92.2%, specificity 100%, PPV 100%, NPV 93.8%. • US: Sensitivity 57.1%, specificity 86.7%, PPV 80.0%, NPV 68.4%. • Diagnostic performance of contrast-enhanced US was better than that of US. • Contrast-enhanced US was almost as accurate as contrast-enhanced CT in depicting solid organ injuries in children.	2
53. Smith JK, Kenney PJ. Imaging of renal trauma. *Radiol Clin North Am* 2003; 41(5):1019-1035.	12	N/A	To review imaging of renal trauma.	CT is recommended for patients with penetrating trauma and hematuria, blunt trauma with shock and hematuria, or gross hematuria.	4

Hematuria—Child
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Strength of Evidence
54. Morgan DE, Nallamala LK, Kenney PJ, Mayo MS, Rue LW, 3rd. CT cystography: radiographic and clinical predictors of bladder rupture. *AJR Am J Roentgenol* 2000; 174(1):89-95.	13	157	To prospectively evaluate clinical and radiographic variables that correlated with positive findings on CT cystography. The variables are then used as selection criteria for CT cystography in trauma patients.	• Of 157 patients, 12 had bladder rupture. • One or more pelvic fractures were present in 9/12 patients (75%) ($p<0.001$). • 8/12 (67%) patients had gross hematuria ($p<0.001$). • No ruptures were seen in patients with <25 RBC/HPF (RBC per high-power field). • All patients with rupture had pelvic fluid revealed on standard contrast-enhanced CT ($p<0.001$). • Gross hematuria, pelvic fluid, and specific pelvic fractures were highly correlated with bladder rupture; identification of these findings may help in selection of trauma patients for CT cystography.	2
55. Peng MY, Parisky YR, Cornwell EE, 3rd, Radin R, Bragin S. CT cystography versus conventional cystography in evaluation of bladder injury. *AJR Am J Roentgenol* 1999; 173(5):1269-1272.	9	55	To prospectively compare CT cystography with conventional cystography to identify bladder injury in patients with hematuria after blunt abdominal trauma.	• 50/55 (91%) patients did not show bladder injury on either CT cystography or conventional cystography. • 33/50 patients had intraperitoneal fluid on the initial abdominopelvic CT scan. • 5/55 (9%) patients had bladder rupture on CT cystography. • CT cystography is an accurate method for evaluating bladder injury in the blunt abdominal trauma victim with hematuria.	2
56. Sivit CJ, Cutting JP, Eichelberger MR. CT diagnosis and localization of rupture of the bladder in children with blunt abdominal trauma: significance of contrast material extravasation in the pelvis. *AJR Am J Roentgenol* 1995; 164(5):1243-1246.	10	1,500	Prospectively evaluate CT scans of children with blunt trauma to determine the value of CT in showing extravasation of IV contrast material as a means of detecting and localizing bladder rupture.	• Extravasated IV contrast material in the pelvis was noted in 7 children with bladder rupture and 2/1,493 children without bladder rupture. • Location of extravasated contrast material at CT was useful in differentiating intraperitoneal from extraperitoneal one rupture.	2
57. Chan DP, Abujudeh HH, Cushing GL, Jr., Novelline RA. CT cystography with multiplanar reformation for suspected bladder rupture: experience in 234 cases. *AJR* 2006; 187(5):1296-1302.	10	234	Retrospective study to determine the accuracy of CT cystography and the role of multiplanar reformation in the diagnosis of bladder injury.	Sensitivity and specificity of CT cystography in diagnosing bladder rupture were each 100%. For extraperitoneal bladder rupture, the sensitivity and specificity were 92.8% and 100%, respectively. For intraperitoneal rupture, the sensitivity and specificity were 100% and 99%, respectively.	3

Hematuria—Child
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Strength of Evidence
58. Wu SR, Shakibai S, McGahan JP, Richards JR. Combined head and abdominal computed tomography for blunt trauma: which patients with minor head trauma benefit most? *Emerg Radiol* 2006; 13(2):61-67.	10	1478	Retrospective review to evaluate which patients with minor head trauma benefit most from combined head and abdomen CT.	Of 1,478 patients, 18 (1%) patients had both head and abdominal injuries detected by combined CT. 112 (8%) patients had only head injuries, and 131 (9%) had only intraabdominal injuries detected. Patients with loss of consciousness and/or Glasgow coma scale of 14 frequently undergo head CT.	3

Evidence Table Key

Study Type Key

Numbers 1-7 are for studies of therapies while numbers 8-15 are used to describe studies of diagnostics.

1. Randomized Controlled Trial — Treatment
2. Controlled Trial
3. Observation Study
    a. Cohort
    b. Cross-sectional
    c. Case-control
4. Clinical Series
5. Case reviews
6. Anecdotes
7. Reviews

8. Randomized Controlled Trial — Diagnostic
9. Comparative Assessment
10. Clinical Assessment
11. Quantitative Review
12. Qualitative Review
13. Descriptive Study
14. Case Report
15. Other (Described in text)

Strength of Evidence Key

- Category 1 - The conclusions of the study are valid and strongly supported by study design, analysis and results.
- Category 2 - The conclusions of the study are likely valid, but study design does not permit certainty.
- Category 3 - The conclusions of the study may be valid but the evidence supporting the conclusions is inconclusive or equivocal.
- Category 4 - The conclusions of the study may not be valid because the evidence may not be reliable given the study design or analysis.