Blunt Abdominal Trauma
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Strength of Evidence
1. Croce MA, Fabian TC, Menke PG, et al. Nonoperative management of blunt hepatic trauma is the treatment of choice for hemodynamically stable patients. Results of a prospective trial. *Ann Surg* 1995; 221(6):744-753; discussion 753-745.	2	136	Prospectively evaluate safety of nonoperative management of hepatic trauma. Unstable patients had laparotomies, and stable patients had abdominal CT.	Nonoperative management is safe regardless of injury severity.	2
2. Delgado Millan MA, Deballon PO. Computed tomography, angiography, and endoscopic retrograde cholangiopancreatography in the nonoperative management of hepatic and splenic trauma. *World J Surg* 2001; 25(11):1397-1402.	12	N/A	To review the role of CT abdominal scans, angiography, and endoscopic retrograde cholangiopancreatography (ERCP) in the nonoperative management of hepatic and splenic trauma.	• Although CT has an accuracy of more than 95%, it is not helpful for follow-up. • Angiography should be done if vessel injury, active bleeding or hemobilia are suspected on the basis of a CT scan in a stable patient. • ERCP is recommended for patients with suspected injury to the biliary tree.	4
3. Garber BG, Yelle JD, Fairfull-Smith R, Lorimer JW, Carson C. Management of splenic injuries in a Canadian trauma centre. *Can J Surg* 1996; 39(6):474-480.	3a	100	Cohort study in a Canadian trauma center to document the current practice pattern for the treatment of splenic injuries and identify factors that determined which method was employed.	96% had blunt mechanism of injury. Diagnosis was made by CT in 55%. 86% of patients treated with observation with a success rate of 90%.	2
4. Maull KI. Current status of nonoperative management of liver injuries. *World J Surg* 2001; 25(11):1403-1404.	12	N/A	To review nonoperative status of surgical therapy of abdominal trauma.	Poor correlation of CT appearance of the liver injury with clinical outcome.	4
5. Pachter HL, Knudson MM, Esrig B, et al. Status of nonoperative management of blunt hepatic injuries in 1995: a multicenter experience with 404 patients. *J Trauma* 1996; 40(1):31-38.	3a	404	Retrospective, multicenter study to assess whether the combined experiences at level I trauma centers can validate high success rate, low morbidity of nonoperative management of liver trauma.	After CT grading, only six patients needed operative intervention. Nonoperative management is the treatment of choice in stable patients regardless of hemoperitoneum.	2
6. Poletti PA, Mirvis SE, Shanmuganathan K, Killeen KL, Coldwell D. CT criteria for management of blunt liver trauma: correlation with angiographic and surgical findings. *Radiology* 2000; 216(2):418-427.	10	72	Retrospective study to determine whether CT can select patients who need angiographic evaluation and therapy.	Compared with angiography, CT was 65% sensitive and 85% specific for detection of arterial vascular injury. When CT severity grades 2 and 3 were analyzed, the sensitivity and specificity of CT were 100% (3/3 patients) and 94% (34/36 patients), respectively (P<.001). CT criteria work well in selecting patients for angiographic therapy.	2
7. Shanmuganathan K. Multi-detector row CT imaging of blunt abdominal trauma. *Semin Ultrasound CT MR* 2004; 25(2):180-204.	12	N/A	To review current imaging protocol with MDCT, the spectrum of diagnostic findings seen in blunt abdominal injury, and the role of MDCT in the characterization of hemorrhage and planning injury management.	MDCT has the ability to obtain high-resolution images during optimal contrast enhancement at unparalleled speed which helps detect the presence and define the extent of injuries and diagnose hemorrhage and vascular injuries.	4

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8. Smith JK, Kenney PJ. Imaging of renal trauma. *Radiol Clin North Am* 2003; 41(5):1019-1035.	12	N/A	To review role of CT in the imaging of renal trauma.	CT is the preferred modality for patients with penetrating trauma and hematuria, blunt trauma with shock and hematuria, or gross hematuria.	4
9. Toutouzas KG, Karaiskakis M, Kaminski A, Velmahos GC. Nonoperative management of blunt renal trauma: a prospective study. *Am Surg* 2002; 68(12):1097-1103.	3a	37 consecutive patients	Prospective study to examine the role of nonoperative management in patients with renal injuries.	Nonoperative management is the prevailing method of treatment after blunt renal trauma. It is successful in many patients without peritonitis or hemodynamic instability and should be considered regardless of the severity of renal injury.	3
10. Farahmand N, Sirlin CB, Brown MA, et al. Hypotensive patients with blunt abdominal trauma: performance of screening US. *Radiology* 2005; 235(2):436-443.	9	128	To determine retrospectively the accuracy of screening US in patients with hypotension (systolic blood pressure) blunt abdominal trauma**.**	Among patients who are hypertensive after blunt abdominal trauma and not hemodynamically stable enough to undergo diagnostic CT, negative US findings virtually exclude surgical injury, while positive US findings indicate surgical injury in 64% of cases.	2
11. Kirkpatrick AW, Sirois M, Laupland KB, et al. Prospective evaluation of hand-held focused abdominal sonography for trauma (FAST) in blunt abdominal trauma. *Can J Surg* 2005; 48(6):453-460.	9	540	To evaluate hand-held US in early trauma care by comparing its results with those of through formal Focused Assessment with Sonography for Trauma examinations (FFAST), CT, operative findings and serial examination at two centers.	Hand-held FAST performed by clinicians detects intraperitoneal fluid with a high degree of accuracy. All FAST examinations are valuable tests when positive. They will miss some injuries, but the majority of the injuries missed do not require therapy. Hand-held FAST provides an early extension of the physical examination but should be complemented by the selective use of CT, rather than formal repeat US.	2
12. Ma OJ, Gaddis G, Steele MT, Cowan D, Kaltenbronn K. Prospective analysis of the effect of physician experience with the FAST examination in reducing the use of CT scans. *Emerg Med Australas* 2005; 17(1):24-30.	9	252 patients 11 physicians	Prospective, consecutive enrolment study to examine the effect of physician experience with the FAST examination in reducing the use of CT scans.	FAST accuracy was greatest among more experienced emergency physicians. Further, a normal FAST examination assisted more experienced emergency physicians with the perceived need to order significantly fewer CT scans than less experienced emergency physicians.	2

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13. McGahan JP, Rose J, Coates TL, Wisner DH, Newberry P. Use of ultrasonography in the patient with acute abdominal trauma. *J Ultrasound Med* 1997; 16(10):653-662; quiz 663-654.	9	500	Prospective study to assess the ability of US to detect free-fluid and organ injury compared to CT and operative findings — not to clinical outcome.	Sensitivity for fluid 63%, specificity 95%, accuracy 85%, PPV 86%, and NPV 85%. US fared better in cases of splenic laceration, permitting detection in 9/14 cases. The emergent ultrasonogram may be used to detect free fluid in the abdomen of the acutely traumatized patient. However, sonography is limited in detecting free fluid in the pelvis using the present technique and does not allow visualization of organ injury.	2
14. Nural MS, Yardan T, Guven H, Baydin A, Bayrak IK, Kati C. Diagnostic value of ultrasonography in the evaluation of blunt abdominal trauma. *Diagn Interv Radiol* 2005; 11(1):41-44.	9	454	Blunt trauma patients admitted to the emergency department were retrospectively reviewed to evaluate the diagnostic value of US in detecting intra-abdominal injuries in patients with blunt abdominal trauma as compared to CT, diagnostic peritoneal lavage (DPL), laparotomy and clinical course.	US had sensitivity of 86.5%, specificity of 95.4%, PPV of 62.7%, NPV of 98.7% and accuracy 94.7%. US has high diagnostic performance in the screening of patients with blunt abdominal trauma**.** Authors recommend clinical follow-up is adequate for patients whose US results are negative for intra-abdominal organ injury.	2
15. Salera D, Argalia G, Giuseppetti GM. Screening US for blunt abdominal trauma: a retrospective study. *Radiol Med (Torino)* 2005; 110(3):211-220.	10	864	Retrospective study to assess the accuracy of screening US in patients with blunt abdominal trauma by reviewing the results against optimal reference standard.	US exhibited a satisfactory overall ability to distinguish negative from positive patients (91.5% sensitivity and 97.5% specificity in major trauma vs 73.3% sensitivity and 98.1% specificity in minor trauma) and a satisfactory specific ability to depict injuries separately and independently in major trauma patients. Of the 21/864 false negative reports (5 in patients with major and 16 in cases with minor trauma), only one affected patient management, a major trauma case, by delaying an emergency laparotomy.	2
16. Valentino M, Serra C, Zironi G, De Luca C, Pavlica P, Barozzi L. Blunt abdominal trauma: emergency contrast-enhanced sonography for detection of solid organ injuries. *AJR* 2006; 186(5):1361-1367.	9	69	Prospective study to compare the diagnostic value of sonography and contrast-enhanced sonography with CT for the detection of solid organ injuries in blunt abdominal trauma patients.	• Sonography had sensitivity of 45.7%, specificity of 91.8%, PPV of 84.2%, and NPV of 64.1%. • Contrast-enhanced sonography had sensitivity of 91.4%, specificity of 100%, PPV of 100% and NPV of 92.5%. • Contrast-enhanced sonography is more sensitive than sonography and almost as sensitive as CT in the detection of traumatic abdominal solid organ injuries.	2

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17. Nordenholz KE, Rubin MA, Gularte GG, Liang HK. Ultrasound in the evaluation and management of blunt abdominal trauma. *Ann Emerg Med* 1997; 29(3):357-366.	12	N/A	To review literature comparing US with DPL and CT in the evaluation of blunt abdominal trauma.	US best used for hemoperitoneum. If urgent laparotomy is not required further diagnostics studies (CT, DPL, or angiography) may be performed.	4
18. Breen DJ, Janzen DL, Zwirewich CV, Nagy AG. Blunt bowel and mesenteric injury: diagnostic performance of CT signs. *J Comput Assist Tomogr* 1997; 21(5):706-712.	10	31 patients 3 observers	Retrospective study to examine CT findings in blunt bowel and mesenteric injury.	• In 12 cases of bowel injury, the CT sign of bowel wall thickening had sensitivity of 50% and specificity of 84% and the CT sign of bowel wall discontinuity had sensitivity of 58% and specificity of 95%. • Extraluminal air had sensitivity 44%, specificity 100%. • In 13 patients with mesenteric injuries, the CT sign of mesenteric hematoma had sensitivity of 54% and specificity of 94%. Isolated mesenteric streaking had sensitivity 77%, specificity 44%.	2
19. Butela ST, Federle MP, Chang PJ, et al. Performance of CT in detection of bowel injury. *AJR* 2001; 176(1):129-135.	10	112 patients (50 patients had bowel injuries 62 controls)	Prospectively and retrospectively review CT of patients with blunt abdominal trauma to identify CT signs of bowel injury and accuracy of those signs.	For prospective study, CT had sensitivity 64%, accuracy 82%, and specificity 97%%. Bowel injuries are challenging to diagnose on CT. Variety of CT criteria can be used by radiologists with various levels of experience to achieve accuracy and reproducible results.	2
20. Cox CS, Jr., Geiger JD, Liu DC, Garver K. Pediatric blunt abdominal trauma: role of computed tomography vascular blush. *J Pediatr Surg* 1997; 32(8):1196-1200.	14	5	Retrospective review of the records of patients to describe vascular blush on CT.	All 5 failed attempted nonoperative management and went to surgery. CT evaluation can accurately define the anatomic grade of intra-abdominal organ injury, but does not predict the failure of nonoperative therapy in splenic injuries.	4
21. Davis KA, Fabian TC, Croce MA, et al. Improved success in nonoperative management of blunt splenic injuries: embolization of splenic artery pseudoaneurysms. *J Trauma* 1998; 44(6):1008-1013; discussion 1013-1005.	3a	524 consecutive patients	Review records of patients with blunt splenic injury to evaluate success of nonoperative management of spleen injuries when embolization is part of the protocol.	344 patients (66%) were hemodynamically stable and underwent CT and nonoperative management. 94% managed nonoperatively. 20/26 with blush/pseudoaneurysm were successful embolized. Aggressive surveillance and embolization improved rate of successful nonoperative management of blunt splenic trauma to 61%, with a nonoperative failure rate of 6%.	2

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22. Federle MP, Courcoulas AP, Powell M, Ferris JV, Peitzman AB. Blunt splenic injury in adults: clinical and CT criteria for management, with emphasis on active extravasation. *Radiology* 1998; 206(1):137-142.	13	150 patients 2 reviewers	Retrospective, blinded study to evaluate and determine the relevance of clinical and CT criteria (extravasation) for prediction of clinical outcome in adults with splenic injuries.	Active extravasation correlated best with need for surgery. Splenic salvage rate was 59.3% overall and was 92% among 100 patients with initial nonsurgical management. Standard clinical criteria allow triage of patients into immediate surgery or initial nonsurgical groups. CT criteria (absence of active extravasation) can help predict successful nonsurgical management of splenic injuries.	2
23. Gavant ML, Schurr M, Flick PA, Croce MA, Fabian TC, Gold RE. Predicting clinical outcome of nonsurgical management of blunt splenic injury: using CT to reveal abnormalities of splenic vasculature. *AJR* 1997; 168(1):207-212.	13	263	Retrospective, blinded study to determine if traumatic pseudoaneurysm or frank active hemorrhage on CT can predict failure of nonoperative management of patients with splenic injury.	Nonoperative management successful in 85% of cases when tried. In 11 who failed, 9 (82%) had a CT detectable vascular abnormality. Failure rate in patients with nonsurgically managed blunt splenic injuries may be reduced if patients with traumatic pseudoaneurysm or active hemorrhage revealed on emergent CT are treated with early surgical or endovascular repair.	2
24. Hagiwara A, Yukioka T, Ohta S, et al. Nonsurgical management of patients with blunt hepatic injury: efficacy of transcatheter arterial embolization. *AJR* 1997; 169(4):1151-1156.	3c	54	Prospective, clinical study to evaluate the efficacy of transcatheter arterial embolization (TAE) for patients with blunt hepatic injury.	Embolization was successful in 15 patients, and the shock index was significantly reduced after TAE. All patients survived, with follow-up at 1-8 months. TAE is an effective alternative to surgery for patients with high-grade liver injury.	2
25. Jhirad R, Boone D. Computed tomography for evaluating blunt abdominal trauma in the low-volume nondesignated trauma center: the procedure of choice? *J Trauma* 1998; 45(1):64-68.	10	55	Prospective case series to determine accuracy of CT findings in trauma in a non-designated community hospital.	Accuracies for the detection of injury were 86% and 90.5% for radiology residents and attending radiologists, respectively. Accuracy comparable to designated trauma centers; able to avert non-therapeutic laparotomy. Better interpretation than with US.	2
26. Killeen KL, Shanmuganathan K, Poletti PA, Cooper C, Mirvis SE. Helical computed tomography of bowel and mesenteric injuries. *J Trauma* 2001; 51(1):26-36.	10	150	Retrospectively grade CT findings to determine accuracy of CT in detecting bowel and mesenteric injuries in blunt abdominal trauma.	Sensitivity 94% in detecting bowel injury and 96% in detecting mesenteric injury. Correctly separated surgical from nonsurgical cases in 86%. CT is very accurate in detecting bowel and mesenteric injuries, as well as in determining the need for surgical exploration in bowel injuries, but less accurate in predicting the need for surgical exploration in mesenteric injuries alone.	2

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27. Willmann JK, Roos JE, Platz A, et al. Multidetector CT: detection of active hemorrhage in patients with blunt abdominal trauma. *AJR* 2002; 179(2):437-444.	13	165	Retrospective study to determine findings and prevalence of active hemorrhage on contrast-enhanced MDCT in patients with blunt abdominal trauma.	Active hemorrhage was detected in 22 (13%) of 165 patients with a total of 24 bleeding sites (14 intraperitoneal sites and 10 extraperitoneal sites). Active hemorrhage appears as a jet of contrast — requires immediate surgical or angio therapy.	2
28. Yao DC, Jeffrey RB, Jr., Mirvis SE, et al. Using contrast-enhanced helical CT to visualize arterial extravasation after blunt abdominal trauma: incidence and organ distribution. *AJR* 2002; 178(1):17-20.	13	565 consecutive patients	Multicenter, prospective study to evaluate the frequency of finding of CT evidence of active hemorrhage plus distribution of organs in patients with abdominal trauma.	Most common organ injured was spleen: 277 (49.0%) of 565 patients, and arterial extravasation occurred in 49 (17.7%) of 277 patients with splenic injury. Higher than expected frequency in stable patients. Spleen, liver, and kidney most frequent areas, but also mesentery and adrenal.	2
29. Omert LA, Salyer D, Dunham CM, Porter J, Silva A, Protetch J. Implications of the "contrast blush" finding on computed tomographic scan of the spleen in trauma. *J Trauma* 2001; 51(2):272-277; discussion 277-278.	13	324	Retrospective study to evaluate correlation between spleen contrast blush on CT of blunt abdominal trauma and need for spleen intervention with surgery or angiography.	Patients with contrast blush needed intervention in 75%, those without in 25%. ($P<0.001$). Contrast blush is not an absolute indication for an operative or angiographic intervention. In the management of these patients factors such as patient age, grade of injury, and presence of hypotension need to be considered.	2
30. Sclafani SJ, Shaftan GW, Scalea TM, et al. Nonoperative salvage of computed tomography-diagnosed splenic injuries: utilization of angiography for triage and embolization for hemostasis. *J Trauma* 1995; 39(5):818-825; discussion 826-817.	13	172 consecutive patients	Prospectively collect splenic injuries detected by diagnostic imaging and retrospective review to determine if angiographic findings can be used to predict successful nonoperative therapy of splenic injury and to determine if coil embolization of the proximal splenic artery provides effective hemostasis.	The absence of contrast extravasation on splenic arteriography seems to be a reliable predictor of successful nonoperative management. Coil embolization of the proximal splenic artery is an effective method of hemostasis in stabilized patients with splenic injury.	2
31. Bode PJ, Edwards MJ, Kruit MC, van Vugt AB. Sonography in a clinical algorithm for early evaluation of 1671 patients with blunt abdominal trauma. *AJR* 1999; 172(4):905-911.	10	1,671 consecutive patients	Prospective, observational study to evaluate sensitivity and specificity of US for abdominal injury and selecting patients for surgery. Surgeons decided whether surgery was therapeutic. Clinical outcome gold standard.	US had sensitivity 88%, specificity 100%, and accuracy 99%. Only two patients mistakenly discharged from the emergency department. All surgery declared to be needed. Missed 9/11 cases of gut injury.	2
32. Croce MA, Fabian TC, Kudsk KA, et al. AAST organ injury scale: correlation of CT-graded liver injuries and operative findings. *J Trauma* 1991; 31(6):806-812.	13	37	Correlate CT grading with intraoperative grading of liver injuries.	Increasing operative hepatic injury scale (HIS) correlated well with increasing severity of injury as measured by transfusions and operative management. 31 CT grades did not correlate with operative findings (84%).	3

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33. Hollands MJ, Little JM. Non-operative management of blunt liver injuries. *Br J Surg* 1991; 78(8):968-972.	13	281 patients 55 patients – no operation 181 patients – had operation	To determine whether clinical criteria can be used to decide who can be managed without operation.	20% managed nonoperatively with no complications. Nonoperative management was a safe alternative to operation in appropriate patients.	2
34. Sclafani SJ, Weisberg A, Scalea TM, Phillips TF, Duncan AO. Blunt splenic injuries: nonsurgical treatment with CT, arteriography, and transcatheter arterial embolization of the splenic artery. *Radiology* 1991; 181(1):189-196.	13	44 consecutive patients	To study the management and outcome of blunt splenic injury diagnosed with CT in patients who were hemodynamically stable or whose condition stabilized rapidly with resuscitation.	Exploratory laparotomy was avoided in 34/36 patients (94%) in whom nonoperative management was attempted; splenic salvage was achieved in 35/36 patients (97%).	2
35. Goins WA, Rodriguez A, Lewis J, Brathwaite CE, James E. Retroperitoneal hematoma after blunt trauma. *Surg Gynecol Obstet* 1992; 174(4):281-290.	13	233 consecutive patients	Retrospective review of patients with retroperitoneal hematoma (RPH).	RPH was located in zone I in 14 % of patients, zone II in 37%, zone III in 46% and zone IV in 3%. Overall morbidity and mortality rates are 59% and 39%, respectively.	2
36. Kristjansson A, Pedersen J. Management of blunt renal trauma. *Br J Urol* 1993; 72(5 Pt 2):692-696.	9	18	Retrospective to compare different methods in management of major renal lacerations after blunt trauma.	CT had a greater degree of accuracy than urography and US in determining the extent of the injury and was more practical to perform than angiography.	3
37. Richards JR, Schleper NH, Woo BD, Bohnen PA, McGahan JP. Sonographic assessment of blunt abdominal trauma: a 4-year prospective study. *J Clin Ultrasound* 2002; 30(2):59-67.	9	3,264	Four-year prospective study to determine accuracy of US in detection of hemoperitoneum and solid organ injury in blunt abdominal trauma patients. Compared to CT and operative findings.	396 (12%) of 3,264 patients had intra-abdominal injuries. US detected free fluid presumed to represent hemoperitoneum in 288 patients (9%). US sensitivity to hemoperitoneum was 60%, specificity 98%, accuracy 94%, PPV 82%, and NPV 95%. US sensitivity for organ injury plus free-fluid was 67%.	2
38. Krupnick AS, Teitelbaum DH, Geiger JD, et al. Use of abdominal ultrasonography to assess pediatric splenic trauma. Potential pitfalls in the diagnosis. *Ann Surg* 1997; 225(4):408-414.	10	32	Prospective, blinded study to assess accuracy of abdominal US for screening and grading spleen injury in patients with such injury on CT.	38% of injured spleens missed on US. 22% had no free-fluid. 53% were downgraded by US from actual. US has low of sensitivity (62% to 78%). Reliance on free intraperitoneal fluid may be inaccurate because not all patients with splenic injury have free intra-abdominal fluid.	2
39. Visvanathan R, Low HC. Blunt abdominal trauma--injury assessment in relation to early surgery. *J R Coll Surg Edinb* 1993; 38(1):19-22.	9	113 patients Group A - 20 Group B - 35 Group C - 58	Retrospectively divide patients with blunt abdominal trauma into three groups to assess parameters of three diagnostic methods and the time-lapse before implementing surgical treatment.	65 had abdominal exploration. DPL had sensitivity of 95%, specificity of 81% and accuracy of 89%. Diagnostic abdominal US had sensitivity of 79%, specificity of 85% and accuracy of 83% in detecting significant injury. DPL in combination with US is recommended.	2

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40. Becker CD, Spring P, Glattli A, Schweizer W. Blunt splenic trauma in adults: can CT findings be used to determine the need for surgery? *AJR* 1994; 162(2):343-347.	13	45	Retrospective analysis of CT scans to determine whether CT findings can be used to determine the need for surgery.	Neither CT score system was predictive. Some low scores needed surgery (20%). The choice between operative and nonoperative management of splenic trauma should be based on clinical findings not CT findings.	2
41. Farhat GA, Abdu RA, Vanek VW. Delayed splenic rupture: real or imaginary? *Am Surg* 1992; 58(6):340-345.	13	75	Review delayed splenic rupture in patients treated at a center with blunt splenic injury.	Peritoneal lavage and abdominal CT scan are accurate in diagnosing splenic rupture but are not always reliable in predicting delayed rupture.	3
42. Miller MT, Pasquale MD, Bromberg WJ, Wasser TE, Cox J. Not so FAST. *J Trauma* 2003; 54(1):52-59; discussion 59-60.	9	359	Evaluate sensitivity and accuracy of FAST for free intraperitoneal fluid compared to CT and surgery.	FAST had sensitivity 42%, specificity 98%, PPV 67%, NPV 93%, and accuracy 92%. FAST results in underdiagnosis of intra-abdominal injury. Hemodynamically stable patients with suspected blunt abdominal injury should undergo routine CT.	2
43. Ochsner MG, Knudson MM, Pachter HL, et al. Significance of minimal or no intraperitoneal fluid visible on CT scan associated with blunt liver and splenic injuries: a multicenter analysis. *J Trauma* 2000; 49(3):505-510.	13	267	Retrospective, multicenter study to describe the incidence and clinical importance of liver and splenic injuries with minimal or no free intraperitoneal fluid visible on CT scan.	11% of liver injuries and 12% of spleen injuries had no free-fluid. Abdominal US thus should not be the sole diagnostic modality.	2
44. Shanmuganathan K, Mirvis SE, Sherbourne CD, Chiu WC, Rodriguez A. Hemoperitoneum as the sole indicator of abdominal visceral injuries: a potential limitation of screening abdominal US for trauma. *Radiology* 1999; 212(2):423-430.	13	466	Retrospective review to determine the prevalence and outcome of visceral injuries from blunt abdominal trauma without associated hemoperitoneum on US. CT as gold standard.	17% of patients with no evidence of hemoperitoneum by US had abdominal organ injury. Includes 27% of spleen injuries, 34% of liver injuries, and 48% of renal injuries. Surgery required on 17% of patients without hemoperitoneum. Reliance on presence of hemoperitoneum as the sole indicator of abdominal visceral injury limits the value of FAST as a screening tool for patients who sustain blunt abdominal trauma.	2
45. McGahan JP, Richards JR. Blunt abdominal trauma: the role of emergent sonography and a review of the literature. *AJR* 1999; 172(4):897-903.	12	N/A	To review role of US in blunt abdominal trauma.	Sensitivity, specificity and accuracy of US compared to CT are 63%, 95% and 85%, respectively. Use of US depends on surgical aggressiveness of local surgeons (if very aggressive use US, if not, do not use US).	4
46. Thomas B, Falcone RE, Vasquez D, et al. Ultrasound evaluation of blunt abdominal trauma: program implementation, initial experience, and learning curve. *J Trauma* 1997; 42(3):384-388; discussion 388-390.	9	300	Prospective study to examine a level I trauma service experience with the de novo establishment of a trauma US program. Standard diagnostic evaluation (CT, DPL, observation) was compared to CT.	US had sensitivity of 81%, specificity of 99.3 %, and accuracy of 98%. Annualized cost savings with use of US vs standard diagnostic evaluation would be over $100,000.	2

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47. Lingawi SS, Buckley AR. Focused abdominal US in patients with trauma. *Radiology* 2000; 217(2):426-429.	10	1,090 consecutive patients	To determine accuracy of focused US in finding blunt abdominal injuries which require in-hospital treatment.	After excluding indeterminate cases, US had 94% sensitivity, 98% specificity, 78% PPV, 100% NPV, and 95% accuracy. NPV for focused abdominal US is high.	2
48. Sirlin CB, Brown MA, Andrade-Barreto OA, et al. Blunt abdominal trauma: clinical value of negative screening US scans. *Radiology* 2004; 230(3):661-668.	13	3,679	Retrospective study to assess outcome of patients with blunt abdominal trauma and negative screening US. All patients observed for 12-24 hours.	99.9% had no injuries. 38 patients had false negative involving 65 injuries of organs. 25/38 has no hemoperitoneum. 6% had CT. Combination of negative US findings and negative clinical observation excludes abdominal injury in patients who are admitted and observed for at least 12-24 hours.	2
49. Self ML, Blake AM, Whitley M, Nadalo L, Dunn E. The benefit of routine thoracic, abdominal, and pelvic computed tomography to evaluate trauma patients with closed head injuries. *Am J Surg* 2003; 186(6):609-613; discussion 613-604.	10	457	Retrospective review to evaluate the role of routine CT of the chest, abdomen, and pelvis as a screening tool for patients already undergoing cranial CT studies.	38% of patients undergoing cranial CT scanning had an unexpected finding on body scans. Changes were made in 26% of the study group because of results found on the adjuvant CT.	2
50. Branney SW, Wolfe RE, Moore EE, et al. Quantitative sensitivity of ultrasound in detecting free intraperitoneal fluid. *J Trauma* 1995; 39(2):375-380.	10	100	Prospective, blinded study of the sensitivity of US in detecting intraperitoneal fluid.	At 400 ml, only 10% of patients had fluid on US. Mean volume to detect on US was 619 ml. Requires greater volume than previously reported.	1
51. Williams RA, Black JJ, Sinow RM, Wilson SE. Computed tomography-assisted management of splenic trauma. *Am J Surg* 1997; 174(3):276-279.	13	50 CT exams for initial study 30 patients enrolled in protocol	Retrospective study to examine CT-assisted management of splenic trauma. During initial period of study, CT was reviewed by radiologists for evidence of splenic injury. The radiologists, blinded to clinical management decisions, graded the CT studies.	The severity of splenic trauma evident on CT staging guides safe nonoperative management. Patients not suffering injury to the splenic hilum can be managed without operation, resulting in shorter hospital stays and fewer blood products used.	3
52. Clancy TV, Weintritt DC, Ramshaw DG, Churchill MP, Covington DL, Maxwell JG. Splenic salvage in adults at a level II community hospital trauma center. *Am Surg* 1996; 62(12):1045-1049.	3b	81	Review blunt trauma patients to study splenic salvage in adults at a level II community hospital trauma center. Authors examined age, race, and clinical data.	Nonoperative management successful in 31/37 patients (83.7%). Nonoperative management is the most common method of splenic salvage.	3
53. Ahvenjarvi L, Niinimaki J, Halonen J, Tervonen O, Ojala R. Reliability of the evaluation of multidetector computed tomography images from the scanner's console in high-energy blunt-trauma patients. *Acta Radiol* 2007; 48(1):64-70.	10	40	To evaluate the reliability of a structured 5-minute evaluation of MDCT images from the scanner's console in high-energy trauma patients. The radiologist scrolled axial images on the scanner's console using three different window settings (lung, soft tissue, and bone) and performed a prospective structured evaluation of the traumatic lesions.	Evaluation from the scanner's console enabled the diagnosis of all potential life-threatening injuries, the sensitivity for all injuries being 60% and specificity 98%.	3

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Strength of Evidence
54. Watson CJ, Calne RY, Padhani AR, Dixon AK. Surgical restraint in the management of liver trauma. *Br J Surg* 1991; 78(9):1071-1075.	15	80	Examine cases involving surgical restraint in the management of liver trauma.	Of the 80, all but five suffered blunt abdominal trauma. Perihepatic packing was used to manage 29 patients, of whom 21 were initially treated elsewhere before being transferred to Cambridge. Six of these required a hemihepatectomy at subsequent exploration. Of the 39 patients who underwent urgent laparotomy and definitive surgery, 11 died; only 3/29 died after initial packing. Only one death from hepatic complications occurred after packing and subsequent transfer.	3
55. Black JJ, Sinow RM, Wilson SE, Williams RA. Subcapsular hematoma as a predictor of delayed splenic rupture. *Am Surg* 1992; 58(12):732-735.	13	966 scans	To determine if subcapsular hematoma (SH) is a predictor of delayed splenic rapture.	• SH is neither a predictor for delayed splenic rupture, nor an indication for operative management of the injured spleen in the hemodynamically stable patient; • Degree of parenchymal injury based on CT morphology indicates need for laparotomy with splenectomy; • Splenorrhaphy has a reduced role in splenic trauma.	2
56. Tricarico A, Sicoli F, Calise F, Iavazzo E, Salvatore M, Mansi L. Conservative treatment in splenic trauma. *J R Coll Surg Edinb* 1993; 38(3):145-148.	3a	215 consecutive patients	To determine if spleen injuries can be triaged by criteria so some are treated with no surgery vs splenorrhaphy vs autotransplantation.	Splenectomy with autotransplantation should be considered since it allows preservation of splenic function in cases where nonoperative management, splenorrhaphy and partial resection are unsafe.	2
57. Mohr AM, Lavery RF, Barone A, et al. Angiographic embolization for liver injuries: low mortality, high morbidity. *J Trauma* 2003; 55(6):1077-1081; discussion 1081-1072.	4	37 consecutive patients	Retrospective study to examine role of angiographic embolization in blunt and penetrating liver injuries and the outcomes of its use.	Addition of angiographic embolization as an adjunctive modality for patients with high-grade liver injuries is a safe and effective therapeutic option.	3
58. Sofocleous CT, Hinrichs C, Hubbi B, et al. Angiographic findings and embolotherapy in renal arterial trauma. *Cardiovasc Intervent Radiol* 2005; 28(1):39-47.	13	22	Retrospective review to evaluate angiographic findings and embolotherapy in the management of traumatic renal arterial injury.	Selective and superselective embolization is a safe and effective method for the management of renal vascular injury.	3
59. Wahl WL, Ahrns KS, Chen S, Hemmila MR, Rowe SA, Arbabi S. Blunt splenic injury: operation versus angiographic embolization. *Surgery* 2004; 136(4):891-899.	3c	25	Retrospective review of a prospective data to determine appropriate treatment for splenic injuries by comparing operation with angiographic embolization.	Angiographic embolization of splenic injuries is safe and associated with fewer complications.	3

Blunt Abdominal Trauma
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Strength of Evidence
60. Kunin JR, Korobkin M, Ellis JH, Francis IR, Kane NM, Siegel SE. Duodenal injuries caused by blunt abdominal trauma: value of CT in differentiating perforation from hematoma. *AJR* 1993; 160(6):1221-1223.	14	7 consecutive patients 3 reviewers	Retrospective, blinded study. To evaluate CT findings in patients with blunt duodenal trauma to determine if CT can differentiate duodenal perforation from hematoma.	CT showed extraluminal gas or extravasated oral contrast material or both in the right anterior pararenal space in all three patients with duodenal perforation and in none of the patients with duodenal hematoma. Results suggest CT may be useful in differentiating duodenal perforation from hematoma without perforation.	3
61. Nghiem HV, Jeffrey RB, Jr., Mindelzun RE. CT of blunt trauma to the bowel and mesentery. *AJR* 1993; 160(1):53-58.	12	N/A	To review gastrointestinal abnormalities that can be shown by CT in patients with blunt abdominal trauma.	Many major gastrointestinal injuries have subtle CT findings although CT has been shown to be accurate for detecting bowel and mesenteric injuries caused by blunt trauma.	4
62. Saku M, Yoshimitsu K, Murakami J, et al. Small bowel perforation resulting from blunt abdominal trauma: interval change of radiological characteristics. *Radiat Med* 2006; 24(5):358-364.	9	12	To retrospectively study radiography and CT findings of small bowel perforation due to blunt trauma to identify the keys to diagnosis.	• Radiography detected free air in 8% and 25% at the initial and follow-up examinations, respectively. • CT detected extraluminal air in 58% and 92%, respectively. • Mesenteric fat obliteration was seen in 58% and 75% at initial and follow-up CT, respectively. • Chance of detecting extraluminal air increases as time elapses. High-density ascites may be seen without extraluminal air and might be an indirect or precedent sign of small bowel perforation.	3
63. Stuhlfaut JW, Lucey BC, Varghese JC, Soto JA. Blunt abdominal trauma: utility of 5-minute delayed CT with a reduced radiation dose. *Radiology* 2006; 238(2):473-479.	10	662	To retrospectively evaluate the utility of 5-minute delayed CT of the abdomen and pelvis by using a reduced radiation dose in patients with blunt abdominal trauma.	Delayed scans were useful in 27% (12/44) of patients with solid organ injury, 5.9% (1/17) of patients with bowel or mesenteric injury, 4.5% (1/22) of patients with pelvic fractures, and in none of the patients with free fluid only. Overall, delayed CT was useful in 2.1% (14/662) of all patients (95% CI: 1.0, 3.2) referred for evaluation following blunt abdominal trauma. Delayed CT should therefore be used selectively.	2
64. Townsend MC, Flancbaum L, Choban PS, Cloutier CT. Diagnostic laparoscopy as an adjunct to selective conservative management of solid organ injuries after blunt abdominal trauma. *J Trauma* 1993; 35(4):647-651; discussion 651-643.	10	15	Prospective study to examine the effectiveness of diagnostic laparoscopy as an adjunct in patient selection for conservative management of solid organ injuries following blunt abdominal trauma.	Diagnostic laparoscopy may become an effective adjunct in patient selection for conservative management of solid organ injuries following blunt abdominal trauma.	3

Blunt Abdominal Trauma
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Strength of Evidence
65. Iverson AJ, Morey AF. Radiographic evaluation of suspected bladder rupture following blunt trauma: critical review. *World J Surg* 2001; 25(12):1588-1591.	12	N/A	To review radiographic evaluation of suspected bladder injuries.	Traumatic bladder rupture is strongly correlated with the combination of pelvic fracture and gross hematuria.	4
66. Eastham JA, Wilson TG, Ahlering TE. Radiographic evaluation of adult patients with blunt renal trauma. *J Urol* 1992; 148(2 Pt 1):266-267.	10	317	Retrospective review of records to determine role of radiographic evaluation of adult patients with blunt renal trauma.	Radiographic staging is not essential in the adult blunt trauma patient with microscopic hematuria but no shock.	2
67. Knudson MM, McAninch JW, Gomez R, Lee P, Stubbs HA. Hematuria as a predictor of abdominal injury after blunt trauma. *Am J Surg* 1992; 164(5):482-485; discussion 485-486.	15	160	To determine how incidence of trauma relate to degree of hematuria.	Incidence of abdominal injury generally increased with degree of hematuria, approaching 24% in patients with gross hematuria. The incidence of abdominal injury in patients with microscopic hematuria and shock was 29% and 65% for patients with both gross hematuria and shock.	3
68. Fuhrman GM, Simmons GT, Davidson BS, Buerk CA. The single indication for cystography in blunt trauma. *Am Surg* 1993; 59(6):335-337.	10	109 patients – microscopic hematuria 31 patients – gross hematuria	Two studies completed to define the indications for cystography in blunt trauma: • 1st study - 15-month retrospective evaluation revealed 26 patients with bladder trauma. All 26 patients had gross hematuria. • 2nd study - Randomized prospective study of patients with blunt trauma. Patients were randomized to be evaluated with cystography for any degree of hematuria or the diagnosis of pelvic fracture vs. those to be evaluated only for the presence of gross hematuria.	Potential savings if gross hematuria is the sole indication for cystography in blunt trauma.	2
69. McGahan JP, Richards JR, Jones CD, Gerscovich EO. Use of ultrasonography in the patient with acute renal trauma. *J Ultrasound Med* 1999; 18(3):207-213; quiz 215-206.	10	32	Retrospective study to evaluate role of US in patients with known renal injuries.	65% had no free-fluid. Renal injury detected in only 22% by US.	3

Blunt Abdominal Trauma
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Strength of Evidence
70. Ptak T, Rhea JT, Novelline RA. Radiation dose is reduced with a single-pass whole-body multi-detector row CT trauma protocol compared with a conventional segmented method: initial experience. *Radiology* 2003; 229(3):902-905	9	20	Comparison of radiation dose of single pass whole-body CT with segmented whole-body CT in trauma patients.	Single pass had 17% lower dose. Analysis of power and subject population by using a difference in mean of 500 mGy. cm and an alpha of.05 revealed a (1-beta) of higher than 0.90 for a sample of 10 patients. Thus, a whole-body single-pass trauma protocol, compared with a typical segmented acquisition protocol matched for imaging technique, resulted in reduced total radiation dose. The reduction in radiation dose is thought to represent a reduction in redundant imaging at overlap zones between body segments scanned in the segmental protocol but not in the continuous acquisition.	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.