Blunt Abdominal Trauma
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
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.	Observational -Dx	136 patients	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.	3
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.	Review/Other -Dx	N/A	To review the role of CT abdominal scans, angiography, and 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.	Observational -Dx	100 patients	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%.	3
4. Maull KI. Current status of nonoperative management of liver injuries. *World J Surg* 2001; 25(11):1403-1404.	Review/Other -Dx	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.	Observational -Dx	404 patients	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 6 patients needed operative intervention. Nonoperative management is the treatment of choice in stable patients regardless of hemoperitoneum.	3
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.	Observational -Dx	72 patients	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.	Review/Other -Dx	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.	Review/Other -Dx	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.	Observational -Dx	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. Anderson SW, Soto JA, Lucey BC, Burke PA, Hirsch EF, Rhea JT. Blunt trauma: feasibility and clinical utility of pelvic CT angiography performed with 64-detector row CT. *Radiology* 2008; 246(2):410-419.	Observational -Dx	53 patient; 2 reviewers	To retrospectively evaluate the integration of pelvic CT angiography into the thoracoabdominal CT examination of blunt trauma by using 64-detector row CT to differentiate active arterial from active venous hemorrhage.	At pelvic CT angiography, 21/53 patients had evidence of vascular injury: 10 isolated active arterial extravasations, three isolated arterial occlusions, three cases of both arterial extravasation and occlusion, two cases of arterial and venous extravasations, and three isolated venous extravasations. 11/21 patients also underwent conventional angiography, with subsequent embolization performed in seven of these 11 patients. The remaining 10 patients were successfully treated conservatively. When the foci of active arterial extravasation were compared on arterial, portal venous, and delayed phase images, the mean areas of hemorrhage across all three phases were larger in patients who required conventional angiography than in those successfully treated with conservative management. With use of 64-detector row scanning, pelvic CT angiography was successfully integrated into the authors' CT protocols and enabled differentiation between active arterial and active venous hemorrhage, which may influence clinical management.	3

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
11. Anderson SW, Varghese JC, Lucey BC, Burke PA, Hirsch EF, Soto JA. Blunt splenic trauma: delayed-phase CT for differentiation of active hemorrhage from contained vascular injury in patients. *Radiology* 2007; 243(1):88-95.	Observational -Dx	47 patients; 2 reviewers	To retrospectively evaluate delayed-phase CT in the differentiation of active splenic hemorrhage requiring emergent treatment from contained vascular injuries (pseudoaneurysms or arteriovenous fistulas) that can be treated electively or managed conservatively.	Portal venous phase CT revealed a focal high-attenuation parenchymal contrast material collection in 19 patients: 9 patients were classified as group 1 and 10 were classified as group 2. All patients in group 1 underwent emergent splenectomy, and all patients in group 2 were initially treated without surgery. Significant differences in management were noted on the basis of whether hyperattenuating foci were seen on portal venous phase images (P<.001) and whether hyperattenuating foci seen at portal venous phase imaging were further characterized as active splenic hemorrhage or a contained vascular injury at delayed-phase CT (P<.001). In blunt splenic injury, delayed-phase CT helps differentiate patients with active splenic hemorrhage from those with contained vascular injuries.	2
12. Drasin TE, Anderson SW, Asandra A, Rhea JT, Soto JA. MDCT evaluation of blunt abdominal trauma: clinical significance of free intraperitoneal fluid in males with absence of identifiable injury. *AJR* 2008; 191(6):1821-1826.	Observational -Dx	669 consecutive male patients 2 blinded reviewers	To retrospectively determine the clinical significance of the isolated finding of free intraperitoneal fluid on 64-MDCT in male patients who have undergone blunt trauma.	48/669 patients (7.2%) had free intraperitoneal fluid. With 64 MDCT, the isolated finding of free intraperitoneal fluid in male patients who have undergone blunt trauma is seen in approximately 3% of patients. The size and mean attenuation coefficient measurements may add useful information regarding the clinical management of these patients, suggesting that small amounts of low-attenuation free fluid, in the absence of identifiable injury, may have no significant clinical implications.	2

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
13. Fang JF, Wong YC, Lin BC, Hsu YP, Chen MF. The CT risk factors for the need of operative treatment in initially hemodynamically stable patients after blunt hepatic trauma. *J Trauma* 2006; 61(3):547-553; discussion 553-544.	Observational -Dx	214 CT scans	Analysis of CT findings to determine risk factors leading to the need of operative treatment in initially hemodynamically stable patients after blunt hepatic trauma.	Intraperitoneal contrast extravasation, hemoperitoneum in six compartments, maceration >2 segments, high Mirvis' CT grade as well as American Association for the Surgery of Trauma injury scale, laceration ≥6 cm in depth, and porta hepatis involvement occurred significantly more frequently (P≤0.001, respectively) in patients who needed operative treatment. Logistic regression analysis identified "intraperitoneal contrast extravasation" (RR = 12.5, 95% CI, 7.8-20.0; P<0.001) and "hemoperitoneum in six compartments" (RR = 22, 95% CI, 9.7-49.4; P<0.001) to independently contribute to the need of operative treatment. Intraperitoneal contrast extravasation and hemoperitoneum in 6 compartments on CT scan both indicate massive or active hemorrhage and should be regarded as high risk for the need of operation in hemodynamically stable patients after blunt hepatic trauma. Patients with low risk profile can be successfully treated with nonoperative modalities.	3
14. Murakami AM, Anderson SW, Soto JA, Kertesz JL, Ozonoff A, Rhea JT. Active extravasation of the abdomen and pelvis in trauma using 64MDCT. *Emerg Radiol* 2009; 16(5):375-382.	Observational -Dx	125 patients 2 reviewers	Retrospective study to determine the clinical and management implications of the finding of active extravasation in blunt or penetrating trauma patients evaluated with abdomino-pelvic CT using 64-MDCT technology.	In blunt and penetrating trauma patient's evaluated using 64-MDCT technology, the location and size of the region of active extravasation are predictive of the type of subsequent clinical management. Normalized attenuation values of the active extravasation, however, are not predictive of subsequent management.	3

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
15. Rhodes CA, Dinan D, Jafri SZ, Howells G, McCarroll K. Clinical outcome of active extravasation in splenic trauma. *Emerg Radiol* 2005; 11(6):348-352.	Review/Other -Dx	82 patients	Retrospective study to determine the necessity for splenectomy in patients with active extravasation on contrast-enhanced CT secondary to splenic trauma.	Of 82 cases evaluated, 12 grade I, 15 grade II, 30 grade III, 17 grade IV, and 8 grade V injuries were present. Eighteen patients were actively extravasating. Of extravasating patients, 13 eventually underwent open splenectomy or embolization and five (27.8%) were managed expectantly with success. Of grade IV injuries, 9/17 showed active extravasation, of which six underwent splenectomy. Of grade V injuries, 3/8 showed active extravasation, and all three underwent intervention. Splenectomy may not be necessary in appropriately chosen patients with active extravasation from the spleen in blunt abdominal trauma.	4
16. Roy-Choudhury SH, Gallacher DJ, Pilmer J, et al. Relative threshold of detection of active arterial bleeding: in vitro comparison of MDCT and digital subtraction angiography. *AJR* 2007; 189(5):W238-246.	Observational -Dx	Test phantom	To determine the relative sensitivity and the lowest threshold of bleeding detectable with DSA and with MDCT using an in vitro physiologic system. Cine loops of MDCT and DSA images were examined by two blinded observers.	The threshold to detect bleeding was as follows for each study: For IV contrast-enhanced MDCT (study 1), it was 0.35 mL/min; DSA with a catheter 10 cm proximal to the holes (study 2), 0.96 mL/min; DSA with a catheter at the holes (study 3), 0.05 mL/min [corrected] or lower; and intra-arterial selective MDCT (study 4), 0.05 mL/min [corrected] or lower. The ease of detection improved with increasing mean arterial pressure and larger volumes of leakage. Interobserver correlation was excellent. In vitro, IV contrast-enhanced MDCT is more sensitive than first-order aortic branch-selective DSA in detecting active hemorrhage unless the catheter position is highly superselective and is close to the bleeding artery. Results suggest that MDCT can be used as the initial imaging technique in the diagnosis of active hemorrhage if the clinical condition of the patient allows.	2

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
17. Thompson BE, Munera F, Cohn SM, et al. Novel computed tomography scan scoring system predicts the need for intervention after splenic injury. *J Trauma* 2006; 60(5):1083-1086.	Observational -Dx	20 patients reviewed Screening test created and validated in CT from 56 consecutive patients	To develop CT scan screening test to predict the need for intervention in patients with splenic injury.	Three findings correlated with the need for intervention: 1) devascularization or laceration involving 50% or more of the splenic parenchyma, 2) contrast blush greater than one centimeter in diameter (from active extravasation of IV contrast material or pseudoaneurysm formation), and 3) a large hemoperitoneum. Sensitivity of the screening test was 100%, specificity was 88%, and overall accuracy was 93%.These CT scan grading criteria appears to reliably predict the need for invasive management in patients with blunt injury to the spleen.	3
18. 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.	Observational -Dx	165 patients	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
19. Farahmand N, Sirlin CB, Brown MA, et al. Hypotensive patients with blunt abdominal trauma: performance of screening US. *Radiology* 2005; 235(2):436-443.	Observational -Dx	128 patients	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.	3

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
20. 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.	Observational -Dx	328 victims of blunt trauma	To prospectively evaluate hand-held US in early trauma care by comparing its results with those of through formal FAST, CT, operative findings and serial examination at two centers.	Hand-held FAST test performances (sensitivity, specificity, PPV and NPV, likelihood ratios of positive and negative test results) were 77%, 99%, 96%, 94%, 95%, 95 and 0.2, respectively, for free fluid, and 64%, 99%, 96%, 89%, 90%, 74 and 0.4, respectively, for documented injuries. Hand-held FAST missed or gave an indeterminate result in 8 (3%) of 270 patients with injuries who required therapeutic intervention and 25 (9%) of 270 patients who did not require intervention. FFAST performance was comparable. 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.	3
21. 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.	Observational -Dx	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
22. 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.	Observational -Dx	500 patients	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 US 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.	3

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
23. 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.	Observational -Dx	454 patients	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, 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.	3
24. Salera D, Argalia G, Giuseppetti GM. Screening US for blunt abdominal trauma: a retrospective study. *Radiol Med (Torino)* 2005; 110(3):211-220.	Observational -Dx	864 abdominal US examinations of primary trauma patients (139 with major and 725 with minor injuries)	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.	3

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25. Lee BC, Ormsby EL, McGahan JP, Melendres GM, Richards JR. The utility of sonography for the triage of blunt abdominal trauma patients to exploratory laparotomy. *AJR* 2007; 188(2):415-421.	Observational -Dx	4,029 patients had sonography, 122 of whom were hypotensive on arrival and underwent FAST	Retrospective study to assess the utility of FAST in the triage of hypotensive and normotensive blunt abdominal trauma patients to exploratory laparotomy.	Of 87 hypotensive patients with positive findings on FAST, 69 (79%) were taken directly to exploratory laparotomy without the need for CT. In predicting the need for therapeutic laparotomy in hypotensive patients, the sensitivity of FAST was 85%, specificity was 60%, and accuracy was 77%. Of the 3,907 normotensive patients, 3,584 had negative FAST findings, whereas 323 had positive FAST findings. In normotensive patients, the sensitivity of FAST was 85%, specificity was 96%, and accuracy was 96%. In the combined patient population (all hypotensive and normotensive patients), 4,029 patients with blunt abdominal trauma underwent US: 3,619 had negative and 410 had positive FAST findings. In all patients regardless of blood pressure, the sensitivity of FAST was 85%, specificity was 96%, and accuracy was 95%. Hypotensive patients screened in the emergency department with positive FAST findings may be triaged directly to therapeutic laparotomy, depending on the results of the sonography examination, without the need for CT.	4
26. Vlachos K, Archodovassilis F, Stefanakos J, Stergiopoulos S, Peros G. Initial ultrasonographic assessment for blunt abdominal trauma: is it a reliable diagnostic modality for emergency laparotomy? *Int Surg* 2009; 94(4):359-364.	Observational -Dx	1,463 patients	Retrospective study to evaluate the ability of US to identify intra-abdominal injuries that require surgical treatment.	Hemoperitoneum and abdominal visceral injury were correctly detected by US with 88% sensitivity and 96.8% specificity. The results are in accordance with the international literature.	4
27. 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.	Observational -Dx	69 patients	Prospective study to compare the diagnostic value of US and CEUS with CT for the detection of solid organ injuries in blunt abdominal trauma patients.	US had sensitivity of 45.7%, specificity of 91.8%, PPV of 84.2%, and NPV of 64.1%. CEUS had sensitivity of 91.4%, specificity of 100%, PPV of 100% and NPV of 92.5%. CEUS 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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28. 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.	Review/Other -Dx	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
29. 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.	Observational -Dx	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 of 44%, specificity of 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%.	4
30. Butela ST, Federle MP, Chang PJ, et al. Performance of CT in detection of bowel injury. *AJR* 2001; 176(1):129-135.	Observational -Dx	112 patients (50 patients had bowel injuries 62 controls)	Prospectively and retrospectively review of 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.	1
31. 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.	Review/Other -Dx	5 patients	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
32. 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.	Observational -Dx	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%.	3

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33. 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.	Observational -Dx	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
34. 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.	Observational -Dx	263 patients	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.	3
35. 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.	Observational -Dx	54 patients	Prospective, clinical study to evaluate the efficacy of 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.	3
36. 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.	Review/Other -Dx	55 patients	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.	4
37. 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.	Observational -Dx	150 patients	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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38. 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.	Observational -Dx	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.	3
39. 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.	Observational -Dx	324 patients	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.	3
40. 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.	Observational -Dx	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.	3
41. 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.	Observational -Dx	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 of 88%, specificity of 100%, and accuracy of 99%. Only two patients mistakenly discharged from the emergency department. All surgery declared to be needed. Missed 9 of 11 cases of gut injury.	3
42. 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.	Observational -Dx	37 patients	Correlate CT grading with intraoperative grading of liver injuries.	Increasing operative hepatic injury scale 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
43. Hollands MJ, Little JM. Non-operative management of blunt liver injuries. *Br J Surg* 1991; 78(8):968-972.	Observational -Dx	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.	3

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EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
44. 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.	Observational -Dx	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%).	3
45. Goins WA, Rodriguez A, Lewis J, Brathwaite CE, James E. Retroperitoneal hematoma after blunt trauma. *Surg Gynecol Obstet* 1992; 174(4):281-290.	Review/Other -Dx	233 consecutive patients	Retrospective review of patients with retroperitoneal hematoma.	Retroperitoneal hematoma 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.	4
46. Kristjansson A, Pedersen J. Management of blunt renal trauma. *Br J Urol* 1993; 72(5 Pt 2):692-696.	Review/Other -Dx	18 patients	Retrospective study 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.	4
47. 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.	Observational -Dx	3,264 patients	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%.	3
48. 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.	Observational -Dx	32 patients	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 sensitivity (62% to 78%). Reliance on free intraperitoneal fluid may be inaccurate because not all patients with splenic injury have free intra-abdominal fluid.	1
49. Visvanathan R, Low HC. Blunt abdominal trauma--injury assessment in relation to early surgery. *J R Coll Surg Edinb* 1993; 38(1):19-22.	Observational -Dx	113 patients Group A 20, Group B 35, and 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.	3
50. 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.	Observational -Dx	45 patients	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.	3

Blunt Abdominal Trauma
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
51. Farhat GA, Abdu RA, Vanek VW. Delayed splenic rupture: real or imaginary? *Am Surg* 1992; 58(6):340-345.	Review/Other -Dx	75 patients	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.	4
52. Miller MT, Pasquale MD, Bromberg WJ, Wasser TE, Cox J. Not so FAST. *J Trauma* 2003; 54(1):52-59; discussion 59-60.	Observational -Dx	359 patients	Evaluate sensitivity and accuracy of FAST for free intraperitoneal fluid compared to CT and surgery.	FAST had sensitivity of 42%, specificity of 98%, PPV of 67%, NPV of 93%, and accuracy of 92%. FAST results in underdiagnosis of intra-abdominal injury. Hemodynamically stable patients with suspected blunt abdominal injury should undergo routine CT.	3
53. 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.	Observational -Dx	267 patients	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.	3
54. 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.	Observational -Dx	466 patients	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.	3
55. McGahan JP, Richards JR. Blunt abdominal trauma: the role of emergent sonography and a review of the literature. *AJR* 1999; 172(4):897-903.	Review/Other -Dx	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
56. 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.	Observational -Dx	300 patients	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.	3
57. Lingawi SS, Buckley AR. Focused abdominal US in patients with trauma. *Radiology* 2000; 217(2):426-429.	Observational -Dx	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.	3

Blunt Abdominal Trauma
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
58. 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.	Observational -Dx	3,679 patients	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.	3
59. Branney SW, Wolfe RE, Moore EE, et al. Quantitative sensitivity of ultrasound in detecting free intraperitoneal fluid. *J Trauma* 1995; 39(2):375-380.	Observational -Dx	100 patients	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.	3
60. Catalano O, Aiani L, Barozzi L, et al. CEUS in abdominal trauma: multi-center study. *Abdom Imaging* 2009; 34(2):225-234.	Observational -Dx	156 patients	Multicenter study to evaluate the concordance of US and CEUS with CT in the assessment of solid organ injury following blunt trauma.	91/156 patients had one or more abnormalities (n = 107) at CT: 26 renal, 38 liver, 43 spleen. Sensitivity, specificity, and accuracy for renal trauma at baseline US were 36%, 98%, and 88%, respectively, after CEUS values increased to 69%, 99%, and 94%. For liver baseline US values were 68%, 97%, and 90%; after CEUS were 84%, 99%, and 96%. For spleen, results were 77%, 96%, and 91% at baseline US and 93%, 99%, and 97% after CEUS. Per patient evaluation gave the following results in terms of sensitivity, specificity and accuracy: 79%, 82%, and 80% at baseline US; 94%, 89%, and 92% following CEUS. CEUS is more sensitive than US in the detection of solid organ injury, potentially reducing the need for further imaging. False negatives from CEUS are due to minor injuries, without relevant consequences for patient management and prognosis.	3

Blunt Abdominal Trauma
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
61. Clevert DA, Weckbach S, Minaifar N, Stickel M, Reiser M. Contrast-enhanced ultrasound versus MS-CT in blunt abdominal trauma. *Clin Hemorheol Microcirc* 2008; 39(1-4):155-169.	Observational -Dx	78 patients	To evaluate the effectiveness of CEUS in the diagnosis and characterization of hepatic, renal and splenic traumatic injuries versus conventional US and MSCT.	In 15/78 patients conventional US identified solid organ injuries: 8 hepatic, 2 renal and 5 splenic injuries. CEUS identified 3 more injuries (2 hepatic and 1 splenic) that had been missed by conventional US. CEUS identified traumatic lesions in 18/78 patients. In one of the 18 patients even active bleeding could be identified by CEUS. In CEUS solid organ injuries appeared hypoechoic. MSCT identified 18 solid organ injuries in 78 patients, corroborating the CEUS results. CEUS greatly improves the visualization and characterization of hepatic, renal and splenic injuries compared to conventional US and correlates well with MSCT. The imaging technique detects even minor blood flow and is able to depict vascular structures in detail. Owing to its bedside availability, CEUS provides a good alternative to MS-CT, especially in patients with contraindications to CT contrast agents and in hemodynamically compromised patients.	2
62. Manetta R, Pistoia ML, Bultrini C, Stavroulis E, Di Cesare E, Masciocchi C. Ultrasound enhanced with sulphur-hexafluoride-filled microbubbles agent (SonoVue) in the follow-up of mild liver and spleen trauma. *Radiol Med* 2009; 114(5):771-779.	Review/Other -Dx	11 patients	To assess the role of CEUS in the follow-up of patients with a diagnosis of traumatic liver or spleen lesions.	CEUS confirmed lesion sites identified on presentation and allowed authors to follow all phases of the repair process until complete resolution. The conservative management of abdominal lesions in both adults and children is increasingly widespread but requires accurate follow-up over time. As a noninvasive, versatile, easy to perform and repeatable technique with a low rate of adverse reactions, CEUS is ideally suited for this purpose and allowed the authors to reduce the number of CT scans, especially in the follow-up of young patients.	4
63. Williams RA, Black JJ, Sinow RM, Wilson SE. Computed tomography-assisted management of splenic trauma. *Am J Surg* 1997; 174(3):276-279.	Review/Other -Dx	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.	4

Blunt Abdominal Trauma
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
64. 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.	Observational -Dx	81 patients	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
65. 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.	Observational -Dx	40 patients	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
66. Watson CJ, Calne RY, Padhani AR, Dixon AK. Surgical restraint in the management of liver trauma. *Br J Surg* 1991; 78(9):1071-1075.	Review/Other -Dx	80 patients	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.	4
67. Black JJ, Sinow RM, Wilson SE, Williams RA. Subcapsular hematoma as a predictor of delayed splenic rupture. *Am Surg* 1992; 58(12):732-735.	Review/Other -Dx	966 scans	To determine if subcapsular hematoma is a predictor of delayed splenic rapture.	Subcapsular hematoma 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.	4
68. 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.	Review/Other -Dx	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.	4
69. 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.	Observational -Dx	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.	4

Blunt Abdominal Trauma
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
70. Sofocleous CT, Hinrichs C, Hubbi B, et al. Angiographic findings and embolotherapy in renal arterial trauma. *Cardiovasc Intervent Radiol* 2005; 28(1):39-47.	Observational -Dx	22 patients	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
71. 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.	Observational -Dx	25 CT + operating room, and 24 angiographic embolization patients of 164 blunt splenic injuries	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
72. 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.	Review/Other -Dx	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.	4
73. Nghiem HV, Jeffrey RB, Jr., Mindelzun RE. CT of blunt trauma to the bowel and mesentery. *AJR* 1993; 160(1):53-58.	Review/Other -Dx	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
74. 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.	Observational -Dx	12 patients	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

Blunt Abdominal Trauma
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
75. 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.	Observational -Dx	662 patients	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
76. 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.	Review/Other -Dx	15 patients	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.	4
77. Iverson AJ, Morey AF. Radiographic evaluation of suspected bladder rupture following blunt trauma: critical review. *World J Surg* 2001; 25(12):1588-1591.	Review/Other -Dx	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
78. Eastham JA, Wilson TG, Ahlering TE. Radiographic evaluation of adult patients with blunt renal trauma. *J Urol* 1992; 148(2 Pt 1):266-267.	Review/Other -Dx	317 patients	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.	4
79. 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.	Observational -Dx	160 patients	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
80. Fuhrman GM, Simmons GT, Davidson BS, Buerk CA. The single indication for cystography in blunt trauma. *Am Surg* 1993; 59(6):335-337.	Observational -Dx	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.	3

Blunt Abdominal Trauma
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
81. 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.	Observational -Dx	32 patients	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
82. 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	Observational -Dx	20 total patients; 10 in case group and 10 controls	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 Quality Category Definitions

- *Category 1* The study is well-designed and accounts for common biases.
- *Category 2* The study is moderately well-designed and accounts for most common biases.
- *Category 3* There are important study design limitations.
- *Category 4* The study is not useful as primary evidence. The article may not be a clinical study or the study design is invalid, or conclusions are based on expert consensus. For example:
  a) the study does not meet the criteria for or is not a hypothesis-based clinical study (e.g., a book chapter or case report or case series description);
  b) the study may synthesize and draw conclusions about several studies such as a literature review article or book chapter but is not primary evidence;
  c) the study is an expert opinion or consensus document.

Dx = Diagnostic

Tx = Treatment

Abbreviations Key

CEUS = Contrast-enhanced ultrasonography

CI = Confidence interval

CT = Computed tomography

DPL = Diagnostic peritoneal lavage

DSA = Digital-subtraction angiography

ERCP = Endoscopic retrograde cholangiopancreatography

FAST = Focused Assessment with Sonography for Trauma examinations

IV = Intravenous

MDCT = Multidetector computed tomography

MSCT = Multislice computed tomography

NPV = Negative predictive value

PPV = Positive predictive value

RR = Relative risk

TAE = Transcatheter arterial embolization

US = Ultrasound