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[Article]

Focused Assessment with Sonography for Trauma (FAST): Results from an International Consensus Conference

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The consensus conference was held at the R Adams Cowley Shock Trauma Center, University of Maryland Medical System, December 4, 1997, Baltimore, Maryland. A summary was presented at the 11th Annual Meeting of the Eastern Association for the Surgery of Trauma, January 17, 1998, Sanibel, Florida.

Consensus recommendations presented within this article are those of the FAST Consensus Conference Committee and have not been formally endorsed by a regulatory agent or medical society.

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Abstract

Objective: To assemble an international panel of experts to develop consensus recommendations on selected important issues on the use of ultrasonography (US) in trauma care.

Setting: R Adams Cowley Shock Trauma Center, University of Maryland Medical System, Baltimore, Md. The conference was held on December 4, 1997.

Participants: A committee of two co-directors and eight faculty members, in the disciplines of surgery and emergency medicine, representing four nations. Each faculty member had made significant contributions to the current understanding of US in trauma.

Results: Six broad topics felt to be controversial or to have wide variation in practice were discussed using the ad hoc process: (1) US nomenclature and technique; (2) US for organ-specific injury; (3) US scoring systems; (4) the meaning of positive and negative US studies; (5) US credentialing issues; and (6) future applications of US. Consensus recommendations were made when unanimous agreement was reached. Majority viewpoints and minority opinions are presented for unresolved issues.

Conclusion: The consensus conference process fostered an international sharing of ideas. Continued communication is needed to advance the science and technology of US in trauma care.

Key Words: Abdominal injuries, Blunt trauma, Consensus conferences, Sonography, Ultrasound.

In the 1980s, numerous publications on the use of ultrasonography (US) in trauma appeared in the German literature. US use then spread to other European nations, including England and Norway, and intercontinentally. It was not until 1992 that surgeon-performed US in the United States was first reported by Tso et al., in a prospective study of 163 blunt trauma patients. [1] This was followed by a larger series of 476 patients by Rozycki et al. in 1993. [2] Since then, studies on the use of US in trauma have been published by various groups from Japan, Canada, Austria, the Netherlands, Switzerland, Italy, and Taiwan, among others.

CONFERENCE OBJECTIVES

The original impetus for this consensus conference came from Bernard R. Boulanger, MD (Toronto, Canada). He noted that the increasing clinical use and research on US in trauma created a need for standardization of terminology, clinical applications, and credentialing criteria. Collaboration with those at the R Adams Cowley Shock Trauma Center allowed this idea to come to fruition.

It was the goal of this conference to assemble an international panel of experts to discuss, share ideas, synthesize, and develop consensus recommendations on selected important issues regarding US in trauma care. The intended audience is surgeons and emergency medicine physicians who care for trauma patients. All disciplines with any involvement in the evaluation of the injured patient, however, may have an interest. We hoped that this conference would further define the current state and appropriate use of US in the management of trauma victims worldwide and generate potential ideas for further research.

CONFERENCE PARTICIPANTS

The consensus conference faculty was selected to provide an international panel of experts in the disciplines of surgery or emergency medicine, representing nations with significant contributions to the current understanding of US in trauma. The countries selected were Canada, Germany, Japan, and the United States. Each faculty member was selected by the conference co-directors based on individual extensive clinical

experience with the application of US in the evaluation of the trauma patient, as well as personal expertise in the particular topics for discussion. Ultimately, a committee of eight panelists, in addition to the two co-directors, was formed. Additionally, two radiologists with significant expertise in trauma were invited as guests and actively participated in conference discussions (see Acknowledgments).

CONFERENCE PROCESS

Preconference Activities

The consensus conference method was modeled after the "ad hoc process." [3] The conference co-directors selected six broad topics felt to be controversial or to have wide variation in practice and in which a general consensus may have a significant impact in the field. Approximately 6 weeks before the conference, individual faculty participants were assigned one of the preselected topics. Each participant was encouraged to impartially examine the available evidence and relevant literature on that topic in preparation for a formal presentation during the conference proceedings. The literature search and evidence-assessment methods used were left to individual preference. A summary of the available literature is beyond the scope of this article, but brief reviews are available. [4-6] A general public announcement and invitation to attend the conference was distributed locally.

Conference Activities

The consensus conference was held on December 4, 1997, at the R Adams Cowley Shock Trauma Center, University of Maryland Medical System, Baltimore, Md. Introductory remarks by the co-directors were followed by topic presentations. An oral presentation of each topic was delivered by the designated faculty member, followed by deliberations on the relevant issues and questions. All faculty members were encouraged to contribute to the discussion to gain a diversity of perspectives. Input from the general audience was also allowed into the discussion, and at times, this was insightful. At the conclusion of each topic discussion, consensus recommendations were formulated by the committee members. Consensus was determined if the recommendation reached unanimous agreement and lack of dissent. For those unresolved issues with significant disagreement, majority viewpoints and minority opinions are presented. Each topic was allotted 1 hour for presentation and discussion. The entire conference was recorded on videotape for subsequent review.

Postconference Activities

The videotape from the conference proceedings and the written notes were reviewed. A summary of the conference results was then drafted into manuscript form. Each conference faculty member was supplied with a copy of the draft and given the opportunity to make comments, suggestions, or revisions. This article represents the culmination of these activities.

NOMENCLATURE AND TECHNIQUE

Question

What name should be given to the procedure of diagnostic US in the initial assessment of the trauma patient, and how should it be defined?

Discussion

With its increased popularity, various names have been used in the literature to describe the use of diagnostic US for the initial evaluation of the trauma patient. It is important to have a distinct name for this unique procedure for several reasons. A distinct name and clear definition of the procedure will allow broad recognition and immediate understanding of the nature of the procedure. Some uniformity in credentialing criteria may then be established.

Several important features of this technique distinguish it from generic US and should be considered when deciding on a name for the procedure. The technique encompasses only a focused examination and does not include a complete survey of the entire abdomen. The procedure is performed rapidly, early during resuscitation, and is used only to identify evidence of injury.

Rozycki et al. referred to the technique of sonographic scanning for free fluid with clear emphasis on four specific areas of attention: (1) right upper quadrant; (2) left upper quadrant; (3) pelvis; and (4) pericardium. [2] Shackford first described the focused nature of this technique in an editorial in the Journal of Trauma. [7] The acronym "FAST" first appeared in 1996, standing for "focused abdominal sonogram for trauma." [8] In a subsequent report describing the incorporation of US into the Advanced Trauma Life Support course, Rozycki's group referred to FAST as "focused assessment for the sonographic examination of the trauma patient." [9]

In 1995, Boulanger's group introduced the term "emergent abdominal sonography" to describe the same technique of real-time US imaging of the abdomen, searching only for the presence of free intraperitoneal fluid. [10-12] This name can be easily confused with US for other nontrauma conditions. It is essential, therefore, to include the term "trauma" in the name.

Some of the names used previously imply that the procedure is limited to

abdominal assessment. The pericardial view is generally advocated, and extension of the technique to other regions, such as the pleural spaces, may be needed in the future. In addition, the technique may be expanded to include the examination for parenchymal lesions.

Consensus Recommendation

"Focused Assessment with Sonography for Trauma," with the acronym FAST, will describe the most common application of US in the initial evaluation of the trauma patient. Currently, the technique should be defined as real-time sonographic scanning in four distinct regions of the torso, identified as the four Ps: (1) pericardial; (2) perihepatic; (3) perisplenic; and (4) pelvic. (Other technical considerations regarding equipment were not discussed, but excellent reviews are available. [13])

Majority Viewpoint

The sequence of scanning the individual regions is not critical and may be left up to individual preference. The majority of the panelists, in their own practices, begin scanning with the perihepatic view, primarily for the technical ease in identifying the liver. Their sequence then proceeds to the perisplenic, pelvic, and finally the pericardial view. This sequence was the practice of the faculty from Canada, Germany, Japan, and some of those in the United States. It was noted that Rozycki et al. recommended that the pericardial view be performed first so that blood in the heart can be used to set the gain. [6]

Minority Opinion

Modification of the technique to include assessment of additional regions, such as the pleural spaces and retroperitoneum, or the inclusion of parenchymal visceral lesions, may be done, but the clinical utility of these additional views by US are not well characterized at this time. Potential advantages to standardizing the sequence of scanning include the possibility that the overall accuracy or reliability of the study would be enhanced. Standardizing the sequence may also enhance the teaching and learning of the technique.

ORGAN-SPECIFIC INJURY

Question

Can US accurately diagnose organ-specific injury, and what is the utility of US identification of individual organ injuries?

Discussion

Yoshii et al. showed that US, although less sensitive than computed tomography (CT), was reliable for the identification of individual solid-organ injuries, especially for the liver, spleen, and kidneys, but not for intestinal injuries. [14] Some institutions are currently using US for parenchymal injuries in addition to free fluid. [15,16] One of the potential advantages of sonographic scanning for parenchymal lesions would be the early determination of organ-specific injury to help determine the need for laparotomy or to help guide the approach to surgery in unstable patients who cannot undergo CT. In stable patients, CT may be avoided with an accurate and reliable organ-specific US study.

A subset of trauma patients with abdominal injuries do not have detectable hemoperitoneum on admission. [17] Sonographic scanning for parenchymal lesions, therefore, would enhance the sensitivity for detecting injuries. It has also been argued that the majority of intraparenchymal lesions are self-limited, do not require intervention, and may never become clinically important. Sonographic scanning for organ-specific injury clearly adds an unspecified amount of time to the examination, which is dependent on the sonographer's experience, skill, and completeness. It may be impractical for surgeons to acquire and maintain the skill to identify lesions by US when CT is readily available.

Consensus Recommendation

In experienced hands, abdominal injuries may be detectable by US. The utility of US in identifying abdominal parenchymal injuries, however, is subject to debate, and further study is necessary.

Majority Viewpoint

Sonographic scanning for parenchymal lesions adds an undetermined amount of time to the examination. In unstable patients, the need for laparotomy can be determined with the identification of hemoperitoneum alone. In stable patients, CT is recommended to further evaluate the abdomen.

Minority Opinion

In experienced hands, US identification of parenchymal injuries adds little to the scanning time and may guide the approach to surgery in patients requiring laparotomy. In addition, US may detect abdominal injury in those patients presenting without hemoperitoneum. Even the finding of a low-grade intraparenchymal lesion may influence management strategy, such as increasing the duration of observation. Rarely,

a low-grade lesion may progress to become clinically significant, such as a delayed rupture of a splenic hematoma.

SCORING SYSTEMS

Question

Should a US scoring system be used, and could it affect clinical management of the trauma patient?

Discussion

Knowing the amount of free intraperitoneal blood may affect the decision for operative versus nonoperative management. A nominal classification, such as minimal, mild, moderate, and large, may be very subjective and unreliable. A standardized scoring system, therefore, can facilitate accurate information transfer. The ideal scoring system should (1) be entirely objective; (2) be simple to perform; (3) provide useful information to guide patient management; and (4) be able to be consistently applied for follow-up.

In 1994, Huang et al. developed a scoring system in which points were assigned based on the location of intra-abdominal free fluid. [18] Four different locations are assessed, and one point is given for each location that contains fluid. Fluid of more than 2 mm width in either Morison's or Douglas's pouch is given 2 points, instead of 1. The presence of floating intestinal loops is also given 1 point. This scoring system seems to be easy to perform, easy to apply, and correlated with estimated intra-abdominal blood at laparotomy, but it did not predict the need for laparotomy well. Although 96% of patients with scores greater than 2 required laparotomy, 38% of those with scores of 2 or less still required laparotomy.

In the scoring system of McKenney et al., the maximum depth of the deepest pocket, plus 1 point for each other area (four areas maximum) with free fluid, represents the total hemoperitoneum score. [19] In this study, 76% of patients with scores greater than 2 required laparotomy, whereas only 10% of patients with scores 2 or less required laparotomy. Although Huang's scoring system had a better positive predictive value, McKenney's scoring system had a better negative predictive value for the need for laparotomy.

Consensus Recommendation

The currently known US scoring systems for abdominal trauma were designed and tested on a limited number of subjects. The ability for these scoring systems to identify patients requiring operative therapy is not established. There is a need, therefore, to conduct a multicenter (perhaps multinational) prospective trial to develop and field-test a scoring system. The initial plans to implement this venture are currently in progress.

Majority Viewpoint

A simple scoring system would enhance reliability during serial examinations and would provide an objective method for information transfer to others involved in a particular patient's care. It would also provide a standard reference against which future clinical studies can be compared.

Minority Opinion

US scoring should not be used in the clinical arena because it may confuse the decision-making when the amount of hemoperitoneum does not explain the patient's condition. For example, a low score may inappropriately lead to nonoperative management in a patient with hemorrhagic shock. Conversely, a high score may lead to laparotomy in a stable patient who may have been successfully managed nonoperatively.

POSITIVE AND NEGATIVE STUDIES

Question

What does a positive or negative FAST study mean, and how should it affect patient management?

Discussion

Numerous studies reported in the literature have referred to the sensitivity, specificity, and accuracy of US. To place these figures in the proper perspective, it is critical to examine the definitions of positivity and negativity, true or false, used to calculate these numbers. It appears that these definitions have been extremely variable and loosely applied in the literature.

Positivity or negativity depends on the question being asked. When US is performed for free fluid only, the detection of free fluid yields a positive result, whereas the absence of free fluid yields a negative result. When US is performed for any evidence of trauma, free fluid or parenchymal lesions, the detection of either yields a positive result and the absence of either yields a negative result. US views that are not clearly positive or negative should be termed "indeterminate".

A true-positive study, therefore, is one in which free fluid is detected and has been confirmed by CT, diagnostic peritoneal lavage (DPL), or laparotomy. A false-positive study is one in which free fluid is found on US, but a criterion standard method has disproved the finding. Likewise, a false-negative study is one in which negative US results are disproved by the criterion standard test.

The category that is the most difficult to define is that of true-negative. In the pure statistical sense, all true-negatives should be confirmed by a standard test. In clinical situations, it may be impractical to confirm all negative results with an additional study. Therefore, many true-negatives have been identified as such based on successful observation for the lack of adverse clinical events. This operational definition of true-negative, therefore, can be used to classify those patients.

In patient management, an early decision point arises regarding hemodynamic status. In unstable patients, the goal of FAST is to rapidly determine whether shock is attributable to hemoperitoneum or hemopericardium. If so, immediate operation may be life-saving. Unfortunately, stable patients represent a variety of patient presentations, leading to a much more ambiguous management algorithm. For example, patients with hemoperitoneum from hepatic or splenic injury may be candidates for nonoperative management. Patients with high-grade abdominal parenchymal injury may not yet have detectable hemoperitoneum on admission, leading to a negative FAST. Still other patients with bowel or retroperitoneal injury may or may not have free intraperitoneal fluid at all.

Consensus Recommendation

In hemodynamically unstable patients, a positive FAST result suggests that hemoperitoneum and laparotomy should be performed in most cases. In hemodynamically unstable patients with a negative FAST result, a search for extra-abdominal sources of hemorrhage should be performed. In hemodynamically stable patients, a positive FAST result should be followed by CT to better define the nature of the injuries. This last point is a major deviation from the guidelines published by the American College of Surgeons' Committee on Trauma for the evaluation of abdominal trauma in 1995. [20] (That algorithm uses US, DPL, and CT interchangeably. It does not suggest CT confirmation of injury, but instead recommends observation or operation based on clinical judgment.)

Majority Viewpoint

In hemodynamically stable patients, a negative FAST result should be followed by a period of observation of at least 6 hours and a follow-up FAST. At least one follow-up FAST examination should be performed on every patient to exclude abdominal injury. Although there is no good evidence clearly supporting the utility of this follow-up study in stable patients, many published algorithms include it as a component. [3,13] The overall timing and frequency of repeat studies should be governed by clinical course.

Minority Opinion

In hemodynamically unstable patients with a positive FAST result, the quantity of free fluid should be considered before proceeding to laparotomy. For example, a patient with a pelvic fracture and a small amount of fluid may be disserved by laparotomy. In hemodynamically stable patients at low risk for abdominal injury, a negative FAST result may be followed by an observational period of at least 6 hours without a follow-up study. These patients should have a normal sensorium, a negative and reliable physical examination, and a stable hospital course. In patients at high risk for abdominal injury and a negative FAST result, CT or DPL should still be performed to exclude injury.

CREDENTIALING ISSUES

Question

What are the important existing credentialing issues, and how do we determine competence?

Discussion

In Germany, US experience is incorporated into residency training and surgeons must have documentation to obtain board qualification. [21] There are courses sponsored by the German Trauma Association in US. The training requirements are 15 hours in theory and 15 hours in practice. Four hundred examinations performed under supervision are also required. In Japan, US training is also a requirement during residency.

Because surgeon-performed US is a more recent development in the United States, no formal training curriculum has yet been adopted by the American Board of Surgery. Instead, American surgeons have learned US through various sponsored courses and through individual mentoring. Although a nationally recognized training curriculum would be preferable in the future, it appears that many surgeons are capable of reaching proficiency in FAST with the currently available courses, combined with adequate personal experience.

Likewise, credentialing issues are much more uncertain in the United States. Rozycki et al. first addressed the importance of credentialing, emphasizing that continuous quality improvement should be an integral component. [8,22] Cushing and Chiu described the process in more detail by clearly outlining five principles of credentialing: (1) procedure specificity; (2) provider specificity; (3) institution specificity; (4) criteria for competence; and (5) performance measurement. [23]

The responsibility for conducting the credentialing process may vary among institutions. Although practice domain considerations among surgeons, emergency medicine physicians, and radiologists may be significant, a surgeon-performed procedure should be credentialled through the department of surgery, and likewise for emergency medicine physicians. Ideally, standard credentialing criteria should be set forth by a nationally recognized organization.

In the process of establishing criteria for credentialing, the FAST procedure must be carefully defined and should be clearly distinguished from formal abdominal US. It should include a description of the patient population and setting in which the procedure will be applied. It should be clear that the privileges are being granted to surgeons or emergency medicine physicians. Clear statements outlining the prerequisites for achieving and maintaining competence must be present. Finally, the entire credentialing process should be data-driven. Performance should be measured and documented for continuous quality assurance.

The amount of training needed to achieve a level of competence has not been clearly established. Similarly, the number of patient examinations required to obtain adequate experience is undetermined. Most published recommendations, such as those by the American Institute of Ultrasound in Medicine and the Society for Academic Emergency Medicine, refer to broader US examinations, and therefore would not pertain to FAST alone. A recently published article regarding implementation and credentialing of surgeon-performed FAST reported excellent results (81% sensitivity, 99% specificity, 98% accuracy) after only a single 8-hour trauma US course. [24] The authors of that study also recommended as few as 50 supervised examinations.

Consensus Recommendation

An integral component of the credentialing process is a clear definition of the procedure to be performed. A format to measure and document performance and accuracy in a continuous quality assurance process is essential. Incorporation of US into residency requirements should provide a more consistent method for training and experience.

Majority Viewpoint

The minimum amount of training required to learn the FAST procedure is 8 hours: 4 hours of theoretical instruction and 4 hours of practical instruction. The minimum number of supervised patient examinations should be 200.

Minority Opinion

It may be impractical to obtain 200 supervised examinations. As few as 50 may be all that is needed to obtain a level of proficiency. The number of examinations needed, therefore, may be modified by each institution. In addition, a minimum number of examinations with a positive result may be required to demonstrate the ability to detect pathologic features. The number of positive studies that should be required has not yet been determined.

FUTURE APPLICATIONS

Question

What are some of the potential directions of US currently undergoing investigation?

Discussion

The disease process of trauma begins at the point of injury in the prehospital setting. Hemorrhage and cellular hypoxia are ongoing before admission to the hospital. For the patient in shock, the early detection of the source of hemorrhage may improve management and outcome.

The application of US in the prehospital setting by flight physicians and nurses is being actively investigated. US performed in the field or during transport may provide early information for the receiving physician. Furthermore, the potential for simultaneous transmission of real-time images to the trauma center may be advantageous. Telemedicine may be able to provide this important data in the future. Using telemedicine, triage decisions can be made regarding air versus ground transport, and preparations by surgeons and operating room teams for receiving critically injured patients may begin earlier at the trauma center.

In the realm of education, there has been discussion to include FAST training as a skill station in the Advanced Trauma Life Support course. [25] In addition, a multimedia, computer-based system for FAST has been developed for training and competency assessment (presented by Cushing et al. at the 10th Annual Meeting of the Eastern

Association for the Surgery of Trauma, 1997). The interactive program presents case histories and FAST examinations in real time and allows the examinee to respond to questions on case management. Correct answers and corresponding CT images are provided. This module is currently being used in trauma fellow and surgical and emergency medicine resident education and is included in an organized course at the R Adams Cowley Shock Trauma Center.

Another innovation is a smaller, more compact, even pocket-sized machine that would be more portable and would be ideal for prehospital use. Three-dimensional US imaging and simulated US models for teaching are ideas that may have an impact in the future. Research on design and implementation of these potential devices is ongoing.

Consensus Recommendation

New technology and applications for US are currently available. There is great potential for basic research and clinical trials to be performed in proposed settings.

SUMMARY

There is considerable variation and controversy in the evolving practice of using US in the management of trauma patients all over the world. This consensus conference committee met with the hope that the results would help provide greater uniformity in the current use of FAST, a Focused Assessment with Sonography for Trauma. The conference process was able to foster an international sharing of ideas and the hope for continued communication in our efforts to advance the science and technology of trauma care.

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APPENDIX: FAST CONSENSUS CONFERENCE COMMITTEE

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REFERENCES

1. Tso P, Rodriguez A, Cooper C, et al. Sonography in blunt abdominal trauma: a preliminary progress report. *J Trauma*. 1992;33:39-44. [360 Link](#) | [Bibliographic Links](#) | [Context Link](#)
2. Rozycki GS, Ochsner MG, Jaffin JH, Champion HR. Prospective evaluation of surgeons' use of ultrasound in the evaluation of trauma patients. *J Trauma*. 1993;34:516-527. [360 Link](#) | [Bibliographic Links](#) | [Context Link](#)
3. Rotondi AJ, Kvetan V, Carlet J, Sibbald WJ. Consensus conferences in critical care medicine. *Crit Care Clin*. 1997;13:417-439. [Context Link](#)
4. Rozycki GS. Abdominal ultrasonography in trauma. *Surg Clin North Am*. 1995;75:175-191. [360 Link](#) | [Bibliographic Links](#) | [Context Link](#)
5. Davis FE. The evolution of ultrasound as a diagnostic modality for evaluation of the abdomen in blunt-injured patients. *Trauma Q*. 1997;13:155-171. [360 Link](#) | [Context Link](#)

6. Rozycki GS, Feliciano DV, Davis TP. Ultrasound as used in thoracoabdominal trauma. *Surg Clin North Am.* 1998;78:295-310. [360 Link](#) | [Bibliographic Links](#) | [\[Context Link\]](#)

7. Shackford SR. Focused ultrasound examinations by surgeons: the time is now. *J Trauma.* 1993;35:181-182. [\[Context Link\]](#)

8. Rozycki GS, Ochsner MG, Schmidt JA, et al. A prospective study of surgeon-performed ultrasound as the primary adjuvant modality for injured patient assessment. *J Trauma.* 1995;39:492-500. [Ovid Full Text](#) | [Bibliographic Links](#) | [\[Context Link\]](#)

9. Han DC, Rozycki GS, Schmidt JA, Feliciano DV. Ultrasound training during ATLS: an early start for surgical interns. *J Trauma.* 1996;41:208-213. [Ovid Full Text](#) | [Bibliographic Links](#) | [\[Context Link\]](#)

10. Boulanger BR, Brenneman FD, McLellan BA, Rizoli SB, Culhane J, Hamilton P. A prospective study of emergent abdominal sonography after blunt trauma. *J Trauma.* 1995;39:325-330. [Ovid Full Text](#) | [Bibliographic Links](#) | [\[Context Link\]](#)

11. Boulanger BR, McLellan BA, Brenneman FD, et al. Emergent abdominal sonography as a screening test in a new diagnostic algorithm for blunt trauma. *J Trauma.* 1996;40:867-874. [Ovid Full Text](#) | [Bibliographic Links](#) | [\[Context Link\]](#)

12. Wherrett LJ, Boulanger BR, McLellan BA, et al. Hypotension after blunt abdominal trauma: the role of emergent abdominal sonography in surgical triage. *J Trauma.* 1996;41:815-824. [Ovid Full Text](#) | [Bibliographic Links](#) | [\[Context Link\]](#)

13. Ochsner MG. The basic abdominal ultrasound exam for the presence of fluid in the abdomen. *Trauma Q.* 1997;13:173-189. [360 Link](#) | [\[Context Link\]](#)

14. Yoshii H, Sato M, Yamamoto S, et al. Usefulness and limitations of ultrasonography in the initial evaluation of blunt abdominal trauma. *J Trauma.* 1998;45:45-51. [Ovid Full Text](#) | [Bibliographic Links](#) | [\[Context Link\]](#)

15. McKenney M, Lentz K, Nunez D, et al. Can ultrasound replace diagnostic peritoneal lavage in the assessment of blunt trauma? *J Trauma.* 1994;37:439-441. [360 Link](#) | [Bibliographic Links](#) | [\[Context Link\]](#)

16. McKenney MG, Martin L, Lentz K, et al. 1,000 consecutive ultrasounds for blunt abdominal trauma. *J Trauma.* 1996;40:607-612. [Ovid Full Text](#) | [Bibliographic Links](#) | [\[Context Link\]](#)

17. Chiu WC, Cushing BM, Rodriguez A, et al. Abdominal injuries without hemoperitoneum: a potential limitation of focused abdominal sonography for trauma (FAST). *J Trauma.* 1997;42:617-625. [Ovid Full Text](#) | [Bibliographic Links](#) | [\[Context Link\]](#)

18. Huang M, Liu M, Wu J, Shih H, Ko T, Lee C. Ultrasonography for the evaluation of hemoperitoneum during resuscitation: a simple scoring system. *J Trauma.* 1994;36:173-177. [360 Link](#) | [Bibliographic Links](#) | [\[Context Link\]](#)

19. McKenney KL, McKenney MG, Nunez DB, McDowell L, Martin L. Interpreting the trauma ultrasound: observations in 62 positive cases. *Emerg Radiol.* 1996;3:113-117. [360 Link](#) | [\[Context Link\]](#)

20. Maier RV. Evaluation of abdominal trauma. *Bull Am Coll Surg.* 1995;80:37-38. [360 Link](#) | [\[Context Link\]](#)

21. Hoffmann R, Nerlich M, Muggia-Sullam M, et al. Blunt abdominal trauma in cases of multiple trauma evaluated by ultrasonography: a prospective analysis of 291 patients. *J Trauma.* 1992;32:452-458. [\[Context Link\]](#)

22. Rozycki GS, Shackford SR. Ultrasound, what every trauma surgeon should know. *J Trauma.* 1996;40:1-4. [Ovid Full Text](#) | [Bibliographic Links](#) | [\[Context Link\]](#)

23. Cushing BM, Chiu WC. Credentialing for the ultrasonographic evaluation of trauma patients. *Trauma Q.* 1997;13:205-213. [360 Link](#) | [\[Context Link\]](#)

24. Thomas BT, Falcone RE, Vasquez D, et al. Ultrasound evaluation of blunt abdominal trauma: program implementation, initial experience, and learning curve. *J Trauma.* 1997;42:384-390. [Ovid Full Text](#) | [Bibliographic Links](#) | [\[Context Link\]](#)

25. Ochsner MG. Future applications of ultrasound in the injured patient. *Trauma Q.* 1997;13:215-218. [360 Link](#) | [\[Context Link\]](#)

