Free Fluid in Morison's Pouch on Bedside Ultrasound Predicts Need for Operative Intervention in Suspected Ectopic Pregnancy

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Abstract

Background: Ectopic pregnancies are frequently present in women who present to the emergency department with pregnancy and abdominal pain or bleeding, a subset of whom may require operative intervention.

Objectives: To prospectively determine if emergency physician (EP)-performed transabdominal pelvic ultrasonography (US) with determination of free abdominal fluid in the hepatorenal space predicted the need for operative intervention.

Methods: Patients who were suspected to have an ectopic pregnancy were prospectively enrolled over a ten-month period. An EP-performed bedside transabdominal pelvic US that included a view of the hepatorenal space (Morison's pouch) for free fluid. The EP US was classified as intrauterine pregnancy (IUP) or no definitive IUP, with Morison's pouch classified as positive or negative. The majority of patients had a subsequent transvaginal pelvic US performed by the Department of Radiology. Patients were followed up for radiology results, need for operative intervention, and ultimate outcome of the pregnancy.

Results: There were 242 patients enrolled, with an average time to complete the EP US of 4 minutes and 27 seconds. There were 28 ectopic pregnancies diagnosed (11.6%), of which 18 patients underwent operative intervention. Free fluid in Morison's pouch was identified in ten patients, nine of whom underwent operative intervention, yielding a positive likelihood ratio of 112 (95% confidence interval = 15 to 831) for patients with suspected ectopic pregnancy who required operative intervention.

Conclusions: Free intraperitoneal fluid found in Morison's pouch in patients with suspected ectopic pregnancy may be rapidly identified at the bedside by EP-performed US and predicts the need for operative intervention.

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Abdominal pain or vaginal bleeding in early pregnancy are common emergency department (ED) presentations that may represent an ectopic pregnancy. Ectopic pregnancies are the leading cause of maternal mortality in the first trimester and may be present in as many as 8% of patients presenting to the ED with complaints related to early pregnancy.[1,2] While the majority of patients presenting with first-trimester bleeding or pain are stable, a subset may present with a hemorrhagic ectopic pregnancy and are potentially unstable.[3] Use of ultrasonography (US) for determination of internal bleeding has been well studied in trauma with the Focused Assessment of Sonography in Trauma (FAST) examination.[4,5] While much interest in the FAST examination has been focused on trauma, FAST may also indicate significant nontraumatic pelvic and intraperitoneal hemorrhage.[6]

In a retrospective study in 2001, Rodgerson et al. demonstrated that identifying patients with a suspected ectopic pregnancy and fluid in Morison's pouch by emergency physician (EP)-performed bedside US decreased the time to diagnosis and treatment.[7] We sought to prospectively investigate the significance of positive fluid in Morison's pouch by EP-performed US in patients with suspected ectopic pregnancy.

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METHODS

Study Design

This was a prospective observational study that enrolled consecutive pregnant patients. Verbal consent was obtained from all patients who agreed to participate in the study. This protocol was approved by the Human Investigation Committee at Yale University School of Medicine.

Study Setting and Population

This study was conducted at Yale-New Haven Hospital, an urban Level 1 trauma center and teaching hospital with more than 70,000 annual ED visits. Patients who presented to the ED in whom there was a suspicion of an ectopic pregnancy were included, that is, female patients with positive pregnancy test results who presented in the first trimester with abdominal pain and/or vaginal bleeding and for whom the EP intended to obtain imaging or consultation.

Study Protocol

All enrolling physicians participated in a three-hour course or the equivalent in the context of an ongoing US education program that included both didactic and hands-on training in FAST examination and transabdominal pelvic US. Actual numbers of US previously performed by enrolling physicians varied, and there was no minimum number required before enrolling patients in this study.

Bedside transabdominal US was performed using a B-K Medical Hawk XDI ultrasound scanner (B-K Medical, Herlev, Denmark). The US was recorded on S-VHS videotape.

Measurements

Morison's pouch was classified as positive, negative, or indeterminate. Pelvic US result was classified as intrauterine pregnancy (IUP) or no definitive IUP, and fluid in the cul-de-sac was classified as present or absent.

Follow-up was performed by one of four study investigators who were blinded to the ED US results. Review of the medical charts, including radiology US findings, operative records, online medical records, and/or telephone conversations, were used to ultimately classify final outcome as nonectopic or ectopic pregnancy and to further define the management as operative or medical. Patients with a radiology study showing an IUP, or who on follow-up were found to have a delivery or abortion, were classified as nonectopic. Ectopic pregnancies were identified by radiology US and/or operative findings. Patients discharged with a β human chorionic gonadotropin level less than 2,000 mIU/mL and a formal US that showed neither an IUP nor a definite ectopic pregnancy, and in whom follow-up data did not allow classification into ectopic or nonectopic, were classified as "expectant management."

Examinations were reviewed in a blinded fashion by the primary investigator (CM, fellowship trained in emergency US) for quality assurance purposes and to record the time taken to complete the study, but the review did not specifically influence the results.

Data Analysis

Study data were entered into a Microsoft Access database (Microsoft Corp., Redmond, WA) and transferred to a Microsoft Excel spreadsheet. Data were analyzed by a statistician (ZL) at the Yale Center for Outcomes Research using SAS (SAS Institute Inc., Cary, NC). A t-test using the pooled method with Satterwhaite adjustment for skewed variables was performed on continuous variables in the operative ectopic group compared with all patients.

RESULTS

From February 2003 to January 2004, 256 patients were approached for enrollment. Patients were excluded if they declined enrollment (three patients), if they were found not to be pregnant (four patients), or if the data form was not filled out (seven patients), leaving 242 patients for analysis.

Ultrasound examinations were performed by 48 different physicians (mean, 5.0 patients per physician; median, 4; range, 1–16). The average time to complete the EP-performed US was 4 minutes and 27 seconds (mean [±SD], 270 [±142] seconds; median, 248 seconds; range, 42–617 seconds). Of the 241 EP-performed US examinations, ten patients were found to have fluid in the Morison's pouch and 23 patients were found to have fluid in the pelvis. EPs classified 90 patients as having an IUP and 150 as having no definitive IUP. One patient was correctly identified as having a definite ectopic pregnancy by transabdominal EP US.

On follow-up, 190 patients (78.5%) were classified as nonectopic (188 IUPs, and two patients with gestational trophoblastic disease). There were 28 confirmed ectopic pregnancies (11.6%); 18 (7.4%) of these patients underwent operative intervention within 24 hours, and ten (4.1%) were treated medically. Twenty-three patients (9.5%) were discharged with expectant management. All operative interventions demonstrated ectopic pregnancy. There was one heterotopic pregnancy (0.4%) initially classified by both EP and radiology US as an eight-week IUP without identification of the ectopic pregnancy or any free fluid by either EP or radiology US. This patient was taken to the operating room on clinical grounds and found to have an ectopic pregnancy in addition to the IUP. We did not include this patient in further analysis. Subsequent transvaginal pelvic US was performed by the Department of Radiology during the initial patient visit on 226 patients (93.4%). Of the 16 patients who did not receive radiology US, four were patients with ectopic pregnancies taken directly to the operating room, and the remaining 12 patients were discharged with an IUP, confirmed on review of images and follow-up.

Free fluid in Morison's pouch was identified by EP-performed US in ten patients (4.1%), nine of whom underwent immediate operative intervention for ruptured ectopic pregnancy. The other patient had an IUP with free fluid from another source, believed to be a ruptured corpus luteum cyst. Free fluid in the pelvis was seen on transabdominal EP US in 23 of 241 patients (9.5%), and on radiology-performed US in 69 of 226 patients (31%), with a moderate to large amount of fluid seen in 23 of

Table 1
Ultrasound Finding of Fluid and Clinical Characteristics of Patients with Ectopic Pregnancy

	Ectopic Pregnancy, Operative	Any Ectopic Pregnancy
Fluid in right upper quadrant on ED US (n = 10/241)		
Sensitivity, % (95% CI)	50 (27, 73)	32 (17, 52)
Specificity, % (95% CI)	99.5 (97, 100)	99.5 (97, 100)
Positive likelihood ratio (95% CI)	112 (15, 831)	68.5 (9, 520)
Fluid in pelvis on ED US (n = 23/241)		
Sensitivity, % (95% CI)	56 (31, 78)	39 (22, 59)
Specificity, % (95% CI)	94 (90, 97)	94 (90, 97)
Positive likelihood ratio (95% CI)	9.5 (4.9, 19)	7.0 (3.4, 14)
Moderate to large pelvic fluid on radiology US (n = 23/226)		
Sensitivity, % (95% CI)	44 (22, 69)	46 (28, 66)
Specificity, % (95% CI)	93 (89, 96)	95 (91, 97)
Positive likelihood ratio (95% CI)	6.6 (3.2, 13.5)	9.9 (4.8, 20.4)
Any fluid in pelvis on radiology US (n = 69/226)		
Sensitivity, % (95% CI)	72 (46, 89)	53 (36, 69)
Specificity, % (95% CI)	73 (66, 79)	74 (67, 80)
Positive likelihood ratio (95% CI)	2.7 (1.9, 3.9)	2.0 (1.4, 3.0)
Clinical characteristics (mean ± SD)*		
Gravida	3.6 ± 2.9	3.6 ± 2.6
Para	1.8 ± 1.7	1.9 ± 1.8
Estimated gestational age (wk)	5.7 ± 2.8	4.1 ± 3.5
Pain (0–10)	7.7 ± 3.1	7.6 ± 3.1
Heart rate (beats/min)	90 ± 13	91 ± 12
Sytolic blood pressure (mm Hg)	111 ± 23	114 ± 20
Shock index (heart rate/systolic blood pressure)	0.85 ± 0.27	0.83 ± 0.22
β human chorionic gonadotropin (mIU/mL, in 1,000s)	13 ± 18	8.3 ± 15
Hemoglobin (g/dL)	12.2 ± 1.4	11.9 ± 1.5
Hematocrit (%)	36.2 ± 4.5	31.5 ± 6.1

US = ultrasonography.
* All p-values >0.05 comparing the two groups.

226 (10.2%). The clinical and test characteristics for all ectopic pregnancies and those who underwent operative intervention are shown in Table 1.

DISCUSSION

Of the 28 ectopic pregnancies identified in this study, 32% had free fluid and all of these ultimately underwent operative intervention. The high likelihood ratio of free fluid for operative intervention suggests that the addition of a Morison's pouch view may provide immediate and useful information regarding patient disposition. In addition, an IUP, if seen on transabdominal US, makes an ectopic (heterotopic) pregnancy unlikely, although the presence of a heterotopic pregnancy in this study highlights the need to consider this uncommon entity.

We do not mean to suggest that transabdominal pelvic US can replace transvaginal US in evaluating patients with a suspected ectopic pregnancy, rather that it may provide supplemental information and may aid in initial risk stratification when transvaginal US is less readily available. In a survey of community EDs in 2004, consultant-performed US was unavailable during nighttime hours in 25% of EDs and took longer than two hours to obtain in another 20%.[8] While EPs may perform transvaginal US, less than 50% of community EDs that had EP US performed transvaginal pelvic US, while more than 80% of these performed the FAST examination. In academic centers, 90% or more centers performed the FAST examination, while less than 60% performed transvaginal US.[9,10] This study demonstrates that transabdominal sonography may be quickly performed by EPs with goal-directed training.

LIMITATIONS

We acknowledge that this study has significant limitations. While we attempted to enroll consecutive patients, some may have been missed. The prevalence of ectopic pregnancy in the study population of 11.5% (28/242) is higher than most published rates and may reflect a selection bias for patients in whom the physician had a higher suspicion for an ectopic pregnancy.

This study was intended to be observational, but our institutional review board did not believe it was ethical to blind treating physicians to the results. Consultants were typically not present when the ED US was performed and tended to act on objective data from the history, physical examination, laboratory, and radiology imaging report. While the decision to pursue operative intervention is multifactorial, the noted presence of free intraperitoneal fluid on ED US may have influenced (increased) the likelihood ratio for operative intervention that would have been independently predicted by a positive Morison's finding in the presence of blinding. It should also be noted that not all pregnant patients with free fluid have a ruptured ectopic pregnancy, as highlighted by the patient with an IUP and free fluid.

While all EPs performing US had undergone at least a basic course in performing transabdominal pelvic US in the context of an ongoing US curriculum, not all had reached the 25 examinations typically required for credentialing. It would be expected that the results would improve with increasing US experience.

Finally, although we attempted to determine final outcome and clinical course on all study participants, a significant number were discharged with a low β human chorionic gonadotropin result and indeterminate US. While in most of these patients' follow-up demonstrated a declining β human chorionic gonadotropin level with no further intervention, some were lost to follow-up and it is impossible to know if these patients actually had an ectopic pregnancy or a miscarriage.

CONCLUSIONS

Free intraperitoneal fluid found in Morison's pouch in patients with suspected ectopic pregnancy may be rapidly identified at the bedside by an EP-performed US and predicts the need for operative intervention. Transabdominal pelvic US may show an IUP in more than one third of patients with suspected ectopic pregnancy.

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References

1. Barnhart K, Mennuti MT, Benjamin I, Jacobson S, Goodman D, Coutifaris C. Prompt diagnosis of ectopic pregnancy in an emergency department setting. Obstet Gynecol. 1994; 84:1010–5.
2. Stovall TG, Kellerman AL, Ling FW, Buster JE. Emergency department diagnosis of ectopic pregnancy. Ann Emerg Med. 1990; 19:1098–103.
3. Centers for Disease Control and Prevention (CDC). Maternal mortality—United States, 1982-1996. MMWR Morbid Mortal Wkly Rep. 1998; 47:705–7.
4. Rozycki GS, Ochsner MG, Feliciano DV, et al. Early detection of hemoperitoneum by ultrasound examination of the right upper quadrant: a multicenter study. J Trauma. 1998; 45:878–83.
5. Blaivas M, Sierzenski P, Theodoro D. Significant hemoperitoneum in blunt trauma victims with normal vital signs and clinical examination. Am J Emerg Med. 2002; 20:218–21.
6. Hsu S, Martin D, Aly A. Operative laparoscopy in tubal pregnancy: preoperative ultrasonographic measurement of hemoperitoneum as a predictor of blood loss and outcome. J Reprod Med. 2005; 50: 117–22.
7. Rodgerson JD, Heegaard WG, Plummer D, Hicks J, Clinton J, Sterner S. Emergency department right upper quadrant ultrasound is associated with a reduced time to diagnosis and treatment of ruptured ectopic pregnancies. Acad Emerg Med. 2001; 8:331–6.
8. Moore CL, Molina AA, Lin H. Ultrasonography in community emergency departments in the United States: access to ultrasonography performed by consultants and status of emergency physician-performed ultrasonography. Ann Emerg Med. 2006; 47:147–53.
9. Counselman FL, Sanders A, Slovis CM, Danzl D, Binder LS, Perina DG. The status of bedside ultrasonography training in emergency medicine residency programs. Acad Emerg Med. 2003; 10:37–42.
10. Moore CL, Gregg S, Lambert M. Performance, training, quality assurance, and reimbursement of emergency physician-performed ultrasonography at academic medical centers. J Ultrasound Med. 2004; 23: 459–66.