



Original Contribution

Diagnosis and management of ectopic pregnancy using bedside transvaginal ultrasonography in the ED: a 2-year experience

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Abstract

Objectives: The objective of this study was to describe diagnosis and management of ectopic pregnancy using bedside transvaginal ultrasound (US) in an established emergency US program.

Methods: This was a retrospective study on patients presenting over a 2-year period performed at a level I urban academic emergency department (ED). The ED sees 78 000 patients annually and has a residency and active US program. Patients were eligible for inclusion if they were pregnant, seen in the ED for a first-trimester complication, and underwent a bedside emergency US suggesting an ectopic pregnancy. Emergency department US logs were reviewed for findings suggestive of ectopic pregnancy. Medical records were reviewed for history, physical examination findings, laboratory results, additional diagnostic testing, management, hospital course, and a discharge diagnosis by the admitting obstetric service (OB). Patients with incomplete data were excluded from analysis. Statistical analysis consisted of descriptive statistics.

Results: Seventy-four patients ranging in age from 16 to 39 years (mean, 25 years) were included in the study. Eight patients with incomplete data were excluded from analysis. Emergency-physician US diagnoses included definite ectopic pregnancy (6/74), probable ectopic pregnancy (28/74), and possible ectopic pregnancy (40/74). Forty-seven (64%) of these patients were eventually diagnosed with definite ectopic pregnancy by the OB. During initial consultation, the OB disagreed with the diagnosis of ectopic pregnancy in 15 (32%) of the 47 eventual patients with ectopic pregnancy, calling them miscarriages. Other eventual diagnoses included 9 (12%) patients with possible ectopic pregnancy, 11 (14%) patients with miscarriage, and 7 (9%) with intrauterine pregnancy. Emergency sonologists found tubal rings in 9 (19%) patients with eventual ectopic pregnancy, complex adnexal mass in 29 (61%) patients, and a large amount of echogenic fluid in the cul-de-sac in 10 (21%) patients. Six (13%) patients had live ectopic pregnancy. The OB ordered a radiology US in 10 cases but did not change the diagnosis or management. β -Human chorionic gonadotropin (β -hCG) levels ranged from 41 to 59 846 mIU/mL (mean, 4602 mIU/mL), but for live ectopic pregnancy, the range was 2118 to 59 846 mIU/mL (mean, 36 341 mIU/mL). Seventeen (36%) patients had β -hCG levels of lower than 1000 mIU/mL. Of

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47 eventual ectopic pregnancies, 29 (62%) patients underwent operative intervention, 17 (36%) patients received methotrexate, and 1 patient left against medical advice. Five (11%) of these patients with definite ectopic pregnancy were initially managed by emergency physicians with follow-up ED visits and serial US examinations without OB consultation.

Conclusion: Our study demonstrates that with increased experience, emergency sonologists can accurately diagnose ectopic pregnancy. Furthermore, patients at risk for ectopic pregnancy should not be denied US examinations if their β -hCG levels fall below an arbitrary discriminatory zone.

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1. Introduction

Ectopic pregnancy is a high-risk condition that occurs in approximately 2% of all pregnancies [1]. The prevalence of ectopic pregnancy is much higher in the emergency department (ED) compared with the general population, accounting for approximately 8% of all pregnant ED patients [2-5]. In the United States, the incidence of ectopic pregnancy has increased from 4.5 per 1000 pregnancies in 1970 to 19.7 per 1000 in 1992, accounting for 9% of pregnancy-related maternal deaths [2,5]. Forty percent of ectopic pregnancies are missed on initial ED evaluation, and ectopic pregnancy remains the leading cause of pregnancy-related death in the first trimester [3,6-8]. Early diagnosis of ectopic pregnancy is crucial to prevent major complications and their sequelae.

Clinical criteria alone are not adequate to distinguish between patients with ectopic pregnancy and miscarriage. Pelvic ultrasound (US) is the test of choice in the initial evaluation of patients with possible ectopic pregnancy. Ultrasound has been shown to be an accurate and rapid method of ruling out ectopic pregnancy. The portability, accuracy, and noninvasive features of US make it an ideal tool for use by trained emergency physicians. Emergency physicians have been using bedside pelvic US in the evaluation of patients with first-trimester complications for more than a decade. Prior studies have shown that emergency physician-performed bedside pelvic US is safe and decreases length of stay, overall cost, and morbidity [9,10]. The objective of our study was to describe diagnosis and management of ectopic pregnancy using bedside transvaginal US in an established emergency US program and to focus toward identifying ectopic pregnancy and not simply ruling in an intrauterine one.

2. Methods

This was a retrospective study on patients with first-trimester complications presenting to our facility over a 2-year period. The institutional review board approved the study. The study took place at a level I urban academic ED with an annual census of 78 000. The ED has a residency and an active US education program including an emergency US fellowship. Hospital credentialing in emergency US is based on the American College of Emergency Physicians US guidelines. Every US examination performed

by emergency medicine residents and faculty is recorded on a videotape or DVD for quality assurance, and US findings are logged separately in a logbook.

In the ED, patients were evaluated by emergency medicine residents and attending physicians. All patients underwent general physical and pelvic examinations. Patients were included in the study if they were pregnant, seen in the ED for first-trimester complication, and underwent a bedside emergency US examination suggesting an ectopic pregnancy. No specific ED US protocol for evaluating suspected ectopic pregnancy was followed. Bedside US examinations of the pelvis were performed using either a Phillips HDI 4000 system (Bothell, Wash) with an 8- to 4-MHz sheathed endocavitary probe or a SonoSite Titan (Bothell, Wash) with an 8- to 4-MHz endocavity transducer. The ED US examinations were performed by emergency medicine residents and attending physicians after clinical assessment. The attending physicians made the final US interpretation and diagnosis. The 4 emergency medicine faculty who contributed to this study are credentialed by the hospital to perform US examinations. All 4 emergency sonologists had previously taken a standardized 16-hour course on emergency US that included a 2-hour lecture and 4 hours of hands-on training dedicated to pelvic US. The physicians had an average of 2 years of US experience in the ED before the study, and each had performed an average of 200 pelvic USs and 800 nonpelvic US examinations before the study.

The sonographic examination was performed on patients with an empty bladder. The US protocol included examining the uterus in sagittal and transverse planes. The adnexa and cul-de-sac were also visualized in 2 planes. All pregnant pelvic sonograms are generally interpreted as intrauterine pregnancy (IUP), no IUP, or findings suggestive of ectopic pregnancy such as extrauterine gestational sac with yolk sac or embryo (with or without cardiac activity), tubal ring, adnexal mass, and large amount of echogenic free fluid in cul-de-sac. Free fluid in cul-de-sac was determined as small, moderate, or large based on the degree that fluid tracks along the posterior wall of the uterus. The amount of fluid was determined as *small* if it tracks less than a third of the way up the posterior wall of uterus; *moderate* if up to two thirds of the way; and *large* if more than two thirds of the way, free-floating among bowel loops, or found in the Morrison pouch or the splenic recess [19]. An extrauterine gestational sac with embryo and cardiac activity is called a live ectopic pregnancy.

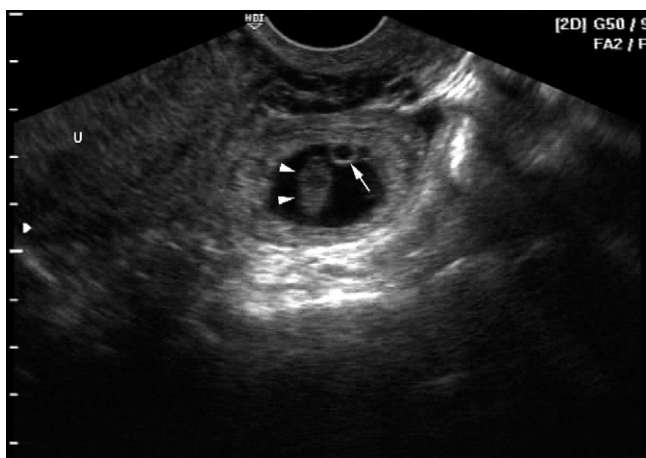


Fig. 1 A live ectopic pregnancy is seen next to the uterus (U). The yolk sac (arrow) and fetus (arrowheads) are clearly seen. Real-time evaluation revealed a beating heart.

Emergency department US logs were reviewed for findings suggestive of ectopic pregnancy. Patients were classified into 3 categories: definite ectopic, if an extrauterine yolk sac is seen with an embryo (with or without cardiac activity) (Fig. 1); probable ectopic, if either a tubal ring or a complex adnexal mass or a large amount of echogenic free fluid is found (Fig. 2); and possible ectopic, if an adnexal mass is seen [11,12]. Patients with a small amount of free fluid and an empty uterus or no other findings suggestive of ectopic pregnancy are not included in the study.

Medical records were reviewed for history, physical examination findings, laboratory results, additional diagnostic testing, hospital course, and a discharge diagnosis by the admitting obstetric service (OB). Patients with incomplete data were excluded from analysis. Data were stored using an Excel spreadsheet (Microsoft, Redmond, WA). Statistical analysis consisted of descriptive statistics calculated using StatsDirect software (Cheshire, UK).

3. Results

A total of 74 patients ranging in age from 16 to 39 years (mean, 25 years) were included in the study. Eight patients with incomplete data were excluded from the analysis. Information regarding last menstrual period was not obtained because of inconsistencies in documentation coupled with frequent documented inability of patients to recall.

Emergency-physician US diagnoses are definite ectopic in 6 (8%), probable ectopic in 28 (38%), and possible ectopic in 40 (54%) cases. Obstetric consultation was obtained during the initial ED visit in all cases. Forty-seven (64%) of these patients were eventually diagnosed with ectopic pregnancy by consulting obstetricians. Other final OB diagnoses are miscarriage in 11 (14%), IUP in 7 (9%), and possible ectopic (resolved with no intervention) in



Fig. 2 A tubal ring (with one caliper across it) is seen next to the left ovary (2 calipers), with both sitting anterior and medial to the internal iliac vein.

9 (12%) cases. Final diagnosis was made by the OB during the initial consultation in 42 (56%) patients and during follow-up visits for the rest. None of the patients included in the study were lost to follow-up. The OB made the final diagnosis based on their evaluation. A repeat bedside US examination was performed by the OB in all patients except for 10 cases where a radiology US was obtained. Twenty-nine patients had surgical pathology diagnosis of ectopic pregnancy. During initial consultation, obstetricians disagreed with the emergency sonologist's diagnosis of probable or possible ectopic pregnancy in 15 (32%) of the 47 patients who were eventually diagnosed with ectopic pregnancy, calling them miscarriages.

Ultrasound findings for patients with a final diagnosis of ectopic pregnancy are shown in Table 1. Table 2 compared patients' initial emergency US diagnosis vs final diagnosis. A radiology US ordered by OB consultants in 10 cases did not change the diagnosis or management.

For patients with final diagnosis of ectopic pregnancy, β -human chorionic gonadotropin (β -hCG) levels ranged from 41 to 59846 mIU/mL (mean, 4602 mIU/mL), but for live ectopic pregnancy, the range was 2118 to 59846 mIU/mL (mean, 36341 mIU/mL). Seventeen (36%) patients with ectopic pregnancy had β -hCG levels of lower than 1000 mIU/mL. Of 47 eventual ectopic pregnancies, 29 (62%) patients underwent operative intervention, 17 (36%) patients received methotrexate, and 1 patient left against medical advice.

Table 1 Ultrasound finding in patients with final diagnosis of ectopic pregnancy

Tubal ring	Complex adnexal mass	Large echogenic fluid	Live ectopic
9 (19%)	29 (61%)	10 (21%)	6 (13%)

Table 2 Final diagnostic outcome for patients initially scanned in the ED

ED US diagnosis	Final (eventual)	Final (possible)	Final (miscarriage)	Final (IUP)
Definite ectopic (n = 6)	6	0	0	0
Probable ectopic (n = 28)	24	2	1	1
Possible ectopic (n = 40)	17	7	10	6

Five (11%) of the patients with eventual ectopic pregnancy were initially managed by emergency physicians and had follow-up ED visits and serial US examinations. This approach was adopted in these cases because of disagreement with the OB in diagnosis or difficulty scheduling follow-up appointments because of weekends or holidays. The 5 patients who were initially diagnosed as possible ectopic by emergency sonologists had small adnexal masses on their initial US examination, with β -hCG levels of lower than 1000 mIU/mL. All 5 patients were noted to have a tubal ring or a complex adnexal mass in their serial US examinations. Three of these patients eventually received methotrexate, and 2 patients required surgical intervention.

4. Discussion

In the past decade, despite major changes in epidemiology, incidence, and demographics, ectopic pregnancy has remained the leading cause of maternal death and serious morbidity in the first trimester. Early detection of ectopic pregnancy is important for preventing major complications such as hemorrhage, shock, surgical tubal removal, tubal scarring, and infertility. Emergency physicians have an important role in recognizing patients at risk for ectopic pregnancy and reducing morbidity and mortality. When ectopic pregnancy is diagnosed early, conservative management is more likely, allowing for favorable outcome and preventing loss of fallopian tubes.

Emergency physicians have begun to increasingly use bedside pelvic US in the evaluation of first-trimester pregnancy complications. Several studies have validated the ability of emergency physicians to perform pelvic US examinations with proper training [13-16]. The accuracy of bedside US performed by emergency physicians for ruling in an IUP after relatively brief training sessions has been well established [9,13,14,17,18]. Typically, the goal of emergency physician-performed US focuses on identifying an IUP. Most studies on emergency physicians performing bedside pelvic US show high rates of IUP with lower rates of abnormal pregnancy on the initial ED visit [10,18,19]. Of patients who receive a bedside pelvic US from an emergency physician attempting to rule out an ectopic

pregnancy, 60% to 70% will be found to have an IUP and can be safely sent home [20].

Few studies have examined the ability of emergency physicians to recognize the sonographic findings suggestive of ectopic pregnancy. Mateer et al [17] found a significant reduction in the number of missed ectopic pregnancies after implementation of an emergency physician-performed rule-out ectopic US protocol. Use of this protocol essentially rules out ectopic pregnancy by ruling in an IUP. Durham et al [18] found that ED pelvic US has a high sensitivity after implementation of a protocol involving emergency physician-performed US. In an observational prospective study conducted by Tayal et al [21], emergency physicians performed bedside pelvic US to rule out ectopic pregnancy and concluded that the outcome for symptomatic first-trimester patients with an indeterminate ED pelvic US is poor, with high rates of embryonic demise and ectopic pregnancy. Blaivas and Bell [22] concluded from their study that emergency physicians decrease the length of time from the ED to the operating room for patients with ectopic pregnancy by using ED US. In a retrospective study to assess the outcome of an emergency-physician pelvic US protocol to rule out ectopic pregnancy, Flanders and Tayal [23] studied 472 patients who received a bedside pelvic US. Of the 28% of patients who were not found to have an IUP, 5% had ectopic pregnancy. Of all patients with ectopic pregnancy, 44% had β -hCG levels of lower than 2000 mIU/mL.

The typical strategy of emergency pelvic US protocols in patients with first-trimester complications is to rule out ectopic pregnancy by locating an IUP. Patients in whom an IUP cannot be ruled in usually receive an OB consultation or perhaps a somewhat delayed US from a traditional imaging provider. This is how emergency US can save hours on disposition in most patients scanned. However, as more emergency physicians are becoming facile with pelvic US, it is important for these physicians to become familiar with sonographic findings suggestive of ectopic pregnancy to prevent delay in diagnosis or misdiagnosis. Furthermore, with increasing experience and skill, physicians will be able to detect more subtle findings and be more efficient with obtaining consultations and additional testing. In our study, we were able to identify the sonographic signs suggestive of ectopic pregnancy in multiple non-IUP cases. Our study illustrates that the bedside scanning skills of emergency physicians may effectively extend beyond just identifying IUP. Emergency sonologists can diagnose ectopic pregnancy and, with increased experience, stratify the risk and manage ectopic pregnancy expectantly without an initial OB consultation if operative or medical intervention is not immediately warranted.

Studies that correlate β -hCG levels with pelvic US have resulted in the concept of the *discriminatory zone*. The *discriminatory zone* is the β -hCG level at which an intrauterine pregnancy should be visualized by US. This level generally is between 1000 and 2000 mIU/mL for

transvaginal US and between 4000 and 6500 mIU/mL for transabdominal US [24]. Some radiologists and clinicians do recommend withholding US in patients who have a β -hCG level of lower than 1000 mIU/mL, but this should be applied with the clinical situation firmly in mind [25].

Approximately 13% of the abnormal IUPs and up to 39% of ectopic pregnancies with β -hCG values of lower than 1000 mIU/mL can be identified on initial US evaluation [26]. In our setting, no discriminatory β -hCG level was used to determine whether or not emergency physicians should perform a US examination. All patients with a positive pregnancy test were imaged if they were having pain and/or bleeding. Among our patients, 36% of those with definite ectopic pregnancy had β -hCG levels of lower than 1000 mIU/mL. The wide range of β -hCG levels in our study suggests that β -hCG values alone should not be used to differentiate between ectopic and intrauterine pregnancy. Our study reemphasizes the futility of β -hCG levels in predicting ectopic pregnancy, and we recommend that US should be obtained regardless of β -hCG level when an ectopic pregnancy is suggested by symptoms. The lowest β -hCG level at which an ectopic pregnancy was identified by an emergency sonologist in our study was 41 mIU/mL.

When no IUP is located and an ectopic pregnancy is considered, an adnexal mass is the most common sonographic finding, found in 65% to 84% of cases. The adnexal mass can appear as a tubal ring in an estimated 48% to 68% of patients or a solid or complex mass [12,27-30]. In a study by Nyberg et al [11], researchers attempted to determine the significance of various extrauterine findings in 68 patients with surgically proven ectopic pregnancy. Sixty-six percent had definitive adnexal findings: extrauterine gestational sac in 31%, adnexal mass in 21%, echogenic fluid only in 31%, and live extrauterine embryo in 15%. Gabrielli et al [31] found adnexal abnormalities in 40 of 42 ectopic pregnancies: 45% complex masses, 28% tubal rings, 16% extrauterine gestational sacs with embryo (11% with cardiac activity), and 4% simple cysts. Abnormal adnexal findings were found more frequently in those ectopic pregnancies with a β -hCG level of higher than 1000 mIU/mL. In our study, a complex adnexal mass was the most common sonographic finding, found in 61% of patients with ectopic pregnancy. All patients with β -hCG levels of lower than 1000 mIU/mL had adnexal abnormalities.

The most specific finding for ectopic pregnancy is the presence of a live extrauterine pregnancy, found only in 3% to 26% of cases of ectopic pregnancy [11,27,28]. The rate of detection of a live ectopic pregnancy in one previous study, where 62% of examinations were performed by OB residents and the rest by radiology, was 3% [6]. In a study of screening US examinations by a radiology group for all ED patients at risk for ectopic pregnancy with a β -hCG level of higher than 1500 mIU/mL, live ectopic pregnancies were detected at a rate of 18% of ectopics [32]. In another study on patients referred to a radiology department with suspicion of ectopic pregnancy, the rate of live ectopic

pregnancies was 32% with a mean β -hCG value of 30031 mIU/mL [33]. The rate of detection of live ectopic pregnancy by bedside emergency US has not been well reported except in one study conducted by Durston et al [34], where 3 live ectopics were found of 36 confirmed ectopic pregnancies (8%), with a mean hCG level of 4214 mIU/mL. In our study, 13% of patients with definite ectopic pregnancy had a live ectopic, with a mean β -hCG level of 36341 mIU/mL.

This study has a number of limitations, including its retrospective nature. Some patients were excluded from the analysis because of incomplete data. The data collectors were not blinded to the study hypothesis. No ED protocol to evaluate suspected ectopic pregnancy was adopted. Only 29 (62%) patients had pathologic diagnosis of ectopic pregnancy, and in rest of the cases, OB diagnosis was considered as a gold standard. Not all faculty in our ED are US credentialed, and gaps do exist in emergency US coverage where patients with first-trimester complications were scanned by radiologists or obstetricians only. Those patients were not included in the study. The other limitation of this study is small sample size. A prospective study with an ectopic pregnancy US protocol, which includes all patients evaluated for ectopic pregnancy, and a large sample size would have been ideal.

In conclusion, our study demonstrates that with increased experience, emergency sonologists can accurately diagnose ectopic pregnancy. Furthermore, patients at risk for ectopic pregnancy should not be denied US examinations if their β -hCG levels fall below an arbitrary discriminatory zone.

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