

Brief Report

High-frequency linear transducer improves detection of an intrauterine pregnancy in first-trimester ultrasonography

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ABSTRACT

Objective: The objective was to determine if the need for transvaginal ultrasonographic examination can be decreased by the addition of the transabdominal high-frequency, 12–4-MHz linear transducer after a failed examination with the 6–2-mHz curvilinear transducer when evaluating for an intrauterine pregnancy (IUP).

Methods: This is a prospective pilot study of women in their first trimester of pregnancy presenting to the emergency department with abdominal pain and/or vaginal bleeding. If no IUP was identified using the curvilinear transducer via the transabdominal approach, they were subsequently scanned using the linear transducer. Patients without evidence of an IUP transabdominally were scanned via the transvaginal approach.

Results: Eighty-one patients were evaluated; no IUP was visualized in 27 using the standard curvilinear transducer approach, and these then had an ultrasonography performed with the linear transducer. Of these, 9 patients (33.3%; 0.95 confidence interval [CI], 15.5%–51.1%) were found to have an IUP with the linear transducer. For the 18 patients who received a transvaginal scan, 15 patients (83.3%; 0.95 CI, 66.1%–100%) had no IUP identified with the transvaginal transducer, and 3 (16.7%; 0.95 CI, 0%–33.9%) had an IUP identified.

Conclusions: The transabdominal use of a high-frequency linear transducer in the evaluation of patients in the first trimester after failed curvilinear transducer results in a clinically significant reduction in the need for transvaginal ultrasonography to confirm the presence of an IUP.

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1. Introduction

Ectopic pregnancy is the leading cause of death in the first trimester of pregnancy [1] and is a feared complication in women in early pregnancy who present with abdominal pain, pelvic pain, or vaginal bleeding. The rate of ectopic pregnancy in the general population is approximately 1.5% to 2% of pregnancies with a maternal mortality of 6% to 9% [2,3]. However, in symptomatic women presenting to the emergency department (ED), the rate of ectopic pregnancy has been demonstrated to be as high as 13% [4]. Pelvic ultrasonography is the diagnostic modality of choice in ectopic pregnancy [3,5]. In the evaluation of the symptomatic first-trimester pregnancy, studies have shown that transabdominal and transvaginal ultrasonography performed and interpreted at the bedside by emergency physicians has a high sensitivity and high negative predictive value, effectively ruling out ectopic pregnancy by affirmatively visualizing an intrauterine yolk sac or gestational sac [6,7].

The primary focus of pelvic ultrasonography in the ED is the detection of an intrauterine pregnancy (IUP) [8]. The American College of Radiology, American College of Obstetrics/Gynecology, American Institute of Ultrasound in Medicine, Society of Radiologists in Ultrasound (ACR-

ACOG-AIUM-SRU) joint guidelines in the evaluation of obstetrical ultrasonography indicate that pelvic ultrasonography can be performed transabdominally or transvaginally [9]. Although a comprehensive ultrasonography requires a detailed evaluation of the uterus and adnexa, a limited study can be performed to answer the specific question of whether there is an IUP. Thus, usual care in our department for the evaluation of the symptomatic first-trimester patient begins with transabdominal ultrasonography. Equivocal or negative studies are followed up transvaginally.

Transvaginal ultrasonography, in addition to being invasive, is time consuming and requires particular disinfection after scanning and may not be ubiquitously available in community EDs. All are potential limitations to its use at the bedside in clinical practice. Prior anecdotal experience in our department has shown that the transabdominal use of the high-frequency linear transducer has been effective at confirming an early IUP after an equivocal or negative evaluation using the curvilinear transducer. To date, there are no known prospective studies evaluating the use of the linear transducer in the detection of early first-trimester pregnancy.

2. Materials and methods

We conducted a single-center, prospective, convenience, pilot sample of women in their first trimester of pregnancy presenting to the ED and

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undergoing bedside ultrasonography for the detection of an IUP. Patients were included if they had a positive pregnancy test in the ED and had not received prior fetal imaging during the current pregnancy. The study was approved by the hospital's Institutional Review Board, and informed consent was obtained before scanning.

The study was performed in a large, urban, academic ED with an annual volume of more than 100,000 patients per year with an established emergency ultrasonography fellowship. The majority of the images were obtained by the ultrasonography fellow or emergency medicine residents under the direct supervision of the department's ultrasonography educator, a registered diagnostic medical sonographer dedicated to the ED. The study was primarily completed during the hours of 8:00 AM to 5:00 PM because of the presence of our ultrasonography team, but participants were eligible to be enrolled at any time if a member of the study was clinically available.

Transabdominal scanning was performed with either a Philips HD11 (Bothell, WA) or 1 of 2 Philips Sparq (Bothell, WA) machines which are used in regular clinical practice in our ED. Imaging presets and settings were set at the bedside at the discretion of the imaging team. Sonographically, an IUP was defined by the presence of a yolk sac and/or fetal pole within a gestational sac in the uterus.

Patients enrolled were first scanned using the standard curvilinear transducer (5–2 mHz for HD11 or 6–2 mHz for Sparq) via the transabdominal approach in both the sagittal and transverse planes. If no IUP was identified, they were subsequently scanned using the linear transducer (12–3 mHz for HD11 or 12–4 mHz for Sparq) in a similar fashion. Patients without evidence of an IUP transabdominally by curvilinear or linear transducer were subsequently scanned via the transvaginal approach by radiology or supervised by an emergency physician privileged in transvaginal ultrasonography (Fig. 1). All images were reviewed by the ultrasonography fellow.

Measurements were obtained from clinical images in either the sagittal or transverse orientation based on image clarity. When seen, a crown-rump length (CRL) measurement was obtained, and machine-based imaging software calculated the gestational age based on CRL. In many images, only a yolk sac was visualized, and no CRL measurement was obtained. The depth to IUP was measured post hoc as the deepest distance from the transducer to the anteriormost surface of the yolk sac or fetal pole.

As a pilot study, data are reported as percentage with a confidence interval (CI) of proportion. Confidence intervals were calculated using the online calculator found at <http://www.mccallum-layton.co.uk/tools/statistic-calculators/confidence-interval-for-proportions-calculator>.

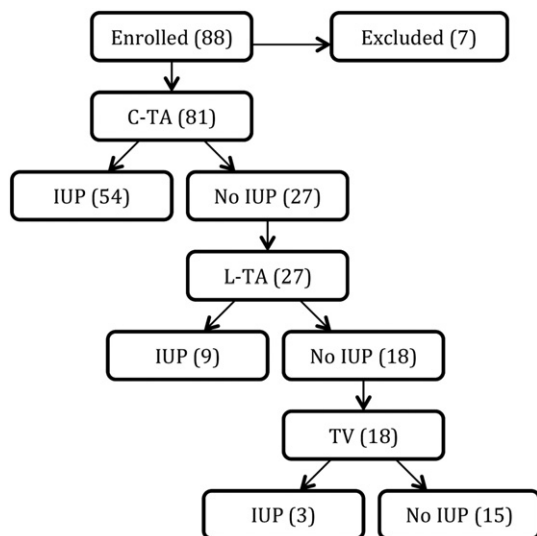


Fig. 1. Scanning protocol for symptomatic first-trimester patients. Total numbers shown with percentages indicated.

3. Results

A total of 88 patients were enrolled that met the inclusion criteria. Seven patients were excluded because incomplete data were obtained. The remainder were scanned as shown in Fig. 1. Of the 81 patients included in this study, no IUP was visualized in 27 (33.3%; 0.95 CI, 23.0%–44.6%) using the standard curvilinear transducer approach, and these then had an ultrasonography performed using the linear transducer. One patient was found to have an ectopic pregnancy on curvilinear transducer and was included in the 54 patients with visualized pregnancy. Of the 27 patients requiring linear ultrasonography, 9 patients (33.3%; 0.95 CI, 15.5%–51.1%) were found to have an IUP with the linear transducer. The linear ultrasonography did not identify an IUP in 18 (66.7%; 0.95 CI, 48.9%–84.5%). For the 18 patients, 15 patients (83.3%; 0.95 CI, 66.1%–100%) had no IUP identified with the transvaginal transducer, and 3 (16.7%; 0.95 CI, 0%–33.9%) had an IUP identified. The linear transducer was able to detect an IUP on 33.3% of the patients in whom it was used. The number needed to treat is 3. The combined failure rate of curvilinear and linear transducer was 18 (22.2%; 0.95 CI, 13.2%–31.3%) of 81 patients (Table 1).

Serum human chorionic gonadotropin (HCG) levels were obtained for patients with no IUP identified for all 3 scanning modalities and are presented in Fig. 2.

The data comparing depth to pregnancy for patients with pregnancy identified based on curvilinear transabdominal or linear transabdominal approach are displayed in Table 2.

4. Discussion

Identification of an IUP in the symptomatic first-trimester patient in the ED is of paramount importance. Ectopic pregnancy is a feared complication of patients in the first trimester with a high mortality if undetected. Ultrasonography is the standard method for evaluating symptomatic patients in the ED. As such, a limited ultrasonography of the pelvis, particularly focused on the identification of an IUP, is a safe and cost-effective means to evaluate symptomatic patients in the ED, and further comprehensive imaging can be obtained as an outpatient.

Previous study protocols have used both transabdominal curvilinear and/or transvaginal transducers [5,10]. As a less invasive technique, the curvilinear transabdominal transducer is used initially in the evaluation of the pelvis for the presence of an IUP. However, this is often limited by the resolution of the low-frequency transducer, particularly early in pregnancy (Fig. 3). Anecdotally, in our practice, we have found the discriminatory threshold for our transabdominal curvilinear transducer to be approximately 6–7 weeks of gestational age. Below this age, additional image is often necessary to identify the location of the pregnancy.

The next evaluation for patients with inconclusive transabdominal ultrasonography is a transvaginal ultrasonographic examination. Studies have shown that a limited transvaginal ultrasonography can successfully be performed by emergency physicians [5,10]. However, emergency physician-performed transvaginal ultrasonography is often limited by equipment, time, and/or training. When not performed by emergency physicians, transvaginal ultrasonography is accomplished by radiology. This addition of comprehensive pelvic evaluation may be limited by staffing availability and adds to the patient's ED length of stay [11].

Table 1
Ultrasonographic findings based on transducer used

Results of ultrasonographic imaging			
	CTA	LTA	TV
IUP	54	9	3
No IUP	27	18	15

CTA, curvilinear transabdominal; LTA, linear transabdominal; TV, transvaginal.

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