



E-ISSN: 2706-9575
P-ISSN: 2706-9567
www.medicinpaper.net/
IJARM 2019; 1(2): 73-77
Received: 10-05-2019
Accepted: 12-06-2019

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Diagnostic value of ultrasound in obstetrics and gynecology

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DOI: <https://doi.org/10.22271/27069567.2019.v1.i2b.20>

Abstract

The diagnosis of acute appendicitis in pregnant women often is difficult to make on the basis of clinical findings, and radiologic examination is limited because of the potentially hazardous effects of radiation.

This research is to assess the value of sonography in the diagnosis of acute appendicitis in pregnant women.

We obtained sonograms in (45) pregnant women with clinically suspected acute appendicitis. Our sonographic technique included graded-compression scanning. The left lateral decubitus position was used in the third trimester of gestation. The sonographic criterion for the diagnosis of acute appendicitis was visualization of an incompressible appendix with a maximal diameter greater than (7 mm).

Keywords: Ultrasound, hazardous, obstetrics & gynecology, compression scanning

Introduction

We correlated the sonographic findings with the surgical findings in (22) cases and with the results of clinical follow-up in (23) cases. Sonography could not be used to make the diagnosis in three (7%) of 45 patients because the size of the gravid uterus prevented use of the graded-compression technique.

These three patients were in the third trimester of pregnancy (greater than 35 weeks' gestation). Sonographic findings were used as a basis for diagnosis in 42 cases.

Acute appendicitis was diagnosed on the basis of sonograms in 16 patients, and in all but one of these patients, acute appendicitis was confirmed by surgical and pathologic findings.

In the 42 cases in which the imaging findings indicated the diagnosis, the overall sensitivity of sonography was 100%, the specificity was 96%, and the accuracy was 98%. Our experience suggests that graded-compression sonography is a valuable procedure for detecting acute appendicitis in pregnant women despite technical difficulty in performing it during the third trimester of pregnancy.

Third trimester placental abruption complicates less than 1% of pregnancies but is associated with increased risk of preterm delivery and fetal death when it does occur.¹

The clinical diagnosis usually is based on bleeding, abdominal pain, and contractions, but sonography often is performed in an attempt to visualize the extent of subchorionic or retroplacental hematoma. When blood easily can drain through the cervix, however, no hematoma would be expected to be visualized. It is unclear how frequently sonography visualizes clots in cases of abruption and, if clots are visualized, whether management and outcome change as a result. Much of the literature on the subject is more than (20) years old.

The purpose of this study was to estimate the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of sonography in the diagnosis of placental abruption and to determine, in women with clinical signs and symptoms of abruption, whether management and outcome are different when a hematoma is visualized compared with when no hematoma is apparent.

Objective

To determine the sensitivity and specificity of sonography for detection of placental abruption and whether sonographic results correlate with management or outcome.
Methods.

Materials and Methods

We performed breath-hold single-shot echo-planar diffusion-weighted MRI of the liver in 10 Healthy volunteers using conventional diffusion, conventional diffusion with parallel imaging, and diffusion tensor with parallel imaging sequences. TE values for the three sequences were 83, 74, and 63, respectively.

Liver signal intensity was measured on all sequences and normalized to the SD of the measurement. Hepatic ADC was calculated by acquiring all sequences with b values of 0 and 500 sec/mm².

So, we identified (149) consecutive patients who underwent sonographic evaluation at 24 weeks' gestational age or longer for ruling out abruption or vaginal bleeding and who gave birth at Strong Memorial Hospital from 1994 to 1996. Scanning was performed primarily on Ultramark systems (Philips Ultrasound, Bothell, WA) by a group of 6 sonographers. Obstetric and neonatal data were obtained from the hospital perinatal database. We reviewed sonographic reports, pathologic reports, hospital charts, and a subset of images to confirm data validity and to determine whether sonographic findings were associated with management and outcome variables. A positive sonographic finding was defined as showing a subchorionic or retroplacental hematoma. Abruption at delivery was defined as a clinical diagnosis of placental abruption made at the time of delivery, whether by concurrent signs and symptoms or by examination of the placenta. Preterm delivery was delivery before 37 weeks' gestation, and low birth weight was defined as birth weight less than 2500 g.

The sonographic sensitivity, specificity, PPV, and NPV were calculated. We used χ^2 , Fisher exact, Mann-Whitney U, and t-tests for comparisons ($P < .05$). Linear and logistic regressions were used to determine independence of associations.

Odds ratios (ORs) were calculated from logistic coefficients. Analysis was done with Stat View 5.0 (SAS Institute Inc, Cary, NC) on a Macintosh G3 computer (Apple Computer, Inc, Cupertino, CA).

We identified (149) consecutive patients who underwent sonography at 24 weeks' gestational age or later for ruling out abruption or vaginal bleeding. Obstetric and neonatal data were obtained from the hospital perinatal database. Sonographic results, pathologic reports, and hospital charts were reviewed. Sonographic sensitivity, specificity, and positive and negative predictive values were calculated, and

regression was used to determine independence of associations. Results.

Of the (149) patients, 17 (11%) had sonographic evidence of abruption, and 32 (21%) had evidence of abruption at delivery. As the scan to delivery interval decreased, the positive predictive value increased and the negative predictive value decreased. of (55) patients who gave birth within (14) days of sonography, 8 (15%) had scans consistent with abruption, and (29) (53%) had abruption at delivery; the sensitivity, specificity, and positive and negative predictive values of sonography were 24%, 96%, 88%, and 53%, respectively. Positive sonographic findings were univariately associated with (2-3) fold greater subsequent tocolysis, betamethasone use, duration of hospitalization, follow up sonograms, preterm delivery, low birth weight, and neonatal intensive care unit admission. All but low birth weight and neonatal intensive care unit admission remained independently significant after adjustment for gestational age ($P < .05$).

Results

Of the 149 patients, 17 (11%) had sonographic evidence of abruption, and 32 (21%) had a clinical diagnosis of abruption at delivery (Table).

Including all patients, positive sonographic findings were univariately associated with approximately 2- to 3-fold greater subsequent tocolysis, betamethasone use, hospitalization-to-delivery duration, follow-up sonograms, preterm delivery, low birth weight, and neonatal intensive care unit admission (Tables 2 and).

When multiple linear and logistic regressions were used to control for gestational age at the time of scanning, all but low birth weight and neonatal intensive care unit admission were independently associated with positive sonographic findings.

When a diagnosis of abruption at delivery was added to the regressions as a dummy variable to try to separate the effect of the sonogram on management from the effect of the actual presence of abruption, betamethasone use still was independently associated with positive sonographic findings (or, 7.4; 95% confidence interval [CI], 1.3–43.9; $P = .03$) to a greater degree than abruption at delivery (OR, 3.5; 95% CI, 1.2–10.4; $P = .03$). Adjusting for abruption diagnosis at delivery, there was a trend toward independent association of sonographic results with tocolytic agent use and preterm delivery (OR for tocolysis, 2.9, 95% CI, 0.89–9.4; $P = .08$; OR for preterm delivery, 4.4; 95% CI, 0.99–19.5; $P = .05$).

Table 1: Clinical Characteristics

Characteristic	Sonographic Findings		
	Positive, n = 17(11%)	Negative, In = 132 (89%)	p
Graodity, median (range)	4 (14)	3(1-11)	.31
Peary. median (range)	1(0-4)	1(0-7)	.18
Tobacco use. It (11)	41 (7)	30(40)	.36
Cocaine use.% (o)	6(1)	11 (15)	.49
EGA at scan. vas medan (range)	30(24-36)	31(24.41)	.53
Scan to delivery, d. median (range)	18 (0-81)	33(0-126)	.15
Hypertension. 1/4(n)	0(0)	6(8)	.30
Hydeammen, 14(n)	24 (4)	13(17)	.23
PROM, en (n)	12 (2)	20(26)	.43

For patients giving birth within 14 days of sonography, only tocolysis and betamethasone use were univariately

associated with positive scan results. However, because of fewer patients in this group, power was less than 80% for

most variables. As the scan-to-delivery interval decreased, PPV increased and NPV decreased (Table). Of 55 patients giving birth within 14 days of sonography, 8 (15%) had positive scan results (consistent with abruption) and 29 (53%) had clinical diagnoses of abruption at delivery; sensitivity, specificity, PPV, and NPV of sonography were 24%, 96%, 88%, and 53%, respectively.

For all scans and for those scans limited to within 14 days before delivery, neither placental location (anterior versus posterior) nor the stated indication for sonography (bleeding versus rule out abruption) significantly affected sensitivity, specificity, PPV, or NPV.

Sonography is not sensitive for detecting abruption, but when a clot is visualized on sonography, the PPV for

abruption at delivery is high. The presence of blood in large enough volumes to be visible sonographically indicates retained hemorrhages that may be more likely to continue to manifest signs and symptoms.

In addition, large collections of blood would be expected to take longer to resorb or drain and are less likely to fully resolve by the time of delivery. The sooner delivery occurs after detection of such clots, therefore, the more often abruption will be clinically apparent.

The shorter the scan to delivery interval, the greater the PPV. When delivery occurred within 2 weeks of a positive sonographic finding, the diagnosis of placental abruption was confirmed in 100% of our cases.

Table 2: Obstetric Interventions & Outcome

Intervention or Outcome	Sonographic Findings		P
	Positive	Negative	
Tocolysis, %(n)	71 (12)	34 (45)	.004•
Iletamethasone, 66(n)	87 (13)	32 (36)	<0001:
Hospitalization to delivery, d, median (range)	4(1-45)	0(0-33)	.0001:
Follow-up sonogram, 96(n)	73 (11)	37 (41)	.008
Labor induction, 96(n)	18 (3)	24 (32)	.55
Cesarean delivery, %(n)	53 (9)	28 (37)	.046
EGA at delivery, wk median (range)	32(27-40)	38(24-42)	.02
Postpartum hemorrhage, 96 (n)	18 (3)	4 (5)	.02

EGA indicates estimated gestational age.

Independently significant after adjustment for EGA at scanning (OR, 4.5; 95% CI, 1.5–13.6; P =.008).

Independently significant after adjustment for tocolysis and EGA (OR, 15.3; 95% CI, 3.1–75.2; P =.0008).

Independently significant after adjustment for EGA (regression coefficient, 4.4; P =.008).

Not independently associated with scan result after adjustment for EGA.

Approximately 50% of women with clinical signs suggesting abruption but with negative sonographic findings have evidence of abruption at delivery. Blood having egress to the cervix may drain and thus may not collect under the chorion, so that no blood is visible during sonography. Such a patient still may be given a diagnosis of abruption at delivery based on intrapartum signs and symptoms of placental examination. Even if the placenta appears grossly normal, a diagnosis of abruption may follow from the classic appearance of vaginal bleeding, abdominal pain, and uterine hypertonicity.

As shown in Table (2), there were no significant differences in clinical characteristics between women with positive and women with negative sonographic findings. When a subchorionic or retroplacental hematoma was identified, however, management was more aggressive than when no hematoma was visualized. Women in whom sonography showed intrauterine hematomas more frequently received betamethasone and tocolytic agents, more commonly underwent follow-up sonograms, gave birth at earlier gestational ages, and had higher frequencies of postpartum hemorrhage. Did the positive sonographic findings themselves alter management, or were positive sonographic findings associated with more severe abruptions, the severity of which led to more aggressive management.

It's difficult to determine from the charts. After statistical adjustments, the sonographic result was more strongly

associated with betamethasone use than was the clinical diagnosis of abruption itself, suggesting that for this intervention, the result did influence management. Because there is some multicollinearity between sonographic results and the diagnosis of abruption at delivery, adjusting for diagnosis at delivery might have masked some of the association of sonography with various interventions and outcomes.

Table 3: Neonatal Outcome

Outcome	Sonographic Findings		P
	Positive	Negative	
Preterm delivery, 96(n)	82 (14)	40(53)	.001
Birth weight, g, mean (50)	2128 (786)	2682 (936)	.01•
Low birth weight, % (n)	76 (13)	34 (45)	.0007•
Apgar <7 at 5 min 96(n)	6(1)	5(6)	.81
WU admission, 96 (n)	71(12)	37(49)	.008•

The Medline (1966–2001) and Embase (1980–2001) databases were searched for relevant studies, published in English. Only studies fulfilling predefined criteria were selected. An assessment of quality was made for each study, and data were then reanalyzed using likelihood ratios to determine the usefulness of the test.

Table 4: Accuracy of Sonography: Sonographic Result versus Clinical Abruption at Delivery

Value	Scan-to-Delivery Interval, wk			
	All	3	2	1
n	149	67	55	45
Sensitivity, 96	28	28	24	23
Specificity, 96	93	94	96	100
PPV, 96	53	82	88	100
NPV, 46	83	59	53	49

In summary, sonography is not sensitive for confirming placental abruption, although its PPV is high, especially when the scan to delivery interval is short. Given a positive sonographic result, obstetric management is more aggressive, and perinatal outcome is worse than when the sonographic result is normal.

Given this information, patients may be counseled more specifically regarding expected treatment and prognosis. Previous studies have related outcome to the sonographic appearance or to second-trimester scans,^{3 5} but this study compared outcomes in groups with and without sonographic evidence of third-trimester abruption.

Discussion

Despite improvements in sonographic machines over the years, the diagnostic sensitivity for abruption has not improved in the past 2 decades. Only 1 of every 9 sonograms obtained to rule out placental abruption revealed evidence of a subchorionic or retroplacental hematoma.

The test had a relatively low yield: sonographic findings for these indications usually are normal and are positive in only 25% of cases of placental abruption that are confirmed at delivery.

Conclusions

Sonography is not sensitive for detection of placental abruption, but a positive finding is associated with more aggressive management and worse neonatal outcome.

The normalized liver signal intensity was higher on diffusion tensor with parallel imaging and conventional diffusion with parallel imaging than on conventional diffusion without parallel imaging for a, b, value of 500 sec/mm² (13.0 and 10.1 vs 9.1, respectively; $p < 0.03$) and for a b value of 0 sec/mm² (9.0 and 7.6 vs 6.9, respectively; without reaching a significant difference, $p = 0.12$).

Hepatic ADC was not significantly different between sequences ($p = 0.16$).

Higher signal intensity can be obtained when using parallel imaging and diffusion tensor imaging during diffusion-weighted MRI of the liver without compromising hepatic ADC measurement.

Presented at the 2004 annual meeting of the American Roentgen Ray Society, Miami Beach, FL. Partially supported by a grant from the Margulis Society, Department of Radiology, University of California, San Francisco.

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