Subchorionic Hematoma

Correlation of Grading Techniques With First-Trimester Pregnancy Outcome

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Objectives—To evaluate and compare grading systems of subchorionic hematoma (SCH) on first-trimester ultrasound examinations with live embryos to assess which best correlates with early pregnancy outcome and to assess the effect of gestational age at the time of diagnosis on outcome.

Methods—First-trimester live singleton pregnancies between 6 and 11 weeks' gestational age with SCH were identified by an institutional database search. First-trimester outcome was categorized as "live" or "demise" based on ultrasound or medical record documentation. Hematomas were categorized in 4 ways: (1) subjective (small, moderate, or large); (2) subjective size based on fraction comparison with gestational sac size; (3) subjective grading based on the estimated percentage of the gestational sac surrounded by hematoma; and (4) 3 orthogonal measurements of the hematoma.

Results—A total of 434 sonograms met study inclusion criteria. The overall rate of first-trimester pregnancy failure was 12.0%. The rate of demise was significantly higher for hematomas diagnosed at or before 7 weeks (19.6%) than for those after 8 weeks (3.6%; $P < .001$). The size of the hematoma estimated as a fraction of gestational sac size significantly correlated with first-trimester pregnancy loss ($P < .001$). There was no statistical significance between first-trimester outcome and the other 2 subjective grading methods. Volume-based measurements provided spurious results because of the irregular shape of most hematomas.

Conclusions—Subjective hematoma size based on the fraction of gestational sac size correlates best with first-trimester pregnancy outcome. The earlier in pregnancy an SCH is detected, the higher the rate of subsequent pregnancy failure.

Key Words—obstetrics (first trimester); pregnancy outcome; subchorionic hematoma; ultrasound grading

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Abbreviations

GA, gestational age; ROC, receiver operating characteristic; SCH, subchorionic hematoma; US, ultrasound

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Subchorionic hematoma (SCH) is a common finding on early first-trimester ultrasound (US) examinations, in both asymptomatic patients and those presenting with vaginal bleeding. Previous studies assessing the risk of first-trimester pregnancy failure when an SCH is seen on an early pregnancy sonogram have used a variety of grading systems for characterizing the size of the hematoma, including subjective grading of the SCH as small, moderate, or large[1]; calculating the volume of the SCH from its US measurements[2–6]; estimation of hematoma size as a fraction of gestational sac size[2,3,7–10]; and estimated fraction of the gestational sac surrounded by hematoma.[9] However, no studies, to our knowledge, have directly compared these grading systems to determine which provides the best risk estimate for subsequent pregnancy failure when an SCH is

seen in conjunction with embryonic cardiac activity on a US examination.

The purpose of this study was to evaluate and compare several grading systems in a study population of first-trimester pregnancies with the US finding of a live embryo and SCH to assess which of these grading systems correlates best with first-trimester outcome. A secondary goal was to assess the effect of gestational age (GA) at the time of SCH diagnosis on outcome.

Materials and Methods

Institutional Review Board approval was obtained before collecting data for this Health Insurance Portability and Accountability Act–compliant study. First-trimester live singleton pregnancies between 6 and 11 weeks' GA with SCH were identified by a key word search of our institutional US database from September 2012 through March 2015. When more than 1 sonogram in a pregnancy showed an SCH, the earliest scan was the one used in the study. Gestational age at the study sonogram was recorded in each case.

First-trimester outcome was categorized as "live" if the patient had a sonogram beyond 14 weeks' gestation showing a fetal heartbeat or if the medical record documented a live birth. First-trimester outcome was categorized as "demise" if the patient had a sonogram showing pregnancy failure before 14 weeks' gestation, or the medical record documented miscarriage.

Images from the US examinations, which were performed transabdominally, transvaginally, or both, were reviewed, and the size of the SCH was categorized in 4 ways: (1) subjective grading as small, moderate, or large (Figure 1); (2) subjective estimation of the hematoma size as a fraction of the gestational sac size, using the following percentage categories: 10% or less, 11% to 25%, 26% to 50%, and greater than 50% (Figure 2); (3) subjective estimation of the fraction of the gestational sac surrounded by hematoma, using the same 4 percentage categories (Figure 3); and (4) measurement of 3 orthogonal dimensions of the SCH.

Cases were included in our study if the sonograms permitted characterization of hematoma size according to the 4 grading systems and if the first-trimester pregnancy outcome was known. For subjective estimation of the hematoma size in relation to the sac size, study images including cine loops were reviewed by 1 of 6 radiologists specializing in obstetric US. The subjectively assessed hematoma volume was then compared to the subjectively assessed gestational sac volume obtained by a similar image review technique.

The frequency of first-trimester pregnancy failure as a function of GA at the study sonogram was assessed. The relationship between outcome and GA was evaluated on the basis of GA as a continuous variable (via logistic regression analysis) and also on the basis of the GA categories of 7 weeks or earlier, later than 7 weeks to 8 weeks, and later than 8 weeks (via the χ^2 test).

The frequency of pregnancy failure was calculated for each of the size categories in the first 3 grading systems. This calculation was performed on the basis of all study cases and also on cases before 8 weeks' gestation. Statistical significance was evaluated with the χ^2 test. For the fourth grading system, the measured size of the SCH was assessed to determine whether a volume could be calculated and then used to correlate with pregnancy outcome.

A receiver operating characteristic (ROC) analysis was used to assess the performance of the first 3 SCH grading systems as predictors of first-trimester outcome. Receiver operating characteristic curves were generated on the basis of all study cases and also on cases before 8 weeks' gestation.

Figure 1. Subjective assessment of SCH size, denoted by white arrows. **A**, Small; **B**, medium, and **C**, large.

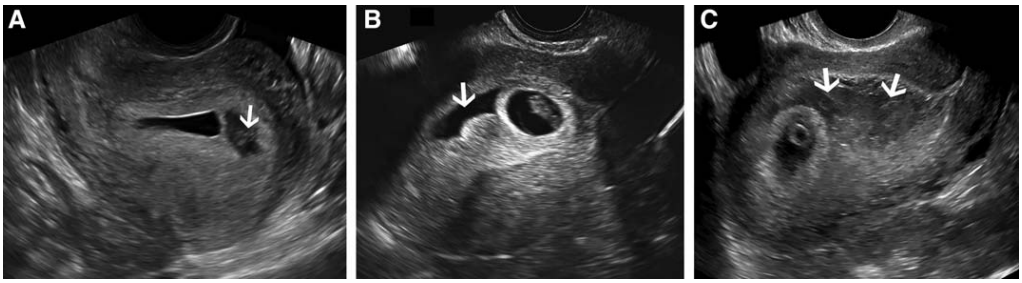


Figure 2. Estimated SCH size, denoted by white arrows, relative to the size of the gestational sac. Subjective size estimates of both the hematoma and the gestational sac were based on radiologist review of all available static and cine images. **A**, 10% or less (same case as Figure 1A); **B**, 11% to 25% (same case as Figure 1B); **C**, 26% to 50%; and **D**, greater than 50% (same case as Figure 1C).

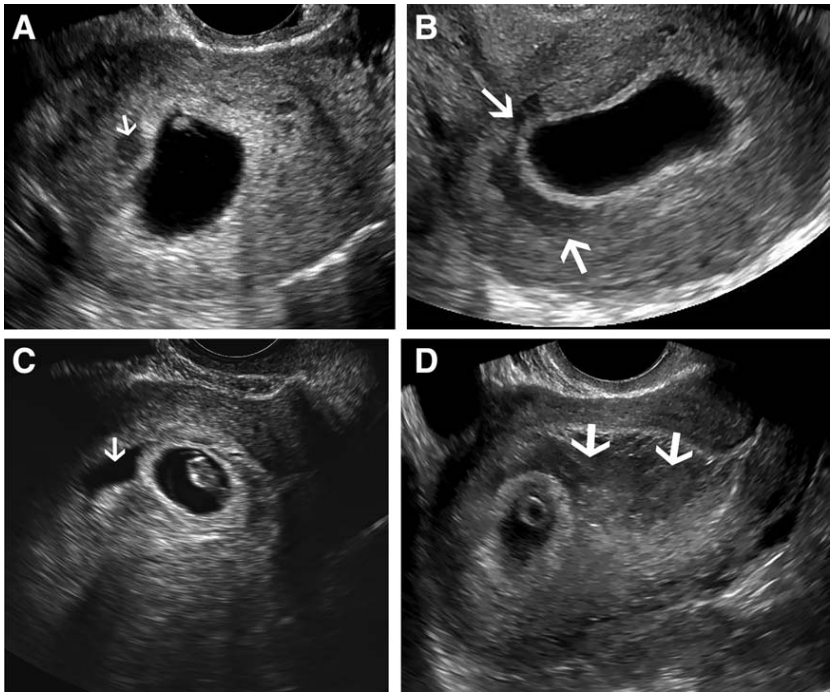
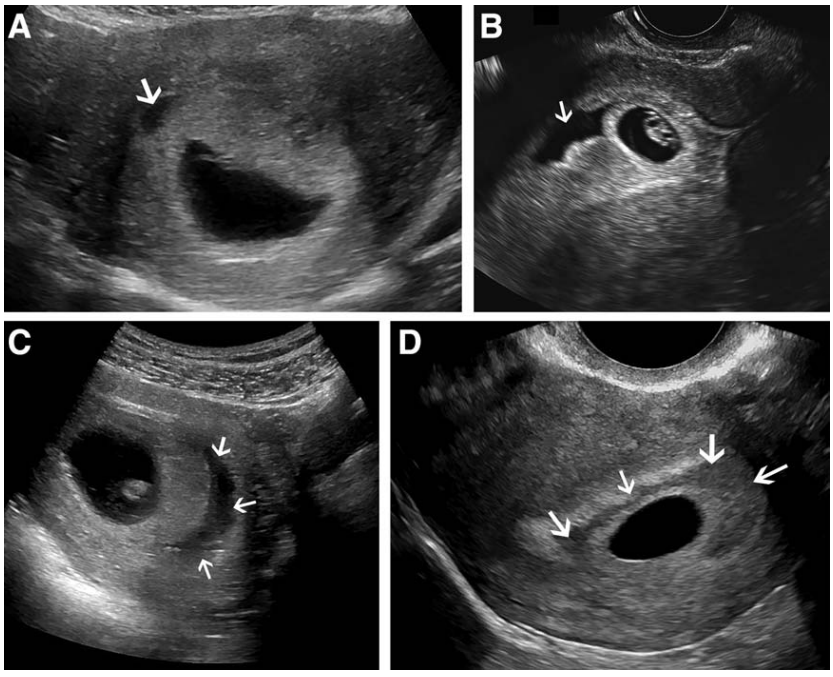


Figure 3. Estimated SCH size, denoted by white arrows, relative to the percentage of involvement of the gestational sac circumference. **A**, 10% or less; **B**, 11% to 25% (same case as Figure 1B); **C**, 26% to 50%; and **D**, greater than 50%.



Results

There were 434 sonograms that met criteria for inclusion in our study: presence of embryonic cardiac activity at 6 to 11 weeks' gestation and an SCH; availability of appropriate images to assess SCH size according to the 4 criteria listed above; and known first-trimester outcome. First-trimester outcomes were live in 382 of the 434 study cases (88.0%) and demise in 52 (12.0%). The earlier in pregnancy that the SCH was seen, the worse the outcome ($P < .00001$, logistic regression). The mean GAs ± SD at the time of the study sonogram were 7.9 ± 1.3 weeks for pregnancies with a live outcome and 7.0 ± 0.8 weeks for those with pregnancies resulting in demise ($P < .000001$, t test). The rates of demise were 19.6% for GA of 7 weeks or earlier at the time of the study scan, 14.6% for GA later than 7 weeks to 8 weeks, and 3.6% for GA later than 8 weeks (Table 1; $P < .001$, χ^2 test).

Of the 206 of 434 pregnancies for which the examination was performed for vaginal bleeding (47.4%), 24 resulted in demise (11.7%), a rate that was not statistically different from that of those without bleeding ($P = .84$, χ^2 test). A total of 113 of 434 pregnancies (26.0%) were the result of assisted reproduction. The demise rate in this cohort was 12 of 113 (10.6%), also not significantly different from those conceived naturally ($P = .60$, χ^2 test). A total of 102 patients (23.5%) were of advanced maternal age (≥35 years). In this group, the demise rate was 20 of 102 (19.6%), which was significantly higher compared to those younger than 35 years ($P = .007$, χ^2 test; Table 2).

There was a statistically significant relationship between SCH size and first-trimester outcome when the size of the SCH was characterized as the estimated fraction of the gestational sac size: the likelihood of demise was 5.8% when the SCH was 10% of the sac size or less, increasing to 23.3% when the SCH size was greater than 50% of the sac size (Table 2; $P < .001$, χ^2 test). For the other 2 grading methods—subjective hematoma size (small, moderate, or large) and fraction of the sac surrounded by hematoma—the relationship between size and outcome was not statistically significant (Table 3).

When the analysis was restricted to study sonograms at a GA before 8 weeks, the finding was similar: the only SCH sizing method with a statically significant relationship to outcome was hematoma size as the estimated fraction of the sac size (Table 4).

The ROC analysis corroborated the superiority of hematoma size as the estimated fraction of the sac size compared to the subjective hematoma size and fraction of the sac surrounded by hematoma. This finding is seen in the graphic depiction of the ROC curves (Figure 4 for all GAs in our study population; Figure 5 for GAs ≤8 weeks), in that the ROC curve for hematoma size as the estimated fraction of the sac size is higher than the curves for the other 2 grading methods. It is also evident in Table 5, which corroborates this finding based on areas under the ROC curves.

Calculation of SCH volume from the 3 orthogonal dimensions of the SCH gave such spurious results that

Table 1. First-Trimester Pregnancy Outcome in Relation to GA at Time of Diagnosis of SCH

First-Trimester Outcome	GA at Time of SCH Diagnosis, wk		
	≤7	>7 to ≤8	>8 to ≤11
Live	115	105	162
Demise	28	18	6
Demise, %	19.6	14.6	3.6

$P < .001$, χ^2 test.

Table 2. First-Trimester Pregnancy Outcome Based on Clinical Factors

First-Trimester Outcome	Clinical Indication						Total Population
	Vaginal Bleeding		Assisted Reproduction		Maternal Age, y		
	Yes	No	Yes	No	<35	≥35	
Live	182	200	101	281	300	82	382
Demise	24	28	12	40	32	20	52
Demise, %	11.7	12.3	10.6	12.5	9.6	19.6	12.0
P[a]	.84		.60		.007		

[a] χ^2 test.

comparison to pregnancy outcome was impossible. The spurious results occurred because most SCHs are crescentic and oblong, shapes for which no mathematical formula is suitable for calculating volume from 3 orthogonal dimensions. Because of this factor, no further analysis was performed using these measurements.

Table 3. First-Trimester Pregnancy Outcome in Relation to Size of SCH (GA 6 to 11 Weeks at Time of SCH Diagnosis)

First-Trimester Outcome					P^a
	Subjective Size of Hematoma				.142
	Small	**Medium**	**Large**		
Live	246	98	38		
Demise	27	20	5		
Demise, %	9.9	16.9	11.6		
	Hematoma Size as Fraction of Gestational Sac Size, %				<.001
	≤10	**10–25**	**25–50**	**>50**	
Live	114	112	66	89	
Demise	7	11	8	27	
Demise, %	5.8	8.9	10.8	23.3	
	Fraction of Gestational Sac Surrounded by Hematoma, %				.085
	≤10	**10–25**	**25–50**	**>50**	
Live	135	123	95	29	
Demise	10	18	17	7	
Demise, %	6.9	12.8	15.2	19.4	

[a] χ^2 test.

Table 4. First-Trimester Pregnancy Outcome in Relation to Size of SCH (GA 6 to 8 Weeks at Time of SCH Diagnosis)

First-Trimester Outcome					P^a
	Subjective Size of Hematoma				.4
	Small	**Medium**	**Large**		
Live	131	64	25		
Demise	24	18	4		
Demise, %	15.5	22.0	13.8		
	Hematoma Size as Fraction of Gestational Sac Size, %				<.05
	≤10	**10–25**	**25–50**	**>50**	
Live	54	53	45	68	
Demise	5	11	7	23	
Demise, %	8.5	17.2	13.5	25.3	
	Fraction of Gestational Sac Surrounded by Hematoma, %				.32
	≤10	**10–25**	**25–50**	**>50**	
Live	67	76	55	22	
Demise	8	17	15	6	
Demise, %	10.7	18.3	21.4	21.4	

[a] χ^2 test.

Figure 4. Receiver operating characteristic curves for SCH sizing methods as predictors of pregnancy outcome (GA 6–11 weeks at time of SCH).

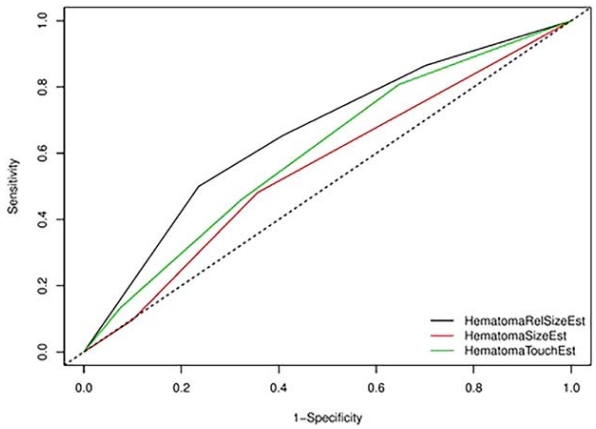


Figure 5. Receiver operating characteristic curves for SCH sizing methods as predictors of pregnancy outcome (GA 6–8 weeks at time of SCH).

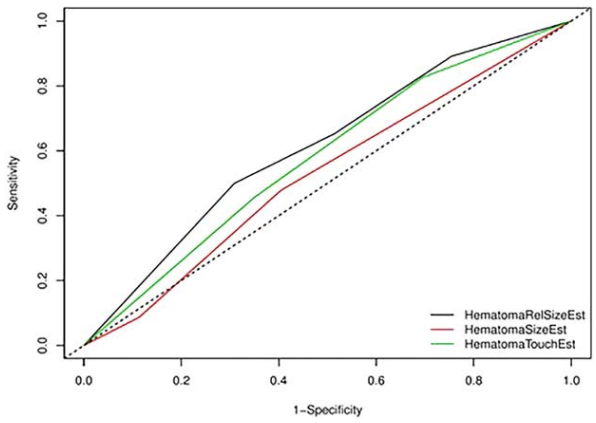


Table 5. Receiver Operating Characteristic Analysis of SCH Sizing Methods for Predicting First-Trimester Outcome

	Area Under the ROC Curve	
SCH Sizing Method	**All GAs (6–11 wk)**	**GA ≤ 8 wk**
Subjective size of hematoma	0.556	0.527
Hematoma size as fraction of gestational sac size	0.660	0.613
Fraction of gestational sac surrounded by hematoma	0.603	0.590

Discussion

The finding of an SCH on a first-trimester US examination of a living embryo is a fairly common finding and one that can be very concerning to the patient. Previous studies have shown that a small SCH carries little to no increased risk of miscarriage,[1–3,9,11–14] and for moderate to large hematomas, the risk of miscarriage increases with increasing hematoma size.[1–3,9,11]

Methods for characterizing an SCH to predict pregnancy outcome have varied considerably. Some studies have reported SCH size as the percentage of the circumference of the gestational sac surrounded by the hematoma.[2,3,7,9] Others have used subjective classification of SCH size as small, medium, or large.[1] Still others have estimated the relative volume of the SCH compared to the gestational sac[2,3,7–10,15] or calculated the SCH volume from measurements.[2–4,6,11,14,16–20] Some have assessed the SCH location in the uterus,[4,5,10,14,15] and others have correlated symptoms and the presence of an SCH with pregnancy outcome.[1,7–10,14]

Because the published literature includes a broad variety of methods for characterizing an SCH, the reporting of an SCH identified on a first-trimester US examination is variable from practitioner to practitioner. This factor can make it difficult to follow the progression of an SCH in a given pregnancy or to compare SCHs in different pregnancies. In addition, because of the varied methods of reporting SCH size, counseling patients as to the prognostic importance of their SCH is difficult.

The major goal of our study was to determine which of the methods used to estimate the size of the SCH is the best predictor of pregnancy outcome. A secondary goal was to determine whether GA at the time the SCH is diagnosed affects pregnancy outcome.

Of the 3 methods for characterizing SCH size, the only one with a statistically significant correlation with pregnancy outcome was the subjective estimate of SCH size as a fraction of the gestational sac size. The superiority of this method over the other approaches—subjective grading of the SCH size and estimated fraction of the gestational sac surrounded by hematoma—was also corroborated by an ROC analysis.

Some authors have advocated calculating the volume of an SCH by measuring 3 orthogonal dimensions and applying the mathematical formula for the volume of an ellipsoid (approximately half of the product of the 3 dimensions).[2,4,6,14,17–20] However, this approach is

mathematically invalid and can yield very spurious results, since most SCHs have highly irregular shapes such that the formula for the volume of an ellipsoid is inapplicable. Thus, we recommend against trying to calculate SCH volume based on US measurements.

We found that the GA at which an SCH was diagnosed correlated with pregnancy outcome, in that the younger the GA at diagnosis of an SCH, the greater the risk of subsequent pregnancy failure. In particular, when an SCH was diagnosed at a GA of 8 weeks or earlier, the risk of pregnancy loss was 17.3%, whereas after 8 weeks, the risk fell to 3.6%. This finding is similar to that of prior studies, which emphasizes the importance of GA at the time an SCH is identified.[5,9]

What we also found was that the presence of vaginal bleeding had no impact on the rate of pregnancy loss, nor did a history of pregnancy achieved by assisted reproductive techniques. These findings differ from prior reports, which found a higher frequency of SCH in patients who were pregnant after in vitro fertilization than those conceived naturally.[21,22] In our study, the rate of pregnancy loss was significantly higher in patients 35 years or older with an SCH than those younger than 35 years, a finding consistent with at least 1 prior study.[9] One limitation of our study was that we were not able to collect information on other factors that may influence the pregnancy loss rate, such as parity, maternal comorbidities, and a history of pregnancy loss.

Our study is one of the few and, to our knowledge, the largest to compare different methods of characterizing first-trimester SCH to determine which correlates best with the risk of pregnancy loss. We found that the estimated hematoma size in relation to the gestational sac size was superior to other methods of hematoma quantification. We also found that GA at diagnosis of an SCH is an important predictor of pregnancy outcome. Our results can be used to counsel patients about the risk of miscarriage after an SCH has been diagnosed at an early pregnancy US examination.

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