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Yolk Sac Size and Shape as Predictors of First-Trimester Pregnancy Outcome

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ABSTRACT

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Article info	rmation 25-10-2022	Background: According to estimates, about 30 and 40 % of implanted conceptions result in spontaneous abortions throughout the first trimester, the majority of which happen at an extremely early stage. Most massive losses occur relatively early in the gestational period, but after the heart activity of the embryo has appeared, the spontaneous abortion rate steadily falls to 2-5%.				
Accepted:	08-03-2023	Aim of the Work: To assess the yolk sac's value in terms of pregnancy outcome prediction.				
DOI: 10.21608/IJI	MA.2023.170918.1532	Patients and Methods: This prospective observational study has been performed on 100 healthy women with singleton pregnancies and				
*Corresponding author Email: dr.a.elrrahman@gmail.com		diameter, the mean gestational sac diameter, and the crown-rump length [CRL] were all measured using electronic calipers through transvaginal ultrasound. These data were correlated with pregnancy				
Citation: Abdelrahman AK, Zakaria AM, Moustafa AA. Yolk Sac Size and Shape as Predictors of First-Trimester Pregnancy Outcome. IJMA 2022 December; 4 [12]: 2876-2884. doi: 10.21608/IJMA.2023.170918.1532.		outcome. Results: Yolk sac regularity was lower in missed abortion cases at different weeks, the differences statistically were significant between 6 and 10 weeks of gestation. Yolk sac diameter higher in missed abortion cases at different weeks, the differences statistically were significant in weeks 8 to 10.				
		Conclusion: The ultrasonography measurement of yolk sac diameter and shape during the first trimester of gestation has proven to be a valuable, useful, and noninvasive technique in the examination, diagnosis, and follow-up of pregnant women in their early stages of gestation. In our study, the irregular shape of the yolk sac was found to be a significant predictor of the outcome of pregnancy.				

Keywords: Pregnancy; Transvaginal; Yolk sac diameter; Gestational sac diameter.



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INTRODUCTION

In the earliest three months of pregnancy, the yolk sac [YS] is the main site of transfer between the mother and the embryo. In addition to hemopoietic and nutritive properties, it possesses endocrine, immunologic, secretory, and excretory functions ^[1]. The main yolk sac is found at almost 24 days of menstrual age. The formation of secondary YS by squeezing off the primary YS after one-week creation of the extra-embryonic celom. The average gestational sac width at this stage of development is about 5 mm ^[1].

There are different methods of anticipating the result of a pregnancy in the first trimester, including imaging using transvaginal ultrasound [TVS] and using biochemical indicators like beta HCG [Beta Human Chorionic Gonadotropin], PAPP-A [Pregnancy Associated Plasma Protein-A], unconjugated estriol, and maternal serum alpha-fetoprotein. But only in particular situations are these biochemical indicators utilized to screen for aneuploidy^[2].

TVS, on the other hand, is a routine technique that is performed for all pregnancies. Guidelines such as gestational sac width, crownrump length, yolk sac width, presence of decidual reaction, and subchorionic bleeding have been used to predict the outcome of a first-trimester pregnancy. Prior to placental circulation being formed, the YS is the main source of change between the mother and the embryo early in pregnancy. It performs functions that are secretory, metabolic, hematopoietic, excretory, and immunogenic ^[3].

Yolk sac comes out round in shape, having an anechoic center surrounded by an echogenic wall that is consistently thick and well defined. The yolk sac's inner diameter is between 3 and 5 mm. From the fifth gestation week through the end of the tenth, its size progressively grows; after that, it gradually declines. There have been lots of studies using both traditional sonography and, more lately, TVs to examine the yolk sac's predictive sense for the outcome of pregnancies. The outcomes are incompatible ^[4].

The yolk sac shape and size are sensitive prognosticators of pregnancy results. So, greater research into the measure of yolk sac size and form, as well as its correlation with normal and abnormal pregnancy results, may aid as an early prognosticator of pregnancy results ^[5].

A miscarriage occurs in roughly 40% of early pregnancies. The main contributing factors are unknown causes, morphologic and chromosomal anomalies, infections, anatomical flaws, endocrine and immunologic variables, and systemic diseases of the mother, whether they are threatening, spontaneous, complete, incomplete, inevitable, and missing. As the gestation period lengthens, the chance of miscarriage decreases ^[2].

The fetal heartbeat ought to be audible when the length from crown to rump is between 4 and 10 mm. The yolk sac ought to be evident at around week five of pregnancy when the gestational sac is wider than 8 mm. An embryo is normally obvious when the gestational sac width exceeds 20 mm. If not, the check ought to be repeated after a week to approve the issue. The many aberrant ultrasound appearances of the YS include the absence of the yolk sac, irregular form, excessively small [<3 mm], excessively large [>6 mm], or exhibiting degenerative alterations [decreased translucency or calcifications]^[4].

Properly distinguishing a normal pregnancy from a pregnancy loss at an early stage of conception is still a clinical challenge. It is predicted that during the first trimester, spontaneous abortion will occur in between 30 and 40 % of implanted pregnancies ^[1].

When the mean gestational sac diameter [MGSD] at endovaginal sonography reaches 5 mm in normal pregnancies, the YS is detected. There is little data on the predictive effect of YS measurement and YS morphology on pregnancy outcomes ^[2].

THE AIM OF THE WORK

The aim of this work is to assess the yolk sac's value in terms of pregnancy outcome prediction.

PATIENTS AND METHODS

This prospective observational study has been performed on 100 healthy women with singleton pregnancies and gestational ages ranging from 5 to 10 weeks at a tertiary care hospital at Al-Azhar's obstetrics and gynecology clinics from June 2021 to April 2022, following approval of the ethical committee and informed consent from the participants. **Inclusion criteria:** Singleton pregnancy, the gestational age was between of 5–10 weeks, and healthy women Aged between 20 to 35 years old.

Exclusion criteria: Patients with clinical infection, vaginal bleeding, hypothyroidism, overt diabetes mellitus, and structural abnormalities of the uterus and cervix.

In this study, 100 of the 120 patients who were evaluated for eligibility were accepted. Eight patients who were eligible for the study declined to participate, while twelve others were excluded according to the inclusion criteria.

Sample size: This study was based on research done by Suguna and Sukanya ^[1]. The Epi Info STATCALC was used to estimate the sample size while taking into account the following hypotheses: - An odds ratio of 1.115 was estimated with a 95% two-sided level of confidence, 80% power, and a 5% error. Ninety was the ultimate maximum sample size derived from the Epi-Info result. Due to the possibility of follow-up dropouts, the sample size was increased to 100 cases.

Study procedure

An informed consent was taken from every patient. Complete history taking including personal history, any complaint, obstetric history, menstrual history, past medical and past surgical history, and family history.

Subjects were examined with endo-vaginal sonography & Transvaginal ultrasound [TVS] was performed on an empty bladder.

The internal YS diameter, the mean gestational sac diameter, and the crown-rump length [CRL] were all measured using electronic calipers.

The MGSD was calculated by averaging three orthogonal measurements.

The yolk sac diameter was measured by the inner/inner diameter.

The menstrual age [MA] was determined from the first day of last menstrual period.

Patients were considered to have had a normal outcome if the pregnancy continued through the conclusion of the 1st trimester [13 weeks of menstruation age or later]; these patients were classified as Group I. Patients in Group II had an abortion or an embryonic death during the first trimester.

A YS size was considered abnormal if it varied by greater than or fewer than two standard deviations [SD] from the mean.

The mean of three perpendicular diameters [in orthogonal planes], assessed from one inner edge to the other inner edge of the trophoblast, was known as the gestational sac diameter [GSD] or mean sac diameter [MSD]. Using calipers at the inner edge of the yolk sac, the yolk sac diameter [YSD] was calculated as the mean of two perpendicular diameters.

The YS size in the normal group was compared to MA, MGSD, and CRL.

The data has been analyzed using both polynomial and straight-line regression analysis to evaluate the best-fit curve.

The YS sizes of Group II cases were compared to those of Group I to establish the sensitivity, specificity, and negative and positive predictive value of abnormal YS size in predicting abnormal 1st trimester results.

Aberrant YS shape has been described as any significant deviation from the typical outline, YS outline interruption, irregular form, and abnormal echogenicity.

The YS shapes of the patients in Groups II and I were compared to determine the sensitivity, specificity, and positive and negative predictive values of abnormal YS shapes in predicting aberrant outcomes.

Statistical analysis

IBM SPSS statistics [Statistical Package for Social Sciences], version 22.0, IBM Corp., Chicago, USA, 2013, and Microsoft Office Excel 2007 were used to code, tabulate, and statistically analyze the collected data. For quantitative normally distributed data. descriptive statistics have been calculated as min and max of the range, mean \pm SD [standard deviation], whereas for qualitatively distributed data, they were calculated as percentage and number. Inferential analysis for quantitative variables was performed using Shapiro-Wilk tests for determining normality and independent t-tests when there are two independent groups having normally distributed data. Inferential analysis for independent variables in qualitative data was conducted using Chi-square tests for proportional differences and Fisher's Exact tests for variables with low anticipated numbers. P values of less than 0.05 are considered significant: otherwise, they are not. Diagnostic characteristics were calculated as follows: Sensitivity = [True positive test / Total positive golden] x 100; Specificity = [True negative test / Total negative golden] x 100; Diagnostic accuracy = [[True positive test + True negative test] / Total cases] x 100; Youden's index = sensitivity + specificity - 1; Positive predictive value = [True positive test / Total positive test] x 100; Negative predictive value = [True negative test / Total negative test] x 100; Likelihood Ratio+ = [sensitivity/ 1-specificity]; Likelihood Ratio- = [1- sensitivity / specificity]; LR= LR+/ LR- Kappa=Observed agreementchance agreement / 1- chance agreement.

RESULTS

Table [1] displays the demographic features of the cases studied. Mean \pm SD of age was 27.0 \pm 3.8 years. Mean \pm SD of BMI was 25.7 \pm 2.3 kg/m². Majority of the enrolled cases were in weeks 7 and 8 of gestational age. Regarding pregnancy outcome, missed abortion recorded an about one quarter of the studied cases.

Table [2] shows Yolk sac shape among the studied cases. Yolk sac absence recorded only in weeks 5 and 8. Regularity was least frequent in week 5 then increased in further weeks.

Table [3] shows Yolk sac diameter among the studied cases. Yolk sac diameter was smallest in week 5 then increased in further weeks.

Table [4] shows: No statistically significant differences according to pregnancy first trimester fate regarding age, BMI and parity.

Table [5] shows Yolk sac regularity was lower in missed abortion cases at different weeks the differences statistically were significant in weeks 6 to 10.

Table [6] shows that Yolk sac shape abnormality [absent/irregular] in week 5 had low diagnostic characteristics in predicting pregnancy first trimester missed abortion, the characteristics increased in further weeks to be perfect in week 10.

Table [7] shows Yolk sac diameter higher in missed abortion cases at different weeks the differences statistically were significant in weeks 8 to 10.

Table [8] shows that Yolk sac diameter abnormality [absent/large] in week 5 had low diagnostic performance in predicting pregnancy first trimester missed abortion, the characteristics increased in further weeks to be perfect in week 10. The performance was statistically significant from week 8 to 10.

Table [9] shows that Yolk sac diameter abnormality [absent/large] in week 5 had low diagnostic characteristics in predicting pregnancy first trimester missed abortion, the characteristics increased in further weeks to be perfect in week 10.

Variables	Results	
Age [years], Mean ± SD [Range]	27.0±3.8 [20.0-35.0]	
BMI [kg/m ²], Mean ± SD [Range]		25.7±2.3 [19.1-31.0]
Parity, No. [%]	Nulli	29 [29%]
	Parous	71 [71%]
Gestational age [weeks], No. [%]	5	12 [12%]
	6	17 [17%]
	7	22 [22%]
	8	22 [22%]
	9	16 [16%]
	10	11 [11%]
Fate, No. [%]	Missed abortion	26 [26%]
	Good outcome	74 [74%]

 Table [1]: Demographic characteristics and pregnancy outcome of studied cases

Gestational age [weeks]	Absent	Irregular	Regular
Week 5	2 [16.7%]	4 [33.3%]	6 [50.0%]
Week 6	1 [5.9%]	5 [29.4%]	11 [64.7%]
Week 7	0 [0.0%]	6 [27.3%]	16 [72.7%]
Week 8	0 [0.0%]	6 [27.3%]	16 [72.7%]
Week 9	0 [0.0%]	4 [25.0%]	12 [75.0%]
Week 10	0 [0.0%]	3 [27.3%]	8 [72.7%]

Table [2]: Yolk sac shape among the studied cases

Table [3]: Yolk sac diameter [mm] among the studied cases

Gestational age [weeks]	Mean ± SD	Range
Week 5	2.5±0.6	1.5–3.7
Week 6	3.1±0.5	2.5–4.0
Week 7	3.2±0.4	2.8–4.2
Week 8	3.4±0.4	2.8–4.6
Week 9	3.6±0.6	2.9–5.2
Week 10	4.0±1.1	3.3–7.2

Table [4]: Comparison according to pregnancy first trimester fate regarding demographic characteristics

Var	iables	Abortion	Good	p-value
Age [years]		27.3±4.0	27.0±3.7	0.722
BMI [kg/m2]		26.4±2.1	25.5±2.3	0.058
Parity Nulli		9 [34.6%]	20 [27.0%]	0.463
	Parous	17 [65.4%]	54 [73.0%]	

Table [5]: Comparison according to pregnancy first trimester fate regarding Yolk sac shape

Gestational age [weeks]	Fate	Abortion	Good	p-value	
Week 5	Absent	2 [33.3%]	0 [0.0%]		
	Irregular	2 [33.3%]	2 [33.3%]	0.481	
	Regular	2 [33.3%]	4 [66.7%]		
Week 6	Absent	1 [20.0%]	0 [0.0%]		
	Irregular	3 [60.0%]	2 [16.7%]	0.028*	
	Regular	1 [20.0%]	10 [83.3%]		
Week 7	Absent	0 [0.0%]	0 [0.0%]		
	Irregular	4 [80.0%]	2 [11.8%]	0.009*	
	Regular	1 [20.0%]	15 [88.2%]		
Week 8	Absent	0 [0.0%]	0 [0.0%]		
	Irregular	4 [100.0%]	2 [11.1%]	0.002*	
	Regular	0 [0.0%]	16 [88.9%]		
Week 9	Absent	0 [0.0%]	0 [0.0%]		
	Irregular	3 [100.0%]	1 [7.7%]	0.007*	
	Regular	0 [0.0%]	12 [92.3%]		
Week 10	Absent	0 [0.0%]	0 [0.0%]		
	Irregular	3 [100.0%]	0 [0.0%]	0.006*	
	Regular	0 [0.0%]	8 [100.0%]		

 Table [6]: Diagnostic characteristics of Yolk sac shape abnormality [absent/irregular] in predicting pregnancy first trimester missed abortion

Characteristics	Gestational age [weeks]						
	5	6	7	8	9	10	Overall
Sensitivity	66.7%	80.0%	80.0%	100.0%	100.0%	100.0%	84.6%
Specificity	66.7%	83.3%	88.2%	88.9%	92.3%	100.0%	87.8%
Diagnostic accuracy	66.7%	82.4%	86.4%	90.9%	93.8%	100.0%	87.0%
Youden's Index	33.3%	63.3%	68.2%	88.9%	92.3%	100.0%	72.5%
Positive predictive value	66.7%	66.7%	66.7%	66.7%	75.0%	100.0%	71.0%
Negative predictive value	66.7%	90.9%	93.8%	100.0%	100.0%	100.0%	94.2%

 Table [7]: Comparison according to pregnancy first trimester fate regarding Yolk sac diameter[mm]

Gestational age [weeks]	Abortion	Good	p-value
Week 5	2.7±0.3	2.4±0.8	0.595
Week 6	3.3±0.5	3.0±0.5	0.343
Week 7	3.5±0.5	3.2±0.4	0.063
Week 8	3.8±0.6	3.3±0.3	0.008*
Week 9	4.3±0.8	3.4±0.4	0.010*
Week 10	5.1±1.8	3.6±0.2	0.026*

 Table [8]: Diagnostic performance of Yolk sac diameter abnormality [absent/large] in the prediction of missed abortion in the first trimester of pregnancy

Gestational age [weeks]	AUC	SE	p-value	Cut point	95 % CI
Week 5	0.604	0.188	0.594	≥3.1	0.237-0.972
Week 6	0.698	0.138	0.249	≥3.4	0.428-0.968
Week 7	0.776	0.113	0.066	≥3.6	0.556-0.997
Week 8	0.840	0.143	0.037*	≥3.7	0.559-1.000
Week 9	0.949	0.057	0.019*	≥3.8	0.837-1.000
Week 10	1.000	0.000	0.014*	≥3.9	1.000-1.000

Among cases with present Yolk sac. AUC: Area under curve. SE: Standard error. *Significant. CI: Confidence interval

 Table [9]: Diagnostic characteristics of Yolk sac diameter abnormality [absent/large] in the prediction of missed abortion in the first trimester of pregnancy

Characteristics	Gestational age [weeks]						
	5	6	7	8	9	10	Overall
Sensitivity	50.0%	60.0%	60.0%	75.0%	100.0%	100.0%	69.2%
Specificity	83.3%	83.3%	88.2%	88.9%	92.3%	100.0%	89.2%
Diagnostic accuracy	66.7%	76.5%	81.8%	86.4%	93.8%	100.0%	84.0%
Youden's Index	33.3%	43.3%	48.2%	63.9%	92.3%	100.0%	58.4%
Positive predictive value	75.0%	60.0%	60.0%	60.0%	75.0%	100.0%	69.2%
Negative predictive value	62.5%	83.3%	88.2%	94.1%	100.0%	100.0%	89.2%

DISCUSSION

Clinically, it is still difficult to distinguish between a normal pregnancy and a loss of pregnancy in the early stages of pregnancy. The number of spontaneous abortions occurring during the first trimester of implanted pregnancies is thought to be between 30 and 40% ^[6]. The imaging of transvaginal ultrasound [TVS] and biochemical indicators like beta HCG, PAPP-A, unconjugated estriol, and maternal serum alpha fetoprotein are among the different methods for anticipating the pregnancy result in the 1st trimester. These biochemical indicators, however, are only utilized in a limited number of circumstances to screen for aneuploidy. In contrast, TVS is a routine baseline process performed for all pregnant women, and measures including diameters of the gestational sac and the yolk sac, length of crown rump, existence of decidual reaction, and subchorionic bleeding were employed to predict the pregnancy result in the first trimester ^[1].

Prior to the establishment of placental circulation, the yolk sac [YS] serves as the main

source of exchange between the fetus and mother in the first trimester. In addition to hematopoietic functions, it also has metabolic, secretory, excretory, and immunogenic ones. At about 24 days of gestation, the main yolk sac forms [estimated from the 1st day of the most recent menstrual cycle] ^[1].

From the 5th to the 12th week of pregnancy, the secondary yolk sac [SYS], the 1st extraembryonic structure that is visible through TVS in the chorionic cavity, can be detected in normal pregnancies. However, the primary yolk sac is not visible on ultrasound ^[7].

Since spontaneous abortions or early pregnancy failure represent major conflict, assessing the association of first trimester pregnancy results employing yolk sac measures was highlighted as a main point of interest ^[8]. Consequently, this study was conducted and aimed to assess the yolk sac's shape and size as indicators of the pregnancy's results throughout the first trimester.

The current study revealed that missed abortion was found in 26% of the cases with no

statistically significant differences based on pregnancy first trimester fate concerning age, BMI, and parity [p values = 0.722, 0.058, 0.463] respectively.

Sakr *et al.* ^[6] conducted a prospective crosssectional study that involved 200 pregnant women in their 1st trimester to evaluate the yolk sac's shape and diameter and the embryo's heart rate as prognostic markers of the outcome of the first trimester of gestation and revealed that fetal loss occurred in 16/200 [8%] of cases from 6 to 12 weeks of gestation.

Ghali *et al.* ^[7] performed a prospective cohort study that involved 72 pregnant women in the 1st trimester to know pregnancy outcome by assessing the role of ultrasound assessment of yolk sac diameter and its shape in the 1st trimester and revealed that fetal loss occurred in 9/72 [12.5%] of cases from 6 to 11 weeks of gestation with no significant relationship between maternal age and pregnancy outcome.

Abd Ellatif *et al.* ^[9] carried out a prospective study that involved 100 pregnant women in the 1st trimester to assess the relationship between the ultrasonography parameters that were evaluated in the 1st trimester [the gestation sac size, yolk sac shape and size, and the heart rate of the embryo] and early loss of pregnancy.

Suguna and Sukanya ^[1] conducted a prospective study that involved 492 pregnant ladies between 6^{+0} and 9^{+6} weeks' gestation to investigate the significance of yolk sac shape and size for predicting pregnancy result during the 1st trimester and reported 393 women [78.6%] who lasted until 12 weeks and were deemed to have a normal result. Ninety-nine women experienced a poor result, which comprised 91 [18.2%] missed abortions and 8 [1.6%] blighted ovules [anembryonic pregnancies].

As regards Yolk sac shape, the current study results revealed that Yolk sac regularity was lower in missed abortion cases at different weeks, the differences statistically were significant between 6 and 10 weeks of gestation [p value<0.05]. Consequently, using ROC curve analysis, the prognostic value of the YS shape abnormality [absent/irregular] in week 5 had low diagnostic characteristics in predicting pregnancy in first trimester missed abortion. The characteristics increased in further weeks to be perfect in week 10. In agreement with our findings, **Sakr** *et al.* ^[6] stated that it had been found that there was a significant relationship between yolk sac shape and the results of pregnancy [p< 0.05]. out of 184 [92%] cases with regular and round yolk sac shapes. 16 cases [8%] had failed pregnancy, 10 cases [62.5%] had the regular shape of the yolk sac, and 6 cases [37.5 %] exhibited an irregular shape of the yolk sac.

These findings concord with those of **Lebda** *et al.* ^[10], who revealed that enlarged YS [4 instances], irregular or absent YS [one instance each], and both were extremely significant predictors of fetal loss. This study demonstrated that visualization of YS is essential for a healthy pregnancy result. Only one of the 41 normal YSD cases had an abortion rate of 2.5%.

Another study from Turkey conducted by **Tan** *et al.* ^[11] prospectively assessed the yolk sac's sonographic characteristics in 305 healthy singleton pregnancies having gestational ages between six and nine weeks and discovered aberrant yolk sacs in 66 cases. 78.8% [52/66] of the yolk sacs were found to be irregular, 12.1% [8/66] to be larger, and 9.1% [6/66] to be echogenic. 37.5% [3/8] of women with larger yolk sacs underwent abortion, and curiously, abortion rates were comparable to those of the general population in women with irregular and echogenic yolk sacs.

Suguna and Sukanya ^[1] revealed that irregular yolk sacs were present in 87.06% of missed miscarriages, with sensitivity of 87.06%, specificity of 86.5%, PPV of 58.2%, and NPV of 96.8%. As a result, a significant correlation between yolk sac shape and the outcome of pregnancy was observed [p = 0.000].

As regards Yolk sac diameter, the current study results revealed that Yolk sac diameter higher in missed abortion cases at different weeks, the differences statistically were significant in weeks 8 to 10 [p value<0.05].

Consequently, using ROC curve analysis, the prognostic significance of the Yolk sac diameter abnormality [absent/large] in week 5 had low diagnostic performance in predicting pregnancy in first trimester missed abortion. The characteristics increased in further weeks to be perfect in week 10. The performance was statistically significant from week 8 to 10. In keeping with our results, **Sakr et al.** ^[6] observed that at 6 weeks only [P< 0.05], there had been a

significant rise in yolk sac diameter in the fetal loss group greater than in the ongoing pregnancy group, while at 12 weeks there was no significance [P> 0.05]. The cutoff value of yolk sac diameter at six and nine weeks is used to predict pregnancy outcome. At 6 weeks, it was 6, with 75% sensitivity, 60% specificity, and 61% accuracy. The cutoff value at 9 weeks was 5, with sensitivity being 62%, specificity being 54%, and accuracy being 55%.

These results are consistent with those of **Sheikh and Anjana** ^[12], who revealed that the sensitivity of yolk sac diameter was higher for the 8 weeks - 8^{+6} weeks group and the 10 weeks - 10^{+6} weeks group, respectively, at 66.67%. For the seven -weeks-seven weeks and six-days group, the sensitivity and PPV were poor. The nine-to-nine-weeks-six-days group has a high specificity of 95.08%. Between all the gestational age groups, the 8 weeks–8 weeks 6 days group had the highest sensitivity, specificity, PPV, and NPV, demonstrating that YSD is a more useful tool for predicting pregnancy outcomes in this specific gestational age group.

Aseri ^[8] demonstrated that the size of the yolk sac ranged from 2.5 to 7.0 mm, with an average of 4.892 mm. The 1st-trimester pregnancy result is significantly linked to the size of the yolk sac.

Suguna and Sukanya ^[1] revealed that the normal range for yolk sac diameter [YSD] was 3–5 mm. There was a significant correlation between abnormal YSD and a bad pregnancy result [p < 0.000], with YSD <3 mm and >5 mm being deemed abnormal. The YSD was abnormal in 62.36% of the cases. YSD's sensitivity was 62.3% and specificity was 64.1% as an indicator of abnormal results. The positive predictive value was 27.3%, and the negative predictive value was 88.7%.

Transvaginal ultrasonography can detect the YS, a sign that the gestational sac is growing successfully, between the fourth and fifth weeks of pregnancy, before the fetal pole and embryonic heart are apparent ^[13].

In concordance with our results, **Abd Ellatif** *et al.* ^[9] revealed that at 6, 9, as well as 12 weeks, the gestational sac diameter significantly decreased in the group that had fetal loss, and that an enlarged yolk sac indicated abnormal embryonic development and a high risk of abortion, so the GS and YS diameter were good predictors of fetal loss [p < 0.05].

This is consistent with **Adiga** *et al.* ^[13], *who* demonstrated that the growing embryo receives its nutrients from the yolk sac before the placenta is completely formed. Between the 4th and 7th weeks of pregnancy, the yolk sac reaches its peak level of functional activity and satisfies the embryo's early metabolic, endocrine, immunologic, and hemopoietic demands.

Also, a study by **Figueras** *et al.* ^[14] to determine the relationship between yolk sac volume and the likelihood of spontaneous abortion revealed that the presence of retrochorial hemorrhage and subsequent miscarriages were significantly linked to yolk sac volumes outside the 5th to 95th percentile. Abortion occurred in 14 [63.63 %] compared to 26 [26%] in our study, indicating that a normally functioning yolk sac is critical for embryo survival. The results are also confirmed by our study.

In contrast to our results, **Ghali** *et al.* ^[7] revealed that there are no significant differences between the outcome of pregnancy and normal and abnormal yolk sac shape and diameter in the studied cases. Also, **Burton and Jauniaux** ^[15] reported an abnormal outcome with a normal YS shape and size.

The YS diameter and shape as a sole parameter is a poor predictor for pregnancy outcome beyond 20 weeks and may be related to early pregnancy loss only ^[7].

These findings support the hypothesis that YSD in the normal range will eventually have a good outcome. YS morphological changes may indicate abnormal embryonic development or death instead of being the primary reason for pregnancy loss. Another explanation is that between 8th and 10th weeks of gestation, the absence of arterial signals in YS circulation simultaneously increasing umbilical while placental flow of blood indicates that the transfer from YS to the placenta occurs as an important source of supply of blood to the embryo and may be a defect in the switch to umbilical placental blood flow at this time. This may be considered an etiology for miscarriage.

The study's strengths include its prospective study design and the fact that no patients were

lost to follow-up during the study. Making the diagnosis immediately has the advantage of preventing vaginal bleeding from happening at an inconvenient time and location and reducing the parent's worry and uncertainty.

The limitations of the study are worthy of mention first, including that it is not a multicentric study, having a smaller sample size than earlier studies, and that this represents a significant risk of publication bias. Secondly, we did not evaluate the gestational sac diameter, the heart rate of the embryo, and CRL as indicators of early pregnancy loss.

Conclusion: The ultrasonography measure of yolk sac diameter and shape during the first trimester of gestation has proven to be a valuable, useful, and noninvasive technique in the examination, diagnosis, and follow-up of pregnant women in their early stages of gestation. In our study, the irregular shape of the yolk sac was found to be a significant predictor of the outcome of pregnancy.

Conflict of Interest and Financial Disclosure: None.

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