



Yolk Sac Diameter and Morphology as A Predictor of Pregnancy Outcome

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Abstract

Background: Pregnancy refers to the condition of nurturing a developing embryo or fetus within the womb. Ultrasonographic assessment of the yolk sac is advantageous for confirming an intrauterine pregnancy and for predicting gestational outcomes by evaluating its morphology, dimensions, and internal characteristics. Hence; the present study was conducted with the assessing yolk sac diameter and morphology as a predictor of pregnancy outcome.

Materials & methods: A total of 60 patients participated in the study. In addition to sonographic data, various demographic and medical factors were documented, including participants' age, gravida status, menstrual regularity, date of the last menstrual period, history of previous abortions, existing medical

conditions, and personal habits such as smoking and alcohol consumption. Hemoglobin levels, platelet counts, and urine microscopy results were also recorded. Participants who did not attend the follow-up scan were excluded from the analysis. Measurements exceeding two standard deviations for yolk sac diameter, crown-rump length, or gestational sac size were deemed abnormal. The sensitivity and specificity of abnormal yolk sac diameter in predicting adverse pregnancy outcomes were subsequently calculated.

Results: A total of 60 subjects were evaluated. Overall, sensitivity and specificity of YSD for assessing abnormal pregnancy outcome was 92.3% and 55.4% respectively. Overall, sensitivity and specificity of Yolk sac morphology for assessing abnormal pregnancy outcome was 95.3% and 58.4% respectively.

Conclusion: The assessment of yolk sac diameter and morphology during the sixth to tenth weeks of gestation serves as a predictive indicator for first trimester pregnancy outcomes.

Keywords: Pregnancy, Yolk sac, Gestation

Introduction

Pregnancy refers to the condition of nurturing a developing embryo or fetus within the womb. The typical duration of human gestation is approximately 39 weeks, which is categorized into three trimesters; the first trimester extends from week zero to week twelve. During this initial period, several critical developmental milestones are achieved as the fetus matures. Furthermore, as the fetus increases in size, it can be visualized through ultrasonography, and various laboratory tests can be conducted to monitor its development.^{1, 2} The yolk sac, also known as the umbilical vesicle, is a diminutive membranous entity situated externally to the embryo, serving multiple roles throughout the process of embryonic development. As development progresses, the yolk sac diminishes in size and establishes a ventral connection with the developing embryo through the yolk stalk, which subsequently undergoes regression. The term "yolk stalk" can be used synonymously with several other terms, including the vitelline duct, omphaloenteric duct, or omphalomesenteric duct. The typical diameter of a yolk sac ranges from 3 to 4 mm, expanding in size until approximately the 10th or 11th week of gestation, after which it begins to diminish. Ultrasonographic assessment of the yolk sac is advantageous for confirming an intrauterine pregnancy and for predicting gestational outcomes by evaluating its morphology, dimensions, and internal characteristics.^{3, 4} Hence; the present study was conducted with the assessing yolk sac

diameter and morphology as a predictor of pregnancy outcome.

Materials & methods

The present study aimed of evaluating yolk sac diameter and morphology as a predictor of pregnancy outcome. Intrauterine singleton pregnancy of seven to ten weeks of gestation and who wished to continue pregnancy were included. A total of 60 patients participated in the study. In addition to sonographic data, various demographic and medical factors were documented, including participants' age, gravida status, menstrual regularity, date of the last menstrual period, history of previous abortions, existing medical conditions, and personal habits such as smoking and alcohol consumption. Hemoglobin levels, platelet counts, and urine microscopy results were also recorded. Participants who did not attend the follow-up scan were excluded from the analysis. Measurements exceeding two standard deviations for yolk sac diameter, crown-rump length, or gestational sac size were deemed abnormal. The sensitivity and specificity of abnormal yolk sac diameter in predicting adverse pregnancy outcomes were subsequently calculated. All the results were recorded in Microsoft excel sheet and were subjected to statistical analysis using SPSS software. Univariate analysis was done for evaluation of level of significance.

Results

A total of 60 subjects were evaluated. Mean age of the patients was 28.6 years. Among these 60 patients, 5 patients, 12 patients, 10 patients, 16 patients and 17 patients were of 6th week, 7th week, 8th week, 9th week and 10th week of gestation. Mean YSD among patients of 7th week, 8th week, 9th week and 10th week was 4.83 mm, 5.26 mm, 5.47 mm and 5.63 mm respectively. Pregnancy outcome was abnormal in 10 patients.

According to YSD, abnormal pregnancy outcome was seen in 12 patients. At 6th week, sensitivity and specificity of YSD for assessing abnormal pregnancy outcome was 95.4% and 55.8% respectively. At 7th week, sensitivity and specificity of YSD for assessing abnormal pregnancy outcome was 97.3% and 52.7% respectively. At 8th week, sensitivity and specificity of YSD for assessing abnormal pregnancy outcome was 89.7% and 68.2% respectively. At 9th week, sensitivity and specificity of YSD for assessing abnormal pregnancy outcome was 94.5% and 52.7% respectively. At 10th week, sensitivity and specificity of YSD for assessing abnormal pregnancy outcome was 90.4% and 52.7% respectively. Overall, sensitivity and specificity of YSD for assessing abnormal pregnancy outcome was 92.3% and 55.4% respectively. At 6th week, sensitivity and specificity of Yolk sac morphology for assessing abnormal pregnancy outcome was 91.3% and 59.5% respectively. At 7th week, sensitivity and specificity of Yolk sac morphology for assessing abnormal pregnancy

outcome was 95.8% and 58.4% respectively. At 8th week, sensitivity and specificity of Yolk sac morphology for assessing abnormal pregnancy outcome was 91.3% and 58.9% respectively. At 9th week, sensitivity and specificity of Yolk sac morphology for assessing abnormal pregnancy outcome was 92.8% and 59.3% respectively. At 10th week, sensitivity and specificity of Yolk sac morphology for assessing abnormal pregnancy outcome was 96.8% and 57.5% respectively. Overall, sensitivity and specificity of Yolk sac morphology for assessing abnormal pregnancy outcome was 95.3% and 58.4% respectively.

Table 1: YSD at different gestational age

Gestational age (weeks)	Number	Mean (mm)	SD
6 th	5	4.23	0.37
7 th	12	4.83	0.42
8 th	10	5.26	0.48
9 th	16	5.47	0.56
10 th	17	5.63	0.59
Total	60	5.28	0.55

Table 2: YSD in relation to pregnancy outcome

YSD	Outcome		Total
	Normal	Abnormal	
Normal	45	3	48
Abnormal	5	7	12
Total	50	10	60

p-value	0.0012 (Significant)
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Table 3: YSD in predicting pregnancy outcome by gestational age

Gestational age (weeks)	Sensitivity (%)	Specificity (%)
6 th	95.4	55.8
7 th	97.3	52.7
8 th	89.7	68.2
9 th	94.5	52.7
10 th	90.4	52.7
Overall average	92.3	55.4

Graph 1: YSD in predicting pregnancy outcome by gestational age

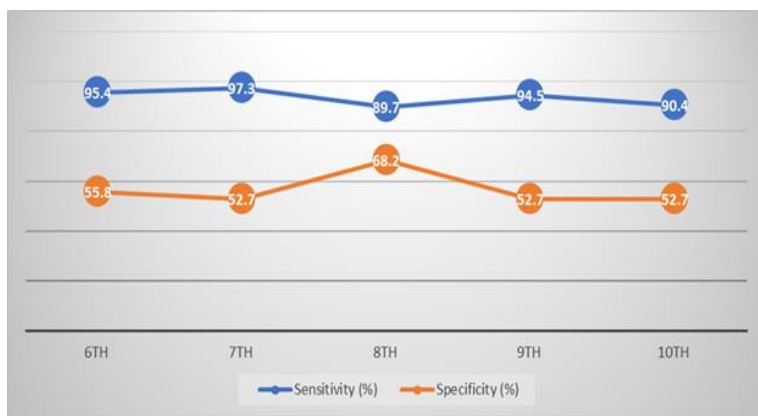


Table 4: Yolk sac morphology

Yolk sac morphology	Number	Percentage
Regular shape	51	85
Irregular shape	9	15
Total	60	100

Table 5: Yolk sac morphology in relation to pregnancy outcome

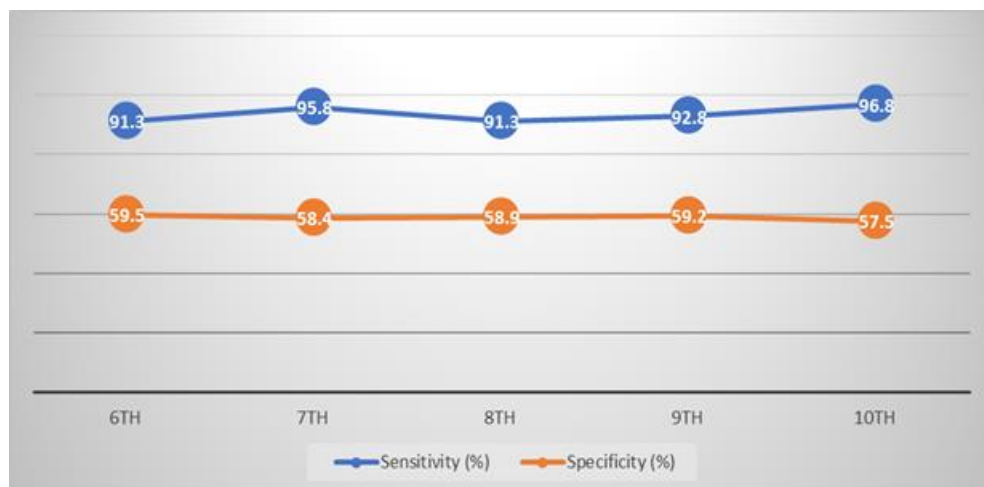
Yolk sac morphology	Outcome		Total
	Normal	Abnormal	
Regular shape	45	6	51
Irregular shape	5	4	9
Total	50	10	60
p-value	0.002 (Significant)		

Table 6: Yolk sac morphology in predicting pregnancy outcome by gestational age

Gestational age (weeks)	Sensitivity (%)	Specificity (%)
6 th	91.3	59.5

7 th	95.8	58.4
8 th	91.3	58.9
9 th	92.8	59.2
10 th	96.8	57.5
Overall average	95.3	58.4

Graph 2: Yolk sac morphology in predicting pregnancy outcome by gestational age



Discussion

The term "pregnancy" refers to the biological process in which an embryo or fetus, or multiple offspring, develops within a woman's uterus. Throughout this period, the expectant mother undergoes a variety of physical, physiological, and biochemical transformations. Some of these alterations are temporary, while others persist for a defined duration even if the pregnancy is interrupted, and many may become permanent. The physiological adaptations associated with pregnancy are typical responses to the developing fetus. In order to nurture and accommodate the growing fetus, the pregnant individual experiences significant morphological and physiological modifications. These changes affect every organ system in the body and commence shortly after conception.^{5, 6} The yolk sac represents the earliest extra-uterine organ to develop in the evolutionary timeline. In marsupials, the yolk sac, which lacks yolk, remains present

throughout gestation, whereas in placental mammals, it undergoes its developmental processes during the initial phases of embryogenesis. Furthermore, it has been observed that throughout evolution, the allantois has diminished in its nutritional and respiratory roles, yet it continues to serve a crucial function as a storage site for metabolic byproducts. The yolk sac is the initial structure that can be detected via sonography within the gestational sac. Its size expands from 8 to 11 weeks of gestation before subsequently diminishing. At a gestational age of 5 to 10 weeks, the typical diameter of a yolk sac measures approximately 6 mm. A diameter exceeding 6 to 7 mm is linked to a heightened risk of adverse obstetric outcomes, including spontaneous miscarriage or fetal anomalies.^{7, 8} Hence; the present study was conducted with the assessing yolk sac diameter and morphology as a predictor of pregnancy outcome.

A total of 60 subjects were evaluated. At 6th week, sensitivity and specificity of YSD for assessing abnormal pregnancy outcome was 95.4% and 55.8% respectively. At 7th week, sensitivity and specificity of YSD for assessing abnormal pregnancy outcome was 97.3% and 52.7% respectively. At 8th week, sensitivity and specificity of YSD for assessing abnormal pregnancy outcome was 89.7% and 68.2% respectively. At 9th week, sensitivity and specificity of YSD for assessing abnormal pregnancy outcome was 94.5% and 52.7% respectively. At 10th week, sensitivity and specificity of YSD for assessing abnormal pregnancy outcome was 90.4% and 52.7% respectively. Overall, sensitivity and specificity of YSD for assessing abnormal pregnancy outcome was 92.3% and 55.4% respectively. Similar to our study, Bhattarai A et al evaluated yolk sac diameter as a predictor of first trimester pregnancy outcome. A total of 80 cases were included in the study, revealing a notable positive correlation between yolk sac diameter and gestational age. The analysis indicated that an abnormal yolk sac diameter, regardless of the gestational age, exhibited a sensitivity of 92.95%, a specificity of 66.66%, a positive predictive value of 95.6%, and a negative predictive value of 54.54% in forecasting adverse pregnancy outcomes.⁹ Vandana V et al, in another previous study evaluated the size of yolk sac as a predictor of pregnancy outcome. A total of 80 cases were included in the study, revealing a notable positive correlation between yolk sac diameter and gestational age. The analysis indicated that an abnormal yolk sac diameter, regardless of the gestational age, exhibited a sensitivity of 92.95%, a specificity of 66.66%, a positive predictive value of 95.6%, and a negative predictive value of 54.54% in forecasting adverse pregnancy outcomes.¹⁰

In the present study, at 6th week, sensitivity and specificity of Yolk sac morphology for assessing abnormal pregnancy outcome was 91.3% and 59.5% respectively. At 7th week, sensitivity and specificity of Yolk sac morphology for assessing abnormal pregnancy outcome was 95.8% and 58.4% respectively. At 8th week, sensitivity and specificity of Yolk sac morphology for assessing abnormal pregnancy outcome was 91.3% and 58.9% respectively. At 9th week, sensitivity and specificity of Yolk sac morphology for assessing abnormal pregnancy outcome was 92.8% and 59.3% respectively. At 10th week, sensitivity and specificity of Yolk sac morphology for assessing abnormal pregnancy outcome was 96.8% and 57.5% respectively. Overall, sensitivity and specificity of Yolk sac morphology for assessing abnormal pregnancy outcome was 95.3% and 58.4% respectively. In a similar study conducted by Shah et al, authors assessed the role of yolk sac diameter as a predictor of pregnancy outcome. In a cohort of 117 cases with favorable outcomes, it was observed that 91.5% exhibited a normal yolk sac diameter, while 8.5% presented with an abnormal yolk sac diameter during the initial examination. Conversely, among the 33 cases categorized as having poor outcomes, 12.1% were identified with a normal yolk sac diameter, whereas 87.9% displayed an abnormal yolk sac diameter at the first visit. The study concluded that the sensitivity of a normal yolk sac diameter in predicting a good outcome is 91.45%, while the specificity of an abnormal yolk sac diameter in forecasting a poor outcome is 87.88%.¹¹ The value of yolk sac size and shape for prediction of pregnancy outcome in the first trimester was assessed in a previous study conducted by Suguna B et al. Out of a total of 500 cases, 8 were lost to follow-up, and YS was not present in 14 cases, 8 of which were classified as

anembryonic pregnancies. Consequently, 478 out of the 492 cases that were followed up were examined for the shape and size of the yolk sac and their correlation with pregnancy outcomes. The presence of an abnormal yolk sac shape demonstrated a sensitivity of 87.06% and a specificity of 86.5%. Additionally, it exhibited a positive predictive value (PPV) of 58.2% and a negative predictive value (NPV) of 96.8% in forecasting adverse pregnancy outcomes when compared to yolk sac diameter.¹² Küçük T et al calculated the correlation coefficients between yolk sac and menstrual age, yolk sac and crown-rump length and between yolk sac and mean gestational yolk sac diameter as $r: 0.9581$ ($p < 0.001$), $r: 0.9427$ ($p < 0.0001$) and $r: 0.8855$ ($p < 0.0001$), respectively. Out of 250 cases examined, 219 experienced a typical pregnancy trajectory up to the conclusion of the first trimester (Group I), whereas 31 cases were associated with adverse outcomes, including abortion or embryonic demise (Group II). The presence of an abnormal yolk sac morphology was found to be predictive of unfavorable pregnancy outcomes, demonstrating a sensitivity of 29%, a specificity of 95%, a positive predictive value of 47%, and a negative predictive value of 90.5%. The authors concluded that the assessment of the secondary yolk sac serves as a significant instrument for forecasting pregnancy outcomes.¹³

Conclusion

The assessment of yolk sac diameter and morphology during the sixth to tenth weeks of gestation serves as a predictive indicator for first trimester pregnancy outcomes. This information is valuable for healthcare providers when advising pregnant women about the potential risks of adverse outcomes and the necessity for subsequent ultrasonographic evaluations.

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