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Risk prediction of placenta previa based on the distance from the lower edge of the gestational sac to the internal cervical os in early pregnancy

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ABSTRACT

Objectives: To explore the relationship between the distance from the lower edge of the gestational sac to the internal cervical os in early pregnancy and placenta previa.

Material and methods: A prospective cohort study of women who underwent pregnancy examination in Weifang People's Hospital or Sunshine Union Hospital from January 2020 to June 2021. The distance from the lower edge of the gestational sac to the internal cervical os was measured at 5–6 weeks' gestation. There were 86 women with distance < 2.5 cm, and 105 women with distance ≥ 2.5 cm were randomly selected. There were 92 cases of scarred uterus and 99 cases of non-scarred uterus among the 191 women. They were divided into six groups according to the distance: (1) < 1.0 cm; (2) 1.0 cm to < 1.5 cm; (3) 1.5 cm to < 2.0cm; (4) 2.0 cm to < 2.5 cm; (5) 2.5 cm to < 3.0 cm; (6) ≥ 3.0 cm. All included women were followed-up during pregnancy and pregnancy outcome, and the likelihood ratio of different distances in

early pregnancy was calculated and risk stratification was performed, and ROC curve was constructed.

Results: There were 15 women in the included studies who were lost to follow-up, 47 had a scarred uterus with placenta previa and 29 had a non-scarred uterus with placenta previa after delivery at 28 weeks or later. The distance from the lower edge of the gestational sac to the internal cervical os in early pregnancy of the scarred uterus < 1.5 cm, and the likelihood ratio was ∞ ; and the distance ≥ 3.0 cm, the likelihood ratio was 0. The distance from the lower edge of the non-scarred gestational sac to the internal cervical os < 1.0 cm, and the likelihood ratio was ∞ ; and the distance ≥ 3.0 cm, the likelihood ratio was 0. The ROC curve showed that when the area AUC under the curve was 87%, the optimal diagnostic cut-off value was 2.4 cm.

Conclusions: When the distance from the lower edge of the gestational sac to the internal cervical os was < 1.5 cm and the distance between the non-scarred uterus was < 1.0 cm, it eventually developed into placenta previa; the distance from the lower edge of the gestational sac to the internal cervical os in the first trimester of pregnancy between the scarred uterus and the non-scarred uterus was ≥ 3.0 cm, and it would hardly develop into placenta previa. When the distance from the lower edge of the gestational sac to the internal cervical os in early pregnancy was ≤ 2.4 cm, it could be used as a predictor of placenta previa.

Key words: early pregnancy; lower edge of the gestational sac; internal cervical os; placenta previa

INTRODUCTION

Placenta previa is an important cause of antenatal and postpartum hemorrhage and placenta accreta spectrum, there can even be serious surgical complications such as laceration of the urinary bladder, intestinal or vascular trauma [1]. And it also increases adverse fetal and neonatal outcomes, with the incidence of placenta previa occurring in about 5 in 1000 [2, 3], which has increased in recent years. The increase in cesarean delivery, assisted reproductive technology, multiple births, and elective pregnancy terminations are major risk factors for the development of placenta previa [4]. Early prediction of placenta previa allows pregnant

women to choose between expectant management and termination of pregnancy, reducing surgical complications. The main purpose of this study is to explore the distance from the lower edge of the gestational sac to the internal cervical os and the risk prediction of placenta previa in early pregnancy, to provide early intervention for pregnant women at risk of placenta previa and improve the prognosis.

Objectives

The prospective cohort study analyzed women who underwent antenatal care at Weifang People's Hospital or Sunshine Union Hospital from January 2020 to June 2021. Inclusion criteria: (1) Complete ultrasound data and good image quality; (2) Singleton pregnancies. Exclusion criteria: (1) Incomplete ultrasound data or poor image quality; (2) Twin or multiple pregnancies; (3) Congenital Uterine Malformation by Experts; (4) History of adenomyosis.

MATERIAL AND METHODS

Study design and population

Patients were included in the study if they had a known conception date, their transvaginal ultrasound at 5–6 weeks' gestation conducted and all the included women were followed-up during pregnancy and pregnancy outcome. Before ultrasound, the pregnant woman emptied the bladder, taken in a supine lithotomy position, and placed the probe in the vagina to clearly show the position of the uterus, the gestational sac, and the internal cervical os. The distance from the lower edge of the gestational sac to the internal cervical os during early pregnancy was measured, repeated three times, and the average value was taken. When performing more than one transvaginal ultrasound in the first trimester, the examination of the gestational sac where the first observation is performed is selected for retrieval. And recorded the woman's age, prior deliveries, body mass index (BMI), history of pre-pregnancy diabetes, chronic hypertension, uterine leiomyoma, etc.

Data collection

For the purposes of this study and referral to the previous findings of Naji et al [5], we measured 86 women with a distance of < 2.5 cm from the lower edge of the gestational sac to

the internal cervical os at 5–6 weeks' gestation, and randomly selected 105 women with a distance of ≥ 2.5 cm. The patients enrolled were divided into the scarred uterus (92 patients) and the non-scarred uterus (99 patients) according to the existence or absence of a uterine scar, and were divided into six groups according to distance: (1) < 1.0 cm; (2) 1.0 cm to < 1.5 cm; (3) 1.5 cm to < 2.0 cm; (4) 2.0 cm to < 2.5 cm; (5) 2.5 cm to < 3.0 cm; (6) ≥ 3.0 cm.

Ethical compliance

All clinical investigations were conducted according to the principles expressed in the Declaration of Helsinki.

Statistical analysis

All data were statistically analyzed using SPSS 26.0. The statistical data were expressed as composition ratio or rate (%) and compared with χ^2 test; The measurement data were tested with nonparametric Kruskal-Wallis H. For different ranges of overlap the corresponding multilevel likelihood ratios were calculated. Plot receiver operating curve (ROC) curves. A p value of < 0.05 was considered to indicate statistical significance.

RESULTS

There was a statistically significant difference in the age and pre-pregnancy diabetes among women at different distances ($p < 0.05$), and there was no statistically significant difference in the comparison of prior deliveries, BMI, Chronic hypertension mellitus and uterine leiomyoma among women at different distances ($p > 0.05$) (Tab. 1).

We included a total of 191 women, and there were 15 cases of loss to follow-up on pregnancy and pregnancy outcomes for all included women, 47 cases of the scarred uterus with placenta previa delivered at 28 weeks or later, and 29 cases of the non-scarred uterus with placenta previa. The incidence of placenta previa in women with different distances in the scarred uterus and the non-scarred uterus were statistically significant ($p < 0.001$), and with the decrease of distance, the incidence of placenta previa gradually increased (the scar uterus 0%, 38.5%, 78.1%, 80%, 100%, 100%, the non-scar uterus 0%, 22.7%, 56%, 62.5%, 75.0%, 100%), the same distance range of the scarred uterus was more likely to occur

placenta previa. The diagnostic criteria for placenta previa are that the lower edge of the placenta adjoins or covers the internal cervical os after 28 weeks' gestation [5] (Tab. 2).

In the scarred uterus, when the distance from the lower edge of the gestational sac to the internal cervical os ≥ 3.0 cm in the early pregnancy, the likelihood ratio of 0, indicated that placenta previa would not develop in the third trimester; when the distance < 1.5 cm, the likelihood ratio of ∞ , indicated that this was a high-risk group and would develop placenta previa in the third trimester. In the non-scarred uterus, a likelihood ratio of 0 when the distance ≥ 3.0 cm that placenta previa would not develop in the third trimester; and a likelihood ratio of ∞ at a distance < 1.0 cm indicated that this was a high-risk group and would develop placenta previa in the third trimester (Tab. 3).

The ROC curve showed that when the area AUC under the curve was 87.0% (95% CI: 81.9–92.7%, $p < 0.001$), the best diagnostic cut-off value was 2.4 cm, and its sensitivity and specificity were 82.9% and 80%, it suggesting that the distance from the lower edge of the gestational sac to the internal cervical os in early pregnancy ≤ 2.4 cm, which could be used as a predictor of placenta previa (Fig. 1).

DISCUSSION

Placenta previa is a serious obstetric complication, which can cause severe prenatal and postpartum hemorrhage, often complicated by placenta accreta spectrum, damage to surrounding organs, and seriously endanger maternal life; The fetus may experience distress, intrauterine hypoxia, even at birth in preterm, low birth weight or congenital defects, with high neonatal mortality [6]. In 2020, [Obstetrics Subgroup, Chinese Society of Obstetrics and Gynecology, Chinese Medical Association](#) pointed out that with the increase in the number of cesarean section, the incidence of placenta previa will also increase, and pregnant women with a history of cesarean section are the main risk factors for the development of placenta previa [7, 8]. In a systematic review and meta-analysis, the incidence of placenta previa increased from 10 per 1000 for one cesarean delivery to 28 per 1000 for three or more cesarean sections, and There was an increased risk of placenta previa and postpartum hemorrhage in pregnant women whose gestational sac passed through the scar [5, 9].

With the increasing incidence of placenta previa, prenatal risk assessment and diagnosis are critical. Studies had indicated that when the distance from the placenta margin to the internal cervical os was less than 15 mm at 12–20 weeks' gestation, the probability of diagnosis of placenta previa at term was 5–5.1%, while the probability of diagnosis of placenta previa at term was 95% for the placenta covering the internal cervical os with a distance greater than 25 mm [10]. However, due to placental migration, the mechanism of placenta previa formation and resolution was unknown, with 10% of placenta previa resolving before 28 weeks' gestation, 31.4% before 32 weeks' gestation, and 62.9% before 36 weeks' gestation [11]. However, previous reported on ultrasonic diagnosis of placenta previa and other placental abnormalities differ greatly, mainly because abnormal placenta in the second and third trimesters of pregnancy might be affected by fetal limbs, amniotic fluid volume, placenta attachment site and other factors. Therefore, the study on the relationship between ultrasound and placenta previa in early pregnancy is of certain significance for the early prenatal diagnosis of placenta previa.

In our study, the likelihood of eventual placenta previa increased as the distance from the lower edge of the gestational sac to the internal cervical os decreased during early pregnancy. This was consistent with the study of Li et al. [12] who found the incidence of placenta previa increased as the distance from the lower end of the hyperechoic trophoblast of the gestational sac to the hypoechoic caesarean scar in the sagittal plane decreased. Happeet et al. [13] conducted transvaginal ultrasound examination on pregnant women with low-implanted suggested by ultrasound in early pregnancy and found that pregnant women with scarred uterus had an increased risk of placenta previa when pregnancy sac was low-implanted and basement membrane covered the internal cervical os.

In our study, risk stratification was conducted between women with scarred uterus and women with non-scarred uterus according to the distance from the lower edge of the gestational sac to the internal cervical os at 5–6 weeks' gestation. When the distance of women with scarred uterus < 1.5 cm or women with non-scarred uterus < 1.0 cm, it indicated a high risk, indicated that all women would develop placenta previa in the third trimester, and even women with scarred uterus might develop pernicious placenta praevia. For such women,

maternal and medical personnel can be better equipped to make decisions and manage whether to continue pregnancy. According to statistics, 20% to 40% of cases of placenta previa would have a large amount of vaginal bleeding in early pregnancy. Early prediction can ensure adequate preoperative preparation and the presence of a senior physician for abortion. Pregnant women with placenta previa often have prenatal, intrapartum or postpartum hemorrhage, which is an independent risk factor for hemorrhagic diseases in pregnant women. There were 20% emergency delivery due to prenatal hemorrhage, 2% needed hysterectomy due to uncontrollable bleeding [14], and pernicious placenta praevia was often combined with placenta accreta spectrum, and the hemorrhage after delivery was difficult to control, which had become the main cause of obstetric bleeding and hysterectomy at present [15]. Therefore, if expectant management is chosen, we need to follow up these women closely, refer them if necessary, increase the number of prenatal check-ups, and provide more detailed assessment by combined use of transabdominal and transvaginal ultrasound [16], so that clinicians can more accurately determine the location and type of placenta previa during clinical treatment of placenta previa. Choose multidisciplinary collaboration to reduce surgical complications and mortality. When the distance between the lower edge of the gestational sac to the internal cervical os ≥ 3.0 cm, it indicated that there was no risk, indicated that both scarred and non-scarred women have normal placental position in the third trimester. Unnecessary follow-up could be reduced for such women, and their psychological and economic burden could be reduced. At the same time, according to the ROC curve, we predicted that when the distance between the lower edge of the gestational sac to the internal cervical os ≤ 2.4 cm in early pregnancy, the area under the curve was 85.1%, which could be used as a predictor of placenta previa, so that obstetricians can develop more effective and individualized treatment plans, which had good guiding value for clinical treatment and better treatment of pregnancy. Thus, reducing maternal and fetal morbidity and mortality in pregnancy.

CONCLUSIONS

In conclusion, the distance from the lower edge of the gestational sac to the internal cervical os in early pregnancy has a good predictive value for placenta previa, which can be

interfered with in advance to eliminate placenta previa in early pregnancy, in order to adjust the follow-up of pregnancy, improve maternal and fetal prognosis and pregnancy outcomes. This study was a prospective cohort study, in which the performance of prenatal ultrasound detection of placenta previa was higher than that of retrospective study [17]. By collecting data prospectively, we reduced the possibility of selection bias. However, due to the small number of samples collected, it is impossible to compare pregnant women of the same gestational age, so a large number of samples are needed to continue this study.

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Conflict of interest

The authors report no conflict of interest.

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Characteristics	□ 1.0 cm	1.0 cm	1.5 cm	2.0 cm	2.5 cm	≥ 3.0 cm	H/X^2	p value
	(n = 7)	to □ 1.5 cm (n = 8)	to □ 2.0 cm (n = 18)	to □ 2.5 cm (n = 57)	to □ 3.0 cm (n = 35)	(n = 51)		
Age [years], $\bar{x} \pm s$	33.7 ± 3.3	32.9 ± 3.8	31.4 ± 3.5	32.4 ± 4.3	33.1 ± 4.0	30.1 ± 4.9	13.394	0.020
Prior	2.0 ± 0.6	3.0 ± 0.5	1.4 ± 0.6	0.4 ± 0.7	1.7 ± 0.6	1.5 ± 0.5	9.530	0.090

deliveries, $x \pm s$

BMI [kg/m²] $x \pm s$ 23.9 ± 24.9 ± 22.4 ± 22.7 ± 23.1 ± 22.2 ± 6.454 0.264
2.8 4.5 2.6 3.4 2.3 2.3

± s

Pre-pregnancy 1 (14.3) 1 (12.5) 3 (16.7) 1 (1.8) 2 (5.7) 1 (2.0) 9.527 0.042

diabetes, n (%)

Chronic 1 (14.3) 1 (12.5) 4 (22.2) 4 (7.0) 2 (5.7) 5 (9.7) 4.927 0.351

hypertension, n

(%)

uterine 2 (28.6) 1 (12.5) 1 (5.6) 3 (5.3) 2 (5.7) 4 (7.8) 5.135 0.326

leiomyoma,

n(%)

Table 1. Clinical characteristics

BMI — body mass index

Table 2. Pregnancy outcomes for women at different distances

Pregnancy outcomes	□ cm	1.0 cm to □ 1.5 cm		1.5 cm to □ 2.0 cm		2.0 cm to □ 2.5 cm		2.5 cm to □ 3.0 cm		≥ 3.0cm	H	p value
		(n = 7)	(n = 8)	(n = 18)	(n = 57)	(n = 35)	(n = 51)					
Scar uterus	1.0 ± 0.0	1.0 ± 0.0	0.8 ± 0.4	0.8 ± 0.4	0.4 ± 0.5	0.0 ± 0.0	25.	□	3	0.00	1	
Totals (n)	5	4	10	32	13	7						
Placenta previa, n (%)	5 (100)	4 (100)	8 (80)	25 (78.1)	5 (38.5)	0(0)						
Non-scar uterus	1.0 ± 0.0	0.8 ± 0.5	0.6 ± 0.5	0.6 ± 0.5	0.2 ± 0.4	0.0 ± 0.0	41.	□	33	0.00	1	
Totals (n)	2	4	8	25	22	44						
Placenta previa, n (%)	2 (100)	3 (75)	5 (62.5)	14 (56)	5 (22.7)	0 (0)						

Table 3. Multilevel likelihood ratios for different ranges of distances

LR — ??

Distance range	Scar uterus			Non-scar uterus		
	Placenta previa	Non-placenta previa	LR	Placenta previa	Non-placenta previa	LR
< 1.0 cm	5	0	∞	2	0	∞
1.0 cm to < 1.5 cm	4	0	∞	3	1	7.9
1.5 cm to < 2.0 cm	8	2	2.0	5	3	4.4
2.0 cm to < 2.5 cm	25	7	1.8	14	11	3.3
2.5 cm to < 3.0 cm	5	8	0.3	5	17	0.8
≥ 3.0 cm	0	7	0	0	44	0
Totals	47	24		29	76	

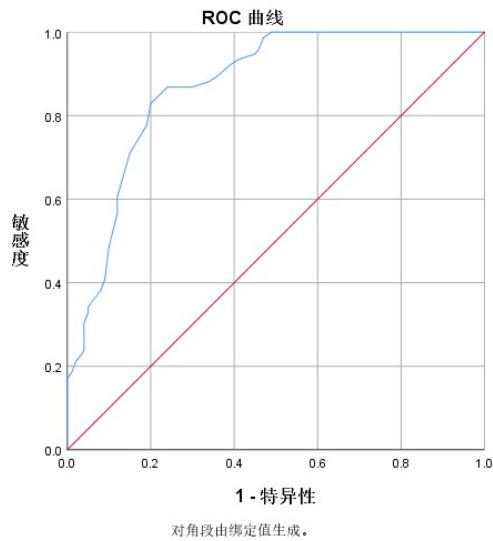


Figure 1. Receiver operating curve (ROC) analysis of the prediction of placenta previa from the lower edge of the gestational sac to the internal cervical os in early pregnancy

