Original Article

Role of Uterine Artery Doppler in Second Trimester in Predicting Adverse Pregnancy Outcome

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Abstract

Aim of the Study: The uterine artery Doppler has potentials for screening for complications of impaired placentation like preeclampsia and adverse fetal outcomes. The purpose of this study was to determine the role of uterine artery Doppler flow velocimetry at 2nd trimester of pregnancy in the early prediction of complications of impaired placentation and elucidate it's role in stratifying antenatal care. *Methods:* This prospective study was carried out in the department of obstetrics and gynaecology and radiodiagnosis in Government Rajaji Hospital, Madurai. This study includes 183 pregnant women from January 2016 to January 2017 whose uterine artery resistive index and presence of notching was noted between 20-24 weeks of pregnancy. R.I>0.6 and presence of diastolic notch in the uterine artery was considered abnormal. *Results:* out of 183 recruited cases 141 were lowrisk and 42 cases were high risk for developing preeclampsia, IUGR, SGA, preterm. Out of 141 low risk cases, 130 had normal doppler and 11 had abnormal doppler. Out of 42 high risk cases 27 had normal Doppler and 15 had abnormal doppler. dmong the patients having abnormal doppler study (including high risk and lowrisk patients) developedpreeclampsia and 8 developed adverse fetal outcome. *Conclusion*: Doppler velocimetry of uterine artery in 2nd trimester of pregnancy can be used as a screening test for complication of abnormal placentation in high risk patients when compared to low risk patients.

Introduction

The complications of impaired placentation are significant contributors of maternal and perinatal mortality and morbidity in both developing and developed countries. Despite advances in medical research, reliable screening test for prediction of this adverse complications is still lacking. A large number of researches have investigatedthe potential of 2nd trimester uterine artery doppler studies as a screening tool for these complications.

Pregnancies affected by the complications of impaired placentation such as preeclampsia, IUGR and preterm have shown to demonstrate increased impedence in the spiral artery [1] .The spiral artery,the major continuation of the uterine artery undergoes trophoblastic invasion during pregnancy .This physiological process is characterised by loss of the musculoelastic properties and its conversion to the uteroplacental arteries which allows an increased blood flow to the placenta and the fetus. This physiological process commences in the first trimester and ends in early second trimester. Second trimester doppler is usually performed between 20th and 24th weeks of pregnancy,when it is expected that the physiological process would have been completed.

The impairment or complete absence of the physiological process is associated with increased vascular resistance and increased impedance to blood flow and ultimately

affect blood flow into the placenta. The sequence of events precede the onset of complications [2] . The effect of abnormal trophoblastic invasion is derived from studies on uterine artery because the uterine artery provides a good representation of the sum of the resistance of placental bed and of the placental perfusion. Doppler flow studies of the uterine artery therefore provides an accurate means of assessing uteroplacental resistance to blood flow and good method of assessing impairment or absence of uteroplacental blood flow.

So this study is intended to study this validity of uterine artery doppler sonography to predict preeclampsia and adverse fetal outcomes and to allow judicious allocation of resources for monitoring and treatment to improve maternal and perinatal outcomes.

Materials and Methods

This study is a prospective study done during aperiod of 1year from January 2016 to January 2017 at the Department of Obstetrics and Gynaecology andRadiodiagnosis at Government Rajaji hospital, Madurai were recruited into the study. Inclusion criteria being any pregnant women irrespective of age and parity. Women with multiple pregnancies, anomalous babies and pregnancies complicated by placenta previa were excluded from the study.

The patients after being recruited into this study were categorised as high risk and low risk depending on presence or absence of any high risk factor for developing preeclampsia, SGA/IUGR, preterm. In all patients adetailed history,the presence of high risk factor such as history of hypertension, diabetes, chronic renal failure, SLE, history regarding previous

pregnancy outcome was obtained. Complete general and obstetric examination was done. Routine biochemical investigations were done. Ultrasound and doppler study were done between 22-24 weeks of gestation. All patients during their visits were examined for edemalegs, weight, bloodpressure and symphysiofundal height.

Those with increased resistance index (R.I) or presence of early diastolic notch were advised to attend antenatal clinic once in 15 days. Neverthless all patients were followed with antenatal check up with specific references to the variables indicating development of preeclampsia and SGA/IUGR like bloodpressure, urineprotein, uterine fundal height. Relevant biochemical investigations if they developed preeclampsia were done.

Transabdominal uterine artery Doppler was done using curvilinear probe by locating the uterine artery at uterocervical junction where it appears to cross the external iliac artery on both sides.

Resistance Index Calculated Using the Formula

RI=peak systolic velocity-peak diastolic velocity/ peak systolic velocity

R.I above 95th percentile (0.6) and presence of diastolic notch unilateral or bilateral was taken as abnormal.

Results

In this study of 183 randomly selected patients 144 had no risk factors and 39 patients had high risk for developing preeclampsia, IUGR, preterm. During the course of study 3 developed gestational diabetes and were included in high risk group. So 141 (77%) were in low risk group and 42(23%) in high risk group.

Table 1: High risk factors

Serial number	Risk factors	Number of patients
1.	Previous h/o PIH	16
2.	Previous h/o SGA / IUGR	7
3.	Previous h/o PRETERM	8
4.	BOH	6
5.	ELDERLY PRIMI	5
6.	CHRONIC HYPERTENSION	1
7	GESTATIONAL DIABETES	3
	Total	43

Table 2: Doppler findings in unselected population

	Abnormal Doppler	Normal Doppler	Total
High Risk	15	27	42
Low Risk	11	130	141
Total	26	157	183

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In our unselected population, 26 had abnormal doppler findings constituting 14.3% of the total while 85.7% had normal doppler findings. Among high risk alone 15 of 42 patients 35%) had abnormal doppler and 141(7.8%) had abnormal doppler.

In our study ,15 patients 7.6% of this total patients (183) developed pre eclampsia. The prevalence of preeclampsia in high risk being 21.4% (9 of 42) and in low risk 4.2% (6 of 141) developed preeclampsia.

Adverse fetal outcome occurred in 6.5% (12 of 183 patients) in our study. When considering the high risk alone, this prevalence was 19%,whereas it was 2.8% among this low risk.

Among the low risk patients having normal doppler 3.8% developed preeclampsia and 1.5% developed adverse fetal outcome. 11cases had abnormal doppler among the low risk cases. Among them 9.09% developed preeclampsia and 18.8% developed adverse fetal outcome.

Among the high risk cases 15 had abnormal findings out of which 46.6% developed preeclampsia and 46.6% developed adverse fetal outcome. While among the 27 high risk cases with normal doppler 7.4% and 3.7% developed preeclampsia and adverse fetal outcome respectively.

42.8% of the patients developed preeclampsia i.e, 6 of the 15 patients between the gestational age of 32-36 weeks . Early onset cases had significant doppler findings and associated with higher perinatal morbidity and mortality when compared to late onset preeclampsia.
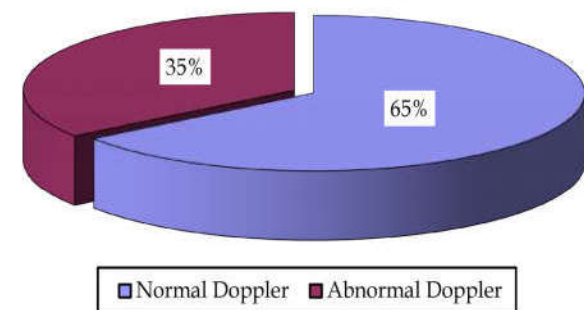

Graph 1: Incidence of high risk and low risk in unselected population
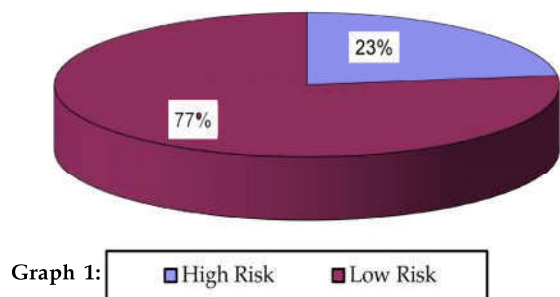
Graph 2: Uterine Artery Doppler Finding In Unselected Population
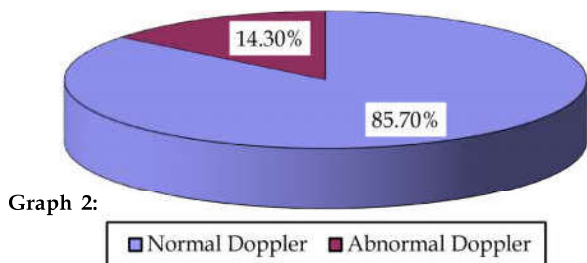
Graph 3: Abnormal Doppler Finding in High Risk Cases

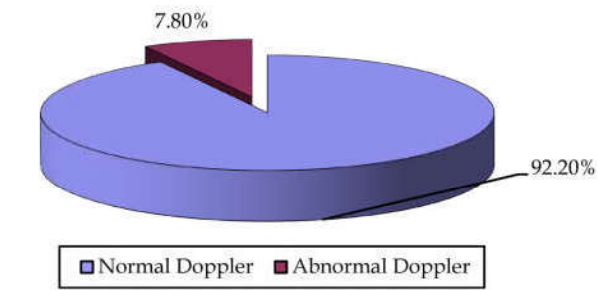Graph 4: Abnormal Doppler Finding in Low Risk Cases

Table 3: Risk factor and adverse outcome –preeclampsia

Risk group	Number of cases	Developed Preeclampsia	Percentage
Low risk	141	6	4.2%
High risk	42	9	21.4%

Table 4: Risk factor and adverse fetal outcome

Risk group Number of patients	SGA	Preterm	Fetal death	Total	Percentage
LOW RISK (n=141)	3	0	1	4	2.8%
HIGH RISK (n=42)	4	3	1	8	19%

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Table 5: Correlation between doppler finding and adverse outcome in low risk population

Doppler findings Number of patients	Number of patients With Preeclampsia	Number of patients With adverse fetal outcome	Total
Normal (n=130)	5 (3.8%)	2 (1.5%)	7
Abnormal (n=11)	1 (9.09)	2 (18.8%)	3
Total	6	4	10

P 0.1588 P> 0.05 Not significant

Table 6: Correlation between doppler finding and adverse fetal outcome in high risk population

Doppler findings Number of patients	Number of patients With Preeclampsia	Number of patients With adverse fetal outcome	Total
Normal (n=27)	2 (7.4%)	1 (3.7%)	3
Abnormal (n=15)	7 (46.6%)	7 (46.6%)	14
Total	9	8	17

P = 1.6 P< 0.05 Significant

Table 7: Gestational age at development of preeclampsia

Gestational age(weeks)	High risk	Low risk
28 to 32	1	1
32 to 36	5	1
36 to 40	3	4

Table 8: Adverse fetal outcome in high risk group

Outcome	Normal Doppler	Abnormal Doppler
Good Outcome	26	8
Adverse Outcome	1	7
Preterm	1	2
SGA/IUGR	1	4
Fetal death	-	1

P 0.0011 P<0.05 Significant.

Table 9: Adverse fetal outcome in low risk group

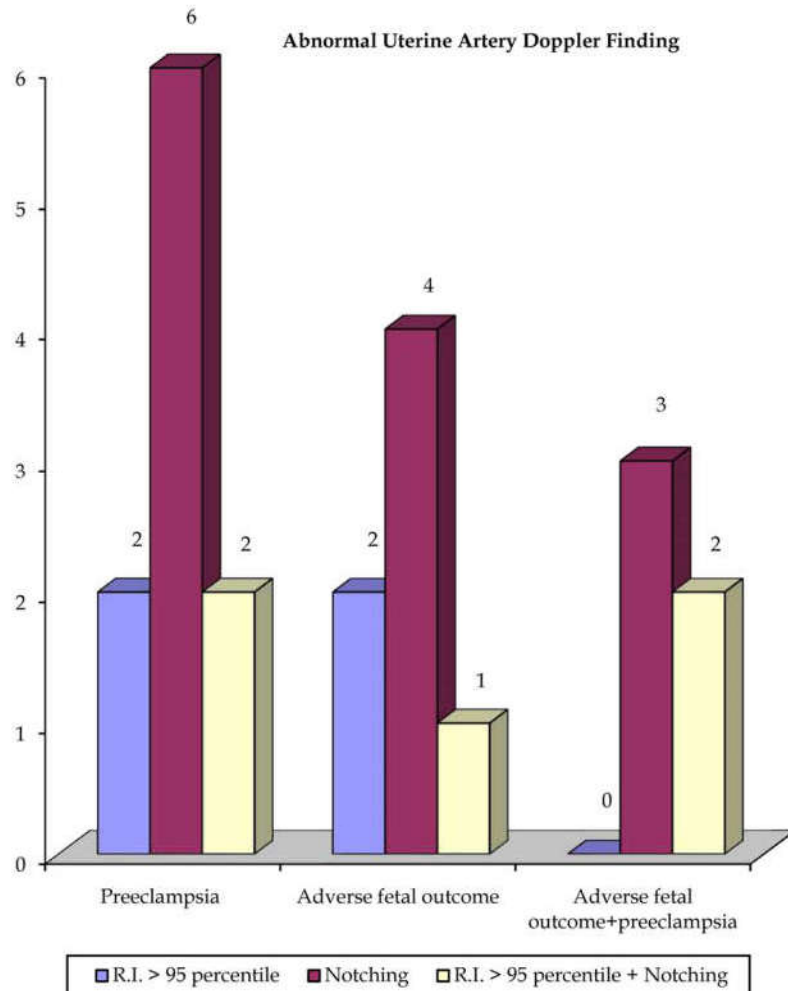| outcome	Normal Doppler	Abnormal Doppler
Good Outcome	128	9
Adverse Outcome	2	2
Preterm	-	-
SGA/IUGR	1	2
Fetal death	1	-

P 0.0880 P >0.05 Not significant

Table 10: Abnormal uterine artery doppler findings

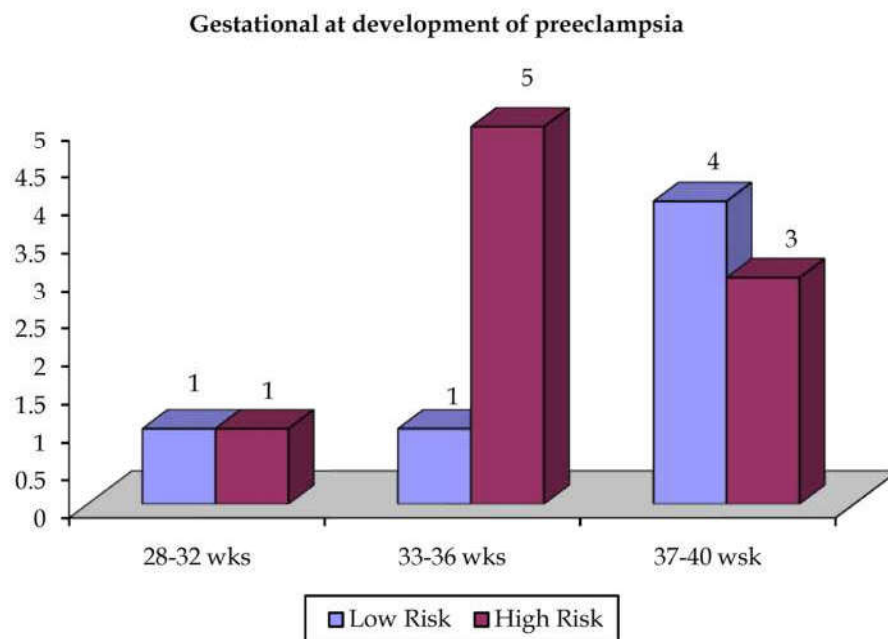| Adverse Outcome	Resistance index >95th centile (0.62)	Notching Unilateral/ bilateral	Resistance index >95th Centile + Notching	Total
PIH	2	6	2	10
Adverse fetal outcome	2	4	1	7
PIH+ Adverse Fetal Outcome	0	3	2	5
Total	4	13	5	22

Table 11: Uterine artery doppler r.i disribution in Adverse outcome

Adverse Outcome	0.38-0.47 series 1	0.48-0.57 series 2	0.58-0.67 series 3	0.68-0.77 series 4	0.78-0.87 series5
PIH (n=10)	0	4	2	3	1
Adverse Fetal outcome (n=7)	0	2	2	2	1
PIH+Adverse Fetal outcome (n=5)	0	0	0	3	2

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Graph 5:

Abnormal Uterine Artery Doppler Finding

Legend: R.I. > 95 percentile — Notching — R.I. > 95 percentile + Notching

Graph 6:

Gestational at development of preeclampsia

Legend: Low Risk — High Risk

Graph 7:

Association of Preeclampsia With Parity
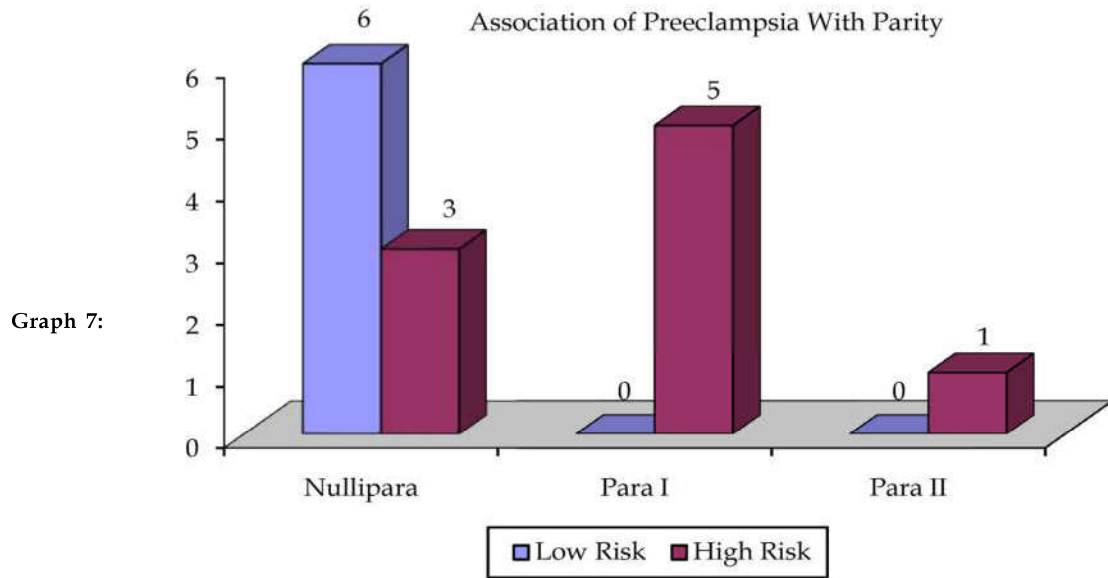
Table 12:

S. No	Preeclampsia	Adverse Fetal Outcomes
Sensitivity	77.78%	87.50%
Specificity	75.76%	76.47%
Positive Predictive Valve	46.67%	46.67%
Negative Predictive Value	92.59%	96.30%

Table 13:

	Preeclampsia	Adverse Fetal Outcome
Sensitivity	16.67%	50%
Specificity	92.59%	93.43%
Positive Predictive Value	10.00%	18.18%
Negative Predictive Value	96%	98.46%

Most of the adversely affected babies had low APGAR (<7 in 5mins) and needed admission in NICU for one or the other reason.

The sensitivity, specificity, positive predictive value and negative predictive value for predicting preeclampsia and adverse fetal outcome in high risk population in our study is shown in Table

The results of uterine artery doppler study for prediction of preeclampsia, adverse fetal outcome in low risk population of our study is given in Table.

Discussion

In the past decades, the prediction of preeclampsia has been attempted by using several maternal assessment methods. In this respect, doppler flow studies of the uteroplacental circulation have been extensively performed since they are easy, inexpensive, non invasive and can be done early in pregnancy.

We chose the 20-24 weeks period to perform the uterine doppler evaluation because the routine anamaly scan is scheduled at 18-20 weeks and placental implantation and trophoblastic invasion is completed by 14-18weeks.

Our study found significant haemodynamic changes evident during second trimester and lower impedance in the uterine artery of normal outcome pregnancies in both high and lowriskgroup , suggesting that lack of normal uteroplacental circulation may predict later development of pregnancy complications. Campbell et all [3] were pioneers in the presentation of data on uteroplacental circulation by means of study of the arcuate arteries with doppler-velocitimetry, having reported that the diastolic notch at second and third trimesters was related to the increase in uteroplacental vascular resistance, IUGR and hypertension.

In our study both R.I and the presence of diastolic notching were used as abnormal doppler findings.

Our study results are similar to the study done by SanjoyBhaltacharyaet al [4] where women were categorized into low risk (77%) and high risk (23%) and Harrington et al[5] where study among unselected population showed low risk [73%] and high risk [27%].

Abnormal doppler findings in unselected population was 14.2%. Study by Kurdew et al [6] showed 23% abnormal findings in unselected population . This variation is mainly due to difference in criteria used to define adverse outcome and may be due to difference in doppler techniques, the population examined etc.

Studies by Coleman et al [7] showed 40% abnormality in doppler among high risk which was similar to our study 35%. Whereas Zimmerman et al [8] showed 24.1%. 7.8% of our low risk patients had abnormal doppler findings while Harrington et al [5] showed 3.9%.

The prevalence of preeclampsiaamonghigh risk in our study was 21.4% whereas Arduini et al [2], Zimmerman et al [8] showed 37% and 18% respectively. Adverse fetal outcome occurred in 2.8% of low risk group while it was 11% for Irion et al [9].

Our study showed 7.8% [11 out of 141] of low risk case having abnormal doppler findings compared to Falk Gurhan et al [10] showing 10.24% . Among the lowrisk patients with normal Doppler 3.8% (Table 4) developed preeclampsia correlating with the study by Falk Gurhan et al (3.4%). 1.5% developed adverse fetal outcomeinpar with them showing 3%.

Among the high risk patients 15 had abnormal doppler (Table 5). Among them 46.6% developed preeclampsia and 46.6% developed adverse fetal outcome in contrast to Harrington et al [5] showing 47% and 53% respectively. 3.7% of the 27 high risk cases with normal doppler developed adverse fetal outcome in contrast to Harrington et al [5] showing 6%.

The sensitivity ,specificity of a abnormal doppler for detecting preeclampsia among high risk cases in our study (Table 12) compared to studies by Sanjoy Bhattacharyya et al [4], 73.3% sensitivity, 86% specificity. The PPV and NPV in high risk is inpar with study of Zimmerman et al [8] showing 43% and 89%. Coleman et al showed the sensitivity, specificity, PPV and NPV for detecting adverse fetal outcome to be 84%, 39%, 33%, 86% which corresponds to the findings in our study (Table 1) except for specificity 39% vs 76.47%.

The results of uterine artery doppler study for prediction of preeclampsia in lowrisk population in our study (Table 13) correlated well with studies of

Irion et all [9][26%,85%,7%,96%] and North et al [11] [27%, 90%, 8%, 97%]. The sensitivity, specificity, PPV and NPV for prediction of adverse fetal outcome in low risk case of our study complies with studies of Irion et al [9] [29%,89%,25%,97%] and North et al [11] [42%, 9%, 27%, 96%].

Conclusion

Abnormal doppler indices were early predictors of fetal compromise and preeclampsia and correlated with adverse perinatal outcome in patients at high risk of developing Preeclampsia, SGA/IUGR and preterm. Observation of the outcome in patients with normal doppler is strongly linked with good neonatal outcome.

Once an abnormal doppler finding is identified then the obstetrician is made well aware of the possible complication that can setin and delivery should be planned in a tertiary care centre with good neonatal care facilities.

Further the risk as determined by the doppler flow allow ultrasound resources and clinical follow up to be tailored to the pregnant women for the most appropriate use of antenatal care. Uterine artery Doppler velocimetry was able to detect 53.3% of cases who subsequently developed preclampsia and 75% of the patients who had adverse fetal outcome.

This study demonstrates the feasibility of defining with some precision an individual risk of severe outcome relating to impaired trophoblastic invasion. This requires a philosophical shift away from the concept of categorizing women simply as high or low risk pregnancies to a level of risk that can instead be quantified.

This study demonstrates that addition of uterine artery doppler waveform analysis to monitoring profile of women at risk of developing Preeclampsia, SGA/IUGR, Preterm can further define those in ahigh risk group and use in determining the type and level of antenatal care offered to them.

The availability of treatment or prevention of this target disorder is an important prerequisite for establishing a screening test. In the case of preeclampsia, this has not been achieved. A considerable amount of research is going on in preventing preeclampsia based on underlying pathophysiology. This scenario may change in future.

In the future, uterine artery screening will probably be combined with biochemical markers of platelet activation or endothelial damage to further improve the screening results.

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