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## Uterine artery resistance index in first trimester and maternal neonatal outcome

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### ABSTRACT

**Objective:** To study the uterine blood flow in early pregnancy, which might provide information about maternal neonatal outcome. **Methods:** Pilot study was undertaken by measuring uterine artery resistance index (UARI) at (10±2) weeks. **Results:** Of study subjects 801 primigravida without past, present obstetric disorder, 307 (38.3%) had mean UARI above 95th centile, 494 (61.7%) below 5th centile. Mean UARI above 95th centile of women had pregnancy problems (foetal growth restriction, hypertensive disorders, placental abruption, oligohydramnios) compared to below 5th centile. Of 307 women with mean UARI above 95th percentile, hypertensive disorders occurred in 53 (17.3%) and 21 (40%) with foetal growth restriction. Of 494 with mean UARI below 5th percentile, 30 (6.1%) developed hypertensive disorders ( $P<0.00006$ ), 4 (13.3%) had FGR ( $P<0.00006$ ). Placental abruption, occurred in 37 (7.48%) and in 10 (2.02%) with mean UARI above 95th percentile and below 5th percentile ( $P<0.001$ ) respectively. There were 143 caesarean births, statistically significantly more for foetal distress in with UARI above 95th percentile. With mean UARI above 95th centile, 296 (96.41%) had term, 11 (3.58%) preterm births. Of 67 (21.82%) caesarean births at term, 17 (25.4%) were for foetal distress, with mean UARI below 5th centile, 487 (98.58%) had term births. **Conclusions:** Women with higher UARI in first trimester had more often hypertensive disorders, placental abruption, oligohydramnios, caesarean births and foetal distress.

## 1. Introduction

Studies suggest that some complications of late pregnancy have their origin in the early gestation<sup>[1,2]</sup>, like the deranged uterine artery blood flow in early pregnancy and occurrence of hypertensive disorders and low birth weight (LBW)<sup>[3–6]</sup>. Impaired trophoblastic invasion of the maternal spiral arteries is associated with increased risk for subsequent development of intrauterine growth restriction, preeclampsia, placental abruption.

Gomez *et al* and Staboulidou *et al* have also reported that

there is a definite association between abnormal doppler sonography in the first trimester of the pregnancy and the development of utero–placental insufficiency as well as hypertensive disorders during later pregnancy<sup>[8,9]</sup>.

Recent studies have suggested that identification of abnormal Doppler waveform during first trimester and subsequent treatment with low dose aspirin may be more beneficial than waiting until second trimester to evaluate these vessels. The main problem with abnormal uterine blood flow that persists throughout the pregnancy is an increased risk for pre–eclampsia during the late second and third trimesters of pregnancy. Foetuses of mothers who have an abnormal uterine artery Doppler waveform have an increased risk for abnormal growth resulting in an undergrown, or small foetus with all its consequences. There are not many studies from resource poor settings, so present study was done to study placental blood flow in

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early pregnancy and its relationship with the maternal and perinatal morbidity and mortality.

### 2. Materials and methods

The present prospective study was carried out over two years. Women from outdoor as well as indoor were registered in the first trimester of pregnancy as per the inclusion criteria (primigravida with no past or present medical / obstetric disorder at the time of inclusion, willing to give informed consent, follow up and delivery at the place of study). Body mass index (BMI) was recorded [ $<20 \text{ kg/m}^2$  (low),  $20\text{--}25 \text{ kg/m}^2$  (normal),  $>25 \text{ kg/m}^2$  (high)]. Obstetric ultrasound was performed to study foeto–placental unit with special reference to UARI in the first trimester.

Out of the initial study population of 915, a total of 801 could be followed for perinatal outcome. Rest were either drop outs or aborted or wished to deliver somewhere else. Uterine artery flow was studied by Doppler prior to its branching into the arcuate arteries and UARI was measured. High resistance cases were those with uterine artery notches and a mean resistance index above the 95th centile, low resistance cases were those with no uterine notches and a mean resistance index below the 5th centile[4].

### 3. Results

Overall, of the total 801 women studied, 307 (38.3%) had mean UARI above the 95th percentile and 494 (61.6%) had mean UARI below the 5th percentile. Out of the 78 women with  $\text{BMI}<20$ , 33 (42.3%) had UARI above the 95th centile in first trimester, 8 (24.2%) of them had multiple disorders later (3 had hypertensive disorders, FGR and placental abruption, 5 had anaemia and FGR], 16 (49.2%) women had single problem (either placental abruption or hypertensive disorders or FGR) and only 9 (27.3%) women didn't have any disorder. Of the remaining 45 (57.7%) women out of 78 with  $\text{BMI} <20$  and UARI below the 5th centile, 4 (9%) had multiple problems (2 had hypertensive disorder with FGR with

oligohydramnios, 2 had anaemia with placental abruption), 10 (22.2%) women had single problem (placental abruption or hypertensive disorders or FGR) and 31 (69%) had no disorder, so women with UARI above 95th centile had statistically significantly more disorders ( $P<0.001$ ).

Out of the 665 women with BMI between 20–25, 255 (38.3%) women had UARI above the 95th percentile in first trimester, 43 (17.2%) of them had hypertensive disorder [of whom 34 (79.6%) also had FGR, 71 women (27.8%) had FGR without other disorder, 35 (14%) had multiple disorders (8 hypertensive disorders with FGR and oligohydramnios, 15 anaemia with FGR, 3 hypertensive disorders with oligohydramnios and placental abruption, 4 hypertensive disorders with placental abruption] and 106(41.56 %) women had no disorder.

Out of the 410 (61.7%) remaining women with BMI between 20–25, 255 (62%) had UARI below the 5th percentile and 28(6.8%) had hypertensive disorders, of which 8 had FGR, 11 had placental abruption, 4 placental abruption with foetal growth restriction, 15 (3.7%) had gestational diabetes mellitus (GDM), 19 (4.6%) had oligohydramnios, 8(2%) had FGR and 340 (82.9%) had no disorders, significantly more than those of BMI between 20–25 and UARI above 95th percentile ( $P<0.001$ ).

Of the 58 women with BMI more than 25, 19 (32.8%) had UARI above 95th centile in the first trimester, one (5.3%) of them had hypertensive disorder and 2 (10.5%) had foetal growth restriction and 16 (84.21%) had no disorder. Of the 39 (67.2%) women with UARI below 5th percentile, 2 (5.1%) had anaemia and 37 (94.60%) had no disorder (Table 1, Table 2).

**Table 1**

Uterine artery resistance index and various disorders.

	UARI>95th centile		UARI<5th centile	
	No.	Percentage	No.	Percentage
HD	49	15.96	32	6.47
PAb	37	12.05	10	2.02
FGR	62	20.19	20	4.04
FD	17	5.53	3	0.60
total	116	37.78	65	13.40

HD: hypertensive disorder; PAb: placental abruption;

FGR: foetal growth restriction; FD: foetal distress.

**Table 2**

BMI with UARI in first trimester with pregnancy disorders.

Disorders	Hypertensive disorders		Foetal growth restriction		Placental abruption		Anaemia		Oligo hydramnios		Gestational diabetes mellitus		No Disorders	Total	
	<	>	<	>	<	>	<	>	<	>	<	>			
UARI															
BMI <20	2	9	3	8	2	5	6	9	1	1	1		31	9	87
20 – 25	28	43	8	18	11	32	29	37	19	26	15	19	300	63	648
>25	0	1	0	1	0	0	2	3	0	0	4	2	37	16	66
Total	30	53	11	27	13	37	37	49	20	27	20	21	368	88	801

<: Resistance index below the 95th percentile uterine artery

>: Resistance index above the 95th percentile of uterine artery

Of over all 307 women with mean UARI above the 95th centile, 296 (96.41%) had term births, 67 (22.63%) had caesarean section, of whom 17 (25.4%) had foetal distress. Of 494 women with mean UARI below the 5th percentile, 487 (98.58%) had term births, 76 (15.60%) had caesarean section, of whom 3 (3.9%) had foetal distress. The caesarean sections and foetal distress were statistically significantly less in cases with UARI below 5th percentile ( $P < 0.0001$ ).

#### 4. Discussion

Harrington *et al* had examined uterine and umbilical artery Doppler at 12–16 weeks and concluded that abnormal Doppler indices, indicative of failure of modification of the uterine circulation in early pregnancy are associated with hypertensive disorders, placental abruption and FGR[10]. Similarly, Ferrazzi *et al* have also reported that a significant negative correlation exists between birth weight and first trimester uterine artery Doppler parameters, a reliable and non-invasive method of examining utero placental perfusion. McLeod *et al* advocate study of uterine artery flow, as effective clinical screening tool for the prediction of subsequent development of hypertensive disorders[11]. However, Makikallio *et al* in their study of uterine, placental and yolk sac haemodynamics between 6–11 weeks have reported no difference in UA haemodynamics between the two groups (normal and in women who developed hypertensive disorder)[12], but a significant difference was noted in yolk sac RI in the two groups, more than 95th percentile and below 5th percentile.

The vascular remodeling in the maternal–fetal interface may reduce local arterial resistance and thereby increase uteroplacental blood flow[13]. Impairment of this process is associated with pregnancy complications including spontaneous abortion, FGR and pre-eclampsia[13–16]. Uterine vascular relaxation and the increase in uterine blood flow in early pregnancy appear to be important determinants of pregnancy outcome. Gomez *et al* have reported that the sequence of changes in uterine flow between the first and second trimesters correlate with the subsequent development of hypertensive disorders and FGR[8]. Women with a persistent abnormal mean pulsatility index represent those with the greatest risk for adverse perinatal outcome. Prefumo *et al*[17] have reported that in pregnancies following a previous gestation complicated by pre-eclampsia, first trimester uterine artery doppler findings are similar to those observed in nulliparous women. In these high-risk women, a combination of UARI and notching can predict the risk of adverse outcome before 37 weeks.

In the present analysis, of the total 801 primigravida, 307 (38.3%) had mean UARI above the 95th percentile in first

trimester, hypertensive disorders occurred in 53 (17.3%), 21 (40%) of whom also had FGR and out of 494 with mean UARI below the 5th percentile, 30 (6.1%) women had hypertensive disorders ( $P < 0.00006$ , highly significant difference between the two) and four (13.3%) had FGR ( $P < 0.00006$ , highly significant difference). Placental abruption occurred in 37 (7.48%) women with mean UARI above the 95th percentile and 10 (2.02%) women with mean UARI below the 5th percentile highly significant difference ( $P < 0.001$ ). Incidence of placental abruption was found to be more than recorded in everyday life probably because each case had recording of events and even mild revealed bleeding was not missed. Comparing cesarean section (CS) also the difference was statistically significant ( $P < 0.02$ ) and the same was for foetal distress as the indication of CS, which was statistically highly significantly more ( $P < 0.0001$ ).

Zimmermann *et al* examined 172 women at high risk for hypertensive disorders of pregnancy or intrauterine growth restriction by measuring impedance to flow in the uterine arteries at 21–24 weeks of gestation[18]. The prevalence of preeclampsia and FGR was 18% and the sensitivity of increased prediction of this complication was 56%. Beverley *et al* have reported that, when the resistance index was greater than the 95th centile, there was a 10-fold increase in risk for a severe adverse outcome, defined by foetal death, placental abruption, FGR or pre-eclampsia[19]. The sensitivity for mild preeclampsia was only 29%, but for moderate/severe disease the sensitivity was 82%. Similarly, the sensitivity for birth weight below the 10th centile and for birth weight below the 5th centile were 38% and 46%, respectively.

Crossen *et al* report that abnormal uterine artery waveforms are a better predictor of pre-eclampsia than of FGR and pulsatility index, alone or combined with notching, is the most predictive doppler index[20]. Melchiorre *et al* have reported that the uterine artery doppler data in preterm cases with pre-eclampsia is strongly associated with defective invasion of the spiral arteries, in contrast to the findings in term pre-eclampsia which may be a consequence of placental deterioration at term[21].

The present study reveals that women with raised UARI in the first trimester had higher incidence of hypertensive disorder with foetal growth restriction and placental abruption and oligohydramnios compared to other cases. The value of first trimester uterine artery doppler as a prognostic screening tool, either in isolation or in conjunction with other possible markers needs to be researched further in view of the possibility of prediction of serious conditions during late pregnancy and labour which affect both the mother and the foetus.

Hence it is worth carrying out more research about uterine artery doppler for detection of abnormalities at early gestation to have appropriate timely interventions as there

are not many studies from resource scarce settings.

### Conflict of interest statement

We declare that we have no conflict of interest.

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