

CORRELATION BETWEEN THE DOPPLER VELOCIMETRY FINDINGS OF THE UTERINE ARTERIES DURING THE FIRST AND SECOND TRIMESTERS OF PREGNANCY

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SUMMARY

OBJECTIVES. Evaluate the feasibility of transvaginal uterine artery Doppler examination in the first and second trimesters of pregnancy, establish reference ranges in a Brazilian population and examine the correlation between these Doppler findings.

METHODS. Longitudinal prospective study at the antenatal clinic of a tertiary teaching hospital. Uterine artery Doppler examinations were carried out transvaginally at 11 to 14 weeks and 20 to 25 weeks of gestation. Uterine artery mean pulsatility index (PI) distributions were determined and the presence or absence of an early diastolic notch was also noted. The degree of correlation between first and second trimester Doppler findings was examined.

RESULTS. Three hundred and forty four women with live singleton pregnancies and normal outcome were first examined at a mean gestation of 12.7 weeks. The values corresponding to the 50th and 95th centiles of mean PI were 1.69 and 2.48. Bilateral notches were observed in 44% of cases and unilateral notches were present in 19%. Second trimester Doppler examinations were carried out at a mean gestation of 23.2 weeks and corresponding figures for the 50th and 95th centiles were 1.03 and 1.57. Bilateral notches were noted in 4.4% of the cases. First trimester impedance indices were significantly higher and positively correlated to second trimester findings ($r = 0.42$, $p < 0.0001$).

CONCLUSION. Uterine artery Doppler examination can be successfully performed transvaginally and incorporated into scans that are routinely offered to women during their antenatal care in the first and second trimesters. Doppler indices obtained during the first trimester are significantly higher than those of the second trimester and findings at both scans are significantly correlated.

KEY WORDS: Uterine artery. Ultrasonography. Colour Doppler. Pregnancy.

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INTRODUCTION

Examination of uterine artery blood flow can be achieved by Doppler ultrasound. The increased impedance to flow in these vessels during the second trimester of pregnancy has been shown to be associated with increased risk of pregnancy complications such as pre-eclampsia and intrauterine fetal growth restriction¹. Both complications are major causes of maternal and perinatal mortality. In the city of São Paulo, hypertensive disorders account for about one fourth of maternal deaths².

Several treatments have been proposed to reduce the incidence of such complications during pregnancy. However randomized studies evaluating interventions, such as low dose daily aspirin for women identified as high-risk, based on second trimester Doppler findings, have not shown a significant reduction in the rate of these complications³.

One may hypothesize that if such interventions were implemented at an earlier gestational age, before the trophoblastic invasion process is complete, they might have been more effective.

This study evaluated the feasibility of transvaginal uterine artery Doppler examination in the first and second trimesters of pregnancy, to determine normal reference ranges and findings in a Brazilian population and assess the degree of correlation between first and second trimester findings. Based on these reference ranges, methodologically appropriate uterine artery Doppler screening studies could then be performed in our population.

METHODS

This was a longitudinal prospective study conducted at the Department of Obstetrics, Hospital das Clínicas, São Paulo

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University School of Medicine. The study was approved by the Hospital ethics committee.

Patients routinely attending the antenatal clinic were informed about the study during their first trimester nuchal translucency scan and those who agreed to participate in the study gave informed consent. During that scan the number of live fetuses was determined, gestational age was confirmed by fetal crown-rump length measurement, fetal nuchal translucency thickness was measured and major fetal structural abnormalities were sought. Only live singleton pregnancies were included in the study.

Uterine artery Doppler examination was performed transvaginally on patients in the lithotomy position, with an empty bladder. The probe was inserted into the vagina and placed in the lateral fornix where color Doppler identified the uterine artery vessels at the level of the internal cervical os. Pulsed Doppler waveforms were obtained and pulsatility index (PI), was calculated for both uterine arteries. Mean (right + left/2) indices were calculated for each patient and the presence or absence of an early diastolic notch was also noted⁴.

As part of the routine antenatal care, an anomaly scan was offered to all patients at 20- 24 weeks gestation when the transvaginal uterine artery Doppler examination was repeated as done in the first trimester scan.

The results of the Doppler examinations were not disclosed to the obstetricians caring for these patients and no intervention was implemented on the basis of the Doppler results. Women with clinical or obstetrical complications, those with an abnormal fetus or that presented abnormal fetal growth, were excluded from the analysis.

Statistical analysis

Mean uterine artery Doppler indices (right + left/2) were calculated for each examination and the distribution in the first and second trimesters was described. Values obtained in the first trimester were compared to those of the second trimester using the paired t-test. Spearman's correlation test and simple linear regression were used to examine the degree of correlation between these values. The frequencies of unilateral and bilateral notches were calculated for each trimester and compared using the Chi-square or Fisher's exact test, when appropriate.

RESULTS

During the study, 645 patients with live singleton pregnancies and known pregnancy outcome were recruited and agreed to participate. They were first examined at a mean gestation of 12.7 weeks (SD: 0.8, range: 11 to 13 weeks 6 days) however, transvaginal uterine artery Doppler waveforms could not be obtained in 6 (0.9%) cases. These women were re-examined at a mean gestation of 23.2 weeks (SD: 0.8, range: 20 to 24 weeks 6 days), and the Doppler scan was unsuccessful in 11 (1.7%) cases during the second trimester.

Uterine artery Doppler index reference ranges and findings were calculated based on 344 pregnancies with a normal pregnancy outcome. Cases with maternal hypertension (47), diabetes (12), thrombophilia (11), cardiac (20), auto immune (19), thyroid (18), respiratory (15) and chronic renal diseases (8) were excluded. Pregnancies with fetal structural

Table 1 - Normal values for mean uterine artery Doppler pulsatility indices at 11 to 13 weeks 6 days and 20 to 24 weeks 6 days in 344 normal pregnancies

percentile	Mean Pulsatility Index	
	11 - 13 weeks 6 days	20 - 24 weeks 6 days
5	1.10	0.72
25	1.37	0.88
50	1.69	1.03
70	2.00	1.19
75	2.07	1.24
80	2.11	1.31
85	2.23	1.35
90	2.34	1.44
95	2.48	1.57

abnormalities (13), intrauterine fetal or unexplained neonatal death (4), pre-eclampsia (25), preterm delivery (87) and birthweight below the 10th centile (112) or above the 90th centile (21) were also excluded.

Values corresponding to various mean uterine artery Doppler pulsatility index centiles are shown in Table 1. First trimester uterine artery Doppler indices were significantly higher compared to those of the second trimester (mean PI difference = 0.66 ± 0.42 , paired *t* test $p < 0.001$) and these measurements were significantly and positively correlated ($r = 0.42$ [95% confidence interval CI = 0.33 to 0.50], $p < 0.001$; Figure 1).

Bilateral notches were observed in 151 (43.9%) cases during the first trimester and in 15 (4.4%) evaluations during the second trimester. The corresponding figures for unilateral notches were 66 (19.2%) and 31 (9.0%). Both findings were significantly less common in the second trimester (Chi-square test $p < 0.001$). Among the 151 patients who had bilateral notches in the first evaluation, 13 (8.6%) had persistence of bilateral notches in the second trimester scan, 25 (16.6%) presented unilateral notches and the remaining (74.8%) showed no notches. Table 2 summarizes uterine artery notch findings in both scans.

DISCUSSION

This prospective study has shown that Doppler examination of the uterine artery can be successfully achieved transvaginally and included to scans that are offered to women during their routine antenatal care, such as the first trimester nuchal translucency and second trimester anomaly scans⁵. Failure to obtain an appropriate Doppler sonogram was observed in less than 2% of our study population.

Historically, uterine arteries have been examined transabdominally, in the second trimester of pregnancy, at the level of their "cross over" with the external iliac artery⁴. However this technique is not applicable during the first trimester and different techniques have been employed⁶⁻⁹. The transvaginal route was chosen for this study because it enables easy identification of the uterine arteries at the level of the internal cervical os, during the entire pregnancy. It therefore allows

Figure 1- First and second trimester uterine artery Doppler indices scatter plots in 344 normal pregnancies. PI: pulsatility index

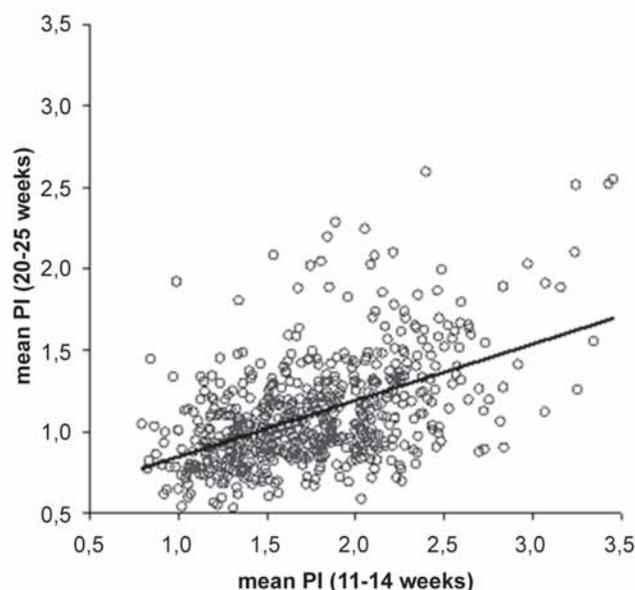


Table 2 - Uterine artery notch findings at 11 to 13 weeks 6 days and 20 to 24 weeks 6 days in 344 normal pregnancies

Uterine notch at 11-13weeks	Uterine notch at 20-24weeks		
	no notch (n= 298)	unilateral (n= 31)	bilateral (n= 15)
no notch (n= 127)	125	1	1
unilateral (n= 66)	60	5	1
bilateral (n= 151)	113	25	13

direct comparison of results obtained at different stages of pregnancy by this standardized technique.

Moreover the transvaginal route conveys a better assessment of fetal anatomy in the first trimester as well as a reliable method for evaluation of the uterine cervix¹⁰. Other advantages of this technique include the possibility of obtaining clear waveforms and a good reproducibility due to the proximity of the transducer to the uterine vessel¹¹.

Our data also show that uterine artery Doppler impedance indices during the first trimester of pregnancy are significantly higher than in the second trimester and that both measurements are significantly and positively correlated. The association between uterine artery Doppler findings in the first and second trimesters has also been described in a smaller study involving 55 pregnancies⁶. Our results showed that the group of women with Doppler measurements above the 85th centile during the first trimester comprises approximately half of the cases with indices above the 95th centile in the second trimester.

The presence of bilateral notches in the first trimester should not be considered an abnormal finding since it was observed in

more than half the cases examined. However, only less than 10% of them showed persistence of bilateral notches when re-examined in the second trimester while 70% did not show any notches. Apparently an absence of notches in the first trimester is highly predictive of the same finding in the second trimester. Similar results were observed in two other studies conducted between 11 and 14 weeks of gestation. Martin et al performed transabdominal studies and recorded bilateral notches in 55% of the cases examined and 2.35 as the 95th centile for mean PI (9). Gómez et al applied the transvaginal technique and described bilateral notches in 46% of the cases and mean PI 95th centile figures between 2.24 and 2.70¹².

Our second trimester findings were very similar to those reported by Papageorgiou et al¹ (mean PI 50th centile= 1.05 vs 1.03; mean PI 95th centile= 1.63 vs 1.57). In fact both studies were carried out transvaginally between 20-24 weeks and with the same technique. The similarities in the results highlight the importance of strict standardization of the technique to promote results reproducibility.

On the other hand, bilateral notches were found in around 8-9% of the cases examined by Papageorgiou¹ and only 4-5% of our cases. This difference is most likely explained because notch assessment is based on subjective criteria. Indeed, the pulsatility index describes the shape of the velocity waveform much better, as it includes the area below the curve in the formula. Likewise and for this reason, the PI index indirectly informs about presence or absence of a protodiastolic notch and is the preferred Doppler impedance index in most recent uterine artery Doppler studies.

Several studies have now shown that increased impedance to flow, in the second trimester of pregnancy is associated with an increased risk of pregnancy complications, such as pre-eclampsia and fetal growth restriction¹³. However randomized studies testing prophylactic interventions, such as low-dose aspirin to reduce such complications in patients identified as high-risk, based on mid-second trimester uterine artery Doppler findings, have not proven effective^{3,14}. Perhaps these interventions are being tested at a gestational age too far ahead in the trophoblastic invasion process.

Therefore, one may hypothesize that if such interventions were implemented at an earlier gestational age, they might have been more effective in reducing the rate of pregnancy complications. However, our data suggest that if prophylactic interventions were to be tested in future studies, based on first trimester uterine artery Doppler findings, such studies would have to recruit a large number of women screened and the sample size would have to be much larger than current second trimester randomized prophylactic studies to show significant reduction of pregnancy complications.

Interest conflict: none

RESUMO

CORRELAÇÃO ENTRE OS ACHADOS DOPPLERVELOCIMÉTRICOS DAS ARTÉRIAS UTERINAS NO PRIMEIRO E SEGUNDO TRIMESTRES DA GESTAÇÃO

OBJETIVO. Avaliar a aplicabilidade de realizar exames dopplervelocimétricos endovaginais das artérias uterinas no primeiro e segundo trimestres da gestação, definir valores

normais na população brasileira e examinar a correlação entre esses achados.

MÉTODOS. Estudo prospectivo longitudinal conduzido em Hospital Universitário Terciário. Os exames dopplervelocimétricos das artérias uterinas foram realizados pela via endovaginal, entre 11 a 14 semanas e 20 a 25 semanas de gestação. Em cada período gestacional estudado, a distribuição dos valores dos índices de pulsatilidade (IP) médio foi descrita e diferentes percentis calculados. Também foi anotada a presença ou ausência de incisura uterina protodiastólica. Os achados dopplervelocimétricos observados no primeiro trimestre foram correlacionados com os achados do segundo trimestre.

RESULTADOS. Trezentos e quarenta e quatro mulheres com gestações únicas de desfecho normal foram examinadas inicialmente em idade gestacional média de 12,7 semanas. Os valores correspondentes aos percentis 50 e 95 para o IP médio foram de 1,69 e 2,48, respectivamente. Incisura bilateral foi observada em 44% dos casos e unilateral em 19%. Na segunda avaliação, realizada em idade gestacional média de 23,2 semanas, os valores correspondentes aos percentis 50 e 95 do IP médio foram de 1,03 e 1,57, respectivamente. Incisura bilateral foi observada em 4,4% dos casos na segunda avaliação. Os índices dopplervelocimétricos do primeiro exame se correlacionaram de forma significativa e positiva com os valores do segundo trimestre ($r = 0,42$; $p < 0,0001$).

CONCLUSÃO. O estudo dopplervelocimétrico endovaginal das artérias uterinas pode ser realizado de forma satisfatória e incorporado nos exames ultrassonográficos oferecidos como parte da rotina de acompanhamento pré-natal no primeiro e segundo trimestres da gestação. Índices dopplervelocimétricos uterinos médios observados entre 11 e 14 semanas são significativamente maiores do que entre 20 e 25 semanas, e esses valores se correlacionam de forma positiva e significativa. [Rev Assoc Med Bras 2009; 55(2): 197-200]

UNITERMOS: Artéria uterina. Ultrassonografia. Doppler colorido. Gravidez.

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