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Uterine artery pulsatility index and diastolic notch laterality according to the placental location

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Summary

Purpose of investigation: The authors aimed to determine the effect of placental site on uterine artery pulsatility index (PI) values and tendency for laterality of uterine artery diastolic notch in singleton pregnancies. *Materials and Methods:* All medical records of singleton pregnancies whose first trimester screening was done between years of 2004-2014, were evaluated retrospectively. Singleton pregnancies with detected/suspicious anatomical or genetic fetal anomalies, any systemic disease, familial genetic diseases, artificial reproduction techniques or missing data were excluded. Mean left and right uterine artery PI values and diastolic notch laterality ratios according to placental sites were determined and compared. *Results:* A total of 2,067 singleton pregnancies were included in data analyses. Mean gestational age was 12.57 ± 0.61 weeks. Left and right uterine artery PI was 1.42 ± 0.47 and 1.48 ± 0.56, respectively. Uterine artery notch was present in 18.86%. PI measurements did not show any statistical difference according to placental locations. Uterine artery notch laterality ratios according to common placental sites are as following; in anterior location (n=190) 67% bilateral, 21% left sided, 12% right sided; in posterior (n=136) 66% bilateral, 18% left sided, 16% right sided. *Conclusion:* The placental site has no effect on uterine artery PI values and the laterality of uterine artery notch in singletons.

Key words: Fetus; Singleton; Placenta; Uterine artery; Pulsatility index; Diastolic notch; Fetal ultrasonography.

Introduction

Imperfect invasion of endometrial tissue by trophoblasts results in an altered blood flow pattern and vascular dynamics of uterine artery as in case of preeclampsia [1]. Thus, evaluation of vascular dynamics of uterine artery using color Doppler ultrasonography (USG) takes a routine part in the prediction and follow of preeclampsia within gynecology and perinatology clinics [2-7].

In this retrospective study the authors aimed to determine the probable effect of fetal placental location on some parameters of vascular dynamics of uterine artery, namely magnitude of uterine artery pulsatility index (PI) and presence and laterality tendency of diastolic notch of uterine arteries on both sides.

Materials and Methods

All medical records of singleton pregnancies, whose first trimester screening was done between years of June 2004 and January 2014, were evaluated retrospectively. Singleton pregnancies with detected/suspicious anatomical or genetic fetal anomalies, any systemic disease, familial genetic diseases, artificial reproduction techniques or missing data were excluded.

Sonographic examinations were performed transabdominally using one type of ultrasonography machine. As depicted previously in literature, by means of color Doppler USG, bilateral uterine arteries crossing the external iliac arteries were identified. Pulsed wave Doppler USG was performed to obtain three similar consecutive uterine artery waveforms and PI were measured with the angle of incidence less than 30 degrees. The uterine artery PI was measured and diastolic notch was noted if present, on both sides [2, 3].

Mean left and right uterine artery PI values and diastolic notch laterality ratios according to placental sites were determined and compared statistically. Statistical analyses were performed using SPSS statistics software. A p value was set as < 0.05 for significance.

Results

In accordance with inclusion and exclusion criteria, a total of 2,067 singleton pregnancies were included in the data analyses. Mean maternal age was 29.44 ± 4.60 years. Mean crown-rump length was 63.05 ± 8.36 mm. Mean gestational age was 12.57 ± 0.61 weeks. Gender distribution was as female 44% and male 56%. Fetal placental sites and ratios were as following; anterior location 47%, posterior location 42%, lateral location 7%, and fundal location 4% (Figure 1). Mean uterine artery PI measurement was 1.46 ± 0.51. Left and right uterine artery PI values were accordingly 1.42 ± 0.47 and 1.48 ± 0.56; there was found no statistical difference between left and right PI measurements with paired t-test ($p = 0.198$). Both left and right PI measurements did not show any statistical difference according to the placental locations (Table 1).

Unilateral or bilateral uterine artery notch was present in 390 pregnant women (18.86%). Uterine artery notch later-

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Table 1. — *Uterine artery pulsatility indices according to the placental locations.*

	Placental Location			
	Anterior	Posterior	Lateral	Fundus
Right uterine artery pulsatility index	1.42 ± 0.54	1.42 ± 0.43	1.46 ± 0.40	1.37 ± 0.52
Left uterine artery pulsatility index	1.51 ± 0.54	1.50 ± 0.47	1.53 ± 0.58	1.38 ± 0.65

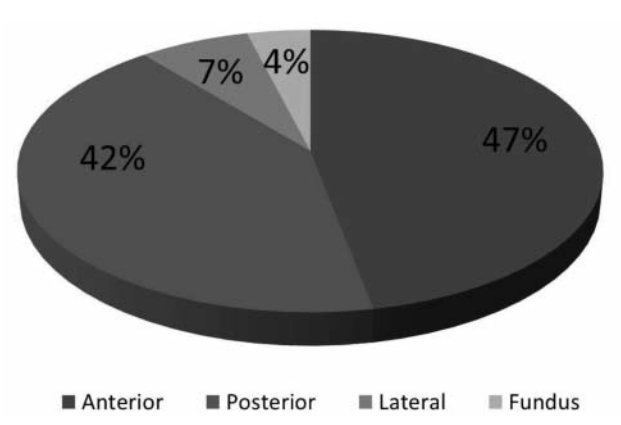

Figure 1. — Fetal placental sites and ratios.

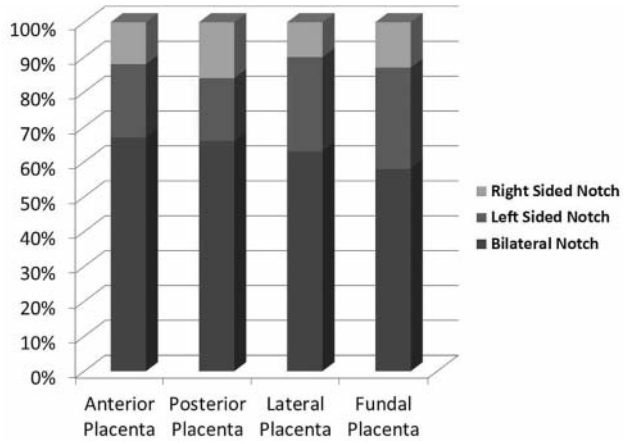

Figure 2. — Uterine artery notch laterality ratios according to placental sites.

ality ratios according to placental sites were as following; in anterior location (n=190) 67% bilateral, 21% left-sided, 12% right-sided; in posterior (n=136) 66% bilateral, 18% left-sided, 16% right-sided; in lateral (n=42) 63% bilateral, 27% left-sided, 10% right-sided and in fundus (n=22) 58% bilateral, 29% left-sided, 13% right sided (Figure 2). The ratios did not show any statistically significant difference. In the lateral group, the laterality of the notches were ipsilateral in higher proportion (65% for left notch and 69% for right notch) without any statistical significance. The ratios did not show any significant difference.

Discussion

In the pathophysiology of preeclampsia, defective trophoblastic invasion of endometrial tissue alters blood flow pattern and vascular dynamics of the uterine artery [1]. This is the reason why during pregnancy both uterine arteries are routinely evaluated with color Doppler USG for any altered pattern in vascular dynamics, to predict the risk of preeclampsia within obstetrics and perinatology clinics [2-7].

Both transvaginal and transabdominal Doppler USG has proved to be effective in the evaluation of the vascular dynamics of the uterine arteries [4, 5]. In this present study the authors have performed uterine artery Doppler studies with transabdominal Doppler USG, in accordance with the methodological criteria described elsewhere [2, 3].

The evaluation of uterine artery PI at 11-14 gestational weeks has proved to be effective in identifying high ratio of pregnancies to develop severe preeclampsia or restricted fetal growth [5]. Although generally direct measurements of left or right uterine arteries' PIs or mean of them are used to predict preeclampsia and some other pregnancy related adverse events, lowest PI measurement has been found to have higher detection rate for early preeclampsia compared to highest or mean PI measurements [6].

In a previous study, reference values for mean uterine artery PI were calculated in singleton pregnancies at 11-41 weeks of gestation [7]. Mean uterine artery PI measurements were slightly lower compared to this reference, which might be the result of the different populations studied. In a controlled study of 131 pregnancies with unilateral increased uterine artery PI and normal mean pulsatility at 20–22 gestational weeks, placental location, central versus lateral placenta, was not found to be associated with any effect on uterine artery PI measurements [8]. As well, unilaterally increased uterine artery PI with normal mean pulsatility was not found to be associated with any adverse pregnancy outcome compared to controls [8]. Similarly, with more detailed placental location, the present authors found no effect of placental location on uterine artery PI measurements.

One study, performed to assess the effect of placental location on uterine artery PI, concluded that ipsilateral artery PI measurements were consistently lower than contralateral ones in both singleton and twin pregnancies [9]. However, patterns of PI change throughout the pregnancy were found to be different between singleton and twin pregnan-

cies; steady decrease in singleton pregnancies continued to term whereas it lasted until 27 weeks of gestation in twin pregnancies, and it remained same thereafter [9]. In addition, at any gestational weeks PI measurements were lower in twin pregnancies compared to singleton pregnancies on both sides [9].

In the literature, the presence of diastolic notch has been reported to be a predictor of poor maternal and perinatal outcome [10-13]. In a study in which 481 pregnancies with selected lateral placentas were evaluated at 22-24 weeks of gestation, the ones with mean resistance index above 90 percentile and diastolic notch were found to have higher risk of subsequent development of pregnancy induced hypertension and intrauterine growth retardation [10].

Presence of notch has been associated with increased resistance index of uterine arteries, higher risk of fetal growth retardation, and cesarean delivery due to fetal distress as well as need for neonatal intensive care unit more than 48 hours [11].

In a study, in which 31 selected preeclamptic women at a mean of 30.1 ± 3.0 gestational weeks were evaluated with their diastolic notch patterns as a prediction of any pregnancy related adverse effect [12]. Diastolic notches were classified as grade I notch (nadir in early diastole higher than half of peak diastolic notch velocity) and grade II (nadir in early diastole lower than half of peak diastolic notch velocity) [12]. The risk of delivery before 32 weeks and newborn spending more than 48 hours in neonatal intensive care unit were significantly higher in ones with diastolic notch [12]. In another study, presence of notch especially bilateral, alone or together with increased resistance index, was associated with increased risk for preeclampsia [13]. Likewise, some other parameters as notch depth index, representing the measured depth of the notch, has been shown to have higher positive predictive value for small for gestational age infant and preeclampsia [14]. In that study similarly, the pregnancies were evaluated for notch at a mean of 20.1 ± 2.0 gestational weeks and the presence of notch was noted in 20% of pregnancies [14]; 64% had midline and rest had lateral placental location and respective ratios of notch presence were 20% and 22% and an insignificant difference was found [14]. Ipsilateral uterine arteries however had significantly lower resistance index measurements compared to the contralateral ones [14]. Again, bilateral notch was associated with increased risk of preeclampsia [15]. Generally, the reported prevalence in the literature is between 4.5% and 38 % [15, 16].

In another study, 654 pregnancies were followed up for uterine artery PIs plus waveforms and were grouped according to the placental location as midline, fully lateral, and in-between groups [17]. The ratios of diastolic notch were 14-16% at 20th gestational week and 5-6% at 32nd gestational weeks in placental groups with lower prevalence of preeclampsia (3-4%) [17]. Full lateral placental group notch was mentioned to be contralateral in more than half of the cases (no clear data given) [17]. The study concluded that preeclampsia can be predicted with diastolic notch taking gestational age and considering placental locations, highest sensitivity at 24th gestational week with bilateral notching, central, and in-between locations [17]. In this present study the diastolic notch was found to be 19% at a mean of 12.57 ± 0.61 gestational weeks and in the lateral group the laterality of the notches was ipsilateral in higher proportion without any statistical significance.

Conclusions

The placental site does not seem to have effect on uterine artery PI values and the laterality of uterine artery notch.

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