

Placental perfusion in 3rd trimester pregnancy

M Sitepu^{1,2,3*}, A Syahriza^{1,2}, D Sibuea^{1,2} and T M Hanafiah^{1,2}

¹Departement of Obstetrics and Gynecology, Faculty of Medicine, Universitas Sumatera Utara, Medan, Indonesia

²Haji Adam Malik General Hospital, Medan, Indonesia

*Corresponding author: makmurstp@gmail.com

Abstract. The placenta is an organ for transmitting nutrition and oxygen to the fetus; it means if there is a defect in the placenta could make growth restriction to the fetus, even death. Uterine artery flow escalated since the halfway point of the pregnancy or the complete trophoblast invasion of spiral artery, and keep going in every week. 3D power Doppler examination on placenta could show the uterine-placenta circulation and fetoplacental at once so could give themore accurate result. A cross-sectional study in RSUP HAM and the private specialist clinic was conducted in 100 pregnant samples with 28-40 week gestational age, exact last menstrual period date, and no underlying disease to examine the alteration of placental perfusion by gestational age and placental location. There was a correlation between VI and VFI in placenta toward umbilical artery flow, but no correlation in FI. The placental location also plays a role in interval blood flow, especially FI and VFI, it means the VFI hold the strongest correlation in both ways.

1. Introduction

The placenta is an important part of oxygen and nutrition delivery system from mother to fetus. The disorder of the placenta could be a manace to fetus survival in the womb, including the incidence of fetal growth restriction.[1]

The examination of placental perfusion could be by measuring its circulation via radial artery and intervillous by uterine artery examination which is show maternal part. For the fetoplacental part, umbilical artery could be used.[2,3] Before pregnancy occurred, the uterine artery has high resistance index with very low, absent or reversed diastole. When pregnancy happened, the flow of uterine artery increased from 50 ml/min (after conception) to 500-750 ml/min when pregnancy aterm.[2] Normally the placental perfusion elevated as much as gestation weeks including the decreased of the resistance index, but in the pathological condition, the diastolic value could be absent or even reversed. The circumstances could happen in placental damage in at least 60%.[3,4] To get the placental perfusion, often used systole/ diastole ratio (stuart index), Resistance index (pourcelot) and pulsatility index.[5]

Merce LT et al 2005 in his study of 98 pregnant women from 14 to 40 weeks of age had increased vascularization in the placenta as the pregnancy progressed where placental vascular peaks were obtained at 30 to 35 weeks' gestation for VI and VFI while FI continued to increase slowly with increasing Old pregnancy.[6]

Pretorius et al 1998 conducted a placental blood vessel examination with 3D Doppler power gain an increase in intraplacental blood vessels and branching along with an increasingly elderly pregnancy. Placental volume representation can indicate the origin of blood vessels, even though it is



not possible to distinguish between two dimensions. Besides, it can also distinguish maternal placenta side of the maternal and fetal.[7,8]

In this study, we aimed to know the changes in placental perfusion with increasingly old pregnancy, knowing placental perfusion in normal arterial blood flow conditions umbilicalis and to know placental perfusion based on the location of implantation in the uterus.

2. Methods

This study was a cross-section where all cases included in the study criteria will be measured only once per variable. This research was on polyclinic of apregnant mother of RSU. H. Adam Malik Medan and obstetric & gynecological specialist private practice and the time of the study was carried out until the sample quantity which is a 3rd trimester pregnant woman who meets the inclusion criteria was fulfilled. The criteria include the age of the pregnancy (28 - 40 wga), singleton pregnancy, without any congenital defect/abnormalities, history The first day of the last menstrual period. It is clear or the presence of CRL data in the first trimester and not with preeclampsia, impaired fetal growth, antiphospholipid syndrome, DM, and anemia. Examination included measurement of DBP diameter, head circumference, abdominal circumference, femoral length, estimated fetal weight and ICA measurements. Using Ultrasound Voluson Pro with Krezt Probe 2D, 3, 4D. Performed umbilical artery blood flow measurements include systolic/diastolic (SD) ratio and index resistance (RI), pulsatile index (PI) in the free thoracic area. 3D measurements of placental ultrasound doppler vascular biopsy were performed in accordance with studies conducted by Merce et al. (2005) and then measured Volume Index (VI), Volume Flow Index (VFI) and Flow index (FW).

3. Data Analysis

The data obtained will be verified, the normal distribution is by using Kolmogorov-Smirnov for later processing of descriptive data (number, size, and description) accompanied by Pearson correlation coefficient analysis using SPSS (Statistical package for social sciences) version 15 program with level 5% significance.

4. Results

The study population included 3rd trimester pregnant women (n=100) and divided into some criteria such as parity, gestational age, the location of the placenta and age (table 1).

Table 1. Sample characteristic.

Gravida	n
Primigravida	39
Sekundi gravida	40
Multigravida	21
Gestational Age	n
28-32 wga	45
33-36 wga	40
37-40 wga	15
Placental location	n
Anterior corpus	51
Posterior corpus	28
Fundal	18
Low cervical segment	3

Age	n
20-24 yo	24
25-29 yo	52
30-34 yo	12
35-39 yo	12

Table 1 showed the highest number of cases was secundi gravida with the most gestational age population was 28 - 32 weeks and 51 cases with a placental location in the anterior corpus with the most maternal age was 25 - 29 years old.

Table 2. Mean value VI, FI, VFI placenta and RI, SD, PI of umbilical artery according to gestational age.

Gestational age	VI	FI	VFI	RI	SD	PI
28	22.070	42.496	9.379	0.60	2.50	0.84
29	4.220	38.526	1.626	0.54	2.79	0.84
30	11.818	36.846	4.354	0.52	2.10	0.72
31	14.291	46.584	6.658	0.57	2.32	0.84
32	10.452	36.298	3.794	0.62	2.67	0.92
33	6.874	39.815	2.739	0.52	2.07	0.69
34	7.173	34.393	2.467	0.64	2.79	1.04
35	23.378	50.019	4.694	0.67	3.00	1.07
36	9.103	42.922	3.907	0.52	2.06	0.72
37	8.784	40.424	3.551	0.57	2.35	0.81
38	12.000	42.339	5.129	0.49	1.52	0.44
39	6.060	32.571	2.156	0.64	2.75	1.10
40	6.874	39.815	2.739	0.52	2.07	0.69
X	11.007	40.489	4.415	0.564	2.396	0.832
SD	5.888	5.000	2.542	0.072	0.389	0.166

Table 2 showed the average vascular index acquired 11.007 with SD 5.888, FI 40.489 with SD 5.000 and VFI 4.415 SD 2.542 at age 35 weeks showed an increase of VI, FI, and VFI but with increased resistance to the umbilical artery.

Table 3. The relationship between gestational age with 3D vascular biopsy.

Vasc. Biopsy	VI	FI	VFI
Gestational age	R - 0.305	R -0.024	R - 0.206

Table 3 showed there was a correlation between gestational age and VI with $r = -0.305$ and VFI correlated weakly whereas FI did not correlate.

Table 4. The umbilical artery blood flow relationship with 3D vascular biopsy.

3D Vascular Biopsy Umbilical Artery	VI	FI	VFI
RI	R 0.280	R -0.20	R - 0.32
SD	R 0.18	R - 0.20	R - 0.38
PI	R 0.16	R - 0.26	R - 0.36

Table 4 showed that weak correlations are found between 3D vascular biopsy with umbilical arterial blood flow and the strongest finding is VFI correlation with umbilical arterial blood flow in which decreased resistance of the placenta is accompanied by increased vascularization in the placenta.

Table 5. The correlation between 3D power biopsy with placental location.

Placental Location Vascular Biopsy	Anterior Corpus	Posterior Corpus	Fundus	Low Cervical Segment	P
VI	13.98	14.97	10.46	48.02	0.088
FI	39.05	40.56	33.44	59.17	0.005
VFI	6.01	7.39	4.14	28.41	0.037

Table 5 showed that placental site has an effect on vascularization in placenta especially FI index with $p < 0.05$ and VFI.

5. Discussion

In this study by examining blood flow in the intervillus segment that runs very slowly and can only be assessed by using power doppler then done the calculation of blood flow value by using the VOCAL program then it needs assessing VI, FI, and VFI. The blood flow to the intervillous region will increase with the age of pregnancy and in this study, the value of blood flow increased from 28 weeks to maximal at 35 weeks. This is slightly different from that obtained by Merce LT 2005 from his study of 86 pregnant women of the age Pregnancy 14 weeks to 40 weeks where the intervillous blood flow continues to increase from 14 weeks to 37 weeks and then decreases until the age of 40 weeks.

In correlation test between circulation intervillus with umbilical artery obtained correlation especially between value VI and VFI in the placenta to umbilical arterial blood flow whereas FI not found correlation at all. The location of the placenta is also correlated to the magnitude of blood flow in the intervillous region, especially the values of FI and VFI. So from this study found that the value of VFI always correlated most strongly, to gestational age, umbilical arterial blood flow and location of the placenta.

6. Conclusion

There was a correlation between 3D vascular biopsy with gestational age where with increasing of gestational age the increasing of vascularization in placenta especially VI and VFI, but no correlation with FI. There is an increase in vascularization in the placenta with an increasingly elderly pregnancy until age 35 weeks later after it decreases. There is an inverse correlation between umbilical arterial bloodstream with 3D vascular by patients of placenta especially VFI against RI, SD, and PI. The placental site also determines vascularization in the placenta, especially significant differences found in the FI and VFI value.

References

- [1] Chen H U, Chiung H C, Huei C K, Wen C C and Fong M C 2003 Assessment of placental fractional moving blood using quantitative three-dimensional power Doppler ultrasound *Ultrasound Med. Biol.* **29**(1) 19–23
- [2] Cunningham F G, Gant N F, Leveno K J, Gillstrap L C, Hauth J C and Wenstrom K D 2001 Doppler velocimetry *Williams obstetrics* vol 21 (New York: McGraw–Hill) pp 1111–39
- [3] Guiot C, Gaglioti P, Oberto M, Piccoli E, Rosato R and Todrost T 2008 Is three-dimensional power doppler ultrasound useful in the assessment of placental perfusion in normal and growth-restricted pregnancies? *Ultrasound Obstet. Gynecol.* **31** 171–6
- [4] Mercé L T, Barco M J, Bau S, Kupešić S and Kurjak 2005 Assessment of placental vascularization by three-dimensional power doppler “vascular biopsy” in normal pregnancies *Croat. Med. J.* **46**(5) 765–71
- [5] Maulik D, Yarlagadda P, Young J P and Ciston P 1991 Comparative efficacy of umbilical arterial doppler Indices for predicting adverse perinatal outcome *Am. J. Obstet. Gynecol.* **164** 1434–40

- [6] Pan H A, Wu M H, Cheng Y C, Li C H and Chang F M 2002 Quantification of doppler signal in polycystic ovary syndrome using three-dimensional power doppler ultrasonography: A possible new marker for diagnosis *Human Reprod.* **17** 201–6
- [7] Pretorius D H, Nelson T R, Baergen R N, Pai E and Cantrell C 1998 Imaging of placental vasculature using three-dimensional ultrasound and color power doppler: a preliminary study *Ultrasound Obstet. Gynecol.* **12** 45–9
- [8] Salim A 2000 Penilaian arus darah janin dan uteroplaster *Kursus dasar ultrasonografi dan kardiokografi*