International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Impact Factor 2024: 7.101

Variations in Placental Locations and in Third Trimester and its Correlation with Fetal Growth Restriction Using Ultrasonography

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Abstract: ***The placenta plays a crucial role throughout pregnancy, and its importance may be overlooked during routine antenatal imaging evaluation. Placental location is determined according to the main placental body position from the uterine equator. It can be anterior or posterior, fundal, or left or right. Fetal Growth Restriction (FGR/IUGR) is said to be present in babies whose birth weight is below the tenth percentile of the average for the gestational age. It has been suggested that placental location plays a role in development of FGR. Poor uterine blood flow to the placental site for a long time leads to chronic placental insufficiency which causes IUGR. The uterine blood flow shows variation based on the location of the placenta. Uterus is supplied by the uterine and ovarian arteries. Each uterine artery supplies its corresponding side of the uterus and anastomoses with the contralateral uterine artery. Pregnancies with increased resistance in the uterine arteries have an increased risk of fetal growth restriction (FGR). This study is designed to find the incidence of the placental sites in the third trimester and investigate the relationship between placental location and FGR.***

Keywords: Placenta, Fetal growth restriction (FGR), Intrauterine growth restriction (IUGR), placental location.

1. Introduction

The human placenta is a complex organ and plays a key role during pregnancy. It serves as a medium by extracting nutrition from the mother and providing it to the growing fetus. As the largest fetal organ, it has indispensable functions in the development and protection of the fetus. The site of implantation and resultant location of the placenta within the uterus are likely important determinants of placental blood flow and therefore pregnancy is successful.[1] The blood supply of the uterus is not uniformly distributed.[2] Centrally located placenta receives equitable distribution of blood flow from both the uterine arteries whereas in laterally located placenta, the uterine artery closer to the side of placenta has a low resistance and a good blood flow, which causes disparity in blood distribution. [2] The other uterine artery supplying the placenta located laterally receives less contribution from the collateral circulation. [3] Unilateral placental implantations (placentas where the bulk of the placenta is implanted over the right or left lateral aspect of the uterus) have been linked with an increased incidence of preeclampsia, fetal distress in labour, abdominal deliveries, and intrauterine growth retardation (IUGR). [4]

The placenta is an organ that attaches the developing fetus by the umbilical cord to the uterine layers to permit nutrient uptake, thermo-regulation, waste removal, and gas exchange by the mother's blood supply; to fight against internal infection, and to produce hormones that preserve the pregnancy. The determination of the location of the placenta inside the uterus is useful to discover any complications earlier and manage them accordingly. The blood supply of the uterus comes from the uterine and ovarian arteries. Each uterine artery supplies its corresponding side of the uterus, it has a substantial number of branches, and has anastomoses with the contralateral uterine artery, the blood supply of the uterus is not constantly spread. [5] The location of placental implantation and then placenta location inside the uterus are significant elements of placental blood source and therefore the fetal and maternal outcomes. [6]

Several studies described that placental location has special effects on pregnant females like preterm birth[7], intrauterine growth retardation (IUGR), fetal malposition, malpresentation, and the development of hypertension. [8,9] The anterior placental location was demonstrated to be associated with increased risks of fetal intrauterine growth retardation and when the placenta is situated in the fundus zone transport the risk of early separation of the membrane is higher.

Studies on the idea that connections between FGR and the placental location are conflicting. [10] The placenta attaches to the uterus wall, and the fetal umbilical cord arises from it. The organ is commonly attached to the top, front, or back of the uterus. In rare cases, the placenta might attach to the lower part of the uterus. When this occurs, it is called a low-lying placenta (placenta Previa). [11]

Ultrasound biometry of the fetus is now the gold standard for assessing fetal growth. The measurements most used are the biparietal diameter, head circumference, abdominal circumference, and femur length. Percentiles have been established for each of these parameters, and fetal weight can be calculated. Accurate dating of the pregnancy is essential in the use of any parameter. [12]

In the past two decades ultrasonography has proved to be the safest, easiest and the most accurate method for assessing placental location. [12]

It has been shown that in humans, both uterine arteries supply

the corresponding side of the uterus through its branches. Although anastomoses be seen the twin uterine arteries exist, there is no proof that these are functional. [12]

When the placenta is centrally located, the utero placental blood flow needs are met by equal contribution from both uterine arteries. However, when the placenta is laterally located, in most of the patients, the utero placental blood flow needs are met primarily by one of the uterine arteries, with some contribution by the other uterine artery via collateral circulation. [13]

This degree of collateral circulation, however, may not be the same in all patients and deficient contribution may facilitate the development of preeclampsia, FGR or both.

This study is designed to find the incidence of the above-mentioned placental sites in the third trimester and investigate the relationship between placental location and FGR.

2. Literature Survey

Goddard Kalanithi et al conducted a study, **Placental Localization and Perinatal Outcome** at Yale University School of Medicine, Connecticut, United States in 2015 concluded that pregnancies with IUGR had four times more likely to have lateral placental location compared to anterior location.[14]

Zia S conducted a study, **Placental location and pregnancy outcome** in 2013 concluded that Anterior placental implantation is associated with an increased risk of pregnancy-induced hypertension, gestational diabetes mellitus, placental abruption, intrauterine growth retardation and intrauterine foetal death. Placental location may be an important determinant of pregnancy outcome. [15]

Lucy E. G. Kalanithi et al conducted a study, **Intrauterine Growth Restriction and Placental Location** at Yale-New Haven Hospital, New Haven, Connecticut USA in 2008 concluded that pregnancies with IUGR were nearly 4 times as likely to have lateral placentation (OR, 3.8; 95% CI, 1.3–11.2) in the second trimester compared with anterior and posterior placentation. [4]

Megann EF et al conducted a study, **Second trimester placental location as a predictor of an adverse pregnancy outcome** in 2007 concluded that an increased risk of IUGR has been reported for both high lateral implantations and low implantations. The risk of developing preeclampsia was not increased in this investigation by the site of placental implantation.[16]

3. Methods

Operational definitions:
Ultrasonography will be performed on the Ultrasonography machine using a curvilinear probe of 3-5 MHz. FGR will be diagnosed by the following parameters on USG-

1) Bi-parietal diameter (BPD)
2) Head circumference (HC)
3) Femur length (FL)
4) Abdominal circumference (AC)
5) Estimated Fetal weight (EFW)

Bi parietal diameter — It extends between the two parietal eminences. The BPD is measured from the outer edge of the cranium nearest the transducer to the inner edge of the cranium farthest the transducer.[17]

The HC is the length of the outer perimeter of the cranium, made on the same transaxial image of the fetal head. It can be measured using an electronic ellipse available on most ultrasound scanners.

The fetal AC is the length of the outer perimeter of the fetal abdomen, measured on transverse scan at the level of the stomach and intrahepatic portion of the umbilical vein.[17]

Femur length —the transducer must be aligned to the long axis of the diaphysis; this can be ensured by demonstrating that the femoral condyles are simultaneously in the plane of section. The cursors should be positioned at the junction of the bone with the cartilage, and the thin, bright reflection of the cartilaginous epiphysis should not be included in the measurement.[17]

When an ultrasound is performed in the third trimester, best estimates of gestational age and fetal weight should be established. The gestational age may be based on a prior ultrasound, clinical dating criteria or current measurements; fetal weight is always calculated from current measurements. The two values should be cross assessed to determine whether the fetus is appropriate in size for dates.

Standards for mean EFW as per respective gestational ages in Asian population.[18]

Gestational Age, as reported in the National Institutes of Child Health and Human Development (NICHD) Fetal Growth Studies- cont'd

Gestational Age (wk)	Percentile						
	3rd	5th	10th	50th	90th	95th	97th
31	1318	1355	1414	1642	1908	1991	2047
32	1467	1508	1574	1830	2129	2222	2284
33	1620	1667	1740	2026	2360	2464	2534
34	1778	1829	1911	2229	2600	2717	2795
35	1938	1995	2085	2438	2851	2980	3067
36	2100	2162	2262	2653	3111	3255	3352
37	2259	2327	2437	2869	3376	3536	3644
38	2408	2483	2606	3077	3637	3814	3933
39	2539	2611	2752	3269	3884	4078	4210
40	2643	2731	2878	3434	4105	4318	4462

Estimated Fetal Weight (g), Asian Gestational Age (wk)	3rd	5th	10th	50th	90th	95th	97th
10	10	18	19	20	24	30	31
11	26	27	28	30	34	41	43
12	36	38	39	43	47	55	58
13	51	53	54	58	63	74	77
14	66	68	71	76	83	97	101
15	86	88	92	98	108	125	131
16	110	113	118	125	138	160	167
17	139	143	149	158	173	202	211
18	172	177	185	197	215	250	261
19	211	217	227	242	264	307	321
20	257	264	275	293	320	373	389
21	308	317	331	352	385	447	467
22	367	378	394	418	458	532	556
23	434	446	466	495	541	628	656
24	509	522	546	580	634	737	769
25	594	611	637	676	740	859	896
26	690	709	740	786	859	997	1040
27	796	818	853	906	990	1149	1199
28	913	938	978	1041	1136	1318	1375
29	1039	1068	1114	1184	1293	1501	1566
30	1175	1208	1260	1340	1463	1698	1772

Statistical analysis:
Data was collected by using a structure proforma. Data entered in MS excel sheet and analysed by using SPSS 24.0 version IBM USA. Qualitative data was expressed in terms of proportions. Quantitative data was expressed in terms of Mean and Standard deviation. Association between two qualitative variables was seen by using Chi square/ Fischer's exact test. A p value of <0.05 was considered as statistically significant whereas a p value <0.001 was considered as highly significant.

4. Results and Discussion

We included total 1000 antenatal women coming to tertiary care centre in the third trimester. Out of 1000 women, majority were from 21-30 years age group i.e. 74.8% followed by 20.9% from less than 20 years and 4.3% from above 30 years age group.

Dhingra S. et al[19] in 2019 conducted the study in Salem district of Tamil Nādu. After informed consent, 200 women with singleton pregnancy of ≥28 weeks attending antenatal OPD were included in the study. The mean age of the study participants was 24.3 ± 4.3 years. They reported the age wise distribution as follows: <20 years - 7%, 20-25 years - 63%, 26-30 years - 21% and >30 years - 9%.

Distribution according to gestational age of the study population showing the results as follows: 28-29 weeks - 5.1%, 29-30 weeks - 6.1%, 30-31 weeks - 6.9%, 31-32 weeks - 5.3%, 32-33 weeks - 5.1%, 33-34 weeks - 5.8%, 34-35 weeks - 10.2%, 35-36 weeks - 17.5%, 36-37 weeks - 14.9%, 37-38 weeks - 9.8%, 38-39 weeks - 7.5%, 39-40 weeks - 4.3%, 40-41 weeks - 1.1% and 41-42 weeks - 0.4%.

Most of the pregnant females came for routine third trimester antenatal scans in 34 – 37 weeks.

USG screening of 1000 ANC women in their third trimester revealed that majority of the women had anterior location of placenta i.e. 43.5% followed by posterior location in 26.9%, fundal location in 14.3%, left lateral in 9.9% and right lateral in 5.4%.

Kalanithi LE et al[2] in 2007 reported that 35.8% had anterior location, 31.3% had posterior location, 9% had fundal and 17.9% had lateral location.

Erdolu MD et al[20] conducted a study in 2015 among 500 healthy pregnant women and reported that 54.6% had anterior location whereas 45.4% had posterior location.

Dhingra S. et al[19] reported that out of the 200 women, 42% (n=84) of placenta were situated in fundus, 30% (n=60) were anterior, 18% (n=36) were lateral, 8% (n=16) were posterior and 2% (n=4) were low lying.

Seckin KD et al[21] in 2015 stated that out of 1,057 patients, 87.4% (n-919) had centrally located placentas and 12.6% (n-133) had laterally located placentas.

Nair VV et al[22] conducted a study in 2019 among 450 pregnant women and reported frequency of laterally located placentas to be 16.2% and central located placentas to be 83.8%

Singh et al[23] conducted a study in 592 pregnant women in which anterior placentas were 18.7%, posterior placentas being 14.5%, fundal placentas were 28.5% and lateral placentas were 17.7%.

Granfors et al[14] conducted a study in 74087 pregnant women in which anterior placentas were 47.8%, fundal placentas were 3.3%, posterior placentas were 46.4% and lateral placentas in 2.5%.

Proportion of normal cases with anterior placental location were 44.1% as compared to 41.8% FGR cases showing no statistically significant difference (p>0.05). Proportion of normal cases with fundal placental location were 14.9% as compared to 12.5% FGR cases showing no statistically

significant difference (p>0.05). Proportion of normal cases with left lateral placental location were 9.1% as compared to 12.1% FGR cases showing no statistically significant difference (p>0.05). Proportion of normal cases with posterior placental location were 27.3% as compared to 25.8% FGR cases showing no statistically significant difference (p>0.05). Proportion of normal cases with right lateral placental location were 4.6% as compared to 7.8% FGR cases showing statistically significant difference (p<0.05).

Kalanithi LE et al[2] in 2007 conducted the study with the objective to determine whether an association exists between intrauterine growth restriction (IUGR) and second-trimester placental location. Most common placental locations in the second trimester were anterior and posterior. The distribution of placental location as determined at 16 to 20 weeks' gestation differed significantly between the 2 groups.

IUGR pregnancies were nearly 4-fold more likely to have lateral placentation (odds ratio, 3.8; 95% confidence interval, 1.3-11.2) compared with anterior or posterior placentation.

The most common placental location in both IUGR cases and non-IUGR controls was anterior, accounting for roughly one third in the IUGR group and half in the non-IUGR group. Lateral placentas were significantly more common in the IUGR group than in the non-IUGR group (17.9% [12/67] versus 5.9% [12/205], respectively; P = .047).

Seckin KD et al[21] in 2015 conducted the study with the objective to evaluate the relationship between placental localisation and perinatal outcomes. The patients were divided into two groups according to the placental locations (central and lateral) in their routine sonographic findings between the 18- and 24-weeks' gestation. Out of 1,057 patients, 87.4% (n-919) had centrally located placentas and 12.6% (n-133) had laterally located placentas. FGR was present in 13.5% of lateral placental locations whereas 7.9% of central locations.

Nair VV et al[22] conducted a study in 2019 among 450 pregnant women and reported significant correlation between IUGR and left lateral placental location.

Singh et al[23] in 2016 found significant correlation between IUGR and lateral placenta with p value <0.0018.

Granfors et al[14] stated that IUGR was more common in fundal and lateral locations of the placentas than the anterior and posterior location in pregnant females.

Amer MB et al[24] reported that there is a significant association between placental location and IUGR;27% of anterior placenta have IUGR and 0% of fundal placenta have IUGR while 14% of posterior placenta have IUGR.

On the contrary, a current study of >3000 pregnancies define the danger of consuming IUGR fetus not increased by placental implantation location. [25]

Warland et al[26] described that placental location either posteriorly and anteriorly is more likely to consequence in stillbirth. Its exact reason is unknown. Many studies have shown a significant association of anterior placenta with high occurrence of hypertension, DM, abruption placenta, IUD, and IUGR, and no significant association between placental location with hypertension and intrauterine demise. [24]

Prevalence of FGR in this study was 25.6%

5. Conclusion

In this study we observed

- Most common placental location in our study was on anterior wall.
- Prevalence of FGR was 25.6%
- There was significant association of right lateral placental location with FGR (p<0.05)

6. Future Scope

This study provides early recognition of risk of fetal growth restriction based on placental location, which can be determined early in pregnancy. Patients with potential risk of developing fetal growth restriction can be followed up frequently and monitored.

This research was carried out as a cross-sectional study. However, further studies can include prospective data collection with placental localization at second trimester and presence of fetal growth restriction during third trimester or after birth.

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