DETERMINING THE NORMAL VALUES OF MYOCARDIAL PERFORMANCE INDEX OF FETUS AND ITS SIGNIFICANCE IN INDIAN POPULATION

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ABSTRACT

Introduction: The use of radiology, especially ultrasonography, is widely prevalent in obstetric care worldwide. Ultrasonography studies during pregnancy are used to identify fetal abnormalities that may impact the health of the fetus as well as that of the child post- delivery.

Aims: To determine the normal values of fetal Myocardial Performance Index (MPI) and lay down its importance in the cardiac workup of foetuses.

Materials and Methods: This is a Hospital based observational Prospective Study. It's conducted from 1st April 2021 to 30th September, 2022 at Department of Radio-diagnosis in collaboration with Department of Obstetrics & Gynecology, Burdwan Medical College and Hospital. 115 patients were include in this study.

Result: Among 115 mothers, 53.9% were primi-gravida, 33.9% were 2nd gravida and rest 12.2% were 3rd gravida, 57.4% undergo Normal vaginal delivery, 17.4% undergo vaginal delivery with induction and 25.2% undergo caesarean section and among 115 babies 82.6% had normal birth weight rest 17.4% were low birth weight babies.

Conclusion: We conclude that myocardial performance index is a better predictor of adverse perinatal outcome than an abnormal IVCT or IVRT. Best results are obtained when MPI is used, rather than IVCT, IVRT and ET separately. In our study MPI had the highest sensitivity of 88.8% in predicting adverse fetal outcomes and 92.3% in predicting perinatal mortality. If the MPI ratio is normal, the fetus is unlikely to have major adverse outcome. This information would be reassuring to parents and referring obstetricians and in addition the fetus would not require intensive surveillance. Doppler patterns follow a longitudinal trend with early changes in the E/A ratio with advancing gestational

ages. Fetal heart rate shows a declining trend with increasing gestational age. There was no statistically significant correlation between gestational age with MPI, ICT, IRT and ET.

Keywords: Ultrasonography, Diabetes, GDM and Pregnancy.

INTRODUCTION

The use of radiology, especially ultrasonography, is widely prevalent in obstetric care worldwide. Ultrasonography studies during pregnancy are used to identify fetal abnormalities that may impact the health of the fetus as well as that of the child post- delivery [1] The well-being of the pregnant woman and the growing fetus can identify and predict adverse maternal conditions using appropriate radiology and imaging studies, including Doppler studies and placental studies. Radiological assessments and imaging therefore are supplement the obstetric decision making around childbirth.

Doppler ultrasound has been in obstetrics since 1977 to study fetoplacental (umbilical) and since 1980s to study the uteroplacental (uterine artery) circulation. [2] Doppler ultrasound provides a non-invasive method for the study of fetal hemodynamics. Doppler US was first used in obstetrics when the examiner could hear flow in the umbilical cord using continuous-wave Doppler US. With the advent of B mode US and pulsed-wave Doppler US, it became possible to see specific vessels and to sample waveforms, providing a window into the fetal circulation. [3] MPI is evolving as an important predictor of adverse pregnancy outcome, and its implications include maternal diabetes, TTTS, congenital heart malformations, pre-eclampsia, IUGR, and other fetal conditions. [4]

Diabetes mellitus is a heterogenous group of disorder which are characterised by chronic hyperglycaemia resulting from diverse group of etiology such as environmental and genetic factors acting simultaneously or jointly. Diabetes mellitus is the most common metabolic disorder complicating pregnancy.

The prevalence of type 2 diabetes is rising at an alarming rate especially in Asia. A recent report by the International Diabetes Foundation projected that, by 2030, up to 438 million people may be affected by type 2 diabetes, accounting for more than 4.5% of the world's projected population.[5] International Diabetes Federation estimates that 16.2% of women with live births had hyperglycaemia in pregnancy, gestational Diabetes Mellitus (GDM) contributed to 85%. Diabetes is a major health problem in India, with prevalence rates reported 4.6%-14% in urban, and 1.7%-13.2% in rural areas.[6]

According to American College of Obstetricians and Gynaecologists (ACOG), U.S. Preventive Services Task Force recommends GDM screening at or after 24 weeks of gestation (level B evidence) using the 50g no fasting glucose challenge test, while women at increased risk of diabetes (family history of diabetes mellitus, ethnicity, and hypertension) are to be tested at the first antenatal visit. GDM is diagnosed by oral glucose tolerance test (OGTT) a 100 g fasting test for those with positive screening (>130-140 mg/dL). Another screening method is a one-step 75 g 2-hour fasting OGIT.[7]"One of the physiologic changes in pregnancy is associated with proliferation of the beta cell of the pancreas that leads to a surge of insulin in fasting and postprandial states; however, in the last trimester the placenta secretes hormones that increase insulin resistance. Therefore, gestational

diabetes is a state of glucose intolerance where beta cells during pregnancy cannot compensate for the insulin resistance. This state can compromise maternal-fetal outcome and increase the risk of complications during the pregnancy. Nowadays more and more younger people are affected such as pregnant women. This is particularly important, since diabetes may not just affect the health of the pregnant lady, but also affect substantially the health of the next generation. Recent evidence also suggested that the prevalence of gestational diabetes (GDM) itself is rising. Possibly in parallel with the increasing prevalence of type 2 diabetes.

GDM is recognized as a risk factor for a number of adverse outcomes during pregnancy including pre-eclampsia, caesarean section, and fetal macrosomia, increased incidence of birth trauma due to macrosomia and shoulder dystocia, and neonatal metabolic abnormalities such as neonatal hypoglycaemia. Maternal GDM is further more associated with long-term adverse consequences in the offspring and subsequent generations, in particular GDM is an important driver of the escalating global burden of diabetes and cardiovascular disease. [8] Women, previously known to have GDM, are at a higher risk of developing it in subsequent pregnancies and even type 2 diabetes mellitus later in life. Due to the increased risk of complications that may arise from GDM that can range from hypertension to fetal growth changes ultrasonography has been used to guide the management of GDM. In this review, the objective is to understand the importance of ultrasonography and its contribution in understanding and managing GDM.

MATERIALS & METHODS

STUDY DESIGN: Hospital based observational Prospective Study.

STUDY AREA: Department of Radio-diagnosis in collaboration with Department of Obstetrics & Gynecology, Burdwan Medical College and Hospital

STUDY POPULATION: The study will be done on patients clinically diagnosed as singleton Normal pregnancy, referred from the Dept. of Obstetrics and Gynecology, Burdwan Medical College and Hospital. They will be subjected to ultrasound and fetal echocardiography.

PERIOD OF STUDY: From 1st APRIL 2022 to 30th SEPTEMBER, 2023

SAMPLE SIZE: 115

METHOD OF DATA COLLECTION:

- Detailed history taking
- Clinical examination
- Ultrasound and fetal echocardiography
- First 2 steps are to be done in Obstetrics and Gynecology OPD and Indoor. Pregnant women with singleton pregnancy are to be taken up for study when they are referred for ultrasound and echocardiography assessment.
- These women will be referred for fetal echocardiography either due to a family

history of heart disease or due to some abnormal finding on routine level-two ultrasound.

- Myocardial performance index will be calculated thrice for the study population, once in 2nd trimester then successively after 8weeks twice.
- Perinatal outcome

INCLUSION CRITERIA:

- Pregnant women with singleton pregnancy whose fetuses were shown to have a normal echocardiogram according to international standards.
- Gestational age: 2nd and 3rd Trimester.

EXCLUSION CRITERIA:

- Patients with congenital anomaly of fetus, multiple gestations.
- Patients those who are not getting booked for delivery at Burdwan Medical college, Purba Bardhaman, West Bengal.
- Patients with unreliable LMP details and not confirmed by early ultrasound.
- History of preeclampsia or eclampsia in previous pregnancy.
- Pre-existing medical disorders like:
  - Diabetes
  - Hypertension
  - Epilepsy
  - Autoimmune diseases
  - Coagulopathy
- Pregnant females with acute complications of pregnancy: Antepartum hemorrhage, Toxemia of pregnancy.
- Extremes of age (<20 years and >35 years)

RESULT AND DISCUSSION

Table 1: Distribution of the study population according to Mode of delivery

Mode of delivery	Frequency	Percent
Caesarean Section	29	25.2
Normal Delivery	66	57.4
Vaginal Delivery (induction with PGE1)	20	17.4
Total	115	100

Table 2: Parameters of the Present study

Parameters	Time intervals (mean ± SD)
Isovolumetric contraction time	39.18±4.92
Isovolumetric relaxation time	46.63±8.04
Ejection time	172.42±12.82
Myocardial performance index	0.50±0.08
Mitral valve E velocity	28.93±2.58

Mitral valve A velocity	49.91±4.28
E/A	0.58±0.03
Fetal heart rate	128.69±7.24
PR interval	118.92±4.10

Table 3: Correlation between E/A and Gestational age

Gestational Age	**EA**			**Pearson correlation coefficient (r)**	**Significance**
	P5	**P50**	**P95**		
1st visit (16-24 wks)	0.5	0.56	0.59	0.833	**<0.0001**
2nd visit (25-32 wks)	0.51	0.57	0.6	0.831	**<0.0001**
3rd visit (33-40 wks)	0.53	0.58	0.61	0.659	**<0.0001**

Table 4: Distribution of the study population according to NICU admission

NICU admission	**Frequency**	**Percent**
Not admitted In NICU	91	79.1
Death after admission	5	4.3
Discharged after admission	19	16.5
Total	115	100

Table 5: Distribution of the study population according to birth weight (n=115)

Birth weight in kg	**Frequency**	**Percent**
1.0 - <1.5	3	2.6
1.5 - <2.0	6	5.2
2.0 - <2.5	11	9.6
>=2.5	95	82.6
Total	115	100.0

Table 6: Distribution of the study population according to NICU admission (n=115)

NICU admission	**Frequency**	**Percent**
Not admitted In NICU	91	79.1
Death after admission	5	4.3
Discharged after admission	19	16.5
Total	115	100.0

TABLE 7: Comparison of Diagnostic Accuracies

Parameters	**Present study**	**Ebru Alici Davutoglu**
MPI	72.7%	80.0%
IVRT	71.4%	73.3%
IVCT	58.0%	58.6%
ET	41.6%	42.4%

Among the 115 mothers 13.9% were up to 20 years of age, 34.8% belongs to 21to25 years, 35.7% belongs to 26 to 30 years and 15.7% belongs to >30 years age groups.
Among the 115 antenatal mothers, most of them were Muslim (52.2%) followed by Hindus (40.0%).
Among 115 mothers, 53.9% were primi-gravida, 33.9% were 2nd gravida and rest 12.2% were 3rd gravida
Gestational age and E/A has statistically significant positive correlation in all the trimester as Pearson Correlation Co-efficient (r) are 0.833, 0.831 and 0.659 and p value <0.0001, so E/A increased with increased Gestational age
Throughout gestation, the Mod-MPI slightly increased. Of the three components, ICT remained constant, IRT increased, and ET slightly decreased. The median time of MPI acquisition was 3 min
Among 115 babies 82.6% had normal birth weight rest 17.4% were low birth weight babies
Among 112 live births babies 24 (20.9%) required NICU admission. After admission 5 died and 19 babies were discharged from NICU after treatment
The diagnostic accuracy of Myocardial Performance Index is more than either IVCT, IVRT or ET, and in comparison, it is less than that of Ebru Alici Davutoglu *et. al.*
Sensitivity: The highest sensitivity in present study is seen in MPI (88.8%) followed by IVRT (81.6%).
Specificity: IVRT has highest specificity (84.7%), closely followed by IVCT (68.4%) and MPI (62.1%) among different indices. Indices with high specificity are required for confirmation of diagnosis.
Positive Predictive Value: IVRT has highest positive predictive value (46.8%) whereas ET has lowest (32.9%) among different indices.
Negative Predictive Value: MPI has highest negative predictive value (91.8%) whereas IVCT has lowest (63.3%) among different indices.
The Diagnostic Accuracy: It is also highest for Myocardial Performance Index (72.7%) followed by IVRT value (71.4%) and least for ET values.
Distribution of Isovolumetric Contraction Time among pregnancies

DISCUSSION

In this study, 115 antenatal mothers were examined and subjected to ultrasound evaluation starting from the early 2nd trimester and serially examined thrice at an interval of 8 weeks and followed up to record the perinatal outcome upto 7 days after delivery.
Maximum number of pregnant women was in the age group of 26-30 (35.7%) with mean age 26.5 years and ranged from 18-34 yrs. The earliest study was done at 16th week of gestation. In mothers who were examined for the first time, the gestational age of the fetuses ranged between 16-24 weeks
During the second visit, the gestational age of the fetuses ranged between 25-32 weeks. The earliest study was done at 25th week of gestation
In majority of the antenatal mothers 54% were primi gravida, followed by 34% who were 2nd gravida. 12% were 3rd gravida

PARITY:

In majority of the antenatal mothers 54% were primi gravida, followed by 34% who were 2nd gravida. 12% were 3rd gravida.

MODE OF DELIVERY:

In majority of expectant mothers (57.4%) had spontaneous vaginal delivery, followed by 25% who required caesarean section due to fetal compromise and distress. 17% had undergone induced delivery.

TABLE 8: Comparison of Elevated Ivrt3 in Predicting Adverse Perinatal Outcome

Study	Sensitivity	Specificity	PPV	NPV
Ebru Alici Davutoglu[9]	68%	98.4%	94.4%	88.0%
Present study	50.9%	84.4%	46.6%	64.5%
Ebru Alici Davutoglu[9]	41%	63.6%	40%	23.3%
Present study	46.6%	62.1%	32.9%	74.5%

The present study was compared with the study of Ebru Alici Davutoglu and coworkers.

According to the study done by Ebru Alici Davutoglu[85] and co-workers it was reported that MPI was more accurate than each of its components in the diagnosis of perinatal morbidity and compromise. The IVRT had 68% sensitivity,98.4% specificity, 94.4% PPV and 88.0% NPV in predicting adverse perinatal outcome In my study the IVCT had 50.9% sensitivity, 84.4% specificity, 46.6% PPV and 64.5% NPV.

Table 9 : Comparison of left ventricular MPI of various studies with Present study (n=115)

Study	No of patients	Left ventricular MPI
Friedman *et al* [10]	74	0.53±0.13
Eidem *et al*.[1]	125	0.36±0.06
Tsutsumi *et al*.[12]	135	0.43±0.03
Present study	115	0.46±0.03 (2nd trimester) 0.50±0.08 (3rd trimester)

Among total pregnancies (n=115), 48 (41.7%) had elevated IVCT3 values and 67 (58.2%) had normal IVCT3 values.

Out of 48 elevated IVCT3 values, 46 babies were born preterm and 2 babies were born at term.

Among total pregnancies (n=115), 40 (34.7%) had elevated IVRT3 values and 75 (65.2%) had normal IVRT3 values.

Out of 40 elevated IVRT3 values, 30 babies were born preterm and 10 babies were born at term.

Distribution of Ejection Time among pregnancies

Among total pregnancies (n=115), 34 (29.7%) had elevated ET3 values and 81 (70.4%) had normal ET3 values.

Out of 34 elevated ET3 values, 24 babies were born preterm and 10 babies were born at term

Distribution of Myocardial Performance Index among pregnancies

Among total pregnancies (n=115), 56 (48.6%) had elevated MPI3 values and 59 (51.3%) had normal MPI3 values.

Out of 56 elevated MPI3 values, 51 babies were born preterm and 5 babies were born at term

TABLE 10: Comparison of Reduced Et3 in Predicting Adverse Perinatal Outcome

Study	Sensitivity	Specificity	PPV	NPV
Ebru Alici Davutoglu[9]	41%	63.6%	40%	23.3%
Present study	46.6%	62.1%	32.9%	74.5%

The present study was compared with the study of Ebru Alici Davutoglu[85] and coworkers.
According to the study done by Ebru Alici Davutoglu and co-workers it was reported that MPI was more accurate than each of its components in the diagnosis of perinatal morbidity and compromise. The IVRT had 41% sensitivity, 63.6% specificity, 40% PPV and 23.3% NPV in predicting adverse perinatal outcome.
In my study the IVCT had 46.6% sensitivity, 62.1% specificity, 32.9% PPV and 74.5% NPV

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