Original Article

Modified Myocardial Performance Index for Evaluation of Intra Uterine Growth Restriction Fetal Outcome

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ABSTRACT

Objectives: To assess the utility of the Modified Myocardial Performance Index in assessing the in utero Mod MPI of IUGR fetuses in order to optimize neonatal outcomes by determining the optimal timing to deliver the baby.

Methods: Our present study was conducted on 100 pregnant ladies and they were divided into 2 groups: Group 1: Patients with IUGR include 50 pregnant ladies diagnosed with IUGR fetuses. Group 2: Control group include 50 pregnant ladies with healthy uncomplicated pregnancy. After recruitment, the mother and the fetus were subjected to sonographic evaluation of fetal biometry, EFW, AFV, fetal ultrasound Doppler study of UA, MCA, fetal Echocardiography to detect mod-MPI, DV.

Results: Our study revealed a significant increase in Tei index and MCO/ ms among cases group .while ET/ms shows significant decrease among cases group than control group. Cut-off Mod-MPI value of 0.505 conferred a sensitivity of 81.2% [confidence interval (CI): 95%] and specificity of 83.7% (CI: 95%) and for validity of Doppler findings in differentiating IUGR indicating that Mod-MPI can be used as good predictor for IUGR.

Conclusion: Mod-MPI was elevated in fetuses with fetal growth restriction. It may be possible to foresee unfavorable perinatal outcomes for FGR fetuses using mod-MPI.

Key Words: Doppler, IUGR, Mod-MPI, tei index.

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INTRODUCTION

10% of pregnancies are, by the description, affected by the common obstetric issue known as intrauterine growth restriction (IUGR). IUGR is a significant contributor to prenatal mortality and morbidity, which can result in physical impairments, cerebral palsy, and other adult-onset effects[1].

According to reports, cardiomyopathy is a reliable marker of the advancement of IUGR; in these babies, it begins during the early phases of fetal growth restriction and worsens as fetal impairment advances[2].

Symphyial fundal height (SFH), fetal biometry using Hadlock's formula, amniotic fluid volume (AFV) for the recognition of late-onset IUGR, and fetoplacental Doppler study—which is helpful for detection but unreliable for screens alone—are the methods used to diagnose intrauterine growth reflux (IUGR). The strongest and most sensitive Doppler parameter for predicting imminent fetal death in early-onset FGR is Ductucs venosus (DV) Doppler. Only when fetal distress has progressed can the DV waveform turn aberrant[3].

A Doppler-derived index was suggested by Tei *et al*. in 1995 as a means of evaluating global heart function. The heart rate, valve status, easily obtained Doppler-derived index, which incorporates aspects of the heart's systolic and diastolic activity, did not significantly alter this index. This index shows promise as a noninvasive tool and is correlated with the cardiac patient's longevity and complaints. This index is employed in the pediatric and adult cardiac populations. Tei-index (MPI) is used to measure fetal cardiac adaptation mechanism to hypoxia, which begin withearly onset IUGR and grows with the degradation of fetal hypoxic state[4].

In growth-restricted babies, umbilical and middle cerebral artery (MCA) Doppler does not always forecast the perinatal fate. Furthermore, aberrant MCA Doppler in IUGR may indicate a hypoxemia in its early stages in fetuses that still have savings, enabling them to survive the strain of vaginal delivery. Given the likelihood of embryonic survival less than one week after the discovery of Ductus Venosus, the identification of absent or inverted atrial contraction wave may likewise come too late for therapy[5].

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The valve click Echo Doppler was used to generate a modified myocardial performance index (Mod-MPI), which reduces the variance of the usual range. Left ventricular Mod-MPI was obtained in a single, four-chamber image of the heart; it was simple to compute and get, and it was used to assess embryonic heart activity[6].

Fetal MPI is normally tested using conventional pulsed Doppler; however, the use of tissue Doppler imaging (TDI) for assessment of MPI might enhance the sensitivity in the detection of mild fetal cardiac failure . TDI is an echocardiographic method that measures the velocity and time movement of the myocardial wall by applying the Doppler principle. Nonetheless, there are a number of technical issues and restrictions with the TDI method. There is ongoing debate on the best time to deliver a baby in a pregnancy compromised by IUGR. The hazards of preterm (if delivery is planned too early) and lethal hypoxemia (if intervention is made too late) are typically taken into consideration when making this choice[7].

The purpose of this research is to assess the utility of the Modified Myocardial Performance Index in assessing the in utero Mod MPI of IUGR fetuses in order to optimize neonatal outcomes by determining the optimal timing to deliver the baby.

SUBJECTS AND METHOD

Study design

This case control comparative study was carried out at Mansoura university hospital (MUH), obstetrics and gynecology departments between June 2017 to June 2019 and it was conducted on a sample of 100 Pregnant ladies, Divided into two groups:

- The 1st group (study group): composed of 50 pregnant lady diagnosed with IUGR fetuses.
- The 2nd group (control group): composed of 50 pregnant lady with healthy uncomplicated pregnancy.

Inclusion criteria of study group

Maternal age between 20 & 35 yrs, Spontaneous pregnancy, Singleton pregnancy, Gestational age at screening between 28-34 wks , Non-anomalous pregnancy, Diagnosis of IUGR based on ultrasound measurement of fetal biometry as EFW <10th percentile or AC < 10th percentile for appropriate gestational age according to Hadlock`s formula.

Exclusion criteria of study group

Fetal abnormality as cardiac anomaly and skeletal anomaly, Multiple pregnancies, Hydropic fetus, Chromosomal abnormality, Cervical dilatation, PPROM, Intrauterine infection, Fetal heart rate abnormality, Maternal condition indicates premature delivery (eclampsia, uncontrolled DM, sever APH).

Informed consent

An oral informed consent was obtained from both groups after a complete description of the study to the participants. The general principles that were explained to them were Participation in the study is totally free and voluntary. Results of the study could be used as a scientific publication, but the identities of the participants will be absolutely confidential except from the principle investigator and supervising professors.

Subjects

A total number of 143 pregnant ladies underwent screening for the eligibility and were recruited from abovementioned sites. After recruitment, the mother and the fetus were subjected to full history taking, clinical examination, sonographic evaluation of fetal biometry, EFW, AFV, fetal ultrasound Doppler study of UA, MCA, fetal Echocardiography to detect mod-MPI, DV. Gestational age was confirmed and documented by sure LMP or early documented first trimester scan. A 50 pregnant ladies meet the abovementioned inclusion criteria of the control group, 93 pregnant ladies were diagnosed with IUGR, but, 17 ladies refused to complete the full examination and fetal Echocardiography, 3 patients diagnosed with twin pregnancies so, were excluded, 15 patients were excluded due to decompensated maternal diseases and 8 patients were excluded due to fetal congenital malformation so, 50 pregnant ladies meet the abovementioned criteria of the study group.

Methods

Antenatal examination included

Full history taking: including menstrual history, obstetric history, and medical disorder. Examination: general examination and abdominal examination (SFH). Full laboratory investigation. Ultrasound examination: fetal biometry, AFV, BPP, detailed anatomy scan to roll out fetuses with congenital anomaly, multi-vessel Doppler study. Fetal echocardiography to measure Mod.MPI of left ventricle: obtained by placing Doppler sample volume in an apical four-chamber view on the lateral wall of ascending aorta near both aortic and mitral valve, measuring ICT, IRT and ET. Calculating Mod_MPI of left ventricle by the sum of (ICT+IRT)/ET. Other antenatal surveillance: investigation for PET, Gestational DM, TORCH, CTG, BPP. All patients underwent ultrasonographic examination using a (Samsung HS40 machine) Mansoura sonoschool MUH outpatient clinic. Fetal biometry was calculated by

Hadlock's formula. Amniotic fluid was assessed by deepest vertical pocket. Doppler and MPI for each patient and the mean was used as a final measurement. Left ventricular cardiac function was assessed in the study and control groups using the modified MPI or Tei index.

Using the pulsed Doppler, the left ventricular MPI was obtained by the landmarks of the clicks of the mitral and aortic valves, as previously described by Hernandez-Andrade *et al*.[8]. An apical 4 chamber heart view was used to obtain the best view of lateral wall of left ventricle both aortic and mitral valve. Modified MPI is obtained by placing the Doppler sample volume on the medial wall of the ascending aorta including the AV and MV, hence the movements of both valves are recorded simultaneously in the Doppler spectrum through measurements of the isovolumetric contraction time (ICT), isovolumetric relaxation time (IRT) and ejection time (ET). The isovolumetric contraction time (ICT) was measured from the closure of the MV to the opening of the AV, the ejection time (ET) from the opening to the closure of the AV, and the isovolumetric relaxation time (IRT) from the closure of the AV to the opening of the MV. The MPI (Tei index) was calculated using the following equation: MPI= (ICT + IRT)/ET, as in (Figure 1).

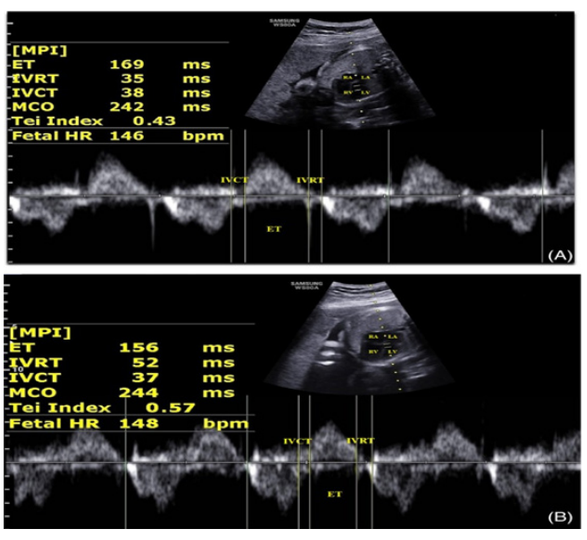

Fig. 1: Mod-MPI measurement in normal fetus (A) and fetal growth restriction fetus (B). ET = ejection time; IVCT = isovolumetric contraction time; IVRT = isovolumetric relaxation time; LA = left atrium; LV = left ventricle; MCO = mitral valve closing and open time; MPI = myocardial performance index; RA = right atrium; RV = right ventricle

UA Doppler was considered abnormal if the UA resistance index was above the 95th percentile for gestational age and cases with absent or reversed end-diastolic flow. Left ventricular MPI was considered abnormal if it was above the mean + 2 SD for the corresponding control group[9].

At delivery, information on gestational age, birth-weight, Apgar score, need for neonatal resuscitation, need for neonatal intensive care unit (NICU) admission, mean duration of NICU stay, umbilical cord arterial pH, and perinatal death were recorded.

Ethical considerations

Study protocol was submitted for approval by IRB. Approval of the managers of the hospitals in which the study will be conducted. Informed consent will be obtained from each participant sharing in the study. Confidentiality and personal privacy will be respected in all levels of the study; data will not be used for other purposes. The study was approved by the Ethics Committee.

Statistical analysis

Data were fed to the computer and analyzed using IBM SPSS software package version 22.0. Qualitative data were described using number and percent. Quantitative data were described using median (minimum and maximum) for non-parametric data and mean, standard deviation for parametric data after testing normality using Kolmogrov-Smirnov test. Significance of the obtained results was judged at the (0.05) level. For Qualitative data Chi-Square test for comparison of 2 or more groups. Fischer Exact test was used as correction for Chi-Square test when more than 25% of cells have count less than 5 in 2*2 tables. For Quantitative data, Student t-test was used to compare 2 independent parametric variables. Mann-Whitney U test was used to compare 2 independent non-Parametric variables. Binary stepwise logistic regression analysis was used for prediction of independent variables of binary outcome. Significant predictors in the Univariate analysis were entered regression model using forward Wald method. Adjusted odds ratios and their 95% confidence interval were calculated.

RESULTS

This table showing no significance difference between both groups among gravidity, parity, abortion and gestational age at examination. As regard US outcomes among the studied groups, this table shows significant decrease in cases group as regard; Average gestational age, Amniotic fluid DVP/cm, biophysical profile, EFW (Table 1).

According to neonatal outcome comparison between studied groups there was significant decrease in cases group score among APGAR 1 Min and APGAR 5 Min ($p<$ 0.001). While it shows increased NICU admission, CPAP and Vent. need among cases group (Table 2).

In (Table 3) there was a significant increase in Tei index and MCO/ ms among cases group. While ET/ms shows significant decrease among cases group than control group.

This table shows that As regards, validity of Doppler findings in differentiating IUGR from control group, MCA.PSV, MCA.PI, MCA.RI, UA.S.DRATIO, UA.RI, UA.PI, UA PSV, TEI, ET/ms and MCO/ms can be used as a predictor for IUGR. Cut-off Mod-MPI value of 0.505 conferred a sensitivity of 81.2% [confidence interval (CI): 95%] and specificity of 83.7% (CI: 95%) and for validity of Doppler findings in differentiating IUGR indicating that Mod-MPI can be used as good predictor for IUGR (Table 4).

Table 1: Comparison of patient characteristics between studied groups:

	Cases N=50	Control n=50	Test of significance
Gravidity Median (IQR) (Min-Max)	3.0(1.0-4.0) (1.0-7.0)	2.0(1.0-4.0) (1.0-10.0)	Z=0.0 *P*=1.0
Parity (IQR) (Min-Max)	1.0(0.0-2.0) (0.0-5.0)	1.0(0.0-2.0) (0.0-4.0)	Z=0.183 *P*=0.855
Abortion (IQR) (Min-Max)	0.0(0.0-1.0) (0.0-6.0)	0.0(0.0-3.0) (0.0-7.0)	Z=0.158 *P*=0.874
Gestational age at examination /weeks Mean ± SD	32.52±2.76	31.82±2.72	t=1.28 *P*=0.206
Average gestational age Mean ± SD	28.38±3.49	31.68±3.23	t=4.85 *P*<0.001*
Amniotic fluid DVP/cm Mean ±SD	2.98±1.42	5.53±1.68	t=8.19 *P*<0.001*
EFW by ultrasound Mean ± SD	1306.76±572.34	1942.78±620.47	t=5.33 *P*<0.001*
Biophysical profile Mean ± SD	6.16±1.61	7.92±0.396	t=7.51 *P*<0.001*

IQR: Interquartile range t: Student t test Z: Mann Whitney U test FET: Fischer exact test t: Student t test

Table 2: Comparison of neonatal data between studied groups:

Neonatal outcome	Cases N=50	Control n=50	Test of significance
APGAR 1 minute	5.66±1.19	8.45±0.87	t=12.94, *P*<0.001*
APGAR 5 minutes	7.66±1.08	9.31±0.47	t=9.74, *P*<0.001*
NICU admission -ve +ve	9(18.8) 39(81.2)	43(87.8) 6(12.2)	x^2=46.43 *P*<0.001*
Received treatment Normal Nasal CPAP Vent	9(18.8) 9(18.8) 13(27.1) 17(35.4)	46(93.9) 3(6.1) 0(0.0) 0(0.0)	MC *P*<0.001*
Weight at birth /gm Mean ± SD	1571.46±626.29	3190±470.82	t=14.41 *P*<0.001*
Preterm Full term or early term	37(77.1) 11(22.9)	2(4.1) 47(95.9)	x^2=53.75 *P*<0.001*
Weight Normal VLBW LBW Large for gestational age	5(10.9) 26(56.5) 15(32.6) 0(0.0)	48(98.0) 0(0.0) 0(0.0) 1(2.0)	MC *P*<0.001*

FET: Fischer exact test t: Student t test x2=Chi-Square test * Statistically significant (if *p*<0.05). MC: Monte-Carlo test

Table 3: Comparison of Tei, ET and MCO between studied groups:

	Cases N=50	Control n=50	Test of significance
Tei Mean ± SD	0.571 ± 0.064	0.471 ± 0.04	t=9.25 *p*<0.001*
ET/ms Mean ± SD	153.77 ± 18.64	188.04 ± 17.79	t=9.12 *p*<0.001*
MCO/ms Mean ± SD	263.64 ± 22.74	236.0 ± 38.12	t=4.27 *p*<0.001*

t: Student t test * statistically significant (if *p*<0.05)

Table 4: Validity of Doppler findings in differentiating IUGR from control group:

	AUC (95% CI)	*P*	Cut off point	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
MCA.PSV	0.720 (0.590-0.850)	0.004*	49.55	78.4	58.3	74.4	63.6	70.5
MCA.PI	0.811 (0.697-0.925)	<0.001*	1.715	76.3	70.8	80.6	65.4	74.2
MCA.RI	0.774 (0.650-0.897)	<0.001*	0.80	82.5	66.7	80.5	69.6	76.6
UA.S.DRATIO	0.881 (0.808-0.953)	<0.001*	2.79	81.6	73.3	72.1	82.5	77.1
UA.RI	0.822 (0.731-0.914)	<0.001*	0.605	83.3	57.8	64.8	78.8	70.1
UA.PI	0.818 (0.721-0.914)	<0.001*	0.995	80.0	68.1	68.1	78.9	72.9
UA PSV	0.689 (0.577-0.802)	<0.001*	40.1	78.0	52.2	59.3	72.7	64.4
TEI	0.888 (0.824-0.952)	<0.001*	0.505	81.2	83.7	83.0	82.0	82.5
ET/ms	0.894 (0.832-0.955)	<0.001*	166.0	76.6	85.1	83.7	78.4	80.8
MCO/ms	0.763 (0.660-0.866)	<0.001*	248.0	80.9	72.3	74.5	79.1	76.6

AUC: Area Under curve. PPV: Positive predictive value. NPV: Negative predictive value. CI: Confidence interval.

DISCUSSION

The global cardiac function, which is independent of heart rate and ventricular shape, has been suggested to be predicted by the myocardial performance index (MPI).1-3 More and more fetuses are being monitored with this index to look for signs of compromise. A modified of myocardial performance index (Mod-MPI) using the start of openings and closure Doppler clicks of both the aortic and mitral valves as assessment points for identification of the various time spans has been published by Hernandez-Andrade *et al*.[8].

The Mod-MPI's usefulness in fetal evaluation is increased by its accessibility, reproducibility, and ability to be incorporated into a standard ultrasound scan. Left ventricular Mod-MPI computation is made more simpler by a single Doppler image due to the unique left ventricular structure and the valvular closeness of the mitral and aortic valves. This method is mostly utilized for fetal cardiac function testing. Higher Mod-MPI levels are linked to left ventricular failure, which has been shown to be a valid indicator of fetal heart condition in terms of early cardiac response to perinatal stressors[10].

The fetal ways of adapting to insufficient placental production and hypoxia rely heavily on the heart. Growth-restricted fetuses have cardiac abnormalities such as reduced E/A ratios, higher aortic and pulmonary peak velocities, decreased pulmonary peak velocities, and an approximate rise in left cardiac output associated with decreased right cardiac output, which improves blood flow to the brain. This indicates that the heart plays a primary role in the growth-restricted fetus's compensatory processes[11].

Therefore, the aim of the current study was to evaluate the role of using Modified Myocardial Performance Index (Mod-MPI) in detecting the grade of deterioration of intrauterine growth retardation (IUGR) fetuses, time of delivery and neonatal outcome.

This was a comparative study conducted in Mansoura University Hospital (MUH) - department 10, department 15 between two groups, 1st group (study group) composed of 50 patient diagnosed with FGR fetuses, 2nd group (control group) 50 patient of healthy uncomplicated pregnancies in terms of immediate neonatal condition (APGAR score, blood PH, admission in NICU) in both groups and after 6 months from delivery.

As regards, comparison of neonatal data between studied groups, there were highly statistically significant differences as regards, gestational age at birth/weeks, APGAR 1 minute, APGAR 5 minutes, NICU admission, Received treatment, weight at discharge, weight and weight at birth (P>0.001), while there were no statistically significant differences as regards Dexamethasone, Anti-d, RM and congenital anomalies (P < 0.05).

This came in concurrence with Alici *et al*. who displayed that, incidences of abnormal uterine artery, Doppler rate, cesarean delivery rate, 5-min Apgar score<7, neonatal intensive care unit (NICU) enrollment and perinatal death were much greater in the early-FGR group in contrast with control group (p<0.001)[12].

Furthermore, Nassr *et al*. found that there were extremely significant differences (P >0.05) between the case (IUGR) and control groups with regard to the mean duration of NICE stay, cord arterial PH, need for neonatal resuscitation, and Apgar score at five minutes[6].

Conversely, Novac *et al*. found that there was not a substantial distinction (P=0.962) between the IUGR and control groups regarding the one-minute Apgar score. However, there was a significant difference (p<0.001) between the two groups regarding the fetal weight at birth and a statistically significant difference (P >0.05) between the two groups regarding the Apgar score at five minutes and NICU stays[13].

As regards, comparison of Doppler data between studied groups, the present study demonstrated that there were statistically significant differences among the control group and IUGR groups as regards MCA PSV, MCA PI, MCA RI, UA PSV, UA S/D ratio, UA RI and UA PI (P >0.05).

This can be attributed to the fact that, in brain-sparing fetuses, pace is associated with greater flow opposition in the umbilical artery (PI rise) and may result in a drop in MCA-PI. The cerebroplacental ratio (CPR), which can be decreased in SGA, can be calculated by combining these two Doppler variables: increased UA-PI and decreased MCA-PI[14].

In harmony with the present investigation, Bhorat *et al*. found that there were highly statistically significant variations among the control group and IUGR groups as respects AFI, E/A ratio and median MPI (P <0.0001)[10].

In accordance Novac *et al*. demonstrated that, there were highly statistically significant differences among the control group and IUGR groups as regards while there was no statistically significant difference as regards UA-PI>95 percentile[13].

As regards, comparison of MPI and MCO, the case group demonstrated higher level in comparison with the control group, while in ET/ms, the case group demonstrated lower level in comparison with the control group with highly statistically significant differences among both studied groups (P>0.001).

The disturbance of the maturation of cardiomyocytes, brought on by a decrease in the availability of oxygen and nutrients, an increase in placental opposition, and chronic cardiac afterload, may be the process underlying the reduction and degradation of cardiac function mediated by fetal growth restriction[4].

Numerous investigations have found increases in the Mod-MPI in fetuses with growth restriction[8]. According to Bhorat *et al*., there was a very statistically significant difference in the median Mod-MPI between growth-restricted fetuses and controls (0.59 vs. 0.37, p < 0.001). Furthermore, it rose in proportion to the severity of IUGR, which was classified according to the degree of abnormality of the ductus venosus (DV) Doppler indices, the existence of arterial reorganization, and the degree of aberration of the umbilical resistance index[10].

In a comparable manner Nassr *et al*. showed that, in IUGR babies with aberrant UA Doppler, the mean left MPI was considerably higher (mean 0.58 ± SD 0.093) than in healthy babies (mean 0.45 ± SD0.070) (P < 0.001). When contrasted with the control group, IUGR babies with defective left MPI had significantly inferior perinatal outcomes and higher rates of morbidity. Whether the UA Doppler was normal or abnormal, IUGR babies with aberrant left MPI similarly had significantly inferior perinatal outcomes when compared to IUGR fetuses with normal MPI. Depending upon the perinatal consequence, the fetal MPI was linked to the degree of fetal impairment in IUGR fetuses[6].

An additional new prospective case-control research carried out by Alici *et al*. on early (EO) and late onset (LO) fetal growth restricted (FGR) fetuses versus control group

showed that Mean Mod-MPI values were significantly much greater in both EO- and LO-FGR group than gestation-matched controls ($p < 0.001$)[12].

As regards, validity of Doppler findings in differentiating IUGR from control group, the current study demonstrated that MCA.PSV, MCA.PI, MCA.RI, UA.S.DRATIO, UA.RI, UA.PI, UA PSV, TEI, ET/ms and MCO/ms can be used as a predictor for IUGR. Cut-off Mod-MPI value of 0.505 conferred a sensitivity of 81.2% [confidence interval (CI): 95%] and specificity of 83.7% (CI: 95%) and for validity of Doppler findings in differentiating IUGR indicating that Mod-MPI can be used as good predictor for IUGR.

Regarding multivariate analysis in prediction of IUGR among studied groups, UA.RI seemed to have the highest association with IUGR followed by UA.PI and MPI. In addition, MCO/ms, MCA PI, UA.S.DRATIO, UA.RI and UA.PI were the only significant factors.

Accordingly, Bhorat *et al*. showed that an unfavorable outcome would result in a probability ratio (LR) of 3.47, a sensitivity of 87% [confidence interval (CI): 66–97%], a specificity of 75% (CI: 55–91%), and a threshold Mod-MPI value of 0.54. In terms of perinatal mortality, a threshold Mod-MPI value of 0.67 resulted in a sensitivity of 100% (CI: 54–100%), specificity of 81% (CI: 65–92%), and LR of 5.28. There were no anomalous results in the control group[10].

Furthermore, Zhang *et al*. showed that when the threshold value was 0.47 in early-onset FGR, the sensitivity and specificity of Mod-MPI forecasting unfavorable outcome were 60% and 80%, respectively, in their study comparing IUGR cases versus control ones. Additionally, they were 65% and 70% in late-onset FGR when the threshold value was 0.50. Additionally, they demonstrated that in cases of early-onset FGR, MPI and UA PI were linked to neonatal outcome. In cases of late-onset FGR, perinatal outcomes was linked to MPI and EFW. It is noteworthy that in this prospective group, MPI was the sole factor associated with unfavorable outcomes for both early-onset and late-onset FGR fetuses. They looked into MPI's ability to predict unfavorable outcomes further, and the results were pretty satisfactory in terms of sensitivity and specificity. Furthermore, they discovered the sensitivity of combining UA PI and MPI predicting adverse outcome was 86% in early-onset FGR[15].

Furthermore, Hernandez-Andrade and colleagues assessed the predictive value of the MPI in premature growth-restricted babies and showed that all Doppler indices had a significant correlation with perinatal fatalities as standalone parameters, except for MCA; on multivariate analysis, only DV-PI and MPI were found to be separate predictors. The predicted accuracy of an algorithm that combined MPI (normal or above 95th percentile) and DV atrial flow (positive, nonexistent, or reversed) was higher than that of any one variable[8].

LIMITATIONS

The main drawback of the current study was the relatively small sample size in the groups of IUGR under investigation. Another limitation of the study was that the Mod-MPI requires experience and training to obtain a reliable result.

CONCLUSIONS

Mod-MPI was elevated in fetuses with fetal growth restriction. It may be possible to foresee unfavorable perinatal outcomes for FGR fetuses using mod-MPI. Mod-MPI was a beneficial measure to identify fetuses with heart failure in FGR, and it was a good way to complement the vessel's Doppler parameters in monitoring FGR.An MPI value-based rating or scoring system for IUGR may be established as a result of the present research, which needs to be verified in larger prospective studies in the future. If approved, this system could be used alongside with typical monitoring methods to help clinicians deliver growth-restricted fetuses on time.

CONFLICT OF INTERESTS

There are no conflicts of interest.

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