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ORIGINAL ARTICLE

Assessment of the Cardiac Function in Intrauterine Growth-Restricted Fetuses and Appropriate for Gestational Age Fetuses

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Abstract

Aim Aim of the study is to evaluate the myocardial performance index in intrauterine growth restricted fetuses and compare this index with appropriate for gestational age fetuses.

Materials & Methods A prospective study was conducted in S.M.S Medical College Jaipur, involving 72 singleton fetuses ≥ 28 weeks of gestation divided into two groups: 36 intrauterine growth restricted fetuses (IUGR) and 36 appropriate for gestational age fetuses (AGA). Myocardial

performance index was obtained by fetal echocardiography.

Results The mean myocardial performance index in the IUGR fetuses and AGA fetuses was statistically significant and that was 0.62 ± 0.02 and 0.45 ± 0.01, respectively; (p value: < 0.0001). These findings suggest that IUGR induces primary cardiac changes, which could explain the increased predisposition to cardiovascular disease in adult life. This study concluded that Fetal echocardiographic parameters (MPI) identify a high risk group within the IUGR fetuses, which could be targeted for early screening of blood pressure and other cardiovascular risk factors, as well as for promoting a healthy diet and physical exercise.

Keywords Myocardial performance index · Fetal echocardiography · Intrauterine growth restricted fetus

Introduction

In the modern world, cardiovascular disorders are the leading cause of morbidity and mortality, which in most cases undergo a long subclinical phase that can last decades before the first clinical symptoms appear. Aside from the well-known risk factors related to lifestyle and genetics, there is growing evidence that in a proportion of cases, the predisposition to cardiovascular disease lies in prenatal life [1]. In IUGR fetuses, in the initial stages of an insult, the heart usually manages to adapt and there is along subclinical period of cardiac dysfunction before end-stage heart failure [2, 3]. During this period of cardiac adaptation, changes in cardiac function, as well as in the heart's shape and size, can be measured. IUGR illustrates how cardiac dysfunction in the fetus is largely subclinical and requires sensitive methods for its identification [2].

Fetal growth restriction is most commonly due to placental insufficiency, and the resulting hypoxia leads to fetal blood flow being redirected to the brain and heart. Intrauterine growth restriction predispose to lower cardiac compliance, increased arterial stiffness, increased cardiac afterload, and end-diastolic ventricular filling. This decrease in longitudinal motion and impaired relaxation may be a fetal adaptive mechanism to the chronic hypoxia and volume/pressure overload of placental insufficiency. These mechanisms, which are the heart's attempt to adapt to an insult, constitute a process known as cardiac remodeling [3].

Fetal echocardiography has developed as the primary noninvasive modality to evaluate fetal cardiac function. The myocardial performance index measured by pulsed-wave Doppler reflects both systolic and diastolic functions as the sum of isovolumetric contraction time (IvCT) and isovolumetric relaxation time(IvRT) divided by the ejection time [4, 5]. In this study, we evaluate the MPI of IUGR fetuses for identification of fetuses at increased cardiovascular risk that would benefit from lifestyle preventive strategies and potentially improve their future cardiovascular health.

Materials and Methods

This study was a prospective observational study conducted between April 2016 and November 2017 in the Department of Obstetrics and Gynaecology, S.M.S Medical College and attached hospitals, Jaipur. This study included two groups consisting of 36 women in each group. Group-A included ≥ 28 weeks with IUGR, Group-B included ≥ 28 weeks with AGA fetuses. Women with multiple pregnancy, congenital malformation, and pregnancy with chronic medical disorder were excluded. Approval from institutional research, review board, and ethical committee was obtained. Ultrasound and Doppler Measurements were performed by Aloka Prosound Alfa-6 4D Machine using a 4–6-MHz curved transducer. Umblical artery pulsatility index, middle cerebral artery pulsatility index, and cerebroplacental ratio were calculated. The myocardial performance index was measured by a fetal echocardiography The echocardiography was done by same senior cardiologist using PHILIPS I.E. 33 MATRIX echocardiography machine as to avoid interobserver variations. The myocardial performance index was measured by obtaining a cross-sectional view of the fetal thorax at the level of the four-chamber view of the heart. The Doppler gate was placed to include both the lateral wall of the ascending aorta and the mitral valve where views of the clicks of opening and closing of the valves were seen. The angle of insonation was as close as possible to zero degree, in the absence of fetal movements. Images were recorded at a Doppler sweep velocity of 6 cm/s with the E/A waveform displayed as positive flow and calculated according to the formula: MPI = (IVCT + IVRT)/ET where the isovolumetric contraction time was calculated as the time from closure of the mitral valve to the opening of the aortic valve. Isovolumetric relaxation time was calculated as the time from closure of the aortic valve to the opening of mitral valve. Ejection time was calculated as the time from opening of the aortic valve to its closure.

Statistical Analysis

Continuous variables were summarized as mean and standard deviation, while nominal/categorical variables were summarized as proportion. Parametric test will be used for continuous variable, whereas Chi-square test and Fisher's

exact test will be used for nominal/categorical variability. *P* value < 0.05 will be taken as significant value.

Results

The mean age of pregnant women was 25.05 ± 2.96 years in the study group and 25.89 ± 3.86 years in the control group. No significant difference in maternal age (*P* value 0.308) and gestational age (*P* value 0.893) was observed between the groups. The umbilical and middle cerebral artery Doppler were done in both groups. In study group, IUGR fetuses showed raised umbilical artery pulsatility index (UMPI), decreased middle cerebral artery pulsatility index (MCAPI), and mean cerebroplacental ratio (*C/P*) compared with control group. Cerebroplacental ratio < 1 shows poor perinatal outcome. MCAPI, UMPI, and C/P ratio parameters of both groups are included in Table 1.

Echocardiographic parameters of both groups are included in Table 2. The mean myocardial performance index was 0.62 ± 0.02 in IUGR group, while in control group, it was 0.45 ± 0.01 and that was statistically significant (*P* value < 0.001). The IVRT and IVCT were longer and ejection time was shorter in IUGR fetuses compared with control group.

Discussion

In our study, IUGR fetuses showed signs of both systolic and diastolic dysfunctions and prolonged isovolumic times. Similar results were obtained by Chawengsettakul et al. [6] who studied myocardial performance index in 50 FGR fetuses and 50 AGA fetuses. MPI in FGR fetuses was higher as compared to control group (0.92 vs. 0.47). Perez Cruz et al. [7] also found in their study on 150 intrauterine growth fetuses and 150 appropriate for gestational age fetuses matched for gestational age that myocardial performance index was higher in IUGR fetuses as compared to the AGA fetuses. They thus suggested that this was due to systolic and diastolic dysfunctions of fetal heart in IUGR fetuses (0.57 ± 0.10 vs. 0.45 ± 0.14). Our results were also comparable to the study done by Hassan et al. [8] who studied cardiac function in intrauterine growth-restricted fetuses. They observed that myocardial performance index in IUGR fetuses was higher as compared to AGA fetuses (0.64 vs. 0.45). Nassr et al. [9] studied 50 IUGR fetuses and 50 AGA fetuses. The mean MPI in IUGR fetuses was 0.58 ± 0.093 and that of AGA fetuses was 0.45 ± 0.070.

Table 1 Doppler parameter

Group	UMPI	MCAPI	*C/P*
IUGR group	1.69 ± 0.37	1.65 ± 0.42	0.98 ± 0.27
Control group	1.005 ± 0.21	1.86 ± 0.86	1.88 ± 0.61
P value	< 0.0001	0.046	< 0.0001

Table 2 Echocardiography parameter

Cardiac parameter	IUGR group	Control group	*P* value
IVRT (ms)	57 ± 3.20	42.11 ± 1.45	< 0.001
IVCT (ms)	37.28 ± 2.44	35.03 ± 1.32	< 0.001
ET (ms)	152 ± 4.49	170.59 ± 2.58	< 0.001
MPI	0.62 ± 0.02	0.45 ± 0.01	< 0.001

Conclusion

Myocardial performance index characterize cardiac function and morphometry prenatally, demonstrating subclinical cardiac dysfunction and cardiac remodeling in IUGR. Myocardial performance index also helps in the prediction of postnatal hypertension and arterial remodeling better than perinatal severity parameters currently used. This study suggests that fetal echocardiography could be incorporated into clinical practice for identification of fetuses at increased cardiovascular risk that would benefit from lifestyle preventive strategies and potentially improve their future cardiovascular health.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical Approval The study has been approved by own institutional ethical committee.

Informed Consent Informed consent was obtained from all participants in the study regarding participation in the study. Guidelines based on Declaration of Helsinki and local ethical guidelines were followed for each patient.

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