OBSTETRICS

# Usefulness of myocardial tissue Doppler vs conventional echocardiography in the evaluation of cardiac dysfunction in early-onset intrauterine growth restriction

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**OBJECTIVE:** To evaluate cardiac function by tissue Doppler imaging vs conventional echocardiography in intrauterine growth restriction.

**STUDY DESIGN:** A prospective study in 25 intrauterine growth restriction, and in 50 normally grown fetuses between 24 and 34 weeks. Conventional echocardiography (E/A ratios, outflow tract velocities and myocardial performance index), and tissue Doppler (myocardial peak velocities, E'/A' ratios and myocardial performance index') measurements were performed.

**RESULTS:** With conventional echocardiography, intrauterine growth restriction fetuses showed an increase in left myocardial performance index but similar values of E/A ratios, outflow tract velocities and right myocardial performance index as compared with controls. Tissue Doppler imaging demonstrated that intrauterine growth restriction fetuses had significantly lower systolic and diastolic myocardial velocities in mitral and tricuspid annulus, higher mitral E'/A' ratio and higher mitral, tricuspid and septal myocardial performance index' values.

**CONCLUSION:** Tissue Doppler imaging demonstrated the presence of both systolic and diastolic cardiac dysfunction in intrauterine growth restriction. Tissue Doppler imaging may constitute a more sensitive tool than conventional echocardiography to evaluate cardiac dysfunction in intrauterine growth restriction.

**Key words:** cardiac function, echocardiography, IUGR, myocardial performance index, tissue Doppler imaging

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Intrauterine growth restriction (IUGR) caused by placental insufficiency affects 1-3% of pregnancies and is associated with an increased risk of perinatal mortality and morbidity.[1] Cardiac dysfunction with maintained cardiac output has consistently been reported to be present in IUGR. [2-4] Although earlier studies suggested that cardiac parameters became abnormal only in severely affected fetuses, [5-7] more recent research strongly suggests that subclinical cardiac dysfunction could be present from early stages of fetal deterioration.[2] The identification and monitoring of cardiac dysfunction may be relevant for clinical purposes and to advance in the understanding of the relation between IUGR and long-term cardiovascular outcome.[8,9]

New developments in echocardiography enable a much fuller assessment of cardiac function, including measurement of myocardial motion by tissue Doppler imaging (TDI). TDI is a robust and reproducible echocardiographic tool that permits a quantitative assessment of motion and timing of myocardial events. Myocardial velocities are a sensitive marker of mildly impaired systolic or diastolic function and therefore useful in the early identification of subtle cardiac dysfunction in preclinical stages.[10,11] In adults and children, TDI has demonstrated its use in the prediction of future cardiovascular diseases.[12,13] Recently, TDI has been shown to be feasible in fetuses.[14-17] The results of preliminary studies in IUGR fetuses suggest that there is a reduction in myocardial velocities.[18-20] We postulated that TDI could constitute a more sensitive tool than conventional echocardiography to detect the presence of cardiac dysfunction in fetuses with IUGR.

We performed a prospective study to evaluate cardiac function parameters with TDI and with conventional echocardiography in a group of fetuses with early onset IUGR.

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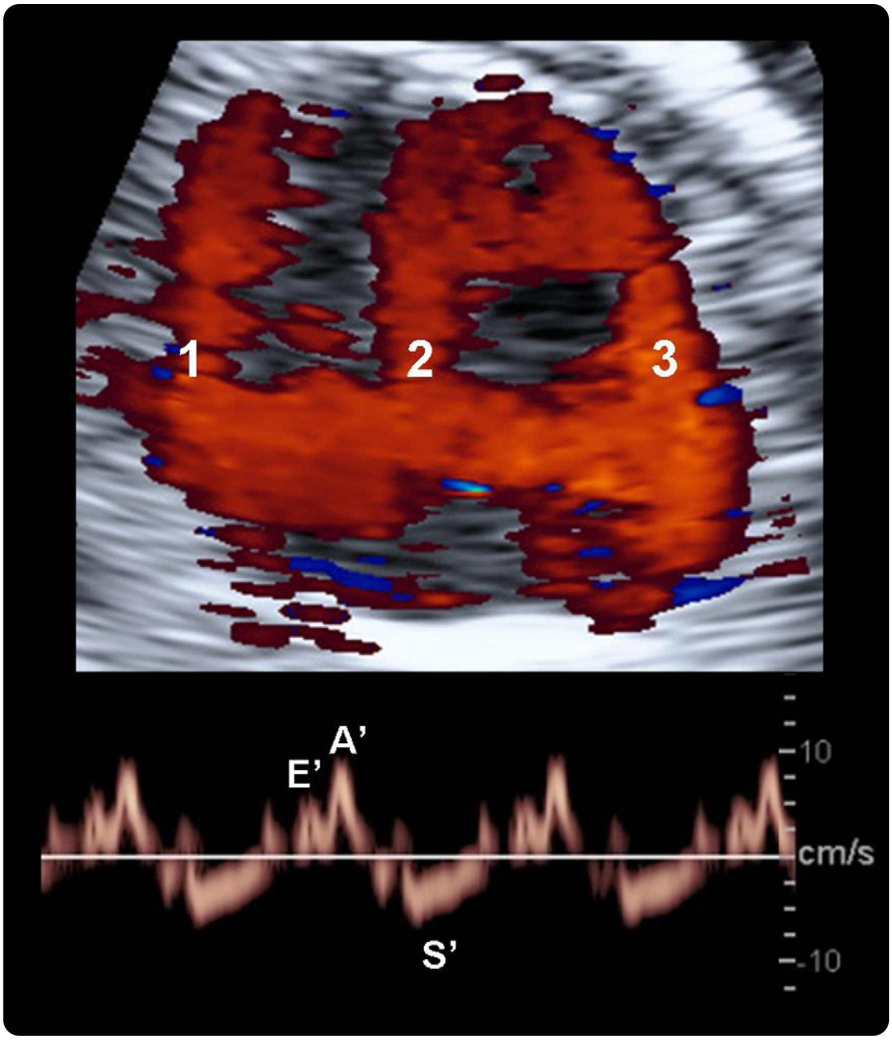
FIGURE 1
**Myocardial velocities**




Myocardial velocities in early diastole (E'), during atrial contraction (A'), and systole (S') by pulsed tissue Doppler in left (1), septal (2) and right (3) annulus.

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## MATERIALS AND METHODS

### Study populations

The study population included 25 IUGR fetuses and 50 controls. Patients were selected from women who attended the Maternal-Fetal Medicine Department at Hospital Clinic in Barcelona, Spain. The study protocol was approved by the local Ethics Committee and patients provided their written informed consent. In all pregnancies, gestational age was calculated based on the crown-rump length at first-trimester ultrasound.[21] IUGR was defined as an estimated fetal weight below the 10th percentile according to local reference curves,[22] together with umbilical artery (UA) pulsatility index (PI) above the 95th percentile.[23] For the purpose of this study, only patients who were delivered between 26 and 34 weeks of gestation were included. The control group consisted of 50 normally grown fetuses matched 2 to 1 with cases by gestational age at ultrasound (± 1 week). Exclusion criteria were structural/chromosomal anomalies or evidence of fetal infection.

All patients underwent ultrasonographic examination using a Siemens Sonoline Antares (Siemens Medical Systems, Malvern, PA). Basic Doppler examination included UA, middle cerebral artery, and ductus venosus. At delivery, gestational age, mode of delivery, birthweight, birthweight percentile, Apgar score, umbilical pH, and perinatal mortality and morbidity were recorded. Perinatal mortality was defined as either intrauterine death or neonatal death within the first 28 days of life.[24] Adverse perinatal outcome was defined by the presence of perinatal death, bronchopulmonary dysplasia, hyaline membrane disease, neonatal intraventricular hemorrhage grade 3 or 4, necrotizing enterocolitis, sepsis, or retinopathy grade 3 or 4.

Cardiac function was assessed in all cases and controls by conventional echocardiography and TDI.

### Conventional echocardiography

Conventional echocardiography included peak early (E) and late (A) transvalvular filling and outflow tracts velocities and myocardial performance index (MPI). Atrioventricular flows were obtained from a basal or apical 4-chamber view, placing the pulsed Doppler sample volume just below valve leaflets, and left and right E/A ratios were calculated.[25] Aortic and pulmonary artery peak velocities were obtained from a long- or short-axis view of the left and right ventricle respectively. Left MPI was obtained using the clicks of mitral and aorta valves as landmarks, as previously described.[26] The following periods were calculated: isovolumetric contraction time (ICT), ejection time (ET), and isovolumetric relaxation time (IRT). Finally, the MPI was calculated as (ICT + IRT)/ET. Right MPI was calculated by obtaining right ventricle inflow and outflow obtained in series from separate cardiac cycles.[27,28]

### TDI

TDI was obtained in real time using a 2-10 MHz phased-array transducer. First, a clear 4-chamber view was obtained in an apical or basal view. The TDI program was set to the pulsed-wave mode with a sample volume size between 2 and 4 mm. Sample volumes were placed in the basal part of the left ventricular wall (mitral annulus), interventricular septum and right ventricular wall (tricuspid annulus) (Figure 1). The in-