

ASSESSMENT OF FETAL CARDIAC FUNCTION: IMPLICATIONS FOR PAKISTAN

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Nuruddin Mohammed has made substantial intellectual contribution in conceptualizing and drafting the manuscript and has given final approval of the version to be published.

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ABSTRACT

The heart is a key organ in the fetal development since it is responsible for perfusion and proper development of all fetal organs. From the very early stages of pregnancy, heart must maintain adequate cardiac output in a continued manner and be able to adapt to changing circulatory demands. Certain pathologies in fetal life can affect the proper functioning of the cardiovascular system and can even cause heart failure, hydrops and fetal death. Fetal echocardiography is one such tool, which can assess the status of the heart, both structural and functional. In Pakistan, fetal echocardiography has been in service for over a decade, primarily to identify fetuses with structural malformations of the heart and is now a part of routine fetal surveillance. However, evaluation of fetal cardiac function using echocardiography has received minimal attention and its utilization in functional assessment of the fetal heart and circulation is still awaited.

Recently, research efforts have recognized the potential value of fetal cardiac function for clinical management. Given the substantial evidence indicating the occurrence of programming of adult cardiovascular disease in fetal life, it is logical to state that the integration of functional fetal echocardiography into clinical practice in developing country like Pakistan will be useful to detect and monitor not only fetuses at-risk of cardiac failure or cardiac dysfunction but also to help predict perinatal and long term cardiovascular outcomes.

Key Words: Fetus, Cardiac Function, Pakistan

INTRODUCTION

The heart is a key organ in the fetal development since it is responsible for perfusion and proper development of all fetal organs. From the very early stages of pregnancy, heart must maintain adequate cardiac output in a continued manner and be able to adapt to changing circulatory demands.¹ Certain pathologies in fetal life can affect the proper functioning of the cardiovascular system and can even cause heart failure, hydrops and fetal death. Fetal echocardiography is one such tool, which can assess the status of the heart, both structural and functional. In Pakistan, fetal echocardiography has been in service for over a decade, primarily to identify fetuses with structural malformations of the heart and is now a part of routine fetal surveillance.² However, despite this development, evaluation of fetal cardiac function using echocardiography has received minimal attention and its utilization in functional assessment of the fetal heart and circulation is still awaited.

In children and adults, functional cardiology has demonstrated its usefulness for the monitoring of several pathologies for more than over two decades. Various parameters of functional echocardiography have been integrated into the diagnostic algorithms of many diseases such as heart failure, renal failure, hypertension or myocardial infarction.³ Further, the technology has substantially developed in the last few years and a variety of new methods are now available to identify extremely subtle changes in cardiac function.⁴ On the contrary, in fetal life, until recently, the cardiac dysfunction was traditionally assessed based on the indirect signs such as the presence of hydrops, tricuspid insufficiency or cardiomegaly. However, the advent of new state of the art high-end resolution ultrasound machines have allowed the development of new parameters for the evaluation of fetal cardiac function. A wide range of ultrasound techniques are now applied for the evaluation of fetal cardiac function which includes M-mode, directional colour, power, spectral conventional and tissue Doppler and two-dimensional speckle tracking imaging.^{5,6} Lately, four-dimensional functional fetal echocardiography using spatiotemporal image correlation has also been recommended to more precisely evaluate cardiac dimensions and volumes.⁷

Functional fetal echocardiography also encompasses cardiac morphometry which is performed to look at the shape and size of the heart. This helps in identifying cardiac remodeling which is defined as changes in size, shape, structure and physiology of the heart in order to adapt to an insult. This means that even if there is no structural anomaly present, whenever there is an insult such as volume or pressure overload or hypoxia, the heart adapts to it by alteration of its morphometry.

Fetal medicine specialists and Fetal and Paediatric

cardiologists have begun to study the physiological adaptation of the fetal heart. Various parameters of cardiac morphometry and function have been assessed, analysis of which have confirmed its high sensitivity as well as its correlation as a marker of disease severity and prognosis in selected fetal conditions such as intra-uterine growth restriction (IUGR), fetal hydrops, maternal diabetes, fetal arrhythmias, complicated mono-chorionic twin pregnancies and congenital heart diseases. Such information might be useful for the clinical management of affected pregnancies.⁸ Recently, cardiac remodeling and longitudinal myocardial dysfunction has been identified by using functional fetal echocardiography, not only in near term growth restricted fetuses, but also in pregnancies conceived through assisted reproductive technologies. It was found that, due to pressure overload (stiffer arteries), the ventricles work under high pressure and gets more hypertrophic and spherical and the atrias, which cannot hypertrophy, dilates. All these changes in structure correlate with changes in function such as decreased systolic longitudinal function and impaired relaxation. These changes were observed to persist postnatally not only at 6 months but also at 5 years of age.^{9,10,11} This indicates that comprehensive assessment of cardiac morphometry and function in such fetuses could identify a proportion of them at-risk for increased predisposition to cardiovascular disease in adult life.

The importance of assessment of cardiac function during fetal life cannot be overemphasized given the ever increasing trend of non-communicable diseases like cardiovascular disease in low resource setting like Pakistan and the emerging evidence of an association between pathological conditions such as fetal growth restriction and maternal diabetes and cardiac dysfunction in fetal life and in early childhood.^{9,10,12} This would eventually help in the early identification of at-risk fetuses for monitoring and subsequent intervention during childhood.

Bringing functional fetal echocardiography into service in Pakistan would open a new avenue for research and education in the field of fetal cardiology. However, it may be technically challenging, as it would require several measures to be adopted. First, qualifications and responsibilities of personnel performance and interpretation of fetal cardiac function assessment require a unique set of advanced skills and knowledge. Therefore, for this purpose, Fetal medicine specialists, Fetal cardiologists and Paediatric cardiologists with expertise in basic fetal cardiac imaging who have acquired the appropriate knowledge base and skills would be required to be trained in this field to perform functional fetal echocardiography. Second, incorporation of specific training requirements module and competency has to be maintained based on the international guidelines.^{13,14} Third, state of the art ultrasound equipment is necessary whereby it could be used not only for service but also the

images can be utilized for off-line analysis and research purpose. Fourth, policies and procedures related to quality control and patient education should be developed. Adequate documentation is essential for high-quality patient care. Video clips together with still images should be an essential part of the documentation. There should be a permanent record of the examination and its interpretation. Reporting should be in accordance with recognized practice guidelines for documentation and communication of diagnostic ultrasound findings. Annual audit for quality assurance purpose should be made mandatory. Further, healthcare practitioners should be made familiar through continuous medical education seminar about the reasons for referral for functional fetal cardiac assessment.

To conclude, research efforts have recently recognized the potential value of monitoring fetal cardiac function for clinical management. We believe that, given the substantial evidence indicating the occurrence of programming of adult cardiovascular disease in fetal life,⁸ it is logical to state that the integration of functional fetal echocardiography into clinical practice in developing country like Pakistan will be useful to detect and monitor not only fetuses at-risk of cardiac failure or cardiac dysfunction but also to help predict perinatal and long term cardiovascular outcomes.

REFERENCES

1. Tutschek B, Schmidt KG. Techniques for assessing cardiac output and fetal cardiac function. *Semin Fetal Med* 2011;16:13-21.
2. Mohammed NB, Chinnaiya A. Evolution of foetal echocardiography as a screening tool for prenatal diagnosis of congenital heart disease. *J Pak Med Assoc* 2011;61:904-9.
3. Crispi F, Gomez O, Bennasar M, Martinez JM. Protocol for functional fetal echocardiography. Barcelona: Fetal Medicine; 2011.
4. Bijmens BH, Cikes M, Claus P, Sutherland GR. Velocity and deformation imaging for the assessment of myocardial dysfunction. *Eur J Echocardiogr* 2009;10:216-26.
5. Comas M, Crispi F. Assessment of fetal cardiac function using tissue doppler techniques. *Fetal Diagn Ther* 2012;32:30-8.
6. Germanakis I, Gardiner H. Assessment of fetal myocardial deformation using speckle tracking techniques. *Fetal Diagn Ther* 2012;32:39-46.
7. Godfrey ME, Messing B, Valsky DV, Cohen SM, Yagel S. Fetal cardiac function: M-mode and 4D spatiotemporal image correlation. *Fetal Diagn Ther* 2012;32:17-21.
8. Hernandez-Andrade E, Benavides-Serralde JA, Cruz-Martinez R, Welsh A, Mancilla-Ramirez J. Evaluation of conventional Doppler fetal cardiac function parameters: E/A ratios, outflow tracts, and myocardial performance index. *Fetal Diagn Ther* 2012;32:22-9.
9. Crispi F, Bijmens B, Figueras F, Bartons J, Eixarch E, Le Noble F, et al. Fetal growth restriction results in remodeled and less efficient hearts in children. *Circulation* 2010;121:2427-36.
10. Crispi F, Figueras F, Cruz-Lemini M, Bartrons J, Bijmens B, Gratacos E. Cardiovascular programming in children born small for gestational age and relationship with prenatal signs of severity. *Am J Obstet Gynecol* 2012;207:121.
11. Valenzuela-Alcaraz B, Crispi F, Bijmens B, Cruz-Lemini M, Creus M, Sitges M, et al. Assisted reproductive technologies are associated with cardiovascular remodeling in utero that persists postnatally. *Circulation* 2013;128:1442-50.
12. Bali S, Pac FA, Ece I, Oflaz MB, Kibar AE, Kandemir O. Assessment of cardiac functions in fetuses of gestational diabetic mothers. *Peadiatr Cardiol* 2014;35:30-7.
13. Carvalho JS, Allan LD, Chaoui R, Copel JA, Devore GR, Hecher K, et al. ISUOG practice guidelines (updated). Sonographic screening examination of the fetal heart. *Ultrasound Obstet Gynecol* 2013;41:348-59.
14. American Institute of Ultrasound in Medicine. AIUM practice guideline for the performance of fetal echocardiography. *J Ultrasound Med* 2013;32:1067-82.