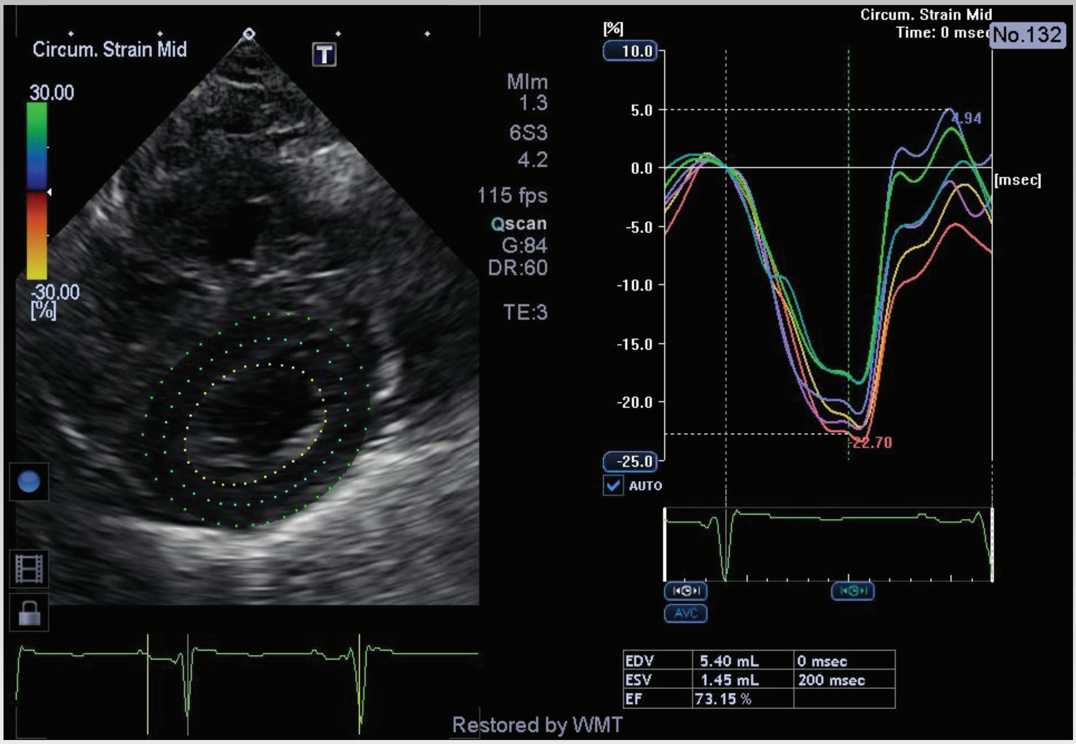
UL Clinical Case Study

Incremental Value of 2D Speckle Tracking Echocardiography (2D-STE)

Hypertrophied Pediatric Heart



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INTRODUCTION

Early detection of changes in myocardial deformation in the presence of ventricular hypertrophy has implications in the diagnosis and treatment plan for neonatal and pediatric patients prior to clinical manifestation of cardiomyopathy.

Left ventricular hypertrophy (LVH) determined by 2D echocardiography is a rather common finding and occurs in more than 15 percent of the general population.[1] In the current literature, LVH has been correlated with the co-morbidities of hypertension, obesity, valvular heart disease, coronary disease and advancing age.[1,2]

However, the early stage pathogenesis and long-term effects of LHV in neonatal and pediatric patients warrants further investigation. Neonatal or pediatric patients born from high-risk diabetic mothers may have confounding factors including multivariate complications that can effect LVH onset and outcomes.

The prevalence of hypertrophic cardiomyopathy (HCM) in infants of diabetic mothers has been reported to be between 12-30 percent.[3] Features of HCM may include thickening of one or both of the ventricular walls, thickening of the interventricular septum, systolic dysfunction, and diastolic dysfunction.[4] The severity of HCM in infants is variable, although symptoms usually reverse within weeks.[3] Echocardiography is an essential tool for accurate diagnosis of HCM and to plan appropriate treatment.

Current literature confirms that 70 percent of myocardial fibers are oriented longitudinally and therefore these longitudinal fibers will exhibit changes in myocardial function prior to the exhibited changes in circumferential and radial myocardial fibers in the setting of LVH.[5]

Two-dimensional speckle-tracking echocardiography (2D-STE) is a semi-automated quantitative technique used to assess myocardial function, and cardiac systolic function and is well established as the method of choice for myocardial mechanics and deformation imaging quantification.[6] 2D-STE is utilized to analyze the lengthening and shortening of myocardial fibers by tracking the ultrasonic grayscale speckle pattern and motion over multiple frames. 2D-STE utilization has been shown to be beneficial in assessment and quantification of both segmental and global myocardial deformation as well as assessment of systolic function.[6]

Therefore, we report the incremental value of 2D-STE in the quantification of systolic function in a neonatal LVH patient of a diabetic mother.

2D-STE is available on the Canon Medical Systems Aplio™ Platinum Series ultrasound systems as part of the Wall Motion Tracking package.

PATIENT CASE HISTORY

One day old male born to a diabetic mother, 18.5 inches, 8.8 lbs., BSA 0.21, BP 57/38, intubated and sedated. Echocardiography study indication: murmur.

OBJECTIVES

Utilize 2D-STE on a neonatal LVH patient from a diabetic mother and observe resultant longitudinal and circumferential strain parameters to find changes in the global longitudinal strain (GLS) and/or global circumferential strain (GCS) patterns which suggest impaired myocardial function.

METHODS

The Canon Medical Systems Aplio 300 CV Ultrasound system was used in this case study. The neonatal patient was positioned supine and three ECG electrodes were placed on the patient.

A 2D parasternal short-axis view was obtained at the left ventricular, mid-cavity level. The echocardiographic image was optimized for 2D-STE imaging emphasizing endocardial border definition and obtained at a fundamental frequency of 4.2 MHz with a frame rate of 115 frames per second (fps). The DICOM image was then stored for later 2D-STE review and analysis.

A 2D apical 4-chamber view was obtained from the axilla. The echocardiographic image was optimized for 2D-STE imaging emphasizing endocardial border definition and obtained utilizing pulse-subtraction tissue harmonic imaging at a frequency of 6.2 MHz and at a frame rate of 138 fps. The DICOM image was then stored for later 2D-STE review and analysis.

The 2D-STE analysis consists of a few simple steps:

- Displaying the stored echocardiographic image(s) of interest
- Selecting a specific view to be analyzed utilizing 2D-STE software

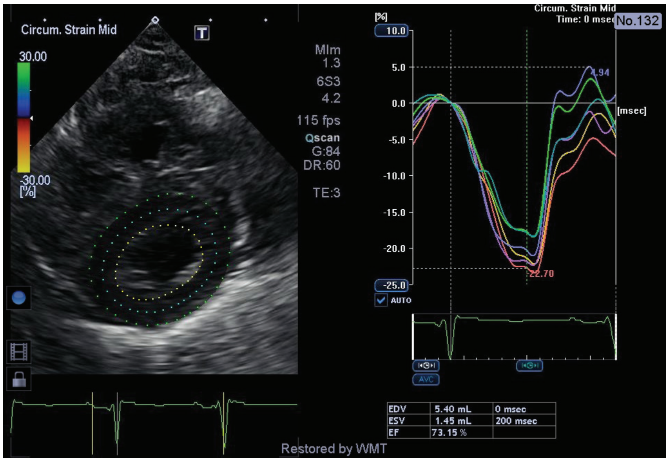

Figure 1: Global circumferential strain—parasternal short axis view at the left ventricular mid-cavity level.

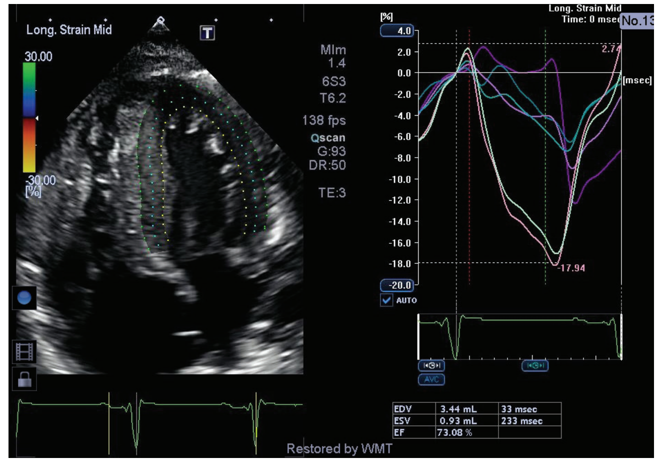

Figure 2: Global longitudinal strain—apical 4-chamber view.

- Placing three landmark cursors in specific regions of the ventricle (lateral annulus, medial annulus and apex) to avoid errors in patients with irregularly shaped or sized ventricles and simply activating the 2D-STE analysis software. The left ventricular regional strain values are then displayed based on the strain parameter(s) of interest.

FINDINGS

- Normal LV cavity size with hyperdynamic systolic function EF: 73 percent
- Increased LV wall thickness
- Systolic and diastolic interventricular septal flattening suggestive of RV volume and pressure overload
- Dilated RV cavity with decreased RV systolic function
- Increased RV wall thickness
- Normal left atrial size
- Dilated right atrium
- No significant valvular abnormalities
- No effusion, mass or thrombus seen
- Bidirectional PFO seen

2D-STE IMAGING FINDINGS

Parasternal short axis view at the mid-cavity level (SAX), revealed a GCS of -22 percent, which falls within normal limits as reported by the JUSTICE study.[7] The regional strain values ranged from -17 to -22.7 percent and the regional time to peak values were also consistent. The ejection fraction was calculated as 73 percent which meets the criteria for hyperdynamic systolic function by American College of Cardiology (LVEF Hyperdynamic =/>70%).[8] Apical 4-chamber view (A4CH) revealed a GLS of -10 percent, which did not fall within the stated normal range based on the JUSTICE study[7] (-15 to -23 percent) and there was marked variability of the regional time to peak strain values and marked variation in peak systolic longitudinal strain values; -7 to -18 percent. (Figure 2)

CONCLUSIONS

Increased left ventricular wall thickness can have significant impact on longitudinal strain values. This case study showed significantly reduced GLS with wide variation in regional peak longitudinal strain and time to peak longitudinal strain values. The markedly abnormal GLS values persist even in the presence of a hyperdynamic LVEF ~73 percent, which is consistent with the results from a study of adult HCM patients.[9] GCS and regional circumferential strain values in the same patient are normal, which correlates with previously cited works of structural remodeling changes in hypertensive heart disease.[5] This case study suggests that longitudinal strain parameters are affected prior to circumferential strain parameters even in the presence of a normal ejection fraction. The use of 2D-STE in echocardiography is a clinically relevant tool to aid in the early detection, diagnosis and treatment of patients with diseases that lead to increased ventricular wall thickness.

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