Myocardial Performance Index in Fetal Cardiology

Introduction

Ultrasound examinations are one of the most important tools for the clinician to determine fetal growth and condition. Beyond the standard investigation of (cardiac) anatomy and dimensions, modern ultrasound offers more advanced methods to describe the condition of the fetal heart, inter alia the calculation of the Myocardial Performance Index (MPI), also called Tei Index. The MPI is based on the changes in the iso-volumetric periods related to the ejection time.

MPI based on PW Doppler signals

MPI is a widely used ratio to describe the systolic and diastolic function of the heart in echocardiography. The timing of the cardiac phases is typically performed on PW Doppler signals. However, the mitral and aortic valve opening and closure times are normally measured on registrations of different cardiac cycles.

MPI based on PW Doppler signals does have some limitations that influence the sensitivity of the method, especially in the fetal heart where events are relatively short. Due to variations in each fetal heart cycle, using measurements from different heart cycles leads to increased variation of the normal values. This in turn results in a less sensitive method to detect abnormalities in an individual case.

The cardiac cycle in the fetal heart is of course shorter than in adults and the iso-volumetric events are more challenging to measure on a PW Doppler signal. The relatively broad spectrum and the freedom of the investigator to select the correct start and end of the event result in less accurate measurements. This also yields a higher standard variation of the results using a PW Doppler spectrum.

MPI based on Tissue Doppler Imaging

The MPI package on the Aplio™ based on Tissue Doppler Imaging provides a clearer and easier to identify signal to perform timing measurement. Tissue Doppler itself is angle dependent. To determine the duration of cardiac events, however, we do not rely on velocity information but on timing which is less dependent on user settings. Thus even if spatial smoothing has been applied and a relatively large ROI has been selected, the detection of timing of the events will not be negatively affected. Consequently, even with relatively strongly angulated ultrasound images MPI can be

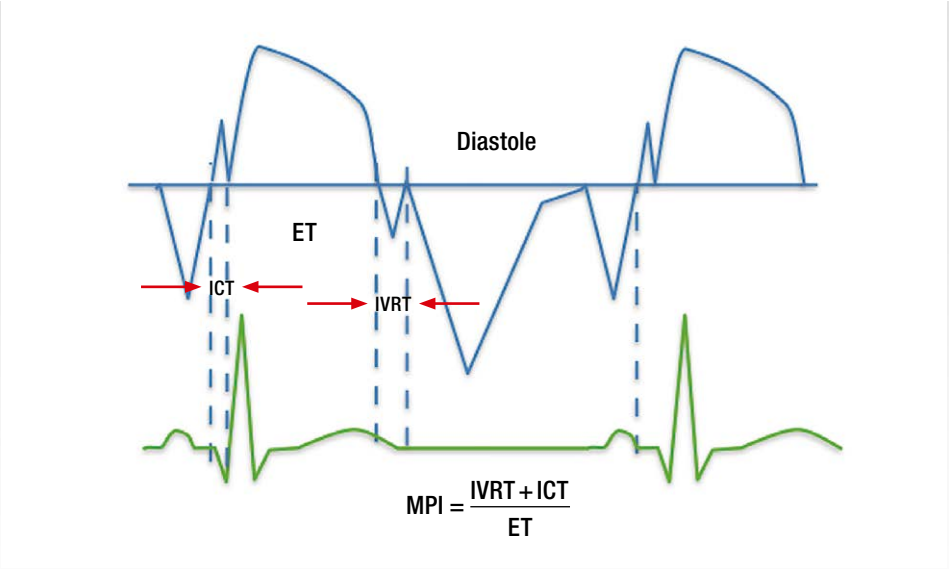

Fig. 1: Measurement and calculation of MPI

successfully calculated on the Aplio. This makes MPI a more practical tool to be used in routine examinations where optimal angulation is not always possible.

Aplio can acquire images with a balanced scan width and scan depth to cover the fetal heart in the 2nd trimester with a frame rate between 100 and 180 fps. A frame rate of 100 fps results in a 10 ms time resolution per frame. Since data are interpolated between the frames, a higher temporal resolution is achieved.

In conclusion, there are several advantages of determining a robust and reproducible MPI by TDI:

- measurement on same cardiac cycle
- high frame rate
- clear and easy to read velocity curves
- less user variance by ROI size and positioning

MPI package

The MPI package allows the examiner to assess the global Myocardial Performance Index in an easy, fast and reproducible way. Global ICT, ET and IVRT can routinely be measured by a large ROI covering the complete fetal heart and the MPI can be calculated. A total of four smaller ROIs can be positioned at the right and left side in order to additionally study inter-ventricular differences of the fetal heart in more detail.

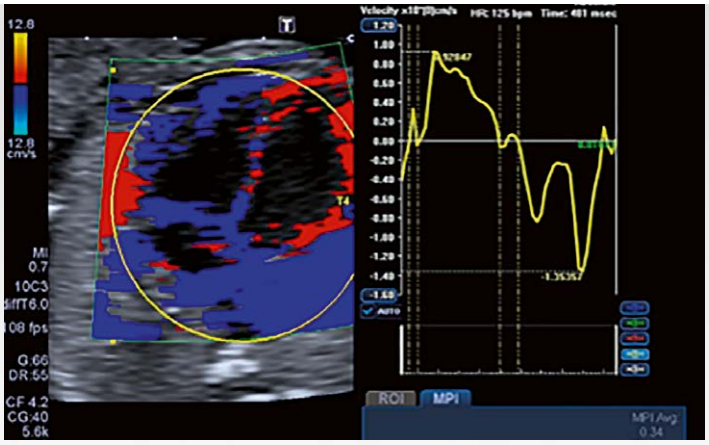

Fig. 2: A large ROI is placed over the fetal heart to display overall global heart velocity

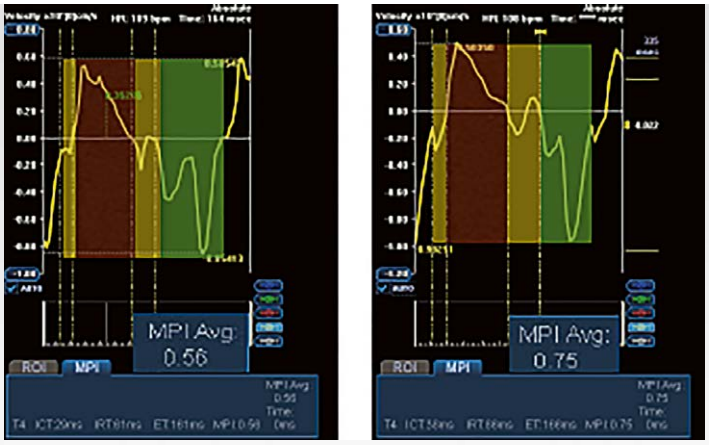

Fig. 3: MPI in a normal heart (left) and increased MPI (right)

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