

5. Summary

Tissue-Tracking Echocardiography is a new method for in vivo quantitative assessment of the myocardial contraction and relaxation on the basis of grey scale 2D digital loops. This method is based on the estimation of motion and deformation parameters due to tissue compression and expansion and traditionally employs for the calculation the so-called "Speckle Tracking" procedure. Speckles originate from the interference of ultrasound waves reflected by many individual scatterers in an ultrasonic image. These many reflections (Speckles) interfere with one another and generate the speckle pattern. The tracking of the movement of a certain speckle pattern between subsequent frames delivers an analysis of how the tissue during the heart cycle behaves. (i.e. shortens or lengthens.)

Since the determination of the contractile properties of the myocardium is in the detection and diagnosis of fetal well-being of fundamental interest, the evaluation of the fetal heart with the Tissue-Tracking algorithm was carried out. In this work it is examined,

- a) whether the motion parameters (Velocity and Displacement) and deformation qualities (Strain and Strain rate) of the fetal myocardium change in the course of the pregnancy and in dependence on the heart rate. Moreover;
- b) the feasibility of the Tissue-Tracking was examined and the repeatability analyzed.
- c) reference values for the global longitudinal peak velocity (V), strain (S), strain rate (SR) and Displacement (D) in the fetal heart were provided for the systole as well as for the diastole.
- d) the correlation between Ejection Fraction (EF) and S was examined.

Two hundred-thirty cases were examined with the ultrasound system Acuson S 2000. Four chamber view (4Ch) 2D-cineloops were saved for off-line analysis. Subsequently the video clips were analyzed with the Velocity Vector Imaging software.

Our results show, that

- a) normal fetuses exhibit a statistically significant increase in all motion parameters in both ventricles with increasing gestational age. In contrast the strength of the

deformation parameters with advancing gestational age decreases and this effect is in the right ventricle (RV) more distinctive. The heart rate (HR) has a little to no effect on global systolic and diastolic V in both chambers, while global D decreased with increasing HR. The global systolic and diastolic SR were raised with rising HR. The HR has no effect on global S in RV. On the other hand in the left chamber (LV) the global S was raised with increasing HR.

b) Ninety-three loops had to be excluded from 230 loops because of the absence of an expressive analysis. The remaining cases were able to be evaluated by one single loop in large part. In a few cases 2 loops were necessary for the analysis of both ventricles.

c) There is no statistically significant difference between RV and LV reference values except the global diastolic V and SR, which were significantly higher in RV.

d) EF and S are correlated with each other significantly. With increasing S the EF rises. This positive correlation is stronger in RV than in LV.

From the results it can be concluded that the diversity in diastolic parameters between two ventricles are possible clues for the fact, that both ventricles own different relaxation patterns. Particularly the link between EF and S points out, that the chambers have their own typical contraction abilities. With these results a base has been established to utilize this method in the future to evaluate pathologic cardiac conditions or compromised fetuses, e.g. cases with cardiac defects, fetuses of diabetic mothers, IUGR would be conceivable. Here a prognostic value could be gained with this method perspective i) before and after the intervention, ii) intrauterine and postnatal with regard to the success of surgical correction, to the normalisation of the fetal metabolic situation or to the time of the fetal decompensation. Tissue-Tracking offers the possibility to investigate the mechanics of the heart from a global perspective. With this approach it is possible to study apical regions of the chambers which are not accessible with Doppler dependent techniques. In this study we have investigated normal pregnancies with the Tissue-Tracking method. We evaluated the heart function in the dependence on different ventricles, on the HR and on the gestational age. The technical limitation of the current investigation possibilities did not allow to resolve myocardial short-living mechanical events (e.g. E- and A-waves) but the current temporal resolution still provides an insight into the overall cardiac function. Advances in technology in terms of an improved Tracking-Algorithm, a better spatial resolution and data acquisition

with higher frame rates will enhance the feasibility and repeatability of the technique in the future.