Changes in Longitudinal Myocardial Contractility and Electromechanical Interval during the First Month of Life in Healthy Neonates

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Background: During the neonatal period, the heart is subjected to significant hemodynamic changes. This study aims at documenting the changes in ventricular tissue velocities, longitudinal strain and the electromechanical coupling during the first month of life.

Methods and Results: We prospectively studied the ventricular performance of 16 healthy neonates at three time-points over the first month of life: at day 3, week 2 and week 4 of life. When measured at the mitral valve annulus, the tricuspid valve annulus and the interventricular septum, we found both right and left ventricular systolic tissue velocities to increase significantly by 21-28% between subsequent visits ($P<0.001$). Early and late diastolic velocities at the same sites increased between the first and third visit by 1.5-1.7 times ($P<0.001$) and 1.4-1.7 times ($P<0.001$), respectively. Tissue velocity E/A ratio did not change significantly during the first month of life. Similar to the increase in systolic tissue velocities, peak systolic longitudinal strain of the right and left ventricle increased significantly during the first month of life. However, no significant changes in longitudinal strain rate were found. Finally, the electromechanical interval, measured as the time between Q (on ECG) and the peak of the systolic wave, significantly shortened with advancing age of the patients: being measured at 12 points throughout the left ventricle and the lateral mitral and tricuspid annulus, time to peak systolic velocity decreased on average to 89% in the 2nd and to 80% in the 4th week of life (22.3±0.2ms vs. 19.8±0.3ms vs. 17.8±0.5ms, $P<0.001$). When comparing opposing walls of the left ventricle, no dyssynchrony in time to peak systolic contraction was found.

Conclusions: During the neonatal period, increasing tissue velocities and shortening of the time to peak systolic contraction reflect the increasing efficiency of the excitation-contraction coupling in the maturing myocardium. Throughout this time, there appears to be no dysynchrony in ventricular contraction. Longitudinal strain increases during this period; however, this may not be explained by changes in the loading condition alone. These novel findings could have significant implications in understanding the normal cardiac function during the neonatal period and in certain disease states.