An analysis of left ventricular strain in premature infants and full-term infants during the early postnatal period using Velocity Vector Imaging - An investigation into the development of cardiac function in newborns-

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Background
The cardiac function in newborns and, in particular, premature infants, is considered to be immature. However, few reports exist in which a detailed investigation was carried out into the development of cardiac function based on myocardial deformation data.

Purpose
To evaluate myocardial strain of the left ventricle and the rate of change in the cross-section of the left ventricle regarding premature infants and full-term infants using velocity vector imaging (VV1) and investigate the mode of development of the myocardial function in the perinatal period.

Subjects
The subjects comprised 36 premature infants and full-term infants with no congenital heart disease, arrhythmias or lung disease. A fixed gestational age range was 29 weeks and 6 days to 41 weeks and 4 days, 1 to 90 days old

Method
- Echocardiography: ACSON X300 premium edition (Siemens Medical Solutions USA, Inc.)
- Frame rate: average 89/sec (72-98/sec)
- View: the left ventricular short-axis view (base and apex) and four-chamber view of the apex
- Using the data of continuous 3 beats

Data analysis
- Analysis: syngo US Workplace (Siemens Medical Solutions USA, Inc.)
- The left ventricular short-axis area of the base and the apex was measured by tracing the lining membrane (Figure 1).
- The analysis of the averaging data of 3 heart rete using original program (S-PLUS; Mathematical System, Inc., Tokyo, Japan) on matching the time phase
- Measurement of Peak circumferential (CS) and longitudinal (LS) strain and systolic diastolic SR (sSR/dSR) on Septal/Lateral wall at Apical/Basal phase in left ventricle (Figure 2)
- Measurement of Peak % area change in Apical/Basal SAX view, volume change with Simpson method in chamber view and area and volume change during IVRT (Figure 3)

Results
The CS of the apex and the diastolic phase CSR showed a positive correlation with the number of weeks of fixed gestation ($r = 0.60$, $P < 0.001$) and the systolic CSR showed a negative correlation ($r = -0.54$, $P = 0.003$). Regarding the rate of changes in the cross-section, only the apex showed a positive correlation with the number of weeks of fixed gestation ($r = 0.58$, $P < 0.001$), with the base not exhibiting any correlation.

Discussion

Development of systolic function
Mechanism: Maturation of Calcium metabolism, Increase in cardiac myofibrillar
Longitudinal Strain and sSR → Systolic function developed only in the circumferential direction mainly at the apical and basal lateral wall.
Apical Septal strain ↑ % area change in only Apical area ↑
Basal Septal strain ↑ The most developed apical lateral area not affected by the right ventricle

Development of diastolic function
Mechanism: Development of active myocardial relaxation
Apical, Basal area and 4ch volume change during IVRT ↑
Apical and Basal dSR ↑
Longitudinal dSR → Diastolic function developed both in the longitudinal and the circumferential direction

Conclusion
Our data showed the development of apical systolic function and global diastolic function with the increasing number of weeks of fixed gestation. This might be a cause be a cause for the development of cardiac function in premature infants and full-term infants during the perinatal period and is thus considered to be important new knowledge regarding the cardiac function of newborns.