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Anatomical and functional changes in foetal left ventricular myocardium

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Background:

Left ventricular myocardium is a strongly anisotropic tissue in adults. Cardiomyocytes are arranged in a complex three-dimensional network which forms a counterclockwise helix in the endocardial layer and a clockwise helix in the epicardial layer. This peculiar organization is fundamental to myocardial functionality because left ventricular contraction is not only longitudinally and radially oriented, but also characterized by ventricular twisting. Foetal physiological myocardial development dynamics has not been completely explained yet and the few studies about this topic focused mainly on the histology of mammalian hearts and not human ones.

Aim of the study:

Speckle Tracking Echocardiography allows to study separately endocardial and epicardial functionality in vivo. Combining this data with morphometrical observation on histological sections of fetal human heart, we compared the development of the different myocardial layers with advancing gestational age.

Materials and methods:

To study fetal myocardial function, we enrolled 72 fetuses and 39 premature babies without cardiac pathologies. We studied longitudinal endocardial and epicardial strain in these patients.

For the histological section, we studied 20 foetal hearts without cardiac pathologies from autoptical investigation. We determined every layer's thickness and cardiac fibres orientation in comparison with gestational age.

Results:

Endocardial values of deformation are higher than epicardial ones. Epi/endocardial values ratio increase with gestational age (see figure). The epicardial layer, in fact, becomes more influencing.

Histological data confirm our observations. All the layers increase their thickness during gestation but epicardium increases fourfold while trabecular and endocardial layers maintain the same value throughout pregnancy. As a consequence, also in this case we found an increasing epi/endo ratio.

Conclusions:

Left ventricular myocardium maturation is a process that begins early during fetal life. It starts from the differentiation of a subendocardial layer. The development of the epicardial is slower and is completed late in the foetal life. Probably this process is led by the increasing pre- and after load in the third trimester of gestation. The creation of different phantom models of myocardial arrangements in order to assess the difference in pressure-volume curves between different layer arrangements at different gestational weeks is an on-going process.

