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Tissue Motion and Assembly During Early Cardiovascular Morphogenesis[1]

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Conventional dogma in the field of cardiovascular developmental biology suggests that cardiac precursor cells migrate to the embryonic midline to form a tubular heart. These progenitors are believed to move relative to their extracellular matrix (ECM); responding to stimulatory and inhibitory cues in their environment. The tubular heart that is formed by 30 hours post fertilization is comprised of two concentric layers: the muscular myocardium and the endothelial-like endocardium, which are separated by a thick layer of ECM believed to be secreted predominantly by the myocardial cells. Here we describe the origin and motility of fluorescently tagged endocardial precursors in transgenic (Tie1-YFP) quail embryos (R. Lansford, Caltech) using epifluorescence time-lapse imaging. To visualize the environment of migrating endocardial progenitors, we labeled two ECM components, fibronectin and fibrillin-2, via in vivo microinjection of fluorochrome-conjugated monoclonal antibodies. Dynamic imaging was performed at stages encompassing tubular heart assembly and early looping. We established the motion of endocardial precursor cells and presumptive cardiac ECM fibrils using both object tracking and particle image velocimetry (image cross correlation). We determined the relative importance of directed cell autonomous motility versus passive tissue movements in endocardial morphogenesis. The data show presumptive endocardial cells and cardiac ECM fibrils are swept passively into the anterior and posterior poles of the elongating tubular heart. These quantitative data indicate the contribution of cell autonomous motility displayed by endocardial precursors is limited. Thus, tissue motion drives most of the cell displacements during endocardial morphogenesis.

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