Branching morphogenesis of chicken embryo yolk-sac vascular networks

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There is emerging evidence that besides biochemical signaling, vascular branching morphogenesis is determined by self organized actions of shear stresses generated by the circulating blood[1,2] and mechanical stresses generated by the growing, deforming surrounding tissue[3,4].

To study these phenomena we use the chicken embryo yolk-sac as experimental model. The yolk-sac is a flat tissue which surrounds the embryo and serves to provide the embryo with nutrients from the yolk. By time lapse video microscopy we observed the growth and vascular development of the yolk-sac for 48h. Tracking the bifurcations of the vascular network in the expanding tissue reveals a possible viscous deformation of the tissue.

Furthermore we measured tissue mechanical properties by deforming the tissue locally for about 5 sec by a tiny air jet through a micropipette of 60 Î$\frac{1}{4}$m (the scanning air puff tonometer[5]). The deformation of the tissue is observed by shadowgraph imaging, while simultaneously the displacement of a laser spot reflecting from the tissue surface is observed. Following an approximate step air impact on the surface of the yolk sac, we observe typically a visco-elastic deformation with at small timescales (¡ 1sec) a visco-elastic response and at larger time scales a pure viscous deformation.

These visco-elastic mechanical properties are in accordance with our displacement observations using time lapse video microscopy. We conclude that the viscous component of the tissue mechanical properties plays an important role in the patterning of vascular networks.

Références

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