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Modification of mechanical environment to control vascular organization within developing chicken embryo

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INTRODUCTION: Vascular tree formation and their network organization has previously been shown to be sensitive to the mechanical environment *in vitro*[1], yet the specific relationship between the mechanical factors such as geometry, shape, pressure, flow characteristics and vascular organization *in vivo* is not well understood. The present study aimed to investigate the effect of yolk shape on vascular network organization, within developing chicken embryos cultured in containers with different geometries, resulting in a different mechanical environment of the egg yolk. Using both laser speckle contrast (LSCI) and laser doppler perfusion imaging (LDPI) techniques, the spatio-temporal changes of heart rate and flow velocity in the vascular networks within developing chicken embryos were determined.

METHODS:

PDMS based artificial egg shell systems

3D geometric (cube, cylinder and triangular prism shaped) containers based on oxygen permeable thin polydimethylsiloxane (PDMS) membranes were assembled using soft lithographic templates. 3D printed poly(lactic acid) frames were used as mechanical support. Fertilized white leghorn chicken eggs were incubated with 38°C and 65% humidity under regular rotation. After 3-days of incubation, chicken embryos were transferred to the artificial geometric culture systems as shown in the figure.

RESULTS: Results showed that the heart beat rate (figure -right) and vascular network density were

influenced by changing the local mechanical environment of egg yolk. Further, LDPI revealed changes in the perfusion rates within the chick vasculature. Moreover, changes in vascular organization with respect to differences in the local microenvironment of the yolk were observed.

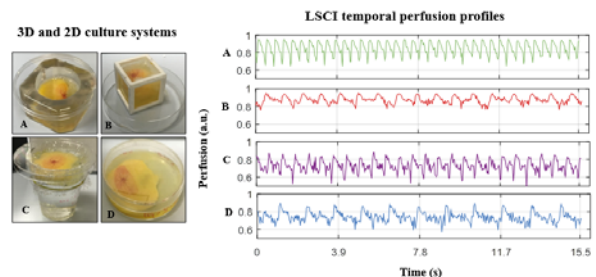


Figure: (left) chicken embryos exposed to different mechanical environments and (right) variations in perfusion rates of chick vasculature subjected to different mechanical environments

CONCLUSIONS & FUTURE PLANS: With the ultimate goal to understand *in vivo* vascular organization, fluid flow and growth factor gradient patterns adjacent to the developing chicken blood vessels will next be introduced in the PDMS systems. This 3D integrated platform offers the possibility to evaluate the effect of multiple signals towards vascular organization in a single system.

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REFERENCES

[1] Rivron NC et al. PNAS, 2012;109(18):6886-91