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Cell elongation and cell adhesion suffice for vascular network formation

The formation of blood vessels is crucial in many biological processes including embryonic development, wound healing and cancer. Vascular networks form by migration of endothelial cells and their interaction with the ECM. A multitude of computational models explain vascular network formation by means of chemotaxis driven aggregation. However, experiments suggest that vascular networks may form also without secreted chemoattractants [1].

Previously, we have highlighted cell length as a key property for vascular-like network formation [2]: a cell-based, Cellular Potts model indicated that chemotaxis and cell elongation, together, suffice for forming stable, regular networks. We have now analyzed the dynamics of this model in absence of chemotaxis, and find that cell elongation and cell adhesion alone suffice for forming network-like structures.

The deformability of cells and their adhesion to the ECM turn out to be key to network formation. Flexible, adherent cells form blobs with individual cells packed closely together. More rigid, elongated cells cannot assume their ideal shape inside a blob, making network-like structures the preferred configuration. Without chemotaxis, network-like patterns form in a narrow region of parameter space; chemotaxis dramatically widens this region and sharpens the phase transitions between blobs and networks. Concluding, vascular network formation does not necessarily require chemotaxis or similar, midrange attractive forces between cells, although such forces make network-like patterning more robust.

References

[1] Andras Szabó, *Network Formation of Tissue Cells via Preferential Attraction to Elongated Structures* Phys Rev Lett 2007
[2] Roeland M.H. Merks *et al*, *Cell elongation is key to in silico replication of in vitro vasculogenesis and subsequent remodeling* Dev Biol 2006