Intermediate adhesion maximizes migration velocity of multicellular clusters

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Abstract Collections of cells exhibit coherent migration during morphogenesis, cancer metastasis, and wound healing. In many cases, bigger clusters split, smaller sub-clusters collide and reassemble, and gaps continually emerge. The connections between cell-level adhesion and cluster-level dynamics, as well as the resulting consequences for cluster properties such as migration velocity, remain poorly understood. Here we investigate collective migration of one- and two-dimensional cell clusters that collectively track chemical gradients using a mechanism based on contact inhibition of locomotion. We develop both a minimal description based on the lattice gas model of statistical physics and a more realistic framework based on the cellular Potts model which captures cell shape changes and cluster rearrangement. In both cases, we find that cells have an optimal adhesion strength that maximizes cluster migration speed. The optimum negotiates a tradeoff between maintaining cell-cell contact and maintaining configurational freedom, and we identify maximal variability in the cluster aspect ratio as a revealing signature. Our results suggest a collective benefit for intermediate cell-cell adhesion.

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