The complexity of the invasive carcinoma pattern under a dynamic change in cell phenotype

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Abstract

According to recent studies, cancer is an evolving complex ecosystem. It means that tumor cells are well differentiated and involved in heterotypic interactions with their microenvironment competing for available resources to proliferate and survive. The important role in changing the concept was played by works that had reported the various cancer structures arising even from identical cells. Such structures help cancer cells to jointly protect themselves against different types of therapies, as well as to increase the metastatic capacity. Thus, when looking for a cancer medicine, one should take into account that cancer is a sophisticated self-organized system which can evolve and adapt to changes in the surroundings and modify its behavioral patterns. In this paper, we propose a chemo-mechanical model for the growth of specific subtypes of an invasive breast carcinoma [1]. The model suggests that a carcinoma is a heterogeneous entity comprising cells of different phenotypes, which perform different functions in a tumor. Every cell is represented by an elastic polygon changing its form and size under pressure from the tissue. The mechanical model is based on the elastic potential energy of the tissue including the effects of contractile forces within the cell perimeter and the elastic resistance to stretching or compressing the cell with respect to the reference area. A tissue can evolve via mechanisms of cell division and intercalation. The phenotype of each cell is determined by its environment and can dynamically change via an epithelial–mesenchymal transition and vice versa. The phenotype defines the cell adhesion to the adjacent tissue and the ability to divide. In this part, we focus on the forms of collective migration of large groups of cells. Numerical simulations show the different architectural subtypes of invasive carcinoma. For each communication, we examine the dynamics of the cell population and evaluate the complexity of the pattern in terms of the synergistic paradigm. The patterns are compared with the morphological structures previously identified in clinical studies. Figure show schematic presentation of an invasive carcinoma spreading outside the duct epithelium (top right). Main special, well-differentiated, architectural types of the invasive breast cancer identified on the base of the histological analysis include solid (a), papillary (b), cribriform (c), alveolar (d), trabecular (e), tubular (f) carcinoma, and discrete groups of cancer cells (g).

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