www.elsevier.com/locate/jbiomech

Collective dynamics of cancer cells confined in a confluent monolayer of normal cells

Shao-Zhen Lin, Bo Li, Guang-Kui Xu, Xi-Qiao Feng

PII: S0021-9290(16)31328-8
DOI: http://dx.doi.org/10.1016/j.jbiomech.2016.12.035
Reference: BM8068

To appear in: *Journal of Biomechanics*
Accepted date: 20 December 2016

Cite this article as: Shao-Zhen Lin, Bo Li, Guang-Kui Xu and Xi-Qiao Feng Collective dynamics of cancer cells confined in a confluent monolayer of norma c e l l s , *Journal of Biomechanics* http://dx.doi.org/10.1016/j.jbiomech.2016.12.035

Collective dynamics of cancer cells confined in a confluent monolayer of normal cells

Shao-Zhen Lin[a], Bo Li[a*], Guang-Kui Xu[b], Xi-Qiao Feng[a*]

[a]*Institute of Biomechanics and Medical Engineering, AML, Department of Engineering Mechanics, Tsinghua University, Beijing 100084, China*

[b]*Department of Engineering Mechanics, State Key Laboratory for Strength and Vibration of Mechanical Structures, Xi'an Jiaotong University, Xi'an 710049, China*

libome@tsinghua.edu.cn

fengxq@tsinghua.edu.cn

[*]Corresponding authors.

Abstract

Tumorigenesis often involves specific changes in cell motility and intercellular adhesion. Understanding the collective cancer cell behavior associated with these specific changes could facilitate the detection of malignant characteristics during tumor growth and invasion. In this study, a cellular vertex model is developed to investigate the collective dynamics of a disk-like aggregate of cancer cells confined in a confluent monolayer of normal cells. The effects of intercellular adhesion and cell motility on tumor progression are examined. It is found that the stresses in both the cancer cells and the normal cells increase with tumor growth, resulting in a crowded environment and enhanced cell apoptosis. The intercellular adhesion between cancer cells and normal cells is revealed to promote tumor growth and invasion. The tumor invasion dynamics hinges on the motility of cancer cells. The cancer cells could orchestrate into different collective migration modes, e.g., directional migration and rotational oscillations, dictated by the competition between cell persistence and local coordination. Phase diagrams are established to reveal the competitive mechanisms. This work highlights the role of mechanics in regulating tumor growth and invasion.

Keywords

Tumor growth; Cancer invasion; Cell motility; Collective cellular dynamics

1. Introduction

Cancer cells feature abnormal growth, proliferation, invasiveness and metastasis to distant organs (Hanahan and Weinberg, 2011). During growth and division, cancer cells produce growth factor ligands by themselves or stimulate the circumambient normal cells for