Oriented cell division affects the global stress and cell packing geometry of a monolayer under stretch

Guang-Kui Xu, Yang Liu, Zhaoliang Zheng

www.elsevier.com/locate/jbiomech

PII: S0021-9290(16)00004-X
DOI: http://dx.doi.org/10.1016/j.jbiomech.2015.12.046
Reference: BM7514

To appear in: *Journal of Biomechanics*

Received date: 9 September 2015
Revised date: 25 November 2015
Accepted date: 30 December 2015

Cite this article as: Guang-Kui Xu, Yang Liu and Zhaoliang Zheng, Oriented cel division affects the global stress and cell packing geometry of a monolayer unde s t r e t c h , *Journal of Biomechanics* http://dx.doi.org/10.1016/j.jbiomech.2015.12.046

Oriented cell division affects the global stress and cell packing geometry of a monolayer under stretch

Guang-Kui Xu,[1,*] Yang Liu,[1] and Zhaoliang Zheng[2]

[1] *International Center for Applied Mechanics, State Key Laboratory for Strength and Vibration of Mechanical Structures, Xi'an Jiaotong University, Xi'an 710049, China*

[3] *Stephenson Institute for Renewable Energy, Department of Chemistry, University of Liverpool, Crown Street, Liverpool, L69 7ZD, UK*

Abstract:

Cell division plays a vital role in tissue morphogenesis and homeostasis, and the division plane is crucial for cell fate. For isolated cells, extensive studies show that the orientation of divisions is sensitive to cell shape and the direction of extrinsic mechanical forces. However, it is poorly understood that how the cell divides within a cell monolayer and how the local stress change, due to the division, affects the global stress of epithelial monolayers. Here, we use the vertex dynamics models to investigate the effects of division orientation on the configurations and mechanics of a cell monolayer under stretch. We examine three scenarios of the divisions: dividing along the stretch axis, dividing along the geometric long axis of cells, and dividing at a random angle. It is found that the division along the long cell axis can induce the minimal energy difference, and the global stress of the monolayer after stretch releases more rapidly in this case. Moreover, the long-axis division can result in more random cell orientations and more isotropic cell shapes within the monolayer, comparing with other two cases. This study helps understand the division orientation of cells within a monolayer under mechanical stimuli, and may shed light on linking individual cell's behaviors to the global mechanics and patterns of tissues.

Keywords: cell division, vertex dynamics models, cell geometry, monolayer

* Corresponding author. *E-mail*: guangkuixu@mail.xjtu.edu.cn