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Does Hypertension Promote Drug Particle Intake and Distribution Across Cancer Cells?

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Introduction

In medicine, it is not uncommon for a patient to have more than one condition that is contributing to their health at a given time. With around 45% of adults ages 20+ being affected by hypertension (CDC, 2017) and 38.3% of adults being diagnosed with cancer in their lifetime (NIH, 2018).

Additionally, how a cancer cell develops can be dependent of the amount of stress being applied to the environment. As hypertension can take the ECM stiffer, we are looking into the distribution of stress over various stiffnesses of the ECM and cancer cells.

Methods

A 3D cube model was created using COMSOL 5.6 and consists of two main components, the extra cellular matrix and one cancer cell, modeled as a 3D sphere.

Solid mechanics physics were applied to the model. A boundary load of 17,332 Pascals was applied along with a Poisson's ratio of 0.495 for each simulation. Values for the Young's Modulus of both the extracellular matrix and cancer cell were chosen based off the type of cancer cell provided by a previous research study (Wullkopf et.al, 2018).

Methods (continued)

The results seen in figures 2, 3, and 4, are data points taken across a horizontal line on the y-axis ranging from 0-10 µm. This line can be seen in figure 1. The location of the cancer cell in the results ranges from 4.5 µm to 7.5 µm. The center of the cancer cell is located at y = 6 µm.

Results

As seen in figures 2, 3, and 4, there is a variation in the amount of stress applied across. When the stiffness of the cancer cell is larger than the stiffness of the surrounding ECM, a higher portion of stress is seen across the cancer cell.

When the stiffness of the cancer cell is less than that of the ECM, the stiffness across the cell will always be lover.

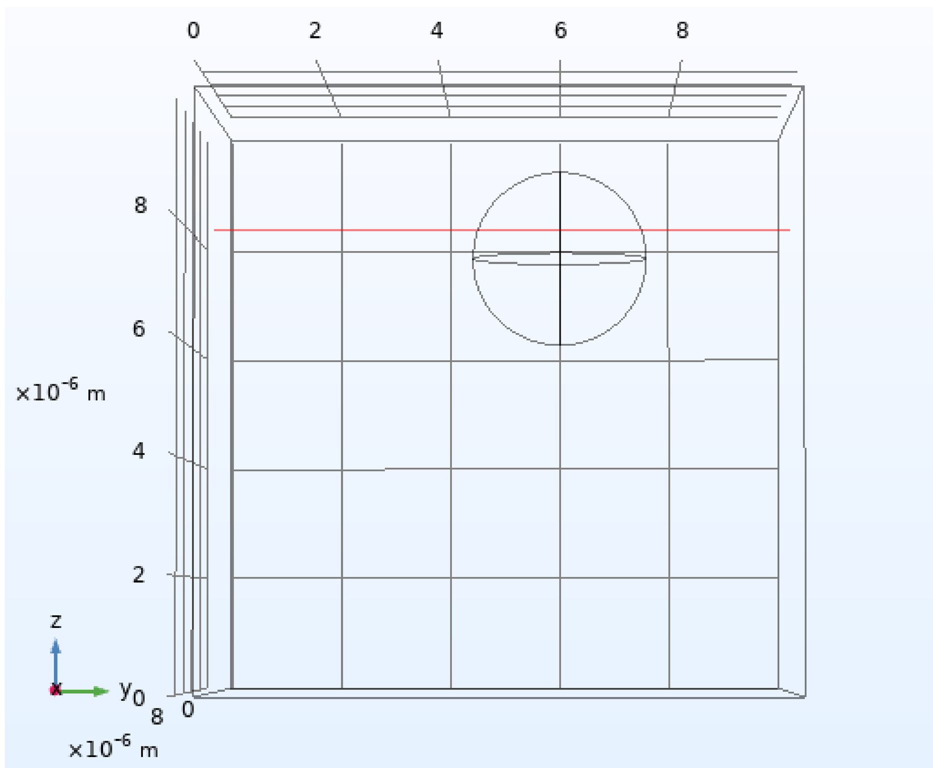

Figure 1: Base 3D Geometry

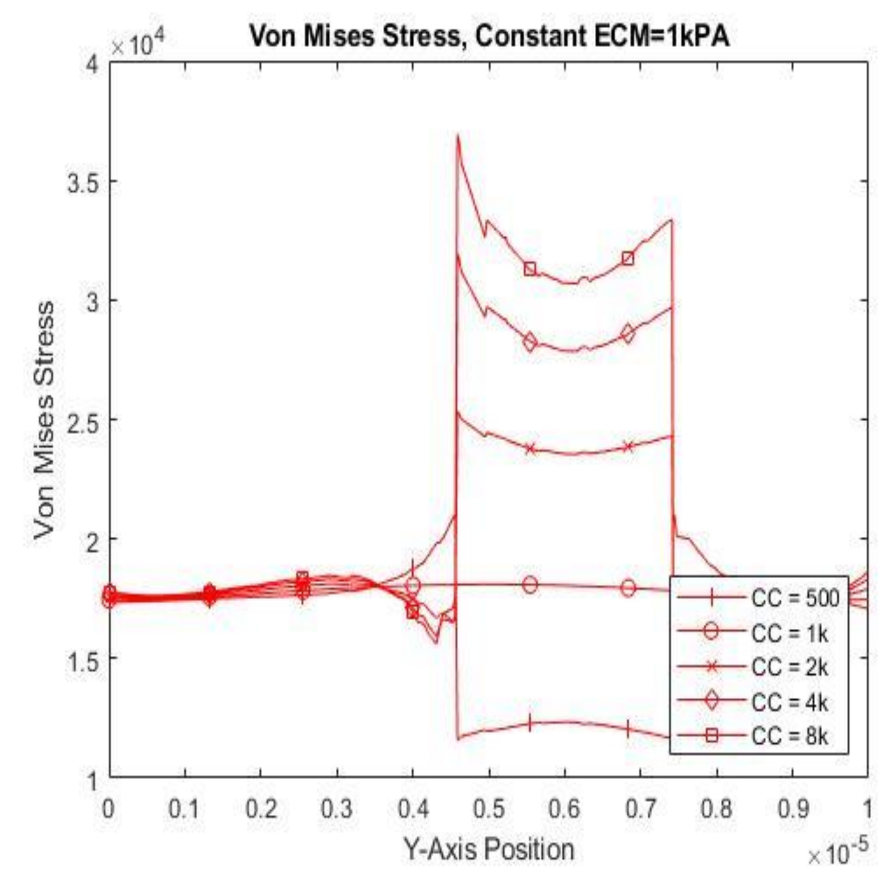

Figure 2: Constant ECM stiffness = 1000Pa

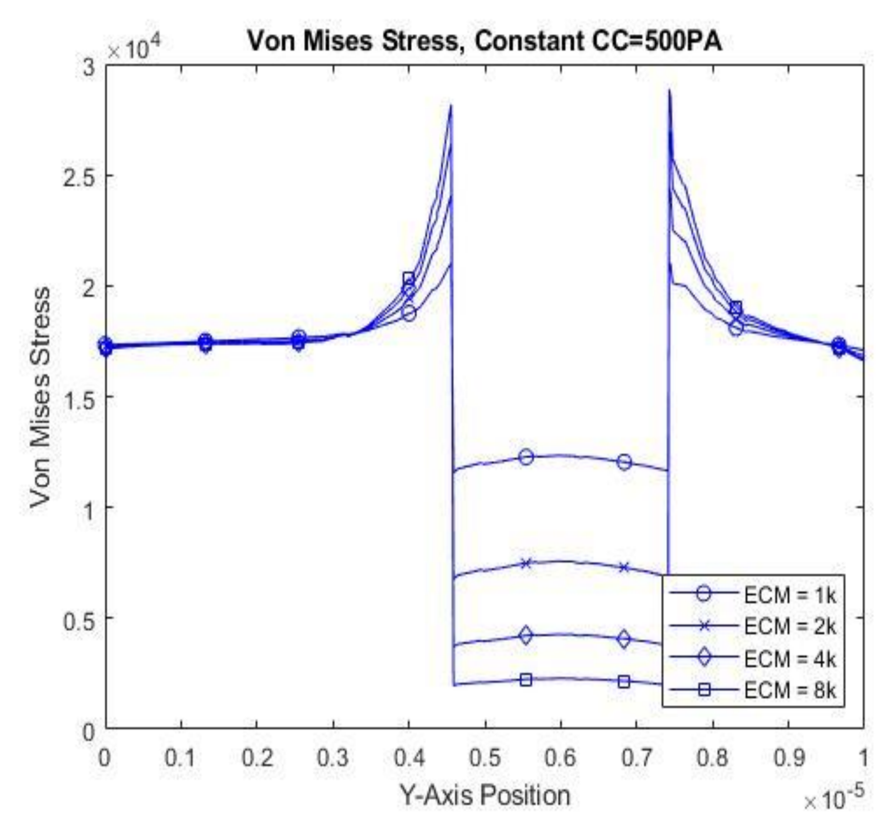

Figure 3: Constant Cancer Cell Stiffness = 500Pa

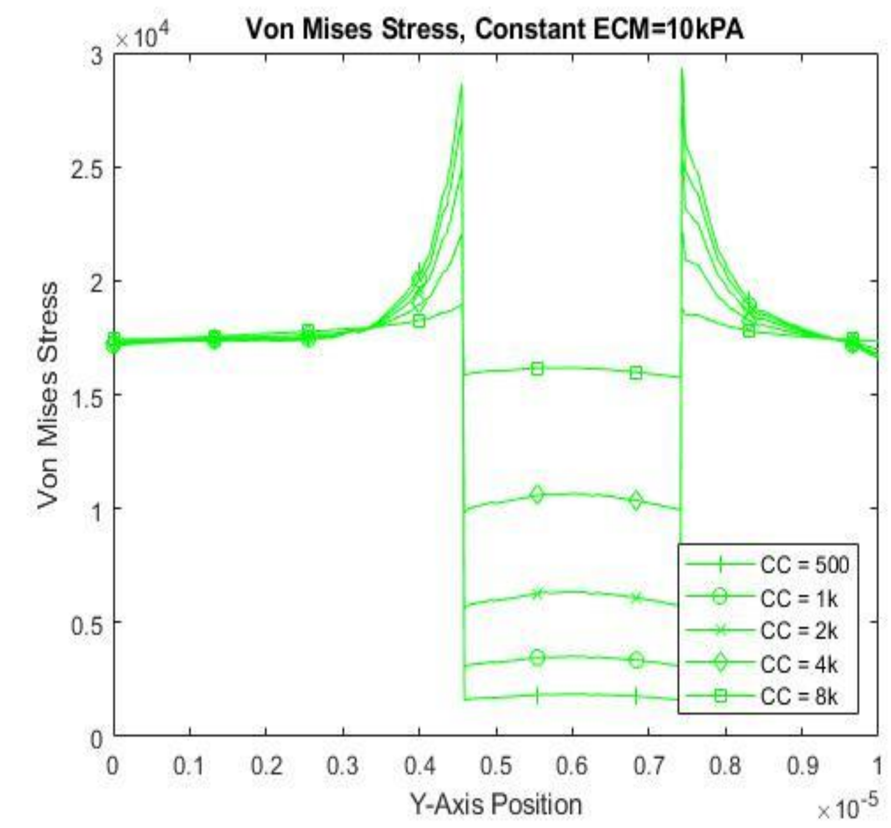

Figure 4: Constant ECM = 10kPa

Conclusions

There is a correlation between the stiffness of both the cancer cell and the surrounding environment. As data was taken across one line of the ECM, we do not know how the rest of the ECM may be affected.

A more complex 3D tumor geometry is being implemented to show how a heterogenous stiffness of the cancer cell may impact the stresses across the ECM a whole.

Literature cited

- "Facts About Hypertension." Centers for Disease Control and Prevention, Centers for Disease Control and Prevention, 25 Feb. 2020,
- "Cancer Statistics." National Cancer Institute,
- Wullkopf, Lena, et al. "Cancer Cells' Ability to Mechanically Adjust to Extracellular Matrix Stiffness Correlates with Their Invasive Potential." Molecular Biology of the Cell, The American Society for Cell Biology, 1 Oct. 2018,

Acknowledgments

Thank you for taking the time to watch and read my presentation today.
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For further information

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