Tissue-scale, patient-specific modeling and simulation of prostate cancer

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ABSTRACT

Predictive medicine is a new trend in Medicine that aims at forecasting clinical outcomes of diseases and designing optimal therapies on a patient-specific basis. Methods of predictive medicine are based on mathematical modeling and computer simulations. Prostate cancer (PCa) is a major cancer among men worldwide and an ideal candidate to benefit from this approach to medical practice [1]. We present a continuous model that reproduces the growth patterns of PCa. We use the phase-field method to account for the healthy-tumoral cell transformation and basic diffusion-reaction equations to model the dynamics of key substances. The growing tumor provokes a mass effect that induces the deformation of the prostate. We also explore the mechanical coupling of this deformation with tumor dynamics. Our simulations leverage Isogeometric Analysis (IGA) using a hierarchical basis of NURBS to accurately and efficiently compute tumor growth [1, 2]. We used our model to perform tissue-scale, patient-specific simulations of PCa cases, based on the patient's prostatic anatomy extracted from medical images. These simulations show tumor progression similar to that seen in clinical practice.

REFERENCES

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