RESEARCH TOPIC CLI22

Patient-Specific 3D Modeling to Guide Nerve-Sparing and Reduce Positive Surgical Margins in Radical Prostatectomy

Research area
Surgical area

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Abstract
Positive surgical margins (PSMs) after radical prostatectomy are associated with an increased risk of biochemical recurrence and remain a critical challenge in prostate cancer surgery. At the same time, nerve-sparing techniques are essential to preserve postoperative erectile function and continence, but their application is often based on subjective interpretation of imaging and intraoperative judgment. This creates a fundamental trade-off between oncological radicality and functional preservation.
The aim of this project is to develop and validate a patient-specific three-dimensional (3D) model integrating imaging and pathological data to guide nerve-sparing strategies and assess their impact on positive surgical margins, with the ultimate goal of reducing and potentially avoiding PSMs while preserving functional outcomes.
This translational study will combine a retrospective cohort for model development and a prospective cohort for validation. Preoperative multiparametric MRI, clinical variables, surgical data including nerve-sparing approach, and whole-mount pathological specimens will be collected in patients undergoing robotic-assisted radical prostatectomy. Prostate and tumor segmentation will be used to generate patient-specific 3D models, enabling detailed assessment of tumor location, proximity to the prostatic capsule, and relationship with the neurovascular bundles. Pathological findings, including margin status, will be spatially mapped onto these models.
The analysis will focus on identifying anatomical and imaging predictors of PSMs and neurovascular bundle involvement, and on developing a predictive model to support personalized nerve-sparing decision-making. Model performance will be assessed using multivariable analysis and internal validation techniques.
By integrating imaging, pathology, and 3D modeling, this project aims to provide a clinically applicable decision-support tool to optimize nerve-sparing strategies while minimizing positive surgical margins. This approach has the potential to improve both oncological safety and functional outcomes, contributing to the advancement of precision surgery in prostate cancer.

Scientific references

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Type of contract

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