First Clinical Study of Prostate Cancer Detection with a Dual Sensor Combining Tactile Resonance Technique with Fiber Optical Raman Spectroscopy

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The precise determination of the boundaries of a tumor during radical prostatectomy is vital. If the tumor is not completely removed the reoccurrence of cancer is most likely. The aim of this study is to develop a dual modality sensor for precise detection of tumor margins. The instrument developed by the authors combines the tactile resonance sensor [1] that determines tissue stiffness with fiber Raman spectroscopy [2] that yields biochemical information of the tissue content. The design of the sensor has been presented before and has shown good results in discerning different tissue types from porcine [3]. Here, we will present the first clinical study of a dual modality sensor for prostate cancer detection on prostate tissue from patients that had undergone radical prostatectomy.

Written consent was retrieved from the patient before operation (ethical approval, regional ethical committee, medical research, Umeå, Sweden, Drn 2013-94-32M). After radical prostatectomy, the orientations (back, front left and front right) of the sides of the resected prostate were marked with different tissue marking dyes (yellow, red and green) for further analysis by histopathology. A slice of 1 cm was cut from the prostate, fixed by needles to Styrofoam, and put onto the xyz-table. Tactile measurements and Raman spectra were taken subsequently at the preprogrammed positions. The tactile sensor's frequency and impression force were recorded during a 1 mm impression and successive retraction, 3 consecutive Raman spectra were acquired (785nm, 10 s, 54 mW). After experiment (1h) the prostate sample was immersed in formalin and prepared for histopathology. The tactile sensor's stiffness parameter, $dF/d\Delta f$, was calculated at maximum depth by linear regression of the ten data points before maximum recorded force reading. The sensor stiffness parameter's ability to discern stiff and normal tissue was evaluated by the nonparametric Kruskal–Wallis test, followed by Tukey–Kramer's multiple comparison test. The number of false positives will be evaluated against the histopathological analysis. Raman average spectra (n = 3) were slightly smoothed (Eilers' algorithm for Wittaker smoothing (d=2, L=10)), thereafter a polynomial base line reduction was performed and the final Raman spectra were vector normalized. The datasets of treated spectra were reduced by Principal Component Analysis (PCA) and grouped by a clustering algorithm. The result will be evaluated using LOO CV (leave one out, cross validating) and compared to the histopathological analysis.

The experiments could be carried out with good logistics and the time table that only allowed 1h of experiment could be followed. The first experiments show promising results.

Acknowledgements: This work was supported by the EU Structural fund, Objective 2, Norra Norrland, and the Kempe foundation.

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