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Optical biopsy to improve the diagnosis of kidney cancer

P.G.K. Wagstaff[1], D.M. de Bruin[1,2], P.J. Zondervan[1], O.M. van Delden[3], T.G. van Leeuwen[2], R.J.A. van Moorselaar[4], J.J.M.C.H. de la Rosette[1], M.P. Laguna Pes[1]

[1] *Department of Urology, Academic Medical Centre, Amsterdam, The Netherlands*

[2] *Department of Biomedical Engineering & Physics, Academic Medical Centre, Amsterdam, The Netherlands*

[3] *Department of Radiology, Academic Medical Centre, Amsterdam, The Netherlands*

[4] *Department of Urology, Free University Medical Centre, Amsterdam, The Netherlands*

Introduction: Optical biopsy is a promising new diagnostic technique aimed at instant and accurate differentiation of Small Renal Masses (SRM). To achieve this, high-resolution Optical Coherence Tomography (OCT) is combined with Diffuse Reflectance Spectroscopy (DRS).

Widespread use of abdominal imaging for non-urological complaints has led to an increased incidence of SRM (≤ 4 cm). Currently CT- and MRI-imaging is the standard for detection and analysis of SRM. However after detection these imaging techniques have proven to be unreliable in differentiating between benign and malignant tumours. Renal core-biopsies in SRM have a non-diagnostic rate of 33%. Due to these diagnostic limitations a rate of 30% of resected SRM turn out to be benign.

Technique: Optical biopsy combines two techniques, OCT and DRS. OCT is the optical equivalent of ultrasonography. Based on backscattered light, an image with a ~10µm resolution is constructed. From the OCT data attenuation coefficients (µOCT: mm^{-1}) can be derived, expressing tissue specific signal scattering. Differences in the attenuation coefficient correlate to histological characteristics providing the means of differentiating benign from malignant tumours.

DRS is the spectroscopic analysis of diffuse reflected near-infrared light. It is based on absorption and scattering of light by tissue chromophores, the part of a molecule responsible for its colour. Different parts of the light spectrum are absorbed in different quantities resulting in a specific spectral reflection pattern. These patterns give an impression of cell and tissue structure, and the presence of vascularisation through the detection of haemoglobin. Co-registered with histology-like OCT images, this results in a functional optical biopsy.

In-vivo Pilot Study: In a phase-I in-vivo study we assessed the ability of OCT to differentiate between benign and malignant renal tissue. OCT analysis of tumour tissue was performed in 16 patients. As controls unaffected renal parenchyma of the same patients was analysed. Normal tissue showed a significantly lower median attenuation coefficient compared to malignant tissue, 5.0 mm^{-1} versus 9.2 mm^{-1} ($P < 0.001$). Although not significant a clear distinction was seen between the median attenuation coefficient of benign tumour tissue and malignant tumour tissue, 7.0 mm^{-1} versus 9.2 mm^{-1} ($P = 0.139$). These promising results prompted research towards real-time OCT, investigating more advanced probes and combining OCT with DRS to attempt subtype analysis of malignant tumours.

Trial Design Multicentre In-vivo Study: Recently, inclusion started in a multicentre prospective in-vivo study combining OCT and DRS (optical biopsy), applied percutaneously under ultrasound guidance. The primary objective of the study is determining the accuracy of OCT and DRS in diagnosing renal malignancy. Secondary objectives are determining: the accuracy of OCT and DRS in distinguishing the 3 main RCC subtypes, and the accuracy of the combination of the OCT and DRS. A total of 194 patients, age ≥ 18 years and diagnosed with a solid mass by cross-sectional imaging, will undergo percutaneous optical biopsy in the weeks prior to surgical intervention (partial or total nephrectomy, or cryoablation). Additional optical biopsies will be performed during planned surgery. The optical biopsy results are analysed and matched to pathology results from either renal core biopsies or resected tissue. To prevent information bias, OCT and DRS data analysis will be performed by a researcher blinded to the pathology results.