PP-53

In vivo optical coherence tomography for the evaluation of upper urinary tract urothelial carcinoma: Initial results from a pilot study

M.T.J. Bus[1], B.G. Muller[1], D.M. de Bruin[1,2], D.J. Faber[2], M.P. Laguna-Pes[1], T.G. van Leeuwen[2], T.M. De Reijke[1] , J.J. de la Rosette[1]

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

Introduction & Objective: Knowledge on tumour stage and grade is imperative for treatment decision choice in Upper Urinary Tract Urothelial Carcinoma (UUT-UC). Current techniques (Ureterorenoscopy combined with histology) to achieve this are insufficient.

Optical Coherence Tomography (OCT) is a novel high resolution imaging technique based on backscattered light intensity in depth, which is hypothetically altered in malignant tissue due to larger and irregularly shaped nuclei with a higher refractive index. These changes can be derived from the light scattering property of OCT images, which is quantified by the attenuation coefficient μ_{oct}. Secondly, as each distinct anatomical layer of the ureter has different scattering properties it enables visualizing the three layers of the urothelial wall and discriminate between invasive and non-invasive lesions. In this prospective pilot study, ten patients underwent URS plus biopsies for UUT-UC combined with three-dimensional (3D) OCT, to determine the feasibility of OCT to provide real time per-operative information on UUT-UC grade and stage.

Materials & Methods: Ten patients with UUT-UC underwent URS that included the simultaneous use of 1300 nm uretroscopic OCT. Imaging was performed at places that showed tumor growth. For lesions visible in the OCT image, the attenuation coefficient (μ_{oct}) and presence of the basal membrane under the lesion was determined. OCT diagnosis was compared with biopsy histology and histology findings in nephroureterectomy specimens.

Results: In lesions with confirmed G1-2 UUT-UC by histology, median (interquartile range) μ_{oct} was 2.3 mm^{-1} (1.5-2.8) compared to 3.6 mm^{-1} (2.8-4.0) (P < 0.001) in histological confirmed G3 UUT-UC lesions (Fig. 1). Individual tissue layers are clearly seen and the basal membrane appears as a dark line. Presence of a dark layer underneath the lesion indicates a non-invasive tumour. Interruption of this line was seen in invasive lesions (Fig 2).

Conclusion:

OCT is a high potential imaging modality that is able to distinguish invasive lesions and non-invasive lesions. In addition there is a difference in μ_{oct} between low grade and high grade tumour, suggesting that OCT is able to provide information on tumour stage and grade. As this is a pilot study, validation of these results is needed in an extended study.
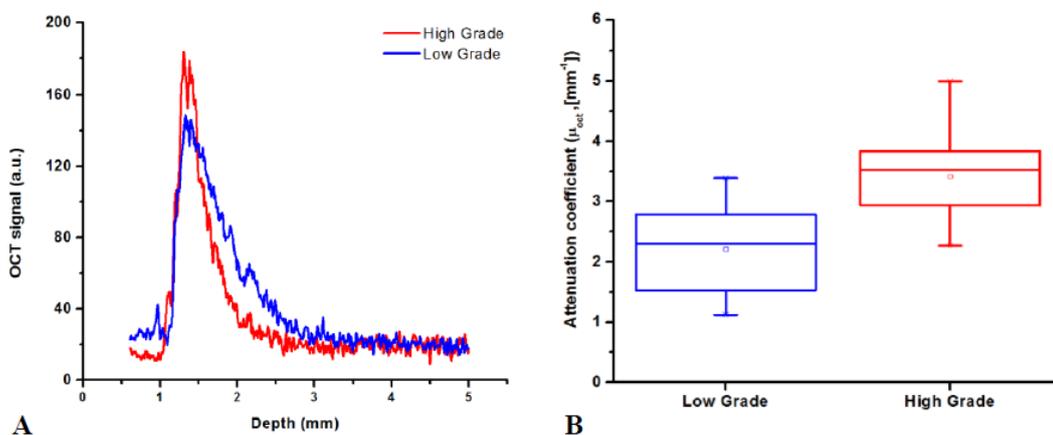
Figure 1: Attenuation data of low and high grade lesions. A) Example of individual depth profiles of a low grade(blue) and a high grade (red) lesion showing the difference in OCT signal attenuation over depth expressed by the differences in slope. Boxplot for individual μ_{oct} values in low grade (n=29) and high grade (n=13) lesions. For all individual OCT measurements on grading, the median (interquartile range) μ_{oct} is 2.3 mm^{-1} (1.5-2.8) in low-grade lesions and 3.6 mm^{-1} (2.8-4.0) in high grade lesions (P < 0.001)
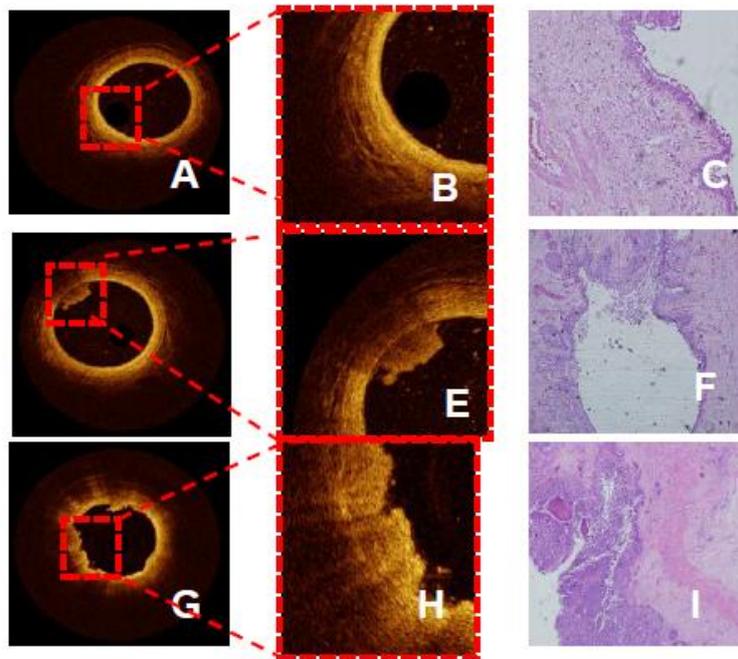
Figure 2: A: Cross-sectional OCT image of normal appearing ureter. B: anatomical layers of the ureter can be identified. C: matching histology. D&E: Cross-sectional OCT image suggesting non-invasive tumor. F: Corresponding histology. G&H: Cross-sectional OCT image suggesting invasive tumor. I: Corresponding histology.