Bern, 14/04/2021

u^b

UNIVERSITÄT
BERN

Segmenting encrustations from clinically retrieved Double-J ureteral stents

DS applications and challenges in Medicine, Natural Sciences, and Engineering

Shaokai Zheng[1], Pedro Amado[1], Bernhard Kiss[2], Fabian Stangl[2], Andreas Haeberlin[3], Dominik Obrist[1], Fiona Burkhard[2], and Francesco Clavica[1]

[1] ARTORG Center, Faculty of Medicine, University of Bern

[2] Department of Urology, Inselspital, Bern University Hospital, University of Bern

[3] Department of Cardiology, Inselspital, Bern University Hospital, University of Bern

shaokai.zheng@artorg.unibe.ch

Abstract

Ureteral stents are indispensable devices in modern urology practice to maintain drainage of the urinary tract in presence of ureteric obstructions. However, encrustation on indwelling stents remains a major problem causing many clinically significant complications. Current knowledge of the localization of encrustations on indwelling stent and their development over time is largely based on qualitative evaluations that bear significant uncertainties and biases. In the current study, we quantify the encrustation volume on clinically retrieved stents by means of micro-Computed Tomography (µ-CT) imaging and image segmentation with the U-Net. Double-J ureteral stents were collected from patients with stone diseases (n=14) and varying indwelling times (11-90 days). Each stent was divided into four sections (the renal pigtail, the proximal straight part near the ureteropelvic junction, the distal straight part near the ureterovesical junction, and the bladder pigtail) for the µ-CT scans. Raw images were pre-processed by intensity normalization and gamma correction. Subsequently, 50 frames from the straight part images and 36 frames from the pigtail images were labelled and supplied to train the U-Net. Two networks were trained independently for the straight part and pigtail samples, and the test result yielded dice coefficients of 0.97 and 0.92, respectively. Finally, the segmented encrustation volumes were normalized by the stent volume to obtain the volume ratio, which was compared over indwelling time and between different stent sections. Our results suggest that encrustations grow significantly after 6 weeks of indwelling time ($p<0.05$, two-tailed Mann-Whitney U-test, same below), and that the proximal straight part is more susceptible to develop encrustations than the distal straight part ($p<0.05$). These conclusions suggest that patient management strategies and future stent design iterations should focus more on the proximal part of the stent.