Fluid mechanics of urine in healthy and pathologic ureters

Background: The ureters are distensible vessels conveying urine from the kidneys to the bladder where the urine is stored until voiding occurs. In healthy individuals, ureteric peristalsis (i.e. involuntary muscular contractions of the ureteral wall) are responsible for the propagation of urine. Ureteric obstruction can occur in certain clinical conditions (e.g. occlusions due to ureteric stones or tumours) and, in such conditions, ureteric stents (e.g. double J stent) are normally used to restore the drainage of the urine. Major limitations associated with the implantation of the ureteric stents are: i) strong reduction of the ureteric peristalsis [1], ii) bacterial colonization on the stent surface and iii) stent encrustation. In a recent work [2] the fluid dynamics of urine has been investigated in a model of stented and obstructed ureter, with rigid and non-moving walls. It was found that the stent itself introduces a significant reduction of the ureter inner lumen and laminar vortices in the ureter lumen.

Aim: To test how a preserved peristalsis in a stented ureter can overcome the limitations introduced by stents. Therefore the project aims at investigating (both computationally and experimentally) the ureteric peristalsis and its changes due to the presence of the stent.

Tasks

- Development of a computational ureter model based on physiological data (computational)
- Investigating the fluid mechanics of urine during ureteric peristalsis (computational)
- Investigation of the ureter physiology in normal and pathological conditions (experimental)
- Possible role of peristalsis against bacterial adhesion and stent encrustation
- Interaction and collaborations with external research groups

Nature of the Thesis
The split of computational and experimental tasks will be defined according to the profile of the candidate.

Requirements
Basic knowledge of fluid mechanics
Basic knowledge of Comsol/ Ansys

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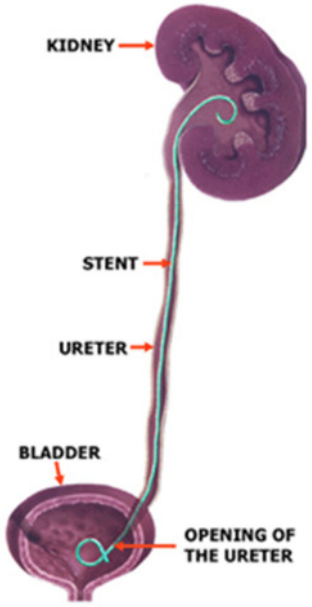

Fig1. schematic of a stented ureter, adapted from: http://www.bui.ac.uk/PatientInfo/ureterstent.html

References
1. Kinn AC, Lykkeskov-Andersen H (2002) Impact on ureteral peristalsis in a stented ureter. An experimental study in the pig. Urol Res 30: 213–218

2. Clavica F, Zhao X, Elmahdy M, Drake MJ, Zhang X, et al. (2014) Investigating the flow dynamics in the obstructed and stented ureter by means of a biomimetic artificial model. PLoS One 9: e87433.

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