

Ureteral Stenting Essentials

Pros & Cons of internal renal stenting



Asst. Prof. MD Frank Strittmatter

(Expert Webinar on Tuesday, September 21st 2021)

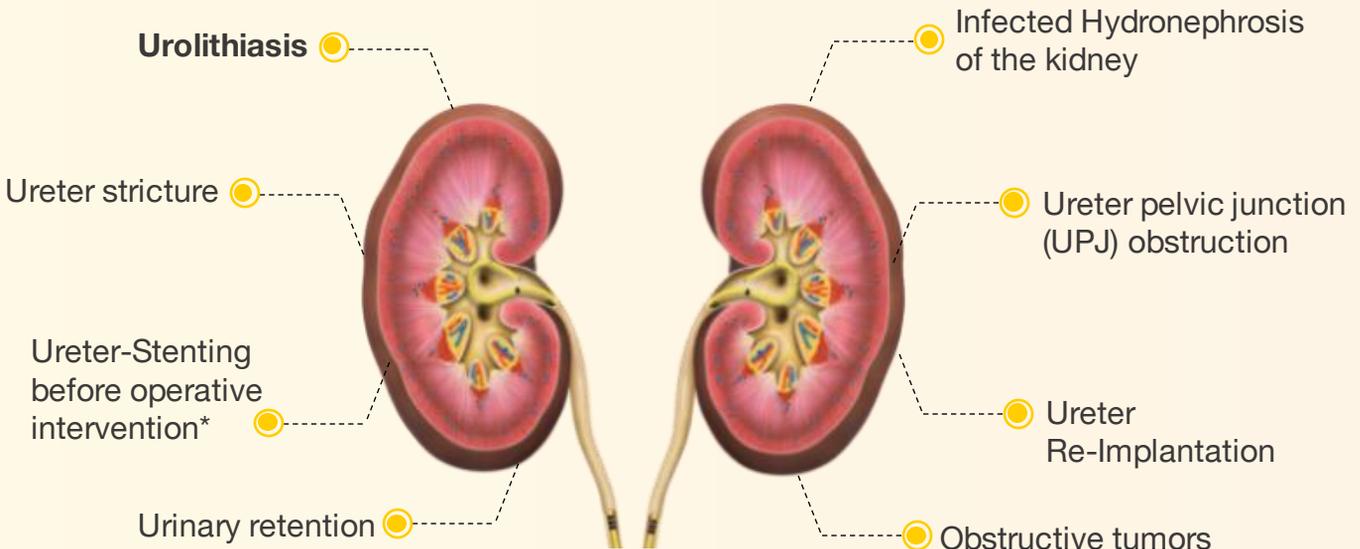
History of Internal Renal Stenting

It all started in 1871 with a report on placing a simple tube in the ureter during open bladder surgery. Over time, materials and techniques have been further refined, so that today we can work with minimally invasive solutions.



Indications for Internal Renal Stenting

Urolithiasis is probably the most common indication for the insertion of an ureteral stent, with a variety of other indications which need ureteral stenting.



*limited evidence but very often requested by surgeons

Common Side Effects (of Ureteral Stents)

- Dysuria with irritative symptoms within the bladder
- Flank pain due to reflux
- Obstruction & incrustation due to biofilm building → retention
- Infections
 - 44 – 90 % contamination
 - 8 – 30 % symptomatic infections or similar

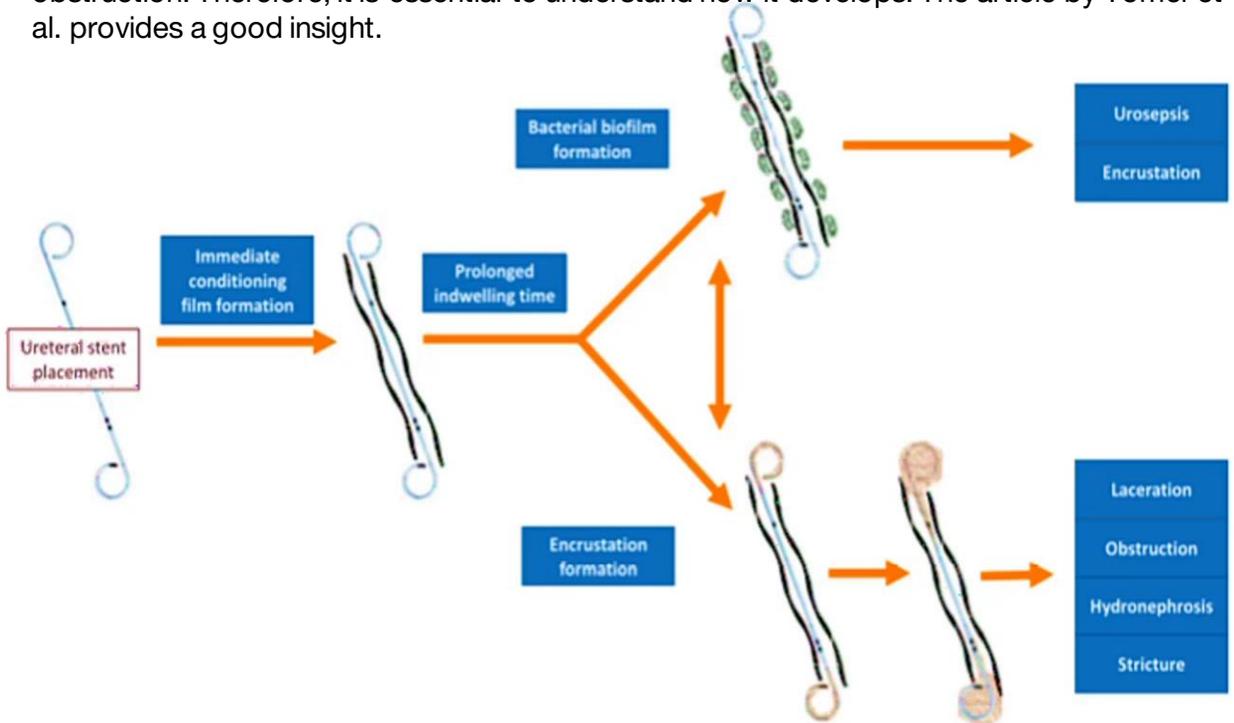
Antibiotics are indicated in symptomatic patients only

- Injuries (urinom)
- Fistula in rare cases to narrow organs (e.g. Intestine- /Vascular system)

Solutions may come from new developments in material, design, coating and in the future potentially drug eluting stents.

Biofilm Formation

Biofilm formation is one of the main reasons for side effects like infection, encrustation and obstruction. Therefore, it is essential to understand how it develops. The article by Tomer et al. provides a good insight.



Tomer et al., J Urol. 2021 Jan; 205: 68-77

STENT PLACEMENT

- | | |
|--------------------------------|---|
| First hour(s) | (1) Micro organisms with extracellular products & organic salts build a structured unit on the stent surface → immediate conditioning film formation |
| Within first 1 – 2 days | (2) Biofilms forms directly after insertion |
| At approx. 2 weeks | (3) Colonization, irrespective of antibiotic treatment |
| Anytime from biofilm formation | (4) Biofilm causes obstruction, dysfunction & infection → with longer indwelling time the risk for associated side effects like urosepsis or hydronephrosis, based on encrustation and infection, increases |

STENT EXTRACTION

Biofilm Formation – Right Stent Selection

Knowing the pathological mechanism of biofilm formation and timing can help selecting the right stent for the patient.

Kidney stone patient after URS

- No remaining stone, removal of stent after 10 to 14 days
- Less sophisticated stent can be used which comes at lower price

Tumor Patient

- Lives with stent, stent is exchanged every 6 to 12 months
- Special tumor stent makes sense even if it is more expensive

TIP 1: How to treat patients with stent infection associated problems?



- ✓ Remove stent and place new one
- ✗ Antibiotic treatment not effective

TIP 2: An additional valuable review article on ureteral stent-associated urinary tract infections, involved bacterial mechanism and preventive or treatment options was published by Lange et al. and is recommended for reading:



[Ureteral stent-associated infection and sepsis: pathogenesis and prevention: a review - PubMed \(nih.gov\)](#)

Scotland et al: Ureteral stent-associated infection an sepsis: pathogenesis and prevention: a review. *Biofouling* 2019 Jan; 35(1): 117-127. doi: 10.1080/08927014.2018.1562549

Stent Materials

Polyurethane

- Bio- and blood compatible
- Surface may be functionalized
- Better durability, compliance & compatibility
- X-ray visibility



- Interacts with epithelial cells
- Limited indwelling time
- Risk of biofilm and incrustation



Silicone

- Very good biocompatibility
- Soft & long indwelling time



- Increased friction between lumen and guide wire
- Complicated in stricture or obstructed ureters
- Reduced stability need thicker walls
- Reduced inner lumen



Gel-based

- Can absorb H₂O without consecutive dissolution
- Soften up after insertion
- Less friction during insertion (ureteral wall-material)



- Registered for pediatric indications



Metal

- High stability due to intrinsic compression
- Long indwelling time
- Special coating (Teflon) possible



- Limited urine flow
- Mechanic ulceration
- Extensive insertion procedure



Stent Coatings

Hydrophilic Coating

- Water-absorbed surface eases insertion 
- Softer stent may have positive impact on patient comfort

- Gel-based surface favors bacteria adherences 

Heparin Coating

- Negative charge avoids cell adhesion 
- Inhibitoric impact on crystalline formation & biofilm building
- Thermosensitive → hard before insertion, after that weak due to body temperature

- Inhibiting effect on bacteria adherence not confirmed 

Diamond Like-Carbene Coating (DLC)

- Plasma-matured; like diamond amorphous carbon material as a coating 
- High mechanical hardness
- High biocompatibility
- Reduced biofilm building & incrustation

Drug-Eluting Stents

- KETOROLAC (NSAID)
- PACLITAXEL
- (TRICLOSAN)
- mTOR Inhibitor

Rarely used & very expensive

Interesting field of development

Protective Role of Phosphorylcholine

Polyurethane stents with phosphorylcholine-treated surface (PC):

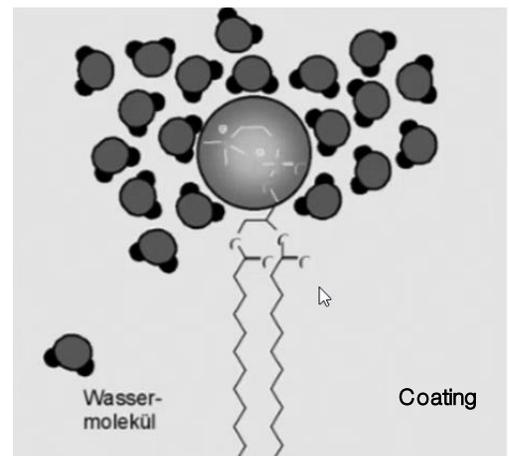
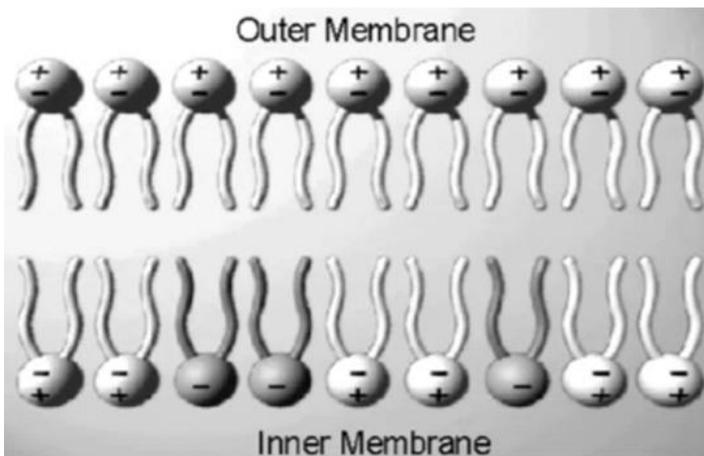
- In vitro **90 % reduction of bacterial adhesion***
- In vivo **40 % reduction of biofilm***



*Russel, J.: Bacteria, Biofilms and Devices: The Possible Protective Role of Phosphorylcholine Materials. Journal of Endourology. Vol. 14, Nr. 1; February 2000

Phosphorylcholine (PC):

- Part of the human body
- Outer membrane, e.g. Erythrocytes consists of appr. 88 % phospholipids with PC → blood compatibility
- Synthetic biomaterial from lipophilic-, PC- and co-monomers formed themselves to a polymere
- Polymers are used for coatings for medical materials



- Imitate the surface structure of cell membrane
- Better biocompatibility
- Maintains surface electrically neutral
- Hydrophilic surface → reduced adhesion of biofilm
- Incrustation and urinary infection reduced significantly

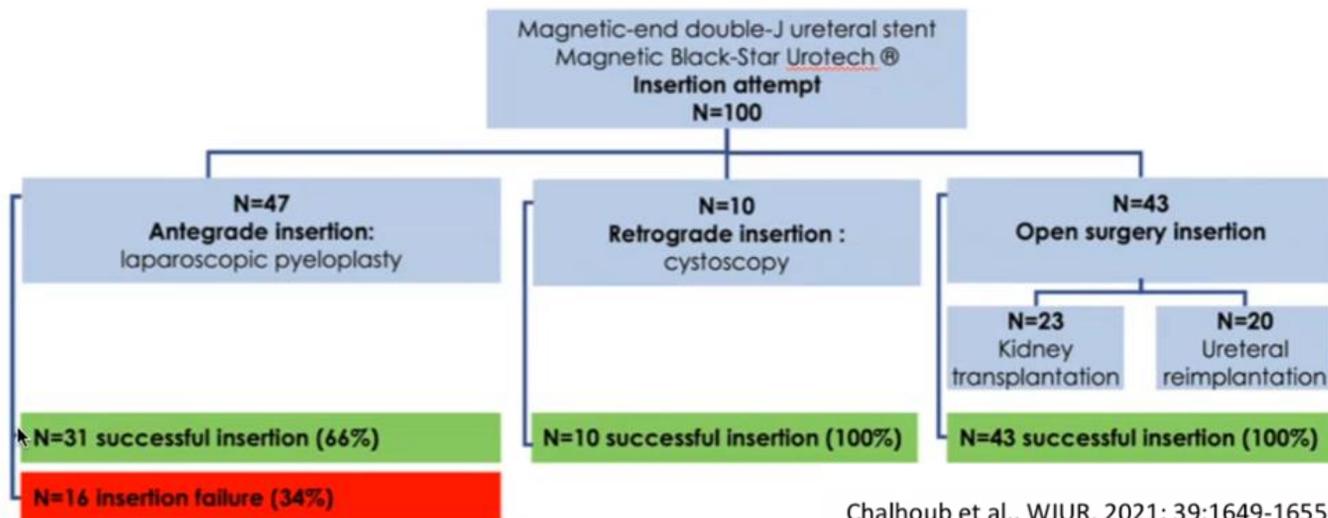
Design Innovation in Ureter Stents

Magnetic Black-Star®

- Magnetic DJ removal is less painful and faster
- Can be performed by nursing staff as well
- No anesthesia necessary
- For young patients/children as well

“The discomfort caused by the indwelling magnetic DJ is comparable with that caused by the standard DJ. **However, the magnetic DJ removal was less painful and faster.**“ *

*Rassweiler et al.: Magnetic Ureteral Stent Removal Without Cystoscopy: A Randomized Controlled Trial. Journal of Endourology. Vol. 31, nr. 8; August 2017, pp. 762-766



Chalhoub et al., WJUR. 2021; 39:1649-1655

Evidence for the use of Magnetic Black-Star® in Children:

- challenging to perform a study in children, 100 included patients is a very good population size
- 65% boys → implantation is more difficult for anatomical reasons
- placement is challenging in patients with pyeloplasty, showing a learning curve within the study
- no general anaesthesia

Visioflux Short Mono-J Stents with Benefits

Short mono-J stent with ending within the ureter with attached suture (e.g. Visioflux)

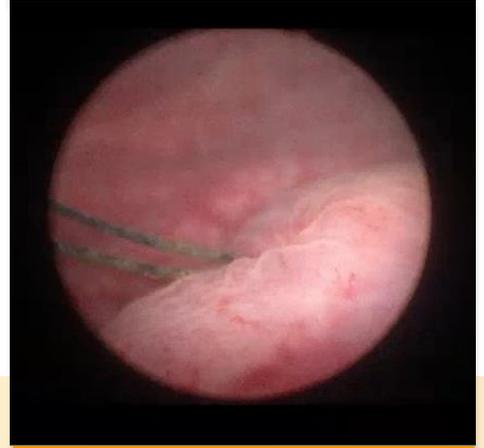


- Originally developed for pregnant women
- Lower part of DJ often results in complaints and irritative symptoms which can be also seen at the bladder wall → reduced with suture only
- Low evidence, very positive personal experience
- Suture is sufficient for dilation as well → personal experience and no evidence
- Easy to insert
- Less reflux as it mainly occurs due to the stent within the orifice
- Idea: with suture you have reduced irritative symptoms in the bladder by the patients as they normally suffer from the lower part of the stent in the bladder

@ 3 – 4 weeks



@ ~2 months



- Single-J stent for reduced irritative symptoms in the bladder
- Indicated for proximal strictures & UPJ obstruction
- Indicated for proximal ureteral stones
- From own experience, a suture is ok for dilation /pre-stenting of the ureter

Stent Requirements

- Easy handling features
- Resistant vs. compression
- No migration / stable position
- Good biocompatibility
- Less infection/incrustation
- Prolonged indwelling time
- Good visibility in ultrasound & X-ray
- Pain & patient comfort
- Good pricing

Does Pre-Stenting Make Sense?

A pooled, multivariant data analysis by Assimos et al concludes:

Pre-stenting as standard procedure for kidney stones: **YES¹**

Pre-stenting as standard for ureter stones: **NO¹**

- Risk reduction of ureter damage when using access sheath

YES²

- Prevent unplanned re-hospitalization

YES³

- May reduce formation of "Steinstrasse" in large stones receiving ESWL

YES⁴

- Increase stone free rate

VARYING^{1,3,4}

The placement of a pre-operative DJ stent increases stone free rates and decreases complications in patients with renal stones but not in those with ureteric stones.¹

¹ Assimos D. et al: Preoperative JJ stent placement in ureteric and renal stone treatment: results from the clinical research Office of Endourological Society (GROES) ureteroscopy (URS) Global Study **2** Traxer O, Thomas A. Prospective evaluation and classification of ureteral wall injuries resulting from insertion of a ureteral access sheath during retrograde intrarenal surgery. J Urol. 2013; Feb;189(2):580-4. doi: 10.1016/j.juro.2012.08.197 **3** Wang H, Man L, Li G, Huang G, Liu N, Wang J. Meta-Analysis of Stenting versus Non-Stenting for the Treatment of Ureteral Stones. PLoS One. 2017 Jan 9;12(1):e0167670. doi: 10.1371/journal.pone.0167670. eCollection 2017. **4** EAU Guidelines on Urolithiasis 2021, <https://uroweb.org/wp-content/uploads/EAU-Guidelines-on-Urolithiasis-2021-V2-1.pdf>

Recommendations from EAU Reflects These Findings

Summary of evidence	LE
In uncomplicated URS, a post-procedure stent need not be inserted.	1a
In URS (in particular for renal stones), pre-stenting ¹ has been shown to improve outcomes.	1b
An α -blocker can reduce stent-related symptoms and colic episodes.	1a

EAU guidelines 2021 (<https://uroweb.org>)

Prevention of Stent Related Symptoms:*

- Avoid if possible and senseful
- Removal asap
- Choose the correct individual stent length
- Detailed patient education
- Pain killer, α 1-Blocker^{1,2,*}, Antimuscarinics

¹ Betschart P, Zumstein V, Piller A, Schmid H-P, Abt D. Prevention and treatment of symptoms associated with indwelling ureteral stents: A systematic review. Int J Urol . 2017 Apr;24(4):250-259. doi: 10.1111/iju.13311 ² EAU Guidelines on Urolithiasis 2021, <https://uroweb.org/wp-content/uploads/EAU-Guidelines-on-Urolithiasis-2021-V2-1.pdf>

* Off-label use, please adhere to local regulation



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“Ureteral Stenting is a **blessing**, with a sensible and situation dependent **choice** of the **right stent** and an **appropriate education** of the patient.”

This summary of the webinar by Dr. Strittmatter reflects his experience and opinion on stenting.

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