

WHAT IS AN URETERAL STENT?

It's an endourological device that delivers urine from the upper urinary tract to the bladder in case of upper urinary tract obstruction or to prevent it.

PHYSICS OF URINE AT UPPER URINARY TRACT

Urine through the ureter: Newtonian, incompressible and laminar fluid

Continuity Equation: Mass entering the ureter (Ma) equals the mass leaving (Mb) it to the bladder.

$$Ma = Mb$$

$$Va \times Aa = Vb \times Ab$$

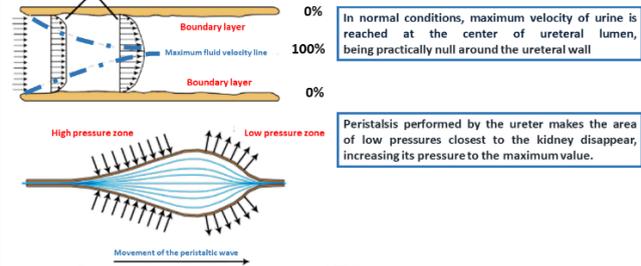
Bernoulli's Principle: Energy (E) of the fluid is equal in 2 sections of the ureter, which implies that the relationship between velocity (V) and pressure (P) remains constant.

$$Ea = Eb$$

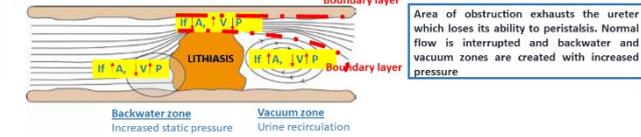
$$Va \times Pa = Vb \times Pb$$

Modified from J.C. Gómez-blanco, J. Martínez-reina, D. Cruz, et Al. Aplicación de la Mecánica de Fluidos y la Simulación: Tracto Urinario y Catéteres Ureterales. Arch. Esp. Urol. 2016; 69 (8): 451-461

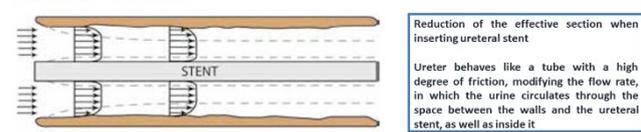
NORMAL URETER



URETERAL OBSTRUCTION



DERIVED URETER



HISTORY OF URETERAL STENTS

- G. Simon (1900): first ureteral stent with bladder opening
- Herdman (1949): first polyethylene ureteral stent, to urethral exterior
- R.P. Gibbons: first ureteral stent with bladder bulb to prevent proximal displacement
- T.W. Hepperlen (70s): first single-J ureteral stent
- R.P. Finney (70S): first double-J ureteral stent

PROPERTIES AND MATERIALS OF URETERAL STENTS

PROPERTIES

- TOUGHNESS:** maximum force required for the proximal end of a catheter to pass through a tissue
- RIGIDITY:** ability to not be deformed when undergoing traction / compression
- RADIAL COMPRESSION:** central lumen reduction
- RESISTANCE TO ENCRUSTATION:** ability to not calcify

MATERIALS

- POLYETHYLENE:** rigid and prone to breakage
- POLYETHYLENE + POLYURETHANE:** more resistant, less encrusting. Better adaptability (memory effect)
- SILICONE:** greater flexibility, less rigidity during insertion = better tolerance but greater placement difficulty in narrow ureters. Less encrustation.
- REINFORCED WITH WIRE (METALLIC):** Greater resistance to radial compression (less central lumen reduction). Nitinol (Nickel + Titanium).

TYPES OF URETERAL STENTS

DOUBLE J

Finney et al (1978).
Displacement prevention.
The most commonly used.

GROOVED

Finney et al (1981).
Improvement in the clearance of residual fragments after lithotripsy.
LithoStent (Olympus, USA), Towers

SPIRAL

Metal guide inside. Improved drainage in extrinsic obstructions. Better adaptation to the ureter. Better tolerated.
Percuflex Helical (Boston Scientific, USA)

DUAL TOUGHNESS

Progressive transition from hard (renal) to soft (bladder) end
Improves tolerability.
*Percuflex® (Boston® scientific, USA)
Inlay® (Bard® medical, USA)*

TAIL STENTS

Polymer loops in the distal loop
Reduce bladder discomfort. No differences in terms of kidney problems.
Polaris™ (Boston® scientific, USA)

FILIFORM

Avoid friction with the trigone: distal loop is replaced by a 0.3Ch Polypropylene suture
Diameter: 7 and 4.8Ch (mini). Mini does not work for obstructive stones.
J-Fil, Mini-Fil (Rocamed), HydroPlus

MAGNETIC TIP

Do not require cystoscopy for removal.
Blackstar (Urotech, Germany)

DUAL DIAMETER

For endopyelotomy
Longitudinal area with a larger diameter than the rest of the catheter. Tapered tips for easy insertion. *Indovasive®*

SELF-EXPANDING MESHED

Improved tolerability (less irritation of the urinary tract). Greater intrastent urinary flow. Decreased risk of obstruction. Decreased retrograde reflux and flank pain.

- Uventa (TaeWoong, South Korea)*
- Allium URS (Allium LTD, Israel)*
- Memokath 051 (PNN Medical, Denmark)*

METALLIC

They are softened and moulded at temperatures between 7-13°C. It keeps its shape with increasing temperature up to 55°C. Used in extrinsic ureteral obstruction. *Resonance (Cook® Medical, USA), Silhouette stent (Applied Medical).*

DUAL LUMEN

Greater intra-stent flow. In extrinsic obstructions and failures with a simple stent, without increasing discomfort

FUTURE OF URETERAL STENTS

- COATING**
To reduce encrustation (antibiotic, heparin, glycosaminoglycans ...)
- BIODEGRADATIVE**
To reduce withdrawal related morbidity
- DRUG-RELEASING**
In upper urinary tract tumors (BCG, mitomycin)