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HISTORY OF DEVELOPMENT AND PROSPECTS FOR THE USE OF URETERAL STENTS AS A RATIONAL SOLUTION TO PROBLEMS OF URETERAL PATENCY

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Annotation

The purpose of this article is to provide a brief history of the development of ureteral stents and to summarize recent developments in ureteral stent design. The authors sought to review data supporting the clinical benefits of the newer ureteral stents available for use by urologists. This includes a discussion of recent developments in ureteral stenting technology and their potential role in clinical urological practice.

Key words: stent, biocompatibility, silicone, ureter, biodegradable test.

Ureteral stenting is a procedure to place a stent. It helps restore the outflow of urine in various pathological processes leading to narrowing of the ureters. A stent is a special, elastic metal or plastic structure made in the form of a cylindrical frame, which is placed in the lumen of hollow organs and provides expansion of the desired area narrowed by the pathological process. The stent ensures the passage of physiological fluids, expanding the lumen of a hollow organ (artery, esophagus, intestine, and ureter).

The stent is a thin plastic frame. It is delivered to the area of narrowing and, due to its high radial rigidity, performs a frame function, thereby preventing the walls of the ureters from collapsing under the pressure of a tumor or scars. As a result, the possibility of fluid outflow remains possible. The stent can be placed either through the nephrostomy opening or retrogonadally. A ureteral stent is most often a thin tube made of a polymer material (silicone). Double J stents (both ends are curved in a J shape to prevent displacement) are used, stents with the ends curved into a pigtail. There are also metal, polyurethane, nickel and titanium reinforced stents.

For stenting the kidney ureters, stents with a length of 6 to 80 cm are used. They can be made of different materials: polyurethane, silicone, C-flex, coated with hydrogel. The most commonly used stents are double-loop stents (J-J stents) - they have both tips curled in the form of "pig tails". Ureteral stents have long been used to maintain ureteral patency, most commonly after ureteroscopy for the treatment of urolithiasis. Since their initial development, ureteral stents have undergone many technological developments that have improved treatment outcomes by improving comfort, durability, patency, resistance to encrustation, biocompatibility, ease of placement, migration, and biofilm development. Several types of new ureteral stents enter the market each year, each with its own advantages.

Ureteral pigtail stents were first introduced in 1978 and have been used for decades to maintain ureteral patency [1]. They are often used after surgery in the treatment of urolithiasis, as well as other diseases of the ureter, to prevent or treat ureteral obstruction. Given the frequent use of stents in endourology practice, it is important to understand the properties of different stents with regard to patient discomfort, biocompatibility, migration, ease of insertion, crusting, and biofilm formation. A lot of work has been done in this area to create the "ideal" stent, but a unified stent standard has not yet been developed. Since the introduction of ureteral stents, several different types of stents have been developed with different compositions, coatings, and designs that have varying clinical impact.

Silicone has long been used as the starting polymer for ureteral stents when they were first introduced. The advantages of silicone material are its soft composition, biocompatibility [2] and lower encrustation rate [3] than other stent materials. Despite these advantages, silicone stents were previously considered impractical due to their high coefficient of friction, which makes placement difficult [2]. More recently, advances in technology have allowed the development of modern silicone stents with higher tensile strength but a softer composition, potentially reducing stent-related discomfort [4]. Coating silicone stents with a hydrophilic material has made stent placement easier [5]. For these reasons, modern silicone stents have become the newest ureteral stents with several significant advantages. Other new stents introduced more recently include the PSS, a distal 0.3 Fr suture that ends in the bladder, and the Tria™ stent, which has a hydrophobic coating to reduce crusting and biofilm formation.

We decided to look back at the long history of ureteral stents, starting back in the 1800s with the first report of placing a tube in the ureter and ending with the introduction of all-metal stents. 1800s - Dr. Gustav Simon describes inserting a tube into the ureter during open bladder surgery. He is credited with the first ureteral stenting. 1900s - Dr. Joaquin Albarrano creates the first catheter designed for use in the ureter. Stents at that time were usually made of fabric coated with varnish.

1967– Dr. Paul Zimskind reports insertion of a straight silicone tube into the ureter to relieve obstruction. This device was called a "ureteral splint." This is the first use of a stent that is placed endoscopically (using a camera) rather than through an open incision. However, since the stent is straight, it could accidentally slip out. 1973 – Dr. James Monti coins the term "stent" to refer to permanent tubes placed in the urinary tract. 1974 – McCullough describes the use of a "Shepherd's crook" stent to prevent the stent from sliding down and out of the kidney. The shepherd's crook design was borrowed from existing stents designed to be inserted into blood vessels. Although the stent no longer moved downward due to the superior bend, it still tended to slide upward into the kidney.

1978 – Finney introduces a new design of the Double-J ureteral stent, which had a curl at both ends of the stent. This is currently the most common type of stent. Having a curl on both ends of the stent helps prevent the stent from slipping off. Modern stent designs that have a full bend instead of a simple J bend are technically called "pigtails", but the term "double J" is still used interchangeably.

2001– Boston Scientific introduced a ureteral stent made of softer plastic at the lower end and stiffer plastic at the upper end for better positioning. The benefit of a stiffer top end is to facilitate insertion during surgery, which can be difficult if the stent is too soft along its entire length.

2006 – Cook introduces the Resonance metal stent. It is made of a continuous coil of metal, similar in appearance to an elastic spring. It has curls on both ends and is designed to be stronger to resist twisting or breaking due to internal pressure coming from outside. This type of stent is most often used to obstruct the ureter in cancers such as cervical or colon cancer, which can sometimes compress the ureter due to direct growth surrounding the ureter.

Future. Researchers are experimenting with new stent designs in an effort to make them more comfortable and avoid the need to remove them. These newer stents include designs impregnated with drugs directly into the stent, which can relieve discomfort, and biodegradable stents, which dissolve over time. One recent development in ureteral technology is a biodegradable stent, which is designed to dissolve in urine over time. These stents have broad benefits, such as avoiding a second surgery or procedure to remove stents and avoiding the fear of a forgotten stent. Many different biodegradable stents have been developed over the past few decades, but none have been able to demonstrate consistent degradation without complications over time in vivo. More recently, a group in Portugal developed HydrUStent™, which is made from an aqueous solution of sodium gelatin, alginic acid and bismuth basic carbonate. These stents were only tested in pigs and showed promise for stent solubility after 10 days. In another model, glycomer 631 and pure polyglycolic acid were used in a new stent that dissolved completely after 3–6 weeks in porcine models without any complications at 5-month follow-up. This year, a new stent made from biodegradable polyurethane, magnesium and calcium was shown in a porcine model to completely dissolve after 4 weeks. Clinical studies of these types of stents are very limited, and further studies in humans are needed before the use of these stents can be justified. However, it is a promising technology that could have several beneficial implications in the future.

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