Strategies to Improve the Quality of Life of Stented Patients

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1 Introduction

Since its introduction in 1967, double-J stents have been an essential tool for urologists worldwide playing a major role in urinary drainage for a wide range of scenarios. However, they present a significant drawback, since up to 80% of patients present bothersome symptoms that negatively affect quality of life [1]. The aim to create innocuous stents is an ongoing challenge and strategies to prevent side-effects have yet to be achieved. In this chapter we will consider different approaches to reduce stented patient's morbidity without the use of drugs. These strategies include proper stenting indication, stent composition and length selection, and correct placement technique, which will be discussed below.

2 Indications of Double-J Stenting

As double J stents are related to high rates of bothersome and distress, the best way to improve quality of life of patients is to avoid stenting altogether. Consequently, as they are often necessary it is imperative to correctly indicate a stent placement, following conscious and evidence-based criteria. Unfortunately, despite the well-known morbidity and economic burden that stents involve, these are thought to be overused in contemporary practice [2].

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2.1 Urgent Indications

In case of obstructive acute pyelonephritis, anuria or sepsis, urgent decompression is needed, where placement of a ureteral stent is an option [3]. Other absolute indications include intolerable acute renal colic, renal failure, or solitary kidney [4]. Relative indications are steinstrasse, pregnancy, long-standing impacted stone and recent history of sepsis or urinary tract infection (UTI) [4].

3 Non-urgent Indications

3.1 Shockwave Lithotripsy (SWL)

Traditionally, pre-SWL stenting for renal stones, especially in larger stones, was thought to help reduce obstructive and infective complications. However, in recent years the need of ureteral stents has been questioned. Several systematic reviews and meta-analysis reveal no difference in terms of stone-free rate, fever or need of auxiliary treatments between stented on non-stented groups; but rather the stent-group demonstrated more retreatment and stent-related symptoms [5–7]. Some authors suggest that stenting may reduce formation of steinstrasse, but specifically in SWL of stones >20 mm, which currently is not standard clinical practice [3]. From an economic point of view, pre-stenting significantly raises healthcare costs, without presenting a clinical benefit and affecting quality of life [5]. Thus, stenting before SWL is not recommended [3, 5]. However, stenting may be considered in cases of ongoing pain, and when SWL cannot be done in a timely manner [5].

3.2 Ureterrenoscopy (URS) and Retrograde Intra-renal Surgery (RIRS)

Thanks to technological advancements and development of new miniaturized endoscopes, ureteroscopy has become a widely used technique for ureteral and renal stone treatment. Regarding double-J stents in the perioperative scenario, several issues arise: if they are advantageous when placed before a surgery, and if they are necessary after every procedure.

3.3 Pre-operative Stenting

The routine ureteral stenting before surgery remains controversial. A double-J stent will cause a passive ureteral dilatation, and therefore facilitating instrument insertions and possibly reducing complications. This is especially relevant for ureteral access sheath (UAS) insertion, which allow multiple and easier access to the collecting system and decreases renal pressure, but UAS can cause severe ureteral injury. In 2013 Traxer et al. [8], stated that pre-stenting decreases by sevenfold the risk of severe access sheath related injuries. Several groups have discussed the need of stenting before URS/RIRS, with dissenting results and conclusions. Several studies report better stone free rates (SFRs) and decreased complications in pre-stented patients, specifically for renal stones [9–12]. However, these improved outcomes come at a price, with a higher care cost and negatively impacting quality of life of patients. Moreover, an additional procedure may not be available in every centre. Other groups advocate ureteroscopy without prior stenting, arguing that in most cases, RIRS can be successfully accomplished in a single surgery, without differences in intraoperative complications, whilst avoiding the bothersome symptoms associated to stents and with less costs [6, 13].

EAU guidelines conclude that pre-stenting is not necessary prior to URS, but may facilitate and improve outcomes, especially for renal stones [3]. AUA guidelines do not recommend routine stenting prior to every URS, since they consider the added medical cost and comorbidity associated to stents overweight the potential benefit of presenting in outcomes [14]. Therefore, if feasible, pre-stenting may be an option for elective renal surgery, especially when UAS is likely to be used during surgery (10–15 mm renal stones). Nonetheless, additional randomized controlled trials are still needed to corroborate findings.

3.4 Post-operative Stenting

Typically, many urologists routinely place a double-J stent after URS, based on the idea that the stent will reduce the incidence of postoperative complications and promote passage of residual stones. However, in recent years, the need of standardized postoperative stent has been questioned. Several randomized trials and meta-analysis have shown similar stone free rate and stricture formation outcomes between stenting and non-stenting groups after uncomplicated URS. Moreover, non-stented patients presented less urinary tract symptoms, as well as decreasing healthcare costs [15–17]. EAU and AUA recommend that

Table 1 Recommendations for postoperative stenting

• Ureteric injury/perforation during URS
• Balloon dilatation during surgery
• Ureteral stricture or anatomical anomalies that will difficult stone passage
• Ureteral wall edema
• Large stone burden (>15 mm) or long operation time
• Anatomical or functional solitary kidney
• Previous history of renal failure
• Recent or recurrent UTI or sepsis
• Pregnancy
• Bilateral URS
• Long-standing impacted stone
• If second look surgery is planned

stenting is not necessary after uncomplicated URS [3]. It is important to correctly identify patients where postoperative stenting is recommended [4, 14, 18] (Table 1).

4 Stent Timing

The ideal duration of stenting is unknown, but a single straightforward maxim can be applied in every situation: as little time as possible [2]. This is based on the logical premise that a lesser indwelling time will shorten patient symptoms and side-effects associated to stents [19].

In general, after obstructive pyelonephritis, definite stone removal should be delayed until the infection is cleared with antimicrobial therapy, approximately 2–3 weeks [3]. In most cases, urologists prefer stenting for 1–2 weeks after surgery [3].

In patients with high risk of stent encrustation (cystinuria, sarcoidosis or brushite stones) a quick removal should be prioritized.

In conclusion, minimizing stent indwelling time is crucial, as it is a significant cause of stent encrustation and negatively impacting patient quality of life [19].

5 Stent Materials and Symptoms

5.1 Soft Vs. Hard Stents

Since its description in 1967, many efforts have been made towards the development of the ideal stent, modifying material, shape, length, and coating. Regarding, stent composition, its chemical and physical properties determine its hardness,

flexibility, tensile strength, which in turn can have a different effect on patient symptoms. Scientists and engineers have focused on optimizing catheter hardness and flexibility to strive to improve stent tolerability and therefore improve quality of life.

Hardness is a physical property of biomaterials such as stents that can be measured using a durometer. This device measures the resistance of materials under pre-established conditions according to the American Society for Testing and Materials (ASTM) [20]. There are many types of durometers, although for soft materials such as stents the durometer called "A" is used. The hardness for biomaterials is measured in an arbitrary scale and varies between 40 A and 90 A (that includes the letter "A" from the durometer used for guidance) [21, 22]. The arbitrary division of hardness classifies materials it into soft if scores less than 64 A and hard if scores from 65 to 90 A, for example, the Percuflex Plus® stent is classified as hard for having more than 65 A, while the Contour® stent belongs to the soft group for having less than 64 A according to the manufacturer's data [23].

Further, the tensile force (the stretching forces of the stent) is an important factor for maintaining the patency of the stent, but it can affect patient's comfort, because is related to hardness in a directly proportional way. The higher the tensile force the hardest and more rigid the stent is. This hardness or rigidity is considered by some authors as the cause of increased hematuria and urgency due to bladder irritation [24, 25].

The application of thermoplastic elastomers has facilitated the development of soft stents that show more flexibility. In recent years, the use of proprietary polymer stents, such as C-flex®, Percuflex®, Silitek®, Dual Durometer®, Sof-Flex®, and polyurethane has increased [23].

Currently, numerous polymeric materials are now available and at the disposal of urologists, from relatively stiff (polyurethane) to relatively soft (silicone). A softer biomaterial "intuitively" should cause fewer symptoms in the patient with a stent, compared to a harder biomaterial, however there is still controversy whether stent material has a major impact in patient discomfort. Bregg and Riehle [25] found no association between the degree of symptoms and the composition, shape or length of the stent in a study with 50 patients. In the same way, Pryor et al. [26] reported no differences in the incidence and severity of lower tract symptoms between four types of stents (74 patients) with different hardness, but both studies were done without a standard measure of symptoms caused by stent.

Lennon et al. [27] conducted a randomized controlled trial with 155 patients comparing polyurethane and Sof-Flex® stents, both from the same manufacturer (Cook Medical, IN, US), finding a significantly higher incidence of dysuria, renal and supra-pubic pain in the group of hard stents, but without differences in reflux pain, urgency, frequency, hematuria, tolerance, encrustation or stent placement. The symptom assessment was performed by the endoscopist who removed the stent using a simple, non-validated questionnaire. Normal activity and return to work were quicker in patients with softer stents (67% vs 45%).

In a prospective randomized trial, Joshi et al. [22]. Compared in 130 patient's hard stents (Percuflex® (6 Fr)) Boston Scientific, MA, USA, versus soft stents (Contour® (6 Fr), (Boston Scientific, MA, USA) founding no significant differences in the USSQ (The quality of life and stents symptoms score) between the two groups in 1–4 weeks after insertion of the stent.

Dual hardness stents such as the Sof-Curl® (ACMI, MA, USA) and the Polaris® (Boston Scientific, MA, USA) incorporate a smooth transition of hard biomaterials from the proximal (renal) end to a softer biomaterial for the distal (bladder) end to minimize the "hypothetical" bladder discomfort caused by irritation from a hard material. Two randomized controlled trials [28, 29] evaluated these devices with the USSQ without demonstrating a significant benefit for the Polaris® compared with the Percuflex® or the InLay® (Bard Medical, GA, USA).

Some stent biomaterials also soften by 50% at body temperature with better tolerance according to Lee et al. [30] although Park et al. [31] identified some advantages in terms of pain, physical activities, work, and antibiotic use in favor of a softer catheter end.

Silicone stents have the property of being highly biocompatible with human tissues, as well as being soft compounds. Recent studies place them as a great alternative to reduce the adverse effects caused by double J ureteral stents [32, 33]. Hendlin et al. investigated 12 commercial stents to test the effect of composition material on mechanical strength after exposure to artificial urine. The Black Silicone® stent and C-Flex stent exhibited strong coil strength with and without exposure to urine [34].

With the current evidence, the composition of stents, specifically its stiffness, seems to influence patient stent-related symptoms. Current tendencies advocate the use of softer stents, which appear to have a better tolerance profile for patients. However, certain controversy remains, and stent composition is not the only factor to take into consideration in the design of the ideal stent.

6 Ureteral Stent Position and Its Relation to Symptoms

As previously mentioned, stents involve significant morbidity that negatively affects quality of life. Several aspects to help mitigate symptoms have been examined, such as stent indication, duration, and biomaterial composition. In addition, a correlation between the position of a ureteral stent and stent-related symptom is also postulated [35–37]. Proper positioning of pigtails of the stent can help decrease patient discomfort [35]. This depends on accurate stent length selection and proper placement technique, which are discussed below. These straightforward approaches can considerably improve quality of life, and therefore it is important for the urologist to take into consideration and apply to daily clinical practice.

6.1 Ureteral Stent Placement Techniques

Many studies have compared the tolerance of different types of ureteral stents, regarding stent composition, but there are few papers analysing predictive factors related to placement technique [38].

Bladder irritation causing urinary frequency and urgency, even suprapubic pain is very common with ureteral stents. The cause of this discomfort is probably secondary to the irritation caused by a foreign body so close to the bladder neck, leading to trigone irritation by the distal end of the stent which has proven to be worse if the stent length is large, it makes sense to think that less foreign material inside bladder generates less irritation and less symptoms [39].

The ideal stent placement should avoid that the bladder coil crosses the mid pelvis (referenced by the symphysis pubis) on an x-ray line to mitigate symptoms (Fig. 1). Moreover, the best scenario is when only the distal coil is in the bladder, just coming out the ureteral orifice meaning less foreign body inside the bladder and therefore less symptoms [38, 39].

Rane et al. [37] showed that stents crossing the midline of the bladder or having incomplete loops at the lower end highly increased the morbidity of the stent.

Stents crossing the midline of the bladder resulted in significantly more patients experiencing bothersome symptoms that those with the coil not crossing the midline (77% vs. 33% respectively $P \leq 0.01$). So, proper stent length and an appropriate placement based on the patient's ureteral length is necessary to improve comfort.

Dysuria is usually experienced near the end of voiding. Again, this event presumably is attributable to trigonal irritation by the distal end of the stent, which is worse

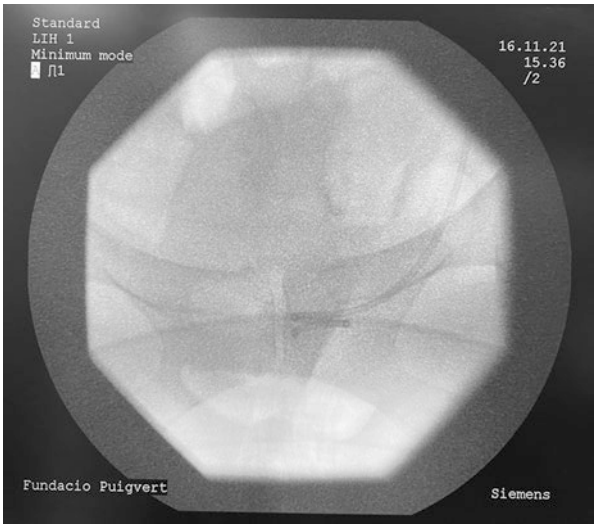

Fig. 1 Proper Double J placement where the distal coil does not pass the midline

even the bladder is empty. This pain can be transmitted into the urethra, giving rise to the typical burning sensation. It is important to achieve a well-formed bladder coil with the stent because incomplete (straight) loops, that point ad pokes the trigone may increase symptoms [38].

Considerable evidence demonstrates the impact of distal coil placement, but limited literature exists regarding proximal end positioning. El-Nahas et al. concluded that caliceal position of the upper coil is a significant factor affecting discomfort, with an estimated relative risk of discomfort of four times for caliceal position [35]. On the other hand, Liatsikos et al. performed a randomized prospective study comparing symptomatology associated placement of the upper coil in the upper pole versus renal pelvis. The group that placement of stent in the upper pole appears to be better tolerated, regarding urgency, dysuria, and quality of life [36]. The possible pathophysiological explanation of proximal coil positioning in worsening symptoms is still unknown, and to date, a clinically relevant impact of pyelic or caliceal placement remains controversial.

7 Ureteral Length Measurement

One of the most important aspects for an adequate stent placement is a prior selection of an appropriate stent length. Different lengths are available, from 24 to 30 cm and can be individualized depending on patient's anatomy [40]. It is very important for patients to have their stent length measured. There is substantial evidence that excessively long stents that cross the bladder midline cause greater morbidity. Measuring the length ureter is a very important manoeuvre for urologists to implement correctly to reduce the symptoms associated with ureteral stents.

However, as simple as it sounds, the prediction of the ureteral length has always been a challenge for urologists who want to accurately choose the double J stent size to reduce symptoms on patients. Nowadays a wide variety of methods have been used for this purpose.

7.1 Ureteral Length Measurement by Body Shape

The predictions and methods may vary widely due to the different body shapes but also due to the presence of any anomalies as dilated or tortuous ureters [41].

Correlations between different body shapes and heights have been widely used for ureteral length measurements including anthropometric measures over the body surface [42]. Although the ureteral length has been linked to the patients height [40, 43, 44] the ureteral length has not been reliably demonstrated as this method has a wide range of variation [45–47].

7.2 *Ureteral Length Measurement by Computed Tomography and Intravenous Urography*

Measurements using diverse lengths such as the uretero-vesical length (with adjustments) [48, 49], the height of lumbar vertebrae (L1-L5) or calculations of the computed tomography (CT) axial images [50] have been used for ureteral length measure with high correlations [51], and with higher equivalence than measuring patients height [42].

Predictive models assessing the ureteral length with CT and intravenous urography have been described using age, sex, side and pyelo-vesical length as evaluation values. Although these reports have shown good correlation compared to endoscopic measurements [52] this has also been revoked in recent analysis of predictive formulas [53].

7.3 *Endoscopic Ureteral Length Measurement*

One of the most reliable methods to determine the ureteral length is by placing a ruled 5–6 French open-ended catheter it into the renal pelvis over a guidewire and measuring the length by using the references in the catheter as a referral [54, 55]. This method also has been used as the standard for comparison with new techniques.

As discussed, an accurate ureteral length measurement is a difficult task. Using body height as a reference to approximately calculate the ureteral length does not always give a proper correlation [56] and the best way to decide stent length is the direct endoscopic measurement [56]. From our clinical point of view, it is mandatory to perform a retrograde pyelography during stent placements for many reasons being the most important the accurate evaluation of the upper urinary tract's anatomy, including calices, infundibulum's and the renal pelvis. When you introduce an open ended catheter to perform a retrograde pyelography it is very easy to measure the ureteral length and select the proper stent by using the references in the catheter as a referral [54, 55]. Once the pyelography is done, the decision of where to place the proximal coil is taken (the pelvis or any of the calyces) and then measure of the distance until the ureteral orifice by references in the catheter is performed. It's important to know that after positioning, the stent could move from the original position and migrate downwards depending on the kidney's anatomy, so more pigtail segment may lie in the bladder than the one left.

8 Conclusions

Stents have become an indispensable tool for urologists; unfortunately there is still no idyllic symptom-free stent. It is the urologist's responsibility to try to minimize morbidity as much as possible. Throughout this chapter, we have focused on

Table 2 Strategies to improve the quality of life of stented patients

Avoid stenting when clinically possible. Thoroughly evaluate the necessity of stent placement, reserving its indication in imperative cases or after careful and evidence-based criteria
Minimize stenting time as much as possible. When there is a high risk of stent encrustation, a quick removal should be prioritized
Make individualized stent material selection. Become familiar with the stent repertoire available to you, and choose the variety depending on purpose, stenting time, previous patient experience, and risk of encrustation. Consider a softer biomaterial to reduce symptoms specially when long-term catheterization is warranted
Measure ureteral length and choose stent length accordingly. If possible, perform a direct endoscopic measurement. To do this, perform a retrograde pyelography before stent placement and measure in situ the ureteral length utilizing the open-ended catheter's marks as a reference
Ensure a proper stent positioning. The ideal position of a stent occurs when both coils are correctly formed, the proximal end in the upper pole (somewhat controversial) and the distal end should avoid crossing the mid pelvis of the bladder

different issues that urologist should take into consideration regarding stent indication, selection, and placement. Table 2 summarizes different approaches proposed to implement in daily practice to help reduce adverse effects and complications in catheterized patients.

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