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Contemporary ureteroscopic management of renal stones

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HIGHLIGHTS

- Flexible ureteroscopy is an effective and safe procedure for the treatment of renal stones.
- Good results by fURS are possible only if a complex organization is established within a so called "stone center".
- Modern endourological armamentarium together dedicated OR schedule is essential.
- Choosing every time the best procedure for the stone and the patient (tailored surgery).

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ABSTRACT

The advancements in the endourological armamentarium and the evolution of ureteroscopes with the advent of fiberoptic first and then digital technology, the introduction of holmium laser lithotripters, together with the increasing number of requests for minimally invasive procedures has ameliorated outcomes, patients' safety and comfort, making the use of flexible ureteroscopy for urinary calculi increasingly attractive and widespread among urological community. Due to its high stone-free rates and low morbidity, flexible ureteroscopy has become a viable option for the treatment of renal stones.

This review describes the contemporary ureteroscopic management of kidney stones.

1. Introduction

Historically, ureteroscopy (URS) started fortuitously in 1912 when Young inadvertently introduced a pediatric cystoscope into a severe dilated right ureter of a child who had posterior urethral valves and he was pleasantly astonished by the renal pelvis [1]. The first rudimental flexible ureteroscopy (fURS) was reported in 1964 by Marshall, who explored the ureter using a 9F pediatric flexible cystoscope, with no working channel or active deflection [2]. Subsequently, the evolution of fURS has been a relentless pursuit for improvement till 1989 when the use of flexible ureteroscope (FU) for stones disease was popularized by Dore et al., who firstly reported his preliminary results of ureteric stones treated by this new instrument [3]. Since then, the advancements in the endourological armamentarium and the evolution of ureteroscopes with the advent of fiberoptic first and then digital technology, the introduction of holmium laser lithotripters, together with the increasing number of requests for minimally invasive procedures has ameliorated outcomes, patients' safety and comfort, making the use of fURS for urinary calculi increasingly attractive and widespread among urological community. It is noteworthy that the impact of urolithiasis on population is significant worldwide with its prevalence increasing at an impressive rate when compared with historical values [4]. This finding in combination with extensive dissemination of ultrasounds and other diagnostic modalities is changing the clinical scenario diagnosing many more stones in their earlier stages (small to medium size) reducing significantly, especially in the developed world, the rate of staghorn stones. As a consequence, fURS is rapidly diffusing worldwide and optimal treatment outcomes are being regularly reported in the literature together with very low morbidity [5]. This has led to expansion of indications for renal calculi, as recently reported in the last version of the European Association of Urology guidelines [6], in which fURS is considered a viable first treatment option for the vast majority of renal calculi, making the pool of patients who may benefit both from shock wave lithotripsy (SWL) and percutaneous nephrolithotomy (PCNL) becoming smaller than was once thought.

This review describes the contemporary ureteroscopic management of renal stones.

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2. Instrumentation

2.1. Flexible ureteroscopes

Currently, many FUs have been marketed. Diameter of their tip ranges between 4.9 F and 8.5 F and of their shaft between 7.9 F and 10.9 F. All but two of them are supplied with a single 3.6F working channel (WC) that can accommodate baskets, laser fibers and/or biopsy devices. Its position into the shaft of the scope varies between brands and models. All these newer FUs are actively deflecting up to 270° bidirectionally so that lower pole access is easier and possible in the vast majority of cases. FUs are divided in two categories: fiberoptic and digital. Fiberoptic scopes provide a good visualization by means of fiberoptic bundles. Quality of vision is good enough to succeed in stone surgery but of course “Moiré ” effect, although significantly reduced in the newer models because of higher number of fibers into the optic bundle, is still present. The advantage of these scopes over the digital ones is the reduced diameter and a better deflection of the terminal part of scope's tip due to the absence of the chip itself. Newer digital FUs have been developed by all of the most important companies with the intent to overcome these limitations and to increase the quality of vision. They are supplied with the so-called “chip on the tip” technology that means that the tip of these instruments houses digital sensors: either a charged-coupled device (CCD) or a complementary metal oxide conductor (CMOS). CCD and CMOS image sensor use different technologies for capturing images digitally, the former providing a little bit higher resolution while the latter a reduced diameter of the scope due to the smaller dimension of the chip. All of these digital scopes guarantee an incredible high image resolution that of course facilitates the surgeon to navigate the entire collecting system more quickly when compared to fiberoptic scopes. Although a clear superiority in terms of stone free rate has not been demonstrated, all these advantages provided by these digital scopes allow the surgeon to save 20–25% operative time [7] and this fact can be helpful in justifying the significantly higher cost of these instruments. Due to these digital sensors, no camera has to be connected to the scope. Moreover, the tip of these complicated instruments allocates also dual light-emitting diode (LED)-driven light carriers so that there is no need for an external light source or a light cable to be connected. As a consequence, these instruments are much lighter and more ergonomic: this fact is not to be underestimated especially in case of prolonged procedures. A major issue remains the durability of these fragile scopes that, apart from some exceptions [8,9] is very short with an average inferior to 20 cases per scope [10,11]. With the purpose of overcoming this problem, disposable flexible scopes have been developed (Polyscope™, Germany and Semiflex®, Maxiflex, New Orleans, USA): unfortunately, their quality in terms of both vision and manoeuvrability is not good enough to consider them as an alternative to traditional scopes but only complementary to them. On the contrary, recently a disposable digital ureteroscope, named Lithovue® (Boston Scientific, Natick, MA, USA), has been introduced: this is a very promising scope whose high quality in terms of manoeuvrability and visibility seems good enough to constitute a potential complete alternative to traditional scopes [12,13].

2.2. Ureteral access sheath (UAS)

UAS represents an essential tool for modern fURS. In fact UAS allows for continuous irrigation outflow so that excessive intrarenal pressure peaks are prevented, multiple quick entries and exits during fragments' extraction, reduction in operative time and, last but not least, preservation of costly flexible scopes [14–16]. An UAS consists of an inner introducer and an outer highly hydrophilic tube, the sheath itself, that is coaxially adjusted on it and secured by a click. Traditionally, this device is passed up into the collecting system alongside a coaxial hydrophilic working wire while a second safety guidewire is left outside the sheath to maintain a safe access to the upper urinary tract throughout the procedure (Fig. 1). Once in place, both the introducer and the working wire are removed and the system is ready to accommodate the flexible ureteroscope. Recently, a new UAS has been developed (Retrace™, Porges-Coloplast, Denmark and Flexor Parallel, Cook, Bloomington, USA): the main novelty of this device is a lateral orifice on the distal part of the introducer which a hydrophilic guidewire can pass through leading the advancement of UAS so that it acts in the same time as both working and safety wire (Fig. 2). This guarantees similar insertion rates but, on the other hand, also time and cost savings (only a single guidewire is required that switches from working to safety one) and an easier re-insertion of the UAS itself during reiterative fragments' removal [17,18]. Different diameters are actually available ranging between 9.5–11.5F and 14–16F: the actual trend is to use UAS around 10F in order to respect the ureters' anatomy. By doing so, of course the fragments' diameter that one can remove is reduced but, on the contrary, intrarenal pressure is in any case kept low preventing increase of septic complications [19] and, most importantly, the chance to damage ureteral wall is reduced. Of course, when choosing UAS, also available scopes characteristics should always considered: it is noteworthy that for example not all scopes fit into a 10/12 UAS, especially the first generation digital scopes. According with this concept, the smallest universal UAS, that means that can accommodate all marketed scopes through it, is 12–14F in size [20].

2.3. Baskets

Disposable armamentarium is a key point to succeed with fURS. The first most important concept is rather intuitive: anything introduced in the WC may affect both scope's deflection and irrigation. It has been already demonstrated that deflection can be impaired by the presence in working channel of laser fiber (4.4% and 10.2% loss for 200μ and 275μ respectively) and biopsy forceps (30.7%–57.8%). Similarly happens for irrigation whose loss varied from 53.7% for 200 μm laser fiber to 62,2% for 1,5F tool and 99% for 3F device [21]. Consequently, during fURS only small diameter baskets (≤2.2F) and laser fibers (≤270 μ) are highly recommended. Secondly, the mechanism of catching stones into the kidney is frontal and not lateral like in the ureter: as a consequence, only tipless basket should be employed. As a matter of facts, the tip itself would keep the basket few millimeters away from the calculus making its entrapment almost impossible.

2.4. Lasers

Holmium lasers energy is ideally suited for the treatment of stones during fURS. YAG crystal with holmium (Ho:YAG) produced laser energy of 2150 nm, delivered in a pulsatile manner, using a thermomechanical action. Ho:YAG has minimal fragment

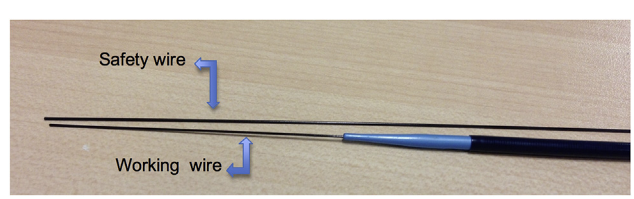

Fig. 1. Traditional UAS: 2 guidewires must be utilized (one working and one safety guidewire).