BJU Int 2024; **134:** 192–200 doi:10.1111/bju.16381, 16406, 16327

BJUI
BJU International

Research Letter

Robot-assisted retrograde intrarenal surgery: first clinical experience with the ILY® system

Keywords

retrograde intrarenal surgery, RIRS, robotic surgery, ureteroscopy, urolithiasis

The management of urinary stones has evolved considerably over the years, from open surgery to today's minimally invasive procedures, thanks to the advent of continuous technological advances, such as new lasers, tools miniaturisation, disposable endoscopes, suction sheaths, artificial intelligence, virtual reality, videoendoscopic technology and the introduction of robot-assisted surgery [1]. Thanks to these improvements, flexible ureteroscopy (fURS) has pushed its indications to treat almost all types of stones [2], due to its feasibility and safety, despite variable success rates. However, fURS is limited by ergonomic deficiencies and can be challenging, especially in complicated cases with multiple stones or a high stone burden. The main ergonomic problems of fURS are related to prolonged standing and static postures of the surgeon while wearing heavy protective lead aprons [3]. The surgeon must control the fluoroscopy and laser device by foot pedals while fixing the position of the endoscope with one hand and doing flexion, deflection, or rotation movements with the other hand, causing continuous tension of the wrist and finger muscles [3]. Also, an assistant is needed to manipulate the manual irrigation system, the laser fibre, or any accessory instruments. This makes the working space limited and uncomfortable. All these can undoubtedly cause musculoskeletal disorders that impair the capacity and quality of work performance [1,3,4]. Implementation of robotics in endourological interventions could offer potential benefits by improving ergonomics and potentially reducing radiation exposure and operation time due to the robot's memory function [4,5]. Another advantage would be the stability and precision of the instrument and the fibre laser during lithotripsy [5,6]. Consequently, robot-assisted retrograde intrarenal surgery (roboRIRS) has emerged to improve the operative outcomes, ergonomic conditions, and impact on surgeon health of conventional fURS. In 2011, Desai et al. [7] performed the first human trial of a robotic device for fURS. This device, originally developed for cardiovascular procedures, was based on a robotic flexible catheter system (Sensei™, Hansen Medical, Mountainview, CA, USA) consisting of an outer catheter sheath (14/12 F) and inner catheter guide (12/10 F) combined with a custom-built fibreoptic flexible ureteroscope, meaning that the ureteroscope is manipulated only passively, which proved to be insufficient for robot-assisted fURS [7]. In 2014, Saglam et al. [8] first reported data from a clinical trial with the Roboflex™ Avicenna (ELMED, Ankara, Turkey), a robot designed specifically for fURS, demonstrating it as a suitable, safe, and efficacious platform with a short learning curve, with ergonomic superiority and lower radiological exposure compared to conventional fURS. To date, few robotic platforms are available on the market to assist fURS procedures [5–8]. The ILY® robotic system (STERLAB, Vallauris, France) is a ureteroscope holder with multiple degrees of freedom, operated remotely by the surgeon with a wireless controller, keeping the surgeon away from sources of ionising radiation [6]. The ILY robot differs significantly from the Avicenna, which is a bulky platform including a master console with pedals and surgeon's seat, along with a manipulator for endoscope movements. Whereas, the ILY is a compact trolley mini-console operated remotely by a wireless controller, occupying minimal space in the operating room, and keeping the surgeon away from the radiation source.

As no evidence for roboRIRS with the ILY robot in humans is available, the aim of this letter is to describe the surgical setting and present our case series to contribute to the existing literature.

We present a descriptive analysis of six patients who underwent roboRIRS for urolithiasis at our centre in July 2023. All procedures were performed by experienced endourologists. The patients' characteristics are detailed in Table S1 (Supplementary materials).

Patients were placed in lithotomy position. In all cases, after the placement of a safety guidewire in the calyceal system, an initial inspection with semirigid URS was performed and a ureteric access sheath (UAS) 10/12 F was placed. Through the UAS, the flexible ureteroscope was manually introduced to reach the renal pelvis. Then, the robot was moved close to the patient and fixed to the UAS and flexible ureteroscope (Fig. 1A–C). The robotic holder was covered by a sterile plastic drape. For proper docking, the robot was previously configured according to the brand and size of the UAS and flexible ureteroscope used. A key feature of this platform is the compatibility with all types of flexible ureteroscopes (reusable and single-use) and most UAS [6]. Finally, when both instruments were properly attached, the wireless controller was activated to move the ureteroscope remotely. The wireless controller, similar to a video-game joystick, is used to remotely manipulate the flexible ureteroscope, which is attached to the robotic holder. Using hand movements it is enabled to perform the endourological movements [6] (Fig. 1D). The ureteroscope can be moved forward and backward with the left and right frontal bottoms of the controller; the flexion, deflection, and rotation movements are performed with the right and the left joystick bottoms, respectively. The robotic holder has a rotation range of up to 360°, beyond human manual capabilities during classical fURS (maximal 120°) [1]. Moreover, it is possible to connect two wireless controllers, this feature can be useful for mentoring. This novel robotic platform has some drawbacks, an assistant is needed during the surgery to manually manipulate the laser fibre, the basket and the irrigation, remaining close to the ionising radiation field. Despite the

Fig. 1 (A, B) Operation room setting for roboRIRS with the ILY platform (STERLAB, Vallauris, France). The ILY robot is a compact trolley cart, weighing 40 kg. It is placed near the patient and remotely manipulated by the surgeon with a wireless controller, away from the ionising radiation source. (C) View of the ILY robot docking procedure: initially attached to the ureteric access sheath, then to the connector link, and finally to the scope. The undocking procedure is performed in the opposite direction. (D) ILY robot uses a wireless controller, similar to a video-game joystick, to remotely manipulate the flexible ureteroscope to perform the endourological movements. Arrows indicate hand movements to manipulate the scope. The ureteroscope can be moved forward and backward with the left and right frontal bottoms of the controller (purple arrows); and the flexion, deflection (green arrows), and rotation movements (orange arrows) with the right and the left joystick bottoms, respectively.

possible different commercial policies of the company among countries, according to the manufacturer, the average end-user price is ~200 000 euros.

We used a high-power holmium laser in four cases and thulium fibre laser in two. In all cases, the dusting technique was used for laser lithotripsy. The type of laser and the operative settings were chosen according to the preferences of the surgeons and the composition of the stone. Two cases were bilateral surgeries, as the patients had ureteric stones at the contralateral kidney of the main renal stone, while the rest were unilateral. The median (interquartile range [IQR]) renal stone size was 13.5 (11–15) mm. The median (IQR) operation time was 77.5 (65–90) min, including docking and undocking procedures. There were no intraoperative complications nor device-related failures. Postoperatively, one patient experienced fever treated with antibiotics (Clavien–Dindo Grade II), and another patient who underwent an uncomplicated infundibulotomy for intradiverticular stone developed a pseudoaneurysm non-attributed to the use of the robot, which was managed with selective embolisation (Clavien–Dindo Grade IIIa). The median (IQR) length of stay was 1 (1–4) days. Stone-free status was defined as the presence of ≤2 mm residual fragments, which was evaluated by a CT scan with a 1 mm cut thickness at 3 months after surgery. A stone-free status was achieved in five of the six patients. All patients had stable renal function at this time. The surgeon's satisfaction with the robot was evaluated through a four-item questionnaire based on a Likert-type scale (ratings 1–5), measuring manageability, ergonomics, feasibility, and stability during lithotripsy. The overall score of the questionnaire was 4/5. We think that the ideal candidates for this approach would be cases where long operative times and when less ergonomic postures are expected. To our knowledge, we present the first clinical experience of roboRIRS with ILY robotic system performed in human patients. The use of this robotic device appears feasible and safe. The future of roboRIRS seems promising, but further investigations are needed to evaluate the benefit in real-life scenarios and the cost-effectiveness of this technology.

Acknowledgement

None.

Source of Funding

None.

Disclosure of Interests

The authors have nothing to disclose.

Declaration

Alba Farré has full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Alba Farré, Oriol Angerri, Andrés Kanashiro, Marta Casadevall, Alessandro Uleri, Josep Balañà, Francisco Sánchez Martin, Félix Millan, Joan Palou and Esteban Emiliani

Department of Urology, Fundació Puigvert, Autonoma University of Barcelona, Barcelona, Spain

References

1 **Rassweiler J, Fiedler M, Charalampogiannis N, Kabakci AS, Saglam R, Klein JT**. Robot-assisted flexible ureteroscopy: an update. *Urolithiasis* 2018; 46: 69–77

2 **Aboumarzouk OM, Monga M, Kata SG, Traxer O, Somani BK**. Flexible ureteroscopy and laser lithotripsy for stones >2cm: a systematic review and meta-analysis. *J Endourol* 2012; 26: 1257–63

3 **Ong CSH, Castellani D, Gorelov D et al.** Role and importance of ergonomics in retrograde Intrarenal surgery: outcomes of a narrative review. *J Endourol* 2022; 36: 1–12

4 **Gabrielson AT, Clifton MM, Pavlovich CP et al.** Surgical ergonomics for urologists: a practical guide. *Nat Rev Urol* 2021; 18: 160–9

5 **Sinha MM, Gauhar V, Tzelves L et al.** Technical aspects and clinical outcomes of robotic Ureteroscopy: is it ready for primetime? *Curr Urol Rep* 2023; 24: 391–400

6 **Gauhar V, Traxer O, Cho SY et al.** Robotic retrograde intrarenal surgery: A journey from "Back to the Future.". *J Clin Med* 2022; 11: 5488. https://doi.org/10.3390/jcm11185488

7 **Desai MM, Grover R, Aron M et al.** Robotic flexible ureteroscopy for renal calculi: Initial clinical experience. *J Urol* 2011; 186: 563–8

8 **Saglam R, Muslumanoglu AY, Tokatli Z et al.** A new robot for flexible ureteroscopy: development and early clinical results (IDEAL stage 1-2b). *Eur Urol* 2014; 66: 1092–100

Correspondence: Alba Farré, Department of Urology, Fundació Puigvert, Autonoma University of Barcelona, Barcelona, Spain.

e-mail: afarrealejo@gmail.com

Abbreviations: IQR, interquartile range; roboRIRS, robot-assisted retrograde intrarenal surgery; UAS, ureteric access sheath; (f)URS, (flexible) ureteroscopy.

Supporting Information

Additional Supporting Information may be found in the online version of this article:

Table S1. Patients' characteristics.

