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UROLITHIASIS

Retrograde intrarenal surgery using the ILY robotic flexible ureteroscope: a single centre experience

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Introduction The ILY robotic flexible ureteroscope has been introduced in order to improve intraoperative ergonomics, reduce operator distance from radiation and shorten the learning curve. In this study we aimed to assess the clinical performance and feasibility of the ILY robot during retrograde intrarenal surgery (RIRS) and combined endoscopic procedures (miniECIRS).

Material and methods The RIRS procedures were performed using the ILY robotic arm in 57 adult patients (46 RIRS and 11 miniECIRS) from 2022 to 2023. All procedures were performed in the supine position. Pre-stenting was not the standard of care.

Results Turning on and calibration of the device took approximately 100 s. Average draping time was 93 s using original ILY drapes and 47 s using classic drapes designed for C-arm covering. Mean docking time was 73 s in procedures with ureteral access sheath (UAS) and 61 s in procedures without it. The undocking took less than 60 s in every case. Average procedure time was 63 min for RIRS and 55 min for miniECIRS. Endoscopically proven stone-free rate was achieved in 37 (80.4%) RIRS and 10 (90.9%) miniECIRS patients. A total of 17 (36.9%) RIRS and 8 (72.7%) miniECIRS procedures required conversion in order to perform basketing and stone fragments retrieval/transposition.

Conclusions The use of ILY robot during endourological procedures is feasible and urologists that are familiar with the device controller do not require extensive training. The time needed for device draping, docking and undocking was approximately 4 minutes. Moreover, use of the robot resulted in satisfactory stone-free rates.

Key Words: urolithiasis ‹› kidney calculi ‹› RIRS ‹› ECIRS ‹› robotic endourology

INTRODUCTION

Robotic assisted flexible ureteroscopy (fURS) and retrograde intrarenal surgery (RIRS) have been developing rapidly in recent years. Classic robotic platforms cannot be used in any minimally-invasive endourological procedures, therefore, new robotic systems such as Sensei, Roboflex Avicenna, Easy-Uretero, Monarch, Virtuoso and ILY have been developed for kidney stone management [1–3].

In this study we aimed to assess the clinical performance and feasibility of the ILY robot during RIRS and combined endoscopic procedures.

MATERIAL AND METHODS

Informed consent was obtained from all participants prior to the surgical procedure. The study was approved by the Institutional Bioethics Committee of the Wrocław Medical University (consent number 16/KB/2023).

The RIRS procedures were performed using the ILY robotic arm in 57 adult patients (46 pure RIRS and 11 endoscopic combined intrarenal surgeries – flexible ureterorenoscope and percutaneous access of 15/16 Fr (miniECIRS)) from 2022 to 2023 by an experienced endourological team of the Department of Minimally Invasive Robotic Urology of Wroclaw Medical University.

Consecutive patients operated in our centre that presented with nephrolithiasis in normal renal anatomy were included. Patients with bulky staghorn stones or otherwise complex cases requiring more than one percutaneous access were not included. General criteria for RIRS procedure included solitary stone not bigger than 1.5 cm or multiple stones with maximal volume of 750 mm^3. More complex cases were usually treated with miniECIRS procedure.

Even though the staff have been adept in manipulating the device's controller before the onset of the study, the first 5 cases performed by our team were excluded from the analysis, as some training was necessary to get familiar with the device. Finally, 57 participants were included in this research.

Hawk flexible ureteroscopes and Quanta CyberHo 60 W holmium laser with 272 micron fibers were used during every RIRS. If UAS was used, 10.7 Fr sheet was employed, with various lengths. Percutaneous access was obtained under combined USG/fluoro control, and 12 Fr nephroscope with 16 Fr Amplatz and 272 microns laser fiber was used for all the miniECIRS procedures. All the procedures were performed in the supine position. Pre-stenting was not the standard of care.

Stone-free status was assessed perioperatively (endoscopically and fluoroscopically) and being stone-free was defined as no visible residual fragments bigger than 2 times the laser fiber diameter.

Demographic data were collected before the surgery. We evaluated the times needed to: turn on and calibrate, drape, dock and undock the ILY robot. Moreover, patients' clinical details were recorded [stone size, density and location, presence of the pre-operative double J (DJ) stent]. Finally, intraoperative data were documented (duration of the procedure, stone-free rate, need for conversion, need for post-operative DJ placement).

RESULTS

Main patients' characteristics are presented in Table 1. The study involved 57 patients with nephrolithiasis that underwent RIRS or miniECIRS procedures supported by the ILY robotic system. Mean age of patients was 46 years (range 18–82 years). For RIRS cases average stone size was 1.3 cm (range 0.8–2.3 cm), while for ECIRS procedures the mean biggest stone size was 1.9 cm (range 1.1–5.6). 37 (65%) patients were pre-stented (32 RIRS and 5 ECIRS cases). In order to assist calibration, draping and docking of the device, one additional briefly trained person (nurse/technician) was needed. Table 2 summarises the average times needed for preparation of the robot and the procedure. Average procedure time was 63 min (range 15–91 min) for RIRS (counting from the first insertion of the scope into the bladder to the bladder catheterisation) and 55 min (range 32–83 min) for miniECIRS (counting from the first insertion of the nephroscope into the kidney to the bladder catheterisation). In total, 34 (73.9%) RIRS and 4 (36.4%) miniECIRS procedures were performed with UAS, the majority in males.

Table 1. *Main patients' characteristics*

Clinical characteristic	Statistical feature
Mean age (SD; range)	46 (19.3; 18–82)
Male/Female	28/29
RIRS/miniECIRS	46/11
Mean biggest stone size in RIRS (SD; range)	1.3 cm (0.41; 0.8–2.3)
Mean biggest stone size in miniECIRS (SD; range)	1.9 cm (1.33; 1.1–5.6)
Mean stone density in RIRS (SD; range) [HU]	943 (264.6; 620–1430)
Mean stone density in miniECIRS (SD; range) [HU]	1101 (234.3; 716–1496)
Mean Guy's Stone Score	1.49
Mean fluoroscopy time in RIRS (SD; range)	1.9 s (4.4; 0–21)
Mean fluoroscopy time in miniECIRS (SD; range)	16 s (9.8; 1–38)
Pre-procedural DJ presence	64.9%
Post-operative DJ placement (RIRS)	67.4%
Post-operative DJ placement (miniECIRS)	63.6%

SD – standard deviation; RIRS – retrograde intrarenal surgery; miniECIRS – endoscopic combined intrarenal surgery; HU – Hounsfield units; DJ – double J

Table 2. *Average times needed for preparation of the robot and the procedure*

Action	Mean time (range)
Turning on and calibration	100 s
Draping (original ILY drapes)	93 s (69–229)
Draping (classic C-arm drapes)	47 s (23–71)
Docking (with UAS)	73 s (32–124)
Docking (without UAS)	61 s (30–99)
Undocking	<60 s
RIRS duration	63 min (15–91)
miniECIRS duration	55 min (32–83)

UAS – ureteral access sheath; RIRS – retrograde intrarenal surgery; miniECIRS – endoscopic combined intrarenal surgery

Perioperatively proven stone-free rate was achieved in 37 (80.4%) RIRS and 10 (90.9%) miniECIRS patients. A total of 17 (36.9%) RIRS and 8 (72.7%) miniECIRS procedures required robot undocking and conversion in order to perform basketing and stone fragments retrieval/transposition.
All miniECIRS cases received a nephrostomy 8 Fr drain that was removed on postoperative day one. Postoperative DJ stent was placed in 31 (67,4%) RIRS cases and in 7 (63,6%) miniECIRS cases.

DISCUSSION

The recent technological improvements in fURS have led to an increased use of endourological and combined procedures in urolithiasis [4]. These methods are characterised by high stone-free rates and low-invasiveness simultaneously. However, a long learning curve, as well as high radiation exposure and forced position of the surgeon performing these operations resulted in the search of improvement. In response to these issues, a few endourological robots have been introduced to the market.
The ILY robotic system is a remotely controlled ureteroscope holder manipulated by a simple gaming controller. The system allows the transmission of all basic flexible ureteroscopy (fURS) movements. Also, it is compatible with all commercially available digital flexible ureteroscopes and ureteral access sheaths (UAS) [2]. During RIRS, the remote control by ILY system is available after the manual introduction of UAS and fURS and their attachment to the receptacle. Throughout the operation, surgeon's position is restricted only by the distance from the device. The robot is characterized by wide rotational manoeuvrability (±360 degrees) – much higher when compared to other systems [2].
The ILY's system differs from the other robots significantly. Firstly, the gaming joystick is used to control the robotic arm, instead of a bulky master console. Gauhar et. al pointed out that the use of a video-game controller is not intuitive, as it does not reproduce the stereotypical hand movements performed during traditional fURS [2]. However, in our opinion, an immense number of people are already experienced in using such controllers, because of the popularity of video games. Moreover, such a solution allows for complete freedom of movements of the operator.
Secondly, the ILY robotic arm is the most compact and mobile of all systems. Due to the lack of master console and a small size of the receptacle, it takes little space in the operating theatre.
Up to date, no other studies involving humans regarding the use of ILY robot have been published [3]. In our research, stone-free rate was satisfactory and the average durations of the procedures were not significantly longer than in the standard approach. As a majority of the robot handling is performed in parallel to surgery, only docking and undocking prolongs the operation. Depending the clinical scenario, additional time needed because of ILY usage ranged between one and three minutes.
Nonetheless, the system has a few disadvantages. Firstly, the laser fiber adjustments and the stone basket manipulations need to be performed manually by the additional assistant. Secondly, there is no mechanism that allows for the control of the inflow and flushing of the irrigation solution. Finally, the ILY and other robots lack tactile feedback. However, the technology is being developed to incorporate force feedback into robotic fURS in the future [5].
We are aware that our study has some limitations. The trial was not comparative, so we could not prove the superiority or at least non-inferiority of robotic procedures over the standard approach. Also, a relatively low number of patients were included. Hence, this article possibly did not contain a complete cross-section of patients with kidney stones.
However, our report still has some clear strengths. It is the first research that used the ILY robotic arm in urolithiasis management. Moreover, the study was conducted in a large urologic centre that performs an immense number of standard RIRS and miniECIRS every year. That certifies the proficiency and repeatability of the procedures.

CONCLUSIONS

The use of ILY robot during endourological procedures is feasible and urologists that are familiar with the device controller do not require extensive training. The time needed for device draping, docking and undocking was approximately 4 minutes. Moreover, use of the robot did not prolong RIRS and miniECIRS procedures significantly and resulted in satisfactory stone-free rates.

CONFLICTS OF INTEREST
The authors declare no conflicts of interest.

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