Case Report

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Mini ECIRS with BotX: our single-case experience

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Abstract

Minimally invasive endoscopic combined intrarenal surgery has become the gold standard procedure for the treatment of large kidney stones. However, one of the most important critical success factors is the level of precision during renal accession, which requires a long learning curve. Robot-assisted fluoroscopy-guided renal access has been developed to address this difficulty. We report here the case of a 63-year-old woman presenting with a very large renal calculus whose treatment was successful using a robot-assisted fluoroscopy-guided minimally invasive endoscopic combined intrarenal surgery with suction sheath. The entire stone was cleared, and the patient recovered well with an absence of adverse events.

Keywords

ANT-X device, mini-endoscopic combined intrarenal surgery, renal calculus, robot-assisted fluoroscopy-guided

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Introduction

Currently, surgical treatment for urolithiasis is usually based on minimally invasive procedures, with a preference for endourologic techniques, which include extracorporeal shock wave lithotripsy, retrograde intrarenal surgery, and percutaneous nephrolithotomy (PCNL).[1,2] Endoscopic combined intrarenal surgery (ECIRS) is a novel way to remove a large or complex kidney that has become increasingly acceptable.[3,4] Nonetheless, there are some remaining concerns regarding the technical difficulty of achieving appropriate renal access, especially for full staghorn stones that lack intrarenal space for endovision puncture. This is particularly challenging for urologists with limited experience or insufficient training, as the approach requires extensive practice.[5]

To overcome the training gap and learning curve, an automated needle targeting with an X-ray (ANT-X) system (NDR Medical Technology, Singapore) can be used to ensure efficiency and safety during renal access. To the best of our knowledge, this is the first clinical case reporting tubeless mini-ECIRS with a suction sheath using robot-assisted fluoroscopy-guided (RAFG) renal access in a patient with a large renal calculus.

Case report

A 63-year-old female was referred to our clinic because of left flank pain. She had a medical history of hypertension and hyperlipidemia. The physical examinations were unremarkable, and the urinalysis showed modest pyuria but negative urine cultures. She had a serum creatinine level of 1.06 mg/dL. A computerized tomography scan demonstrated a large left kidney calculus 4.7 cm in size, with an average stone density of 657 HU and still preserved kidney parenchyma (Figure 1). Excretion function was mildly reduced in the left kidney but normal excretion was observed on the right side. After the available treatment options were discussed, this patient selected the mini-ECIRS with a suction sheath using RAFG renal access.

The patient was placed under general anesthesia and arranged in the Galdakao-modified supine Valdivia position, and intravenous cefuroxime was administered during the induction phase. According to the preoperative imaging, an ANT-X instrument was applied over the patient's left flank area by a surgeon (Figure 2(a)). A retrograde pyelogram was performed by inserting a 6 F ureteral catheter cystoscopically into the renal pelvis and illustrating the collecting

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system using contrast dye. Then, an 11/13 F ureteral access sheath was applied to the ureter over a hybrid guidewire that the tip of the access sheath placed below the ureteropelvic junction. An 8.4 Fr flexible ureteroscope (fURS) (Scivita Medical, Suzhou, China) was passed through the access sheath and created artificial hydronephrosis. After a contrast agent was provided by the fURS to provide the details of the collecting system, the ANT-X software acquired a fluoroscopic image and generated a suitable axis puncture line (Figure 2(b)). Then, without difficulty, the surgeon introduced an 18-gauge needle into the lower pole calix under the navigation of the ANT-X software in a single step and then placed a guidewire. Another safety guidewire was passed into the collecting system using a dual-lumen catheter. A Clear Petra disposable nephrostomic sheath (Well Lead Medical Co.) was placed over the guidewire to create a 16 Fr working channel. A mini-percutaneous nephroscope (Olympus, Tokyo, Japan) was inserted, and laser lithotripsy was performed with the fragmentation technique using a 60 W thulium fiber system (SOLTIVE™; Olympus, MA)and a 550-micrometer laser fiber, with the settings of 1.5 J and 30 Hz, respectively. The fURS repositioned some large stone fragments into the nephrostomy sheath (pass-the-ball technique). Subsequently, the stone fragments and dusting powder were evacuated and washed out through the suction system of a nephrostomic sheath. An 8 Fr double-J stent was placed in a retrograde fashion at the end of the procedure.

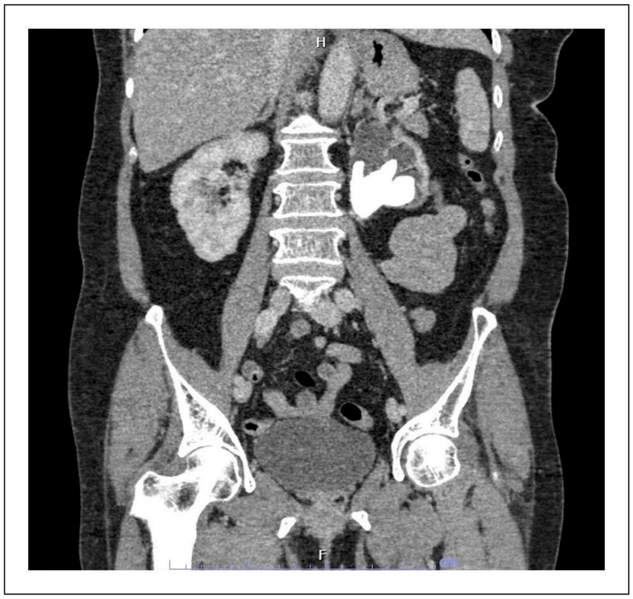

Figure 1. Computerized tomography scan illustrating a very large renal calculus.

The total operative time was 100 min, the accession time was 5 min with a single attempt, and the laser time was 40 min. We obtained a plain abdominal X-ray to determine the location of any residual fragments and to confirm the adequate positioning of the retrograde stent (Figure 3). The patient had an uneventful postoperative recovery and was discharged on day 3. The ureteral stents were removed at 6 weeks postoperatively.

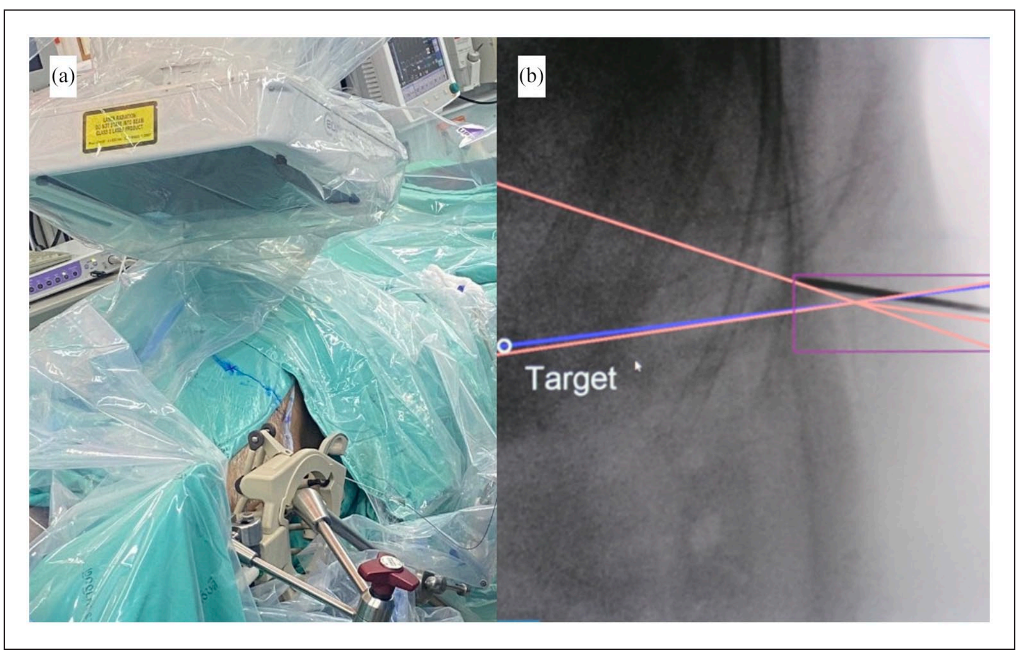

Figure 2. (a) Intraoperative images of the ANT-X device applied over the patient's flank area. (b) The axis line of the needle to the targeting calyx is generated by the ANT-X device.
ANT-X: automated needle targeting with an X-ray.

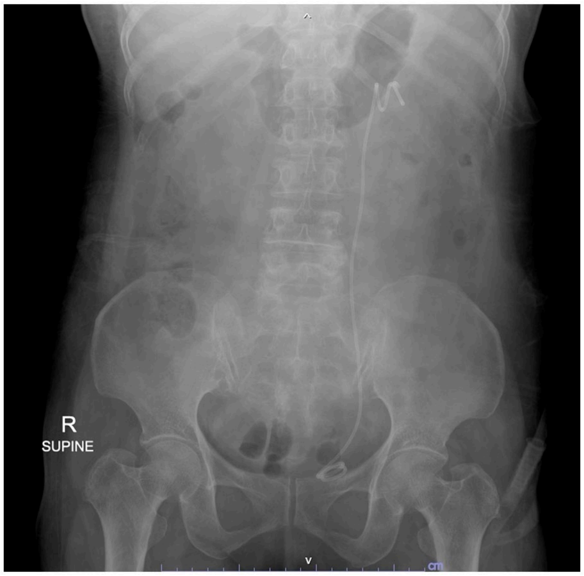

Figure 3. No evidence of residual stones on the postoperative abdominal X-ray.

Discussion

Urolithiasis is one of the most common diseases in Thailand and throughout the world, with prevalence ranging from 1% to 5% in Asia and 7% to 13% in North America, of which 10%–20% are staghorn stones.[6] Over time, an untreated staghorn calculus commonly contributes to the destruction of the renal parenchyma, which deteriorates its function and/or causes life-threatening septicemia.[7] Complete removal of the stone is an extremely mandatory procedure in terms of preventing further stone growth, relieving urinary tract obstruction, preserving kidney function, and eradicating infection. Moreover, evaluating the kidney's excretory function is crucial prior to undertaking percutaneous nephroscopic surgery, for both anatomical and functional assessment. To ensure an accurate preoperative evaluation, we strongly recommend performing a contrast-enhanced computed tomography scan.

Globally, the current procedure of choice for the treatment of large or complex renal calculi is still percutaneous nephrolithotomy with a standard size (over 24 Fr of Amplatz sheath).[8,9] However, operative techniques and procedural instrumentation have seen rapid developments and obvious progression in recent years. Equipment advances include better quality of vision technology, nephroscope designs, miniaturization of instruments, and the implementation of artificial intelligence and surgical robotics.[10,11] In terms of surgical techniques, PCNL has been performed in a prone position throughout most of the world due to concerns regarding colonic interposition.[12] Nevertheless, for the last 30 years, the supine approach has been increasingly considered, and scientific research has supported its effectiveness, safety, and feasibility, demonstrating that it shortens operative time, facilitates anesthesia, and is more ergonomic for the urologist.[11] Moreover, the combination of the supine approach with fURS may be a good choice for the treatment of complex renal stones compared to standard PCNL alone. Simultaneously, fURS applications serve to evaluate the anatomy of the collecting system and the characteristics of renal calculus in terms of configuration, location, and size. In addition, the kidney puncture can be guided under direct endoscopic vision by making a proper papillary accession through the renal papilla.

Not all urologists are comfortable performing a renal accession. Sometimes, an interventional radiologist may conduct this percutaneous puncture.[13] Accordingly, automated systems for targeting have been developed to address this discomfort and improve PCNL accession results.[14,15] In the present case, we performed mini-ECIRS by RAFG renal access using ANT-X. Artificial intelligence controlled the optimal trajectory using single-shot fluoroscopy, and the needle was inserted into the target calyx through only one attempt. This ANT-X procedure mitigates the learning curve of percutaneous access and also improves efficiency, as there is less dependence on human skill during the procedure compared with the current method. Enhanced precision may lead to reduced operative durations, fewer complications, and subsequently, shorter hospitalizations and diminished ancillary treatment needs.

Conclusion

In conclusion, we suggest that patients with complex renal stones might benefit from RAFG mini-ECIRS due to its high stone-free rate, fewer complications, and safe performance even by inexperienced hands.

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Author contributions

All authors contributed equally to the article and read and approved the final version of the article.

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Ethics approval

Ethical approval to report this case was obtained from the institutional review board (COA. MURA2023/501).

Informed consent

Written informed consent was obtained from the patient(s) for their anonymized information to be published in this article.

Consent for publication

Written informed consent was obtained from the patient to publish this report in accordance with the journal's patient consent policy.

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