

Retrograde Intra-Renal Surgery Using Thulium Fibre Laser as an Alternative to Percutaneous Nephrolithotomy in the Management of Multiple Renal Stones: A Case Report and Literature Review.

Azodoh EU¹, Suraj A^{1,2}, Magnus FE¹, Egekwu C¹, Kutu TD¹, Tolani MA², Sudi A², Nasir O², Awaisu M²

¹Chivar Specialist Hospital and Urology Centre, Abuja and Owerri, Imo State. ²Ahmadu Bello University Teaching Hospital, Zaria, Kaduna State.

ABSTRACT

RIRS has increased by 164% in the last decade. RIRS utilizes flexible ureteroscopy while PCNL create a direct access to the kidney via the skin. TFL has been found to be effective for stone lasing. RIRS with TFL avoids skin puncture, nephrostomy tube placement, reduce complications and radiation exposure, enhances recovery and outcome for high-risk patients compared to PCNL. We present a 45-year-old woman with recurrent right flank pain and CT imaging confirmed right renal stones in the lower and middle calyces measuring 2.9cm, 1cm, 0.7cm, 0.6cm and 0.4cm with mild hydronephrosis. She was obese (BMI=35.6kg/m²) and has had multiple previous abdominal surgeries. She declined PCNL on account of skin puncture and opted for RIRS. She had RIRS using thulium fiber with successful stone lasing and ureteric stenting. Patient was discharged 24hours later and 6weeks post-operative imaging showed complete stone clearance. RIRS with TFL is feasible for obese patients, those declining PCNL or wish to avoid skin puncture including those with multiple renal stones.

Keywords: Percutaneous Nephrolithotomy, Retrograde Intrarenal Surgery, Thulium Fiber Laser

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*Correspondence

Aliu Suraj
Ahmadu Bello University Teaching
Hospital, Zaria.
Email: surajsurajali03@gmail.com
Tel: +2348065123937

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INTRODUCTION

There is a recent global rise in the number of retrograde intra-renal surgery (RIRS) and percutaneous nephrolithotomy (PCNL) performed for renal stone due to technological advancement and the need to minimize tissue trauma.^[1] RIRS is estimated to have increased by 164% in the last decade. RIRS is a minimally invasive technique that utilizes flexible ureteroscopy to access the renal pelvis and calyces, allowing for fragmentation, dusting or popcorning of kidney stones which are then removed.^[1,5] RIRS is suitable for stones <2 cm, failed extra-corporal shock wave lithotripsy (ESWL), certain stone locations, body habitus (obesity) and coagulopathy and it is performed mostly under general, spinal or local anesthesia while PCNL is a surgical technique in which a puncture is made on the lumbar skin to create a direct access point to the renal pelvis and calyces under image guidance through which kidney stones are fragmented and evacuated usually under general anesthesia.^[1] PCNL is indicated in stones >2cm, staghorn calculi, failed RIRS and high renal stone burden (multiple). Common sources of energy for stone breaking include laser (Holmium or

thulium), ultrasonic or pneumatic.^[2] Preliminary studies showed that thulium fiber laser (TFL) have excellent stone free rates, shorter operating time and less stone migration compared to other energy sources. TFL also have higher water absorption coefficient, smaller optical penetration depth, lower stone ablation threshold, transmit high-power laser beams, have smaller more flexible optical fibers with conducive portable device, better dusting and low retropulsion compared to holmium laser and other energy sources in respect to urinary tract stones even though further studies are needed to elucidate these findings.^[3] Thus, thulium fiber laser when used for RIRS effectively competes with PCNL to a reasonable extent.^[3,11] RIRS especially with thulium fiber is currently being used as an alternative to PCNL with same and sometimes better outcome because it avoids skin puncture, percutaneous nephrostomy tube placement, ensure faster recovery, less complications, less exposure to radiations, best for high-risk surgical patient and largely cost effective. We present a case with the use of TLF for multiple right renal stone in an obese patient with multiple previous abdominal surgeries.

stones and these were confirmed on CT scan which showed multiple right renal stones in the middle and lower calyces measuring 2.9cm, 1cm, 0.7cm, 0.6cm and 0.4cm (fig. 1-3). Urea, electrolyte and creatinine were normal, Urine culture was negative. Other investigations including; full blood count was normal with a PCV of 42%, Coagulation profile, ECG, echocardiogram and chest x-ray were normal.

CASE SUMMARY

The patient is a 45-year-old woman who presented with recurrent right flank pain of five months' duration described as colicky and has been increasing in severity and frequency since onset. It was bothersome and interfered with her activities. There were associated occasional storage lower urinary tract symptoms, nausea and vomiting. She had previous appendicectomy and four caesarean sections. She was neither hypertensive nor diabetic. Examination revealed a well-preserved obese woman with a BMI of 35.6kg/m². Abdominal examination revealed a gridiron and a broad midline infraumbilical scar. No renal angle tenderness and kidneys were not ballotable.

She had abdominal ultrasound scan done which showed multiple right mid and lower renal calyceal



Figure 1: A Coronal CT View Showing a Right Renal Mid Calyceal Stone measuring 1cm



Figure 2: A Coronal CT View Showing Right Renal Mid and Lower Calyceal Stones Measuring 0.7cm, 0.6cm and 0.4cm



Figure 3: A Coronal CT Scan View Showing Right Renal Lower Calyceal Stone Measuring 2.9cm
Patient was counseled for PCNL for which she declined on account of percutaneous access and

requested for a RIRS. She was then counseled on the pros and cons of RIRS and the procedure was planned. Prophylactic intravenous ciprofloxacin 200mg at induction of anesthesia was given and she had RIRS using a TFL with successful dusting and popcorning of the stones in the right, mid and lower renal calyceal moieties (fig. 4). Using a 200uM thulium fibre, lasing parameters for dusting were 12W power, 0.5J energy and 20HZ frequency while popcorning parameters were 12W power, 1.2J energy 10HZ frequency with slight modifications during the procedure. The total lasing time was 2hours 30minutes while total operation time was 3hours. This was followed by double J stent insertion and patient was placed on antibiotics, analgesics, high fluid intake and smooth muscle relaxant (Tamsulosin). She was discharged 24hrs later following normal urea, electrolyte, creatinine and full blood count. Few stone fragments retrieved were sent for stone analysis. 6weeks post-surgery, repeat CT urography done showed complete stone clearance (fig. 5).

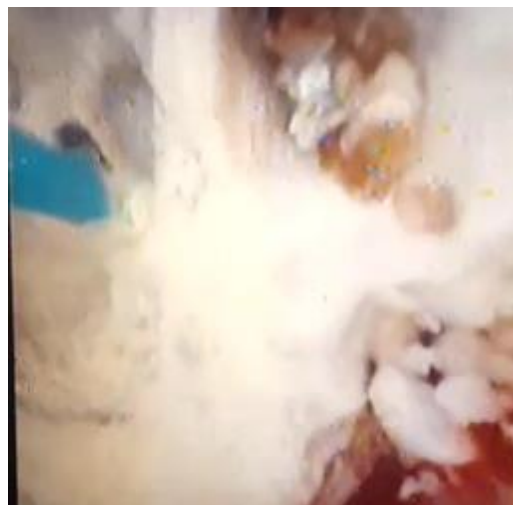


Figure 4: Intraoperative Image Showing the Thulium Laser Fibre and One of the Partially Dusted Stone

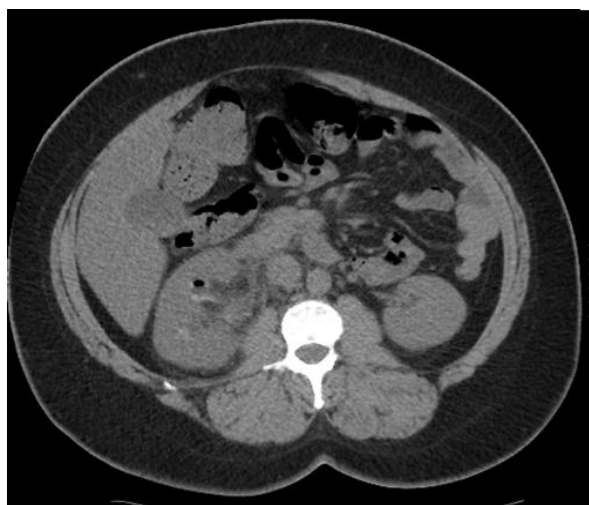


Figure 5: Post-Operative Axial CT View Showing Complete Right Renal Stone Clearance.

DISCUSSION AND LITERATURE REVIEW

RIRS is a minimally invasive technique that utilizes flexible ureteroscopy to access the renal pelvis and calyces, allowing for fragmentation, dusting or popcorning of kidney stones which are then removed. It is particularly suitable for stones <2 cm, failed ESWL, certain stone locations, obesity and coagulopathy. It may be performed under general, spinal or local anesthesia while PCNL is a surgical technique in which a small incision is made on the lumbar skin to create a direct access point to the renal pelvis and calyces under image guidance through which kidney stones are broken and evacuated usually under general anesthesia.^[1] PCNL is indicated in stones >2cm, staghorn calculi, failed RIRS and multiple renal stones. Common sources of energy for stone breaking include laser (Holmium or Thulium), ultrasonic or pneumatic.^[2] Although Holmium laser is currently the gold standard for stone fragmentation, preliminary studies have shown that thulium fiber laser have better stone free rates, shorter operating time and less stone migration compared to holmium laser and other energy sources in respect to urinary tract stones, thus, thulium fiber laser when used for RIRS effectively competes with PCNL to a reasonable extent.^[3]

RIRS has emerged as a viable alternative to PCNL for the management of renal stones, particularly in certain patients and stone profiles with good surgeon experience.^[4] RIRS avoids the need for a puncture and nephrostomy tube placement, ensure faster recovery, less complications, suitable for challenging stone locations, certain anatomic variation and best for high surgical risk patient and largely cost effective as opposed to PCNL.^[5] Huang et al compares the efficacy of RIRS versus PCNL. The results indicate that both methods are effective and may be used interchangeably but RIRS has been associated with lower complication rates, particularly in patients with smaller stones.^[5] While PCNL has traditionally been the preferred method for larger stones (>2 cm). An article by Giusti et al in 2021 highlighted that advancements in RIRS techniques and technologies (such as thulium laser lithotripsy) makes RIRS a feasible option for larger stones, with outcomes that may be comparable to PCNL.^[6] This finding was also demonstrated in this case report where despite some of the stones being larger than 2cm, retrograde intrarenal surgery with thulium fibre laser was effective in clearing them.

Breda et al conducted a systematic review and meta-analysis of RIRS for kidney stones larger than 2.5cm and found that the stone-free rate was 89.3% with minimal complication rate of 1.9% and concluded that RIRS for stones >2.5cm offer an acceptable efficacy with low morbidity.^[7] Srougi et al found that RIRS ensures a better patient satisfaction and quality of life compared to PCNL due to less invasiveness of the procedure.^[8] RIRS is currently challenging PCNL for the treatment of renal stones >2cm, becoming a safe and effective alternative with a comparable stone free rate, lower complication rate and lower hospitalization time. However, patient should be counselled on the possibility of additional procedures to clear residual stones.^[9] In this report, the patient was counseled on the possibility of additional procedure to clear residual stones but there was eventually no need for such. RIRS is also an alternative to PCNL for multiple renal stones in well selected patients as seen in this report.^[10]

Mahmoud et al (2025) found that treatment of lower calyceal renal stones can be effectively and safely accomplished with RIRS. Even though stone clearance with PCNL was better in this location base on the study, the difference was not statistically significant.^[11] This report confirms this possibility. RIRS with thulium or holmium laser is an option for treating renal stones in calyceal diverticulum compared to more traumatic PCNL. However, Success is influenced by stone size, nature and length of the diverticular neck with smaller stones, wider and shorter neck having better outcome.^[10] The choice between RIRS and PCNL for managing lower calyceal renal stones should be determined by surgeon experience, proficiency with each technique, and patient-specific factors. It is crucial to counsel patients on the benefits, risks, and potential outcomes of both procedures to ensure informed decision making that aligns with their best interests.^[11] While RIRS presents several advantages, it also has limitations in terms of stone size, composition and technical skills. Very large calculi (staghorn and partial staghorn) and hard stones may still require PCNL for effective removal. RIRS requires a surgeon skilled in ureteroscopy and familiar with advanced tools. Where stone clearance is the ultimate goal in patients with high stone burden RIRS may be less useful.^[9]

CONCLUSION

RIRS with thulium fiber laser is a viable alternative to PCNL as it gives same result and sometimes better surgical outcome. RIRS is feasible for obese patients, those declining or wish to avoid skin puncture for PCNL including >2cm, multiple and lower calyceal renal stones. Using TFL, RIRS can treat some PCNL indicated stones. With advancement in RIRS armamentarium, PCNL indication is diminishing. Adequate patient selection is however required for either procedure.

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