Simultaneous endoscopic combined intrarenal surgery in Galdakao-modified supine Valdivia position versus prone percutaneous nephrolithotomy for complex renal stones management

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Background: To compare the efficacy and safety of simultaneous percutaneous nephrolithotomy combined with flexible ureteroscopic lithotripsy in Galdakao-Modified Supine Valdivia position (GMSV) with percutaneous nephrolithotomy (PCNL) for complex renal stones.

Methods: ٦٠ patients with complex renal stones. were randomly divided into two groups. In PCNL Group, conventional PCNL was performed in the prone position. In the other group, simultaneous combined PCNL and flexible ureteroscopic lithotripsy (Endoscopic Combined Intra-Renal Surgery, ECIRS) serves as single session treatment in the GMSV position (ECIRS Group). Demographic, clinical characteristic, perioperative complications and stone free rate (SFR) were recorded.

Results: No significant differences were observed between both groups regarding age, sex, body mass index, side, and Guy's score. Operative time was significantly higher in PCNL group (١١٩ ±١٨ minutes) than in ECIRS group (١٠٥ ±١٤ minutes) (P = ٠.٠٠٢). A significant association was observed in the number of punctures, it was higher in PCNL group than in ECIRS group (P = ٠.٠٠١). Hospital stay was significantly higher in the PCNL group (median = ٣, range = ٣ – ١٠) than in the ECIRS group (median = ٢, range = ٢ - ٦) (P < ٠.٠٠١). On day one, KUB or CT revealed significantly higher residual in the PCNL group (٤٦.٧٪) than in the ECIRS group (١٦.٧٪) (P = ٠.٠١٢).The immediate success was significantly higher in the ECIRS group (٨٣.٣٪) than in the PCNL group (٥٣.٣٪) (P = ٠.٠١٢). The auxiliary procedures required for all patient with significant residual stone(s) and reveled significantly higher in the PCNL group (٤٦.٧٪) than in the ECIRS group (١٦.٧٪) (P = ٠.٠١٢) but no significant differences were reported between both groups regarding the types of auxiliary procedure (P = ١.٠)

Also there was no significant difference between the two groups regarding to final success (P = ١.٠).No significant differences were reported regarding post-operative hemoglobin (P = ٠.٨٨٧) and blood transfusion

Conclusion: Simultaneous combined PCNL and flexible ureteroscopic lithotripsy is an effective and safe treatment for partial and complete staghorn calculi, with significantly higher one-step SFR when compared to conventional PCNL monotherapy, without additional procedure-related complications.

Introduction

Due to higher incidence of renal stones, recent technological advances have been made to improve minimally invasive techniques for the management of renal stones, as percutaneous nephrolithotomy (PCNL), extracorporeal shock wave lithotripsy (ESWL), and retrograde intrarenal surgery (RIRS). Although ESWL and RIRS are currently widely used as less invasive modalities of treatment for renal stones, PCNL still has a role depending on the size, position, shape, and composition of the stones**.** These advancements have been largely focused towards delivering greater stone clearance, while minimizing morbidity, procedure time and length of hospital stay. **(١)**PCNL was developed to reduce the morbidity and mortality associated with open renal surgery, and it currently remains the first-line treatment for large renal stones. And since then, it has continued to undergo innovation and minimization. **(٢)**According to European Association of Urology (EAU) guidelines, PCNL still remains the standard procedure for large and complex renal calculi. In comparison to other treatment modalities, as it is the gold standard and the first choice for renal stones larger than ٢٠ mm and for lower calyceal stones sized ١٠ to ٢٠ mm. with unfavorable factors for ESWL, The stone composition is another important factor that influences the treatment options. ESWL-resistant stones such as brushite, cystine and calcium oxalate monohydrate should be alternatively treated by PCNL. Contraindications for PCNL treatment according to EAU guidelines include ongoing anticoagulant therapy, untreated urinary tract infection (UTI), tumor in the presumptive access tract area, potential malignant renal tumor and pregnancy. **(٣)** In accordance with the developing technology, PCNL requires better instruments for complete stone removal, more precise stone targeting, and access to the kidney and relevant calyces. The newer developments have focused on imaging techniques, as well as the fusion of

multiple imaging procedures and navigation systems during access to the stone, the debate continues over the use of the prone or supine position, tube or tubeless PCNL. **(٤)**Staghorn calculi comprise complete and partial forms. Complete staghorn stones occupy the renal pelvis and the caliceal system, or more than ٨٠٪ of the renal collecting system, while partial stones occupy the renal pelvis and at least two calices. According to current guidelines, large volume and staghorn stones should be managed with PCNL. **(٥)** Despite recent refinements to the technique and instrumentation of PCNL for the treatment of staghorn calculi, the number of PCNL procedures remained stable over the years and these stones are still a troublesome challenge for endourologists and are associated with a higher rate of perioperative complications than that for non-staghorn disease. **(٦)** Retrograde intrarenal surgery (RIRS) refers to the surgical management of upper urinary tract pathologies with a retrograde ureteroscopic approach and considered one of the least invasive procedure for doing surgery within the kidney using a viewing tube called a fiberoptic endoscope. In RIRS the Flexible Ureteroscope (F-URS) is placed through the urethra into the bladder and then through the ureter into the urine-collecting part of the kidney. The scope thus is moved retrograde to the kidney. The stone can be seen through the scope and manipulated or crushed by an ultrasound probe or fragmentation, dusting by a laser fiber or grabbed by small forceps. Recently, the role of RIRS has expanded to the treatment of urinary calculi in the upper urinary tract especially with the development of new surgical instruments, the deflection mechanism, visuality, and its durability. **(٧)** F-URS procedures were introduced in the ١٩٦٠. However, these F-URS had no integrated deflecting systems or working channels and were not widely utilized until the introduction of the new F-URS and the holmium:yttrium aluminium garnet (YAG) laser system in the ١٩٩٠.**(٨)** F-URS basically consist of the optical system of the fiberoptic image and light bundles, a deflection mechanism, and a working channel. However, recently developed digital scopes are expected to provide improved image quality and durability because they do not require a separate light cable or camera head. **(٩)** PCNL was initially performed with the patient in the supine-oblique position, but the prone position later became the conventional one. The prone position provides a larger area for the percutaneous renal access, a wider space for instrument manipulation, and a claimed lower risk of splanchnic injury. It is, however, associated with patient discomfort, increased radiological hazard to the urologist’s hands, and the need for several nurses to be present for

intraoperative changes of the decubitus. The prone position also implies important anaesthesiological disadvantages including circulatory, haemodynamic, and ventilatory difficulties, particularly in obese patients**. (١٠)** In ١٩٨٧ Valdivia-Urìa described a PCNL with the patient supine, with a ٣-Litre serum bag below the flank. Ten years later he reported ٥٥٧ consecutive percutaneous nephroscopies performed in this way. **(١١)** The modified Valdivia position for simultaneous PCNL and ureteroscop was described by Valdivia et al to allow simultaneous rigid ureteroscopy during PCNL. The difference from the original supine position is that the legs are flexed in supports, with the ipsilateral leg more elevated and the contralateral more descended, to facilitate the use of a rigid ureteroscope. **(١٢)** The Galdakao-modified supine Valdivia position (GMSV) was described by Ibarluzea et al in ٢٠٠٧ and renewed the attention of the urological community on supine PCNL. Other authors confirmed that the operation in this position is a safe, practical and versatile procedure, with high success rates and has important advantages over the prone position. The main characteristic is a slight lateralization of the Valdivia supine position, with the contralateral leg flexed. The patient is placed in an intermediate supine lateral position with a ٣-Litre bag placed to raise the flank. The ipsilateral leg is extended and the contralateral leg is abducted and flexed, achieving a modified lithotomy position (fig.١). **(١٠)**

(Fig. ١): A): The ‘Valdivia’ supine position. **B):** The modified ‘Valdivia’ position. **C):** GMSV position.

Patient and method

This prospective randomized comparative study was conducted on ٦٠ patients. The study was conducted at The Urology Department, Benha University Hospitals and Urology department of Theodor Bilharz Resarch Institute during the period from june ٢٠٢٠ till may ٢٠٢٢. All patients were suffering from complex renal stone(s) and were submitted to either prone PCNL or ECIRS including ٣٥ male and ٢٥ female patients with age range from ١٩ to ٦٨ years old .

Consent:

Informed consent was signed by all patients included in the study after explaining the benefits and risks of each procedure such as bleeding, infection, and associated neighboring organ injury.The ٦٠ patients will be randomized into two groups, prone PCNL group and ECIRS group with ratio ١:١

Group A: included ٣٠ patients (١٩ males and ١١ females) who were treated by cPCNL.Group B: included ٣٠ patients (١٦ males and ١٤ females) who were treated by ECIRS. Inclusion criteria: patients with complex renal stone(s) (GSS grade III and IV) and patients more than eighteen years old .Exclusion criteria: Patients with uncorrected bleeding disorders,Patient with severe cardiac and pulmonary dysfunction ,Patients with renal stone(s) (GSS grade I and II).and Single functioning kidney

All patients underwent complete urological evaluation with special emphasis on History, Physical examination, Standard laboratory investigations and Radiology: including KUB was performed for all patients.,Pelvi-abdominal ultrasonography was done for all patients, Non-contrast spiral CT was done for all patients,and Excretory urography done when indicated

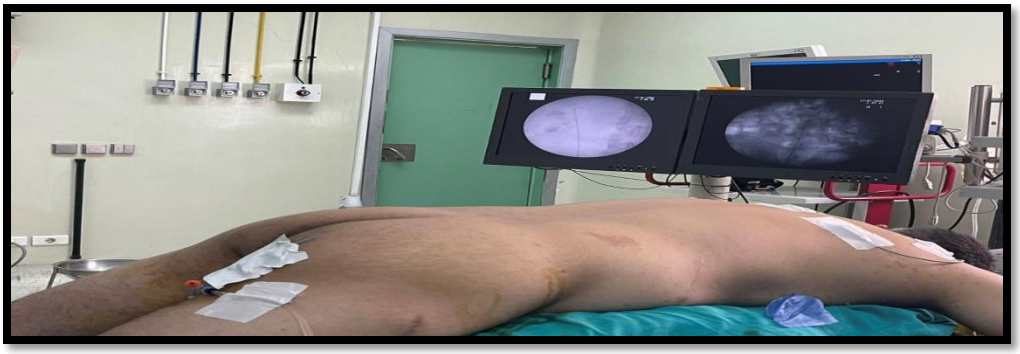
Operative technique:Group A: PCNL

The patients underwent the procedure under general anesthesia using endotracheal intubation and good muscle relaxation.

Prophylactic antibiotics were administered after fixation of the intravenous line according to The American Urological Association guidelines which has

determined that a prophylactic regimen consisting of a single dose during induction is sufficient.

Positioning: **(١٣)** The patient is placed in lithotomy position. Cystoscopy was performed to advance a six French open-ended ureteral catheter in a cephalad direction under fluoroscopic guidance to the collecting renal system. The ureteral catheter was fixed with tape to a urethral catheter.Patients conducted in this arm were repositioned in prone flexed position (fig.٢). All pressure points were carefully padded. A bloster was placed under the chest to allow optimal ventilation and another blosters were placed under the symphysis pubis, knee and ankles for support.(**١٤**)



(Fig.٢):patient in prone flexed position

Technical aspect **(١٥)**The skin was punctured at the posterior axillary line.Renal access was achieved under fluoroscopy after opacification the collecting system via the ureteral catheter.An ١٨-gauge translumbar angiography needle (TLA) is advance towards the chosen calyx, sometimes another puncture was required. Confirmation that the needle is within the calyx is obtained by free flow of fluid Once the TLA needle is in the target calyx a curved guidewire (٠.٠٣٨ inch) is introduced into the collecting system either towards the renal pelvis, upper calyx or the upper ureter or some times in the targeted calyx only to act as a guide over whom the track is dilated.A ١ cm skin incision and opening of the lumbodorsal fascia using straight artery forceps. Then the needle is removed carefully leaving the guidewire in place. Then safety guide wire was introduce. Dilation was done using the first metal Alken dilator over the curved wire either by using Sequential method in ٥ cases: with metallic coaxial dilators that were used for tract dilation up to ٣٠ F. Acute (single step) method in ٢٥cases: with Amplatz dilator ٣٠ F. At the

end of dilation, a ٣٠ F Amplatz sheath was positioned, allowing the introduction of ٢٦ F nephroscope. The stone was disintegrated using pneumatic lithotripsy onto small fragments to be extracted by forceps. A ٢٤ Fr. nephrostomy catheter was applied at the end of the procedure under fluoroscopic guidance. Antegrade pyelography was done to assess the collecting system (extravasation) or filling defects (sizable residual stone).The nephrostomy secured at the skin with a silk suture, and the wound was cleaned and dressed. The ureteral catheter was routinely maintained in place following PCNL. Ureteral catheter was replaced by JJ stent if the patient was scheduled for an auxiliary procedure. Two puncture were required in ١٣ cases with two access sheath and two nephrostomy. The operative duration was estimated from cystoscopy time till securing the nephrostomy tube to the skin. - Postoperative CBC was done for all patients in Postoperative day one, blood transfusion was needed when HB level was < ٨ gm/dl according to British Haematological Society or for hemodynamic instability. **(١٦)** KUB for all patients on the first postoperative day was done .in patients with radiolucent, spiral CT was obtained for accurate assess to any significant residual .The procedure was considered successful if the patient was stone free or had asymptomatic residual fragments ≤ ٤ mm in diameter. In patients with significant residual stones an auxiliary procedure(s) was prescribed.if there was no residual required to ٢nd look PCNL , The nephrostomy tube was removed ٢٤ hours postoperatively on condition that urine was clear, the ureteral catheter and the Foley's urethral catheter were removed ٢٤to ٤٨ hours later if there is no urine leakage.The patients received IV antibiotics for ٢ days postoperatively and then oral antibiotic for ٥ days after discharge. Perioperative complications were assessed according to the modified Clavien grading system**.(١٧)**

Group B: ECIRS

The patients underwent the procedure under general anesthesia using endotracheal intubation and good muscle relaxation. Prophylactic antibiotics were administered after fixation of the intravenous line.

Positioning(**١٠)** ECIRS was performed in the GMSV position (fig.٣),in which the patient was placed in the supine position with a ١-L saline bag below the ipsilateral flank. Thus, the ipsilateral flank was elevated ٢٠ degree, causing the posterior calyx to project more laterally.

(Fig .٣):(GMSV) position

Technical aspect: (١٨) The procedure done by two surgical teams who had a good experience in PCNL and RIRS under general anesthesia in the GMSV position. Cystoscopy was performed to advance a hydrophilic guidewire (٠.٠٣٨-inch) to the renal pelvis with fluoroscopic assistance followed by retrograde pyelography using a ٦F ureteric catheter to assess the pelvicalyceal system. Dual lumen ١٠F ureteral catheter was sometimes used for wire placement, providing two separate working channels for second wire placement or dye injection to perform retrograde pyelography. The ureter is then dilated with Teflon ureteric dilators up to uretero-pelvic junction and a ureteral access sheath (١٢/١٤ Fr) was passed over the guide wire.In four cases the ureter was noncompliant for dilatation two of them allowed the passage of flexible uretroscope without ureteral access sheath and the others did not allow its passage and the procedure ended with JJ insertion and the procedure postponed two weeks which may be considered a drawback of the procedure.The flexible ureteroscopes thad used were Wolf Boa (fig. ٣٢) (shaft diameter ٨.٧ Fr, Tip diameter ٦.٦ Fr, Working channel ٣.٦ Fr, ٢٧٠ degree of deflection) in ٨ cases , Pusen single use flexible ureteroscope (shaft diameter ٩.٥ Fr, Tip diameter ٩Fr, Working channel ٣.٦ Fr, ٢٧٠ degree of deflection) in ٢٢ cases. Retrograde pyelography through the flexible uretroscope done then the puncture of chosen calyx was done under fluoroscopy in addition to the endovision of flexible scope through which the antegrade wire and sometimes the puncture itself was seen that increased the accuracy and minimized the complications of

the puncture, then complete the steps of safety wire, dilatation, and amplatz sheath as described in group A. Two surgon started simultenously in stones fragmentation. For F-URS lithotripsy laser machines used were lumenis, sphinx JR and Asclepion , and pneumatic lithotripsy for the rigid nephroscope- Retrograde pyelography through the flexible uretroscope done then the puncture of chosen calyx was done under fluoroscopy in addition to the endovision of flexible scope through which the antegrade wire and sometimes the puncture itself was seen that increased the accuracy and minimized the complications of the puncture, then complete the steps of safety wire, dilatation, and amplatz sheath as described in group A.Two surgon started simultenously in stones fragmentation. For F-URS lithotripsy laser machines used were lumenis, sphinx JR and Asclepion (fig.٣٤) and pneumatic lithotripsy for the rigid nephroscope- In the intrarenal space ,nephroscope and flexible uretrorenoscope been in finger-touch with eachothers (fig.٤)Two puncture were required in two cases with two access sheath and two nephrostomy ,one of them the stone was in closed calyex that required another puncture ,the other case the stone was in cayex couldnot reached by either nephroscope or FURS

(Fig. ٤): finger-touch of both scopes on C-arm and F-URSseen with nephroscope

- Using the nethroscopic forceps through amplatz sheath the fragmented stones were exetracted ,even without forceps passive retrieval using (wathout mechanism) was done depending on downward orientation of amplantz sheath and continuous irrigation fluid fron FURS. For in acceissable stones to the nephroscope ,the FURS had been used to transport it in front of the nephroscope (transport technique) to be exetracted. At the end FURS had been used to investigate all calecies for any residual stones. Antegrade pyelography was done to assess the collecting system (extravasation). or filling defects (sizable residual stone). A ٦F JJ stent was

routinely applied to be removed when the patient proved to be stone free. The operative duration was calculated from the time of cystoscopy to JJ insertion and nephrostomy fixation

Results

No significant differences were observed between both groups regarding age (P = ٠.٩١٠), sex (P = ٠.٤٣٢), body mass index (P = ٠.١٨٧), side (P = ٠.٣٠١), and Guy's score (P = ٠.٧٩١)

Operative and post-operative characteristics

Operative time was significantly higher in PCNL group (١١٩ ±١٨ minutes) than in ECIRS group (١٠٥ ±١٤ minutes) (P = ٠.٠٠٢). A significant association was observed in the number of punctures, it was higher in PCNL group than in ECIRS group (P = ٠.٠٠١). Hospital stay was significantly higher in the PCNL group (median = ٣, range = ٣ – ١٠) than in the ECIRS group (median = ٢, range = ٢ - ٦) (P < ٠.٠٠١). **Table(١)** No significant differences were reported regarding post-operative hemoglobin (P = ٠.٨٨٧) and blood transfusion (P = ٠.٧٠٦)

Table (١) Operative and post-operative characteristics

	PCNL (n = ٣٠)	**ECIRS (n = ٣٠)**	**P-value**
Operative time (min)	١١٩ ±١٨	١٠٥ ±١٤	٠.٠٠٢*
Postoperative HB	١١.١ ±١.٤	١١.٢ ±١.٣	٠.٨٨٧
Blood transfusion	٥ (١٦.٧)	٣ (١٠.٠)	٠.٧٠٦
Number of punctures			
One	١٧ (٥٦.٧)	٢٨ (٩٣.٣)	٠.٠٠١*
Two	١٣ (٤٣.٣)	٢ (٦.٧)	
Hospital stay (days)	٣ (٣ - ١٠)	٢ (٢ - ٦)	<٠.٠٠١*

Data were presented as mean ±SD, number (percentage), or median (min-max); * significant

❖ ***Outcome***

On day one, KUB or CT revealed significantly higher residual in the PCNL group (٤٦.٧٪) than in the ECIRS group (١٦.٧٪) (P = ٠.٠١٢).The immediate success was significantly higher in the ECIRS group (٨٣.٣٪) than in the PCNL group (٥٣.٣٪) (P = ٠.٠١٢).

The auxiliary procedures required for all patient with significant residual stone(s) and reveled significantly higher in the PCNL group (٤٦.٧٪) than in the ECIRS group (١٦.٧٪) (P = ٠.٠١٢) but no significant differences were reported between both groups regarding the types of auxiliary procedure (P = ١.٠)

Also there was no significant difference between the two groups regarding to final success (P = ١.٠) ***(Table ٢).***

According to the final success in PCNL group achieved in ٢٧ patients, failed in three patients, one of them died from COVID ١٩ after ESWL session before the assessment of the session, the second one refusing the second session of ESWL, and ale last one lost from follow up after FURS.

For the ٢nd group (ECIRS group) the final success achieved in ٢٨ patients, failed in two patients one of them lost in follow up and the other refusing to complete the required procedure.

Table (٢) Outcome of the studied groups

	PCNL (n = ٣٠)	**ECIRS (n = ٣٠)**	**P-value**
KUB or CT day one			
Free	١٦ (٥٣.٣)	٢٥ (٨٣.٣)	٠.٠١٢*
Residual	١٤ (٤٦.٧)	٥ (١٦.٧)	
Immediate success (Stone free rate)	١٦ (٥٣.٣)	٢٥ (٨٣.٣)	٠.٠١٢*

Significant residual stones	١٤ (٤٦.٧)	٥ (١٦.٧)	٠.٠١٢*
Need of auxiliary procedure	١٤ (٤٦.٧)	٥ (١٦.٧)	٠.٠١٢*
Types of auxiliary procedure			
ESWL	٧ (٥٠.٠)	٢ (٤٠.٠)	١.٠
F-URS	٤ (٢٨.٦)	٢ (٤٠.٠)	
PCNL	٣ (٢١.٤)	١ (٢٠.٠)	
Final success	٢٧ (٩٠.٠)	٢٨ (٩٣.٣)	١.٠

Data were presented as number (percentage); * significant

- ***Complications***

No significant differences were reported between both groups regarding all complications, including fever ٣٨° managed by observation (P = ٠.٥١٩), pain managed by opioid (P = ١.٠), bleeding required pressure dressing (P = ٠.٧٠٦), bleeding required IV fluid without transfusion (P = ٠.٢٥٤), bleeding required single episode of nephrostomy clamping (P = ١.٠), bleeding required blood transfusion (P = ٠.٧٠٦), fever ٣٨° managed by antibiotics (P = ٠.٥١٩), pulmonary edema managed by diuretics (P = ١.٠), colon perforation managed conservatively (P = ١.٠), urosepsis required supportive therapy (P = ١.٠), bleeding required multiple bladder irrigation (P = ١.٠), leakage managed by ureteric stenting without anesthesia (P = ٠.٤٩٢), bleeding managed by angio-embolization (P = ١.٠), pulmonary edema recurring ICU management (P = ١.٠), and Hypo saturation required ICU (P = ١.٠) ***(Table ٣).***

Table (٣) Complications in the studied groups

	PCNL (n = ٣٠)	**ECIRS (n = ٣٠)**	**P-value**
Clavien I			

Fever ٣٨° managed by observation	٧ (٢٣.٣)	٥ (١٦.٧)	٠.٥١٩
Pain managed by opioid	٥ (١٦.٧)	٤ (١٣.٣)	١.٠
Bleeding required pressure dressing.	٥ (١٦.٧)	٣ (١٠.٠)	٠.٧٠٦
Bleeding required IV fluid without transfusion.	٦ (٢٠.٠)	٢ (٦.٧)	٠.٢٥٤
Bleeding required single episode of nephrostomy clamping	٢ (٦.٧)	٢ (٦.٧)	١.٠
Clavien II			
Bleeding required blood transfusion	٥ (١٦.٧)	٣ (١٠.٠)	٠.٧٠٦
Fever ٣٨° managed by antibiotics	٧ (٢٣.٣)	٥ (١٦.٧)	٠.٥١٩
Pulmonary edema managed by diuretics	٠ (٠.٠)	١ (٣.٣)	١.٠
Clavien III			
Colon perforation managed conservatively	١ (٣.٣)	٠ (٠.٠)	١.٠
Urosepsis required supportive therapy	١ (٣.٣)	١ (٣.٣)	١.٠
Bleeding required multiple bladder irrigation	٣ (١٠.٠)	٢ (٦.٧)	١.٠
Leakage managed by ureteric stenting without anesthesia	٢ (٦.٧)	٠ (٠.٠)	٠.٤٩٢
Bleeding managed by angio-embolization	١ (٣.٣)	٠ (٠.٠)	١.٠
Clavien IV			
Pulmonary edema recurring ICU management	١ (٣.٣)	٠ (٠.٠)	١.٠
Hypo saturation required ICU	٠ (٠.٠)	١ (٣.٣)	١.٠

Data were presented as number (percentage)

Discussion

In this study, we compared the clinical efficacy and safety between conventional PCNL and ECIRS for partial and complete staghorn calculi. Our results showed that simultaneous combined PCNL and flexible ureteroscopic lithotripsy generated significantly higher one-step SFR when compared to conventional PCNL (٨٣.٣%e٥٣.٣%), without additional procedure-related complications.

With the development of endourological device and surgical technique, PCNL is regarded as the most effective treatment for staghorn calculi **(١٨).** However, the SFR of PCNL monotherapy for staghorn calculi is ٥٦٪e٨٣٪ **(١٩).** For treatment of staghorn calculi with PCNL, since branched stone or residual stone in parallel calyces, it is usually very hard to remove all of the stones through single tract, thus it requires multiple tracts during PCNL procedures. However, the increased tract numbers may increase the chance of renal hemorrhage**(٢٠).** Bryniarski et al. reported that retrograde intrarenal surgery (RIRS) showed great clinical efficacy for renal stones larger than ٢ cm , with significantly lower surgical complications compared with PCNL. However, since the removal of stone fragments was difficult and time-consuming, RIRS is not recommended as first-line choice for treatment of staghorncalculi. **(٢٠)**

This study has certain limitations that, firstly, the number of cases enrolled in both groups was relatively small, because the cases of staghorn calculi in our center were exactly not numerous. Secondly, this study is a single center study. For better understanding of the outcomes, our observations on this small cohort of patients need to be verified by multiple centers study with larger size sample.

In conclusion, simultaneous combined PCNL and flexible ureteroscopic lithotripsy is an effective and safe treatment for staghorn calculi, with significantly higher one-step SFR when compared to conventional PCNL. It could be recommended as primary treatment option for partial staghorn calculi.

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