Results of mini-PCNL at the Thanh Hoa General Hospital through 300 cases

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Abstract. To evaluate the results and make some remarks on mini – percutaneous nephrolithotomy (mini-PCNL) under the ultrasonic guidance for treatment of kidney stones at Thanh Hoa General Hospital. The descriptive study method, the period from July 2016 to September 2018 with 300 cases of kidney stones performed mini-PCNL under the ultrasonic guidance. Nephrolithotripsy by Homium laser 30W and 100w of Lisacompany.A number of 300 patients included 190 men (63.3%) and 110 women(36.7%). The average age is 42.13 ± 33.4 years. Recurrent stones: 45 patients (15%). Renal pelvis and 1 calyx stone: 51.7%. Hydronephrosis before surgery level 1: 140 patients (46.7%). Stones size: average length 3.11 ± 0.63cm; average area 5.16 ± 2.41cm^2. Tunnel position in middle calyx: 68.3%. Average surgery time: 58.42 ± 27.8 minutes. Bleeding in surgery in 15 patients. Hematuria after surgery in 2 patients. Fever after surgery in 46 patients. The average hospitalization is 4.6 ± 2.3 days. Early stones clearance rate: 78.3%. Mini – PCNL under ultrasound guidance with Holmium Laser energy source 30 – 100w is a method of treating kidney stones safely and achieving early stone clearance efficiency of 82.4%, low rate of postoperative complications 16.7%. This method has replaced the open surgery for the treatment of kidneystones.

Key words: Nephrolithiasis; Nephrolithotripsy; Renal stone; PCNL; Holmium Laser; tunnel

INTRODUCTION

Urinary stone disease influences all age groups. The reported prevalence rate of stone disease is 5%-12% in men, 4%-7% in women. Stone formation is affected by gender, age and geography. Men’s possibility of forming stones is more than women’s.

Over the years, there has been a great advancement in technology for minimally invasive treatment of urinary stones.

Percutaneous Nephrolithotripsy is currently the most popular minimally invasive method of treating renal stones. The use of PCNL has steadily increased as a replacement for the traditional open surgery besides other methods such as Retrograde IntraRenal Surgery (RIRS) and Extracorporeal (ESWL). RIRS was not recommended as a first-line treatment for renal calculi until 2013 according to the EAU guidelines. In recent years, significant improvements have been made to the PCNL method in terms of identifying stone location, puncture of the renal pelvis and calices, miniaturization of the access tracts, and enhancing instruments for the endoscopic grinding of stones, making it a highly efficient and much safer way of treating renal stones. From 2008, mini-PCNL has been performed worldwide with a smaller access tract to the kidney that measured only 12-20Fr, resulting in higher stone-free rates (SFR) and less complications than the standard PCNL which uses larger tracts of24 – 30Fr (Nagele et al., 2008; Hiep Nguyen Trong Hoang, 2016).

In Vietnam, the standard PCNL was performed in 2004 and has been carried out in many hospitals so far. However, the standard fluoroscopy-guided PCNL has many limitations and undesirable effects. On the other hand, the new Mini-PCNL has been implemented only in a few hospitals in the country since 2012. Therefore, we conducted this study to evaluate the feasibility and effectiveness of Mini-PCNL in treatment of renal stone with a puncture technique and creates percutaneous tunnel under ultrasound guidance and uses lithotripsy energy by Holmium Laser 30w-100w.

MATERIAL AND METHODS

Research subjects

There were 300 patients diagnosed with kidney stones received mini-PCNL treatment from July 1, 2016 to August 1, 2017 at the Department of Urology – Thanh Hoa General Hospital. Indications for lithotripsy include:

- Solitary stones of the renal pelvis (Sl-2), partial or complete staghorn stones (S3-4-5) according to the classification MooresWK and Boyce PJ(1976)**.**
- Caliceal stones or calyx diverticular stones. Pelvis – combined pelvic and ureteral stones or stones of the upper ureter that had been treated by a failed prior retrograde lithotripsy Kidney stones has been unsuccessful in lithotripsy, kidney stones have recurred aftersurgery.

All the patients did agree to participate in the experiment and do not deny the results of the experiment to be provided in the research paper. All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000.

Research methodology: cross-sectional description

Research period was from July 2016 to September 2018. Patients are tested and diagnosed to evaluate morphology, bilateral kidney function, anatomical correlation of renal calyx and pelvis with morphology, location of stone, identify the accompanying kidney pathology. The patient was actively treated for urinary tract infection before surgery.

Prepare equipment and instruments: urological endoscope apparatus, Hitachi-Ezu ultrasound machine with Convex 3-5 MHz transducer. Holmium Laser Sphin X 30W-100W lithotripsy machine with 550 um canopy heads. Karl Storz water pump with speed of 100 – 800 ml / min, rigid uretero-renoscope size 6.2/6.5Fr. Amplatz renal dilation set 6 – 18Fr and sheath 18Fr made by plastic ofSeplou.

The procedure was as follows:

- General anesthesia.
- The patient lies on his back, the doctor cystoscopically evaluates the condition of the ureter and places the catheter on the renal pelvis. If the ureter is narrow and cannot fold the guide wire, do not continuemini-PCNL.
- Move the patient to a lying on the opposite side with a cushion of lumbar pits. Ultrasound to check the position and morphology of pyelonephritis of the kidney, determine the most convenient renal calyx to access, has the shortest distance to the skin, access to other kidneystations.
- Skin incision, abdominal wall of waist area 0.7cm at the puncture site is determined in accordance with the ultrasound scan. Insert the 18-gauge needle into kidney under ultrasound guidance. When you enter the renal calyxes, there will be signs of a needle touching the stone or aurine.
- Put the curved lead wire into the renal pelvis. Create tunnel with Amplatz renal dilation set 6 – 18Fr. Place a sheath 18Fr into tunnel to the renal pelvis and calyx. Using a ureteroscope to determine the position, number and size of stones related to the structure and morphology of the renal pelvis andcalyx.
- Dissolve kidney stones with energy Holmium Laser 30W and 100W into small pieces, combine with water pump by machine with the pressure of 200 – 400ml/min. Pump to remove gravel or use pincers. Check for clean gravel. Remove the ureter catheter and place the JJ catheter downstream or upstream. Renal drainage with sonde Mono J 14-16Fr through thetunnel.

Monitoring after procedure: Abdominal condition, general condition, quantity and color of urine through renal drainage and urethral catheter. Early detection of complications such as bleeding and urinary tract infections.

X-ray and ultrasound examination after 3 days to determine the SFR without gravel> 4mm. Renal drainage and urethral catheter withdraw after 2 – 6 days and patients discharged. Re-examination after 15-30 days, X-ray and ultrasound examination to determine the SFR and indicate JJ withdrawal.

RESULTS

The study included 300 patients including 190 men (63.3%) and 110 women (36.7%). Average age: 42.13 ± 33.4 years (range: 22 – 84 years). The most aged 41 – 60 years old. There were 15 patients who had ESWL and stones were located in the kidney. 24 patients had undergone a prior open surgery to remove their renal and ureteral stones (13.3%): 5 patients (1.67%) patients had undergone a previous retroperitoneal laparoscopic surgery to treat ureteral stones on the sameside.

A number of 65/300 patients (21.7%) had a medical historyincluding:

- 15 cardiovascular patients,hypertension;
- 10 patients with chronic heartdisease;
- 10 diabetics; 5 patients with first stage renalfailure;
- 5 patients with scoliosis(1.5%).

There are 20 patients with urological infection treated before surgery.

The left stone has 175 patients, accounting for 58.3% and the right stone 41.7%. Average length of gravel: 3.1 ± 0.6 cm (1 – 4.9 cm), average width: 2.2 ± 0.3 cm (1 – 4.2 cm) and average area of 5.1 gravel ± 2.4cm^2 (l-16.72cm^2).

Table 1. Renal stone characteristics

Morphology and location of stones	No. Of patients	%
S2 (renal pelvis)	65	21.7
S3 (renal pelvis + calyce)	155	51.7
S4 (renal pelvis + 2 calyces)	45	15
S5 (renal pelvis + 3 calyces)	10	3.3
Lower calyce	10	8.3
Total	300	100

Renal pelvis stone is 21.7%, pyelo-calyxes stone is 66.7%, Coral stone (S 4.5) is18.3%.

First-degree hydration is most common with 140 patients (46.7%). Grade II 75 patients, accounted for 25%. Grade III 20 patients, accounting for 6.6% and non-dilated pyelonephritis in 65 patients, accounting for 21.7%.

Select patient's position: All patients were anesthetized and put on recumbent position.

Choosing renal calyx to access, create a tunnel: The middle calyxes group is the most chosen 68.3%, the upper calyxes group is the lowest chosen 6.7% and the lower calyxes group is 25%. All pucture into renal calyx. And create a tunel under ultrasound guidance are successful. The percentage of creating 1 tunnel accounted for the majority of 290 patients (98.3%) and creating 2 tunnels in 5 patients accounting for 1.7% due to complicated S5 gravel having branches in a separate calyx. Puncture into pyelo-calyxes system is the majority 215 patients, accounting for 71.7%.Directpuncture in stones 85 patients (28.3%).

Table 2. Access location

Renal calyces	S2 stone	S3 stone	S4 stone	S5 stone	Lower calyce stone	Total

Upper	5	15	0	0	0	20 (6,7%)
Middle	30	120	40	10	5	205 (68,3%)
Lower	30	20	5	0	20	75 (25%)
Total	65	155	45	10	25	300 (100%)

Happening in surgery: 15 patients (5%) bleeding during surgery from the tunnel location in the S2 – S5 stone does not cause hydronephrosis, thick renal parenchyma, no hemodynamic disorders and no blood transfusion.

Table 3. Operative time

Times	S2 stone	S3 stone	S4 stone	S5 stone	Lower calyce stone
Tract dilation	6,41 ± 5,91	7,45 ± 4,50	7,72 ± 1,35	8,31 ± 3,11	5,97 ± 1,21
lithotripsy	41,9 2± 6,31	52,46 ± 1,14	70,43 ± 7,49	91,52 ± 2,35	53,47 ± 6,41
Sonde JJ	4,32 ±2,61	4,47 ± 2,13	3,82 ± 2,26	4.58 ± 4,61	4,66 ± 2,22

Average operating time: 58.42 ± 27.8 (32 – 110 minutes), the longest in the stone group S5, group S2 and renal calyx has the shortest time, the catheter JJ 6 or 7Fr is placed downstream. Benefits in 290/300 patients accounted for 96.7%. 6 patients (2%) placed JJ upstream due to the tunnel in the lower channel perpendicular to the pyelo-ureter axis and 4 patients did not place JJ.

Long operative time increases the duration of anesthesiaandmay risk postoperativepulmonarycomplications .Also it increases blood loss, the need for transfusionandoverallcomplicationrates. In addition, short operative time is importantbecause it is cost effective.

Renal drainage by catheter Mono J 14 Fr in 48 patients (80%), 16 F in 12 patients (20%).

Happening after surgery: Complications after surgery in 49 patients accounting for 16.3% including: 46 patients with fever and stable treatment. There are 2 patients with hematuria need to intervene renal vessels (0.67% and 1 patient with S4 graveldue to the tip of JJ catheter not coming to the blader after Mono J withdrawal with small round fluid around the kidney, no need to aspire for internal fluid, only retrograde endoscopy to pull the tip of JJ down to the blader on day 3).

Average duration of hospitalization: 5.6 ± 2.3 days (3 – 17 days). Renal drainage is withdrawn after 2 – 5 days (2.1 ± 1.2 days). X-ray and ultrasound examination on day 3 after surgery had 247/300 patients still having stones > 4mm, the early SFR after surgery 82.4%. Postoperative analgesia is administered for 2days.

Table 4. Stone free rate after PCNL

Stone free rate	S2 stone	S3 stone	S4 stone	S5 stone	Lower calyce stone
After procedure	86,2%	81,7%	71,2%	68,7%	100%
After 1 month of PCNL	94,1%	88,4%	77,8%	76,7%	100%

Distal postoperative monitoring: 300 patients were re-examined after 15 – 30 days. Painless, no fever and X-ray and ultrasound examination showed 266/300 patients with the SFR (stones < 4mm) reached 88.7% and JJ was withdrawn. There were 34 patients with stones > 4mm (11.3%). Indicate ESWL for 18 patients, 11 patients after the JJ withdrawal had stones to the ureter and had retrograde endoscopy to lithotripsy by laser energy.

DISCUSSION

In the treatment of kidney stones so far, there have been many great developments with the use of less invasive intervention techniques instead of open surgery. Standard PCNL with a 24-30Fr tract size has been widely recognized as one of the most powerful instruments as it allows for rapid stone removal and is highly efficient in treating large kidney stones and complex staghorn stones.

A number of studies showed that PCNL can be performed successfully without risk of complications in patients with a history of previous open surgery or PCNL. Especially with the mini-PCNL which uses smaller access tract (18Fr), the complications of bleeding and kidney parenchyma have been reduced. The use of high power 80w Homium laser enables a faster destruction of stones, and enhances stone fragmentation. Stone fragments can be easily removed during the lithotripsy procedure, resulting in a higher efficiency rate of stone clearance. In the treatment of complex staghorn stones where multiple accesses are needed, the use of smaller tracts has demonstrated MiniPCNL's superiority over other methods. Some studies have also reported that Mini-PCNL was as efficient as the standard PCNL in the treatment of larger kidney stones. This technique can use 7.5Fr ureter endoscope insteadofspecialized kidney endoscope to flexibly manipulate into the calyxes of kidney, especially prevailing when the calyx neck is narrow. Use Holmium Laser 100W energy to dissolve stones quickly, safely, improve stone cleanliness, reduce kidney damage, reduce the risk of bleeding and reduce reflux pressure. Thanh Hoa General Hospital has started to implement mini-PCNL application under ultrasound guidance to treat kidney stones. Over 300 cases were performed showing the SFR is 82.4%. When compared with a number of authors doing internal and external, no statistically significant differences were found between these ratios: Hoang Long (2017), mini- PCNL study at Hanoi Medical University Hospital showed a 77.7% cleanliness rate (Hiep Nguyen Trong Hoang, 2016). According to Abdelhafez MF, the SFR is 83%(Abdelhafez et al., 2012).

Ultrasonic tunneling is proposed by Pederson in 1976. In recent years Ultrasound guided access during percutaneous nephrolithotomy has been widely reported as an approach with high success rate. Gamal et al. (2011) reported a series of 34 PCNL in which only ultrasound guidance was used during the whole procedure with the SFR 94%. We determine the location of stone and plick completely under ultrasound guidance. So far, domestic researches on ultrasonic guidance are still few.

Ultrasonic guidance has shown many convenient and accurate advantages, showing clear stone or no visible contrast on X-ray. Despite the many advantages of this method, research on ultrasound localization of kidney stones has been relatively limited in Vietnam. Poking under the ultrasound guidance is making an approach in the direction of the ultrasound layer to give the most visible image and the most favorable puncture so that the landmark can be determined to be in the dilated renal pelvis or directly into the gravel. Therefore, the puncture position will not be fixed. The ultrasound assessment is related to the kidneys with stones and other internal organs, showing the thickness and texture of the abdominal wall soft tissue that the needle pokes through to avoid organ damage. Ultrasound can reveal gas-filled images of the colon sometimes lying behind the kidneys, especially in patients undergoing surgery. However, ultrasound positioning should clearly show the path and the puncture needle to stop in the renal pelvis or when touching stones to avoid the risk of the needle penetrates the neck or the adjacent renal parenchyma causingbleeding.

Observing the needle tip will definitely determine the depth and direction of the hot tool, safe operation, high success rate, different from under-X-ray probe, which takes a lot of time, uses contrast dye and at risk of radiation. Under the ultrasound guidance, the location of the gravel branches in the renal pelvis group was measured in front or back plane so that the needle could be oriented and the tunnel into the optimal kidney channel from which the lens can be removed. The calyx of kidney do not damage the neck. Ultrasound during and after surgery clear stones, detect complications during surgery, significantly reducing operative time. Using a color ultrasound can prevent damage to blood vessels when puncturing through theparenchyma.

Other advantages of ultrasound guidance over fluoroscopic guidance include radiation avoidance, and shorter operative time. Ultrasound can be used both intra-operatively and post-operatively to verify stone clearance, which significantly reduces operative times.

The position of the patient performing PCNL

Fernstrom and Johansson first performed in 1976 with the patient lying on prone. This position is considered to have an effect on resuscitation anesthesia, especially in patients with cardiovascular and respiratory diseases, or obesity. Recent studies have conducted in an inclined position for patients to reduce the risk of respiratory and circulation. We have chosen the inclined position, the inclination based on many different factors. The inclined posture reduces the risk of respiratory, circulatory and well monitoring of patients during surgery, so it is possible to detect complications of visceral injury or drainage into the abdomen and retroperitoneal

(Osman et al. 2005; Cheng et al. 2010). The puncture site creates a tunnel that usually enters the free side or slopes backward so that the renal parenchyma is thicker but minimizes the risk ofbleeding (Ichaoui et al. 2019).

Choosing the location of renal calyxes to make a tunnel into the kidney

The most important step is the decision to success and the complication of intervention. Selecting the way to the renal pelvis or directly into the stone based on pre-imaging and ultrasound imaging during surgery. The evaluation of the type of kidney stone on CT scan and ultrasound scan is very necessary for determining the most appropriate entrance before puncture (Basiri et al. 2016;Gunawan et al. 2019).

Staghorn stones are mostly treated by percutaneous nephrolithotomy (PCNL), either with an upper-pole (UP) or non-upper (lower- or middle-) pole (NP) approach(Knoll, 2019). NP access has a lower risk of bleeding and thoracic complications but may not be sufficient for complete stone clearance. UP access is advocated as the preferred approach, because of direct access to the collecting system. However, it is associated with a higher complications rate, including pneumothorax and hydrothorax, and a higher risk of bleeding (Rizvi et al. 2017; Jones et al. 2018).

Puncturing into the renal pelvis accounts for the majority of 71.7% and poking directly into the stones is 38.3% (indicated for complex stone or stones in separate renal calyx do not dilate).

In fact, the pelvis and its dependent middle calyx offer the largest area for renal puncture, and from this site of Amplatz placement access to the other calices might be more favourable and easier. Similarly, access to the ureter to assess its patency and to place the Double J stent was also easier (Van Can et al. 2019).

The location of puncture and tunneling into the lower calyxes in 75 patients accounting for 25% is done when the access road to the lower stones is directly needed.

The lowest rate of puncture on the upper calyxes was 20 patients (6.7%) selected for pyelo stone plus the upper stone. This position is more difficult, entangled ribs, associated pleura, difficult manipulation when lithotripsy and observing other renal calyxes (Reddy and Shaik, 2016).

Percutaneous renal lithotripsy technique

Poking out urine is the most sure sign of having entered the renal pelvis. For patients with an old incision in the lumbar flank, favorable probe placement in the recumbent position because the kidneys are relatively fixed due to old surgical adhesive. Our study met 45 patients with recurrent gravel disease, including 40 patients with old lumbar surgery, 5 patients with retroperitoneal laparoscopy. Evaluation of surgery showed that the organization around the kidney and parenchyma of the kidneys was more stiffer, when puncturing and dilating the tunnel into the renal pelvis is moredifficult.

The rate of stone cleanup is not only related to the size of the main stone, but also greatly dependent on the number of small stones attached. We only calculate the size of the main stone, so for SSH with many separate small stones in the stations, the removal of the gravel after the canopy will take longer and be more thorough. The advantage of Amplatz 18Fr plastic is that it is thin and soft, so it can be inserted deep and spleen through the kidney stations, sometimes even angled Amplatz corner to have access to gravel in small stations and removed by using water pump or gravel pliers directly. However, for small, narrow stands, the movement to take Amplatz through the neck should be careful not to hurt the neck causing bleeding and this is also difficult to remove thestones.

Difficulty encountered when the gravel is located in the adjacent station, parallel to the access road position. The gravestone-antiquated citadel is then opposite to the direction of the Amplatz so it is difficult to access the gravel so that it can be easily spread and left in separatestations.

The time taken to probe, create a tunnel and place the Amplatz on the pyelonephritis depends on many factors such as: Experience of the surgeon, the size of the stone is the target for direct puncture and the degree of dilatation of the kidney. If the stone is located in the renal pelvis, then the exploration and spread of the stone will likely be difficult. If the stone is located in the kidney, it is best to poke the stone directly, and then the Amplatz will come into direct contact with the gravel, so when the stones are small, the gravel will be sucked out and avoid the introduction of Amplatz through the neck. at risk of tearing the neck causing bleeding. The more the kidneys relax, the easier it will be to prick and place the Amplatz. Grade II hydronephrosis to see 25% will be most convenient when probing, placing Amplatz and lithotripsy. The first degree of hydronephrosis is 46.7%, and 21.7% is not hydrated. If the stones are large and the renal pelvis is not dilated, the thick kidney parenchyma will have difficulty in tunneling. Easy poke and tunnel into the kidney does not mean lithotripsy is also favorable. Dilated to the third level of water retention of 9.3% will cause difficulty lithotripsy due to moving stones, prolonging surgery time, high risk of missing stones, longer time for renaldrainage.

Recent studies (Bum Soo Kim, 2015) have shown that shrinking tunnel and renal tubular dimensions is the gold standard to increase the efficiency of lithotripsy and reduce complications of standard PCNL. The first mini-PCNL and micro-PCNL are used for children and are also highly effective and safe for use in adults mainly with the 18Fr tunnel. In order tominimize tunnel size and further reduce complications, Desai and Solanki (2011) described the MicroPerc technique with the concept "All seeing needle" as a 1-step "Single step PCNL" method using a scope. 0.9mm Fr small through the tunnel 4.85 Fr, laser fragments of gravel are taken through a vacuum and not using a gravel removal device. In 2013, Desai described the Ultra mini PCNL (UMP) technique using a 6 Fr tube through the 11 – 13Fr tunnel with a high rate of 88.9% gravel removal and fewer complications. However, both methods specify lithotripsy of less than 2cm in the subcellular kidney(Desai and Solanki, 2011).

The rate of clean gravel removal after ablation was reported to be from 62% to 94.3%, a large difference between the authors due to heterogeneity in gravel selection criteria for the implementation of energy efficiency as well as methods and energy sources. gravel canopy. The rate of stone removal depends on many factors such as the size of the stone, the number of stones, the degree of complexity, the location of the stones, the pathological characteristics of the kidneys and especially the surgical skills and the method used. Our NC has a gravel ratio of 11.3% related to SSH S4 – S5 complex has many stones in separate kidney stations so it is very difficult to access them all (Xiao et al. 2017).

But does the standard patient benefit from miniaturized PCNL? This answer cannot be given yet, and no guideline gives advice on this. But what can be observed in daily practice is an increasing frequency of PCNLs in medium-sized stones instead of ureteroscopy or extracorporeal shock wave lithotripsy, justified by miniaturization. Caution is advisable considering the very weak available data supporting this concept. It is worldwide accepted, that retrograde ureteroscopy, that competes with mini-PCNL, comes with significantly lower complication risk than percutaneous surgery.Maxi complications may occur even with micro access. Size might matter, but what matters more are the right indication and a skilledsurgeon (Mehmet and Ender, 2015; Fahmy et al. 2017).

Disadvantages of Mi-PCNL

Use of Mi-PCNL equipment leads to longer operative times to achieve fragments of a size small enough to fit through the smaller instrument channel. Furthermore, m-PCNL does not allow for stone extraction but relies on passive clearance of fragments similar to SWL. In this respect, stone analysis can be difficult (unless sieved by the patient during urination). This inability to retrieve fragments leads to a higher rate of steinstrasse, therefore necessitating urgent drainage of the collecting system via JJ stenting.

To improve the safety of PCNL, there has been a trend towards using progressively smaller nephrostomy tracts. The modified techniques of PCNL, such as miniperc, microperc, and ultraminiperc, have been introduced for clinical use with the aim to reduce the likelihood of major complications, such as bleeding and renal injury that could enable accomplishing these procedures in an outpatient setting. There is an increasing trend towards outpatient PCNL, which represents a safe and feasible surgical option for carefully selected patients. Our present results are comparable to the growing body of evidence suggesting that the outpatient PCNL procedure can be safely done with excellent outcomes, and could potentially become the standard of care for manypatients

The changes in PCNL techniques included not only decrease of the working instruments diameter but also improvement of patient positioning, safer and more accurate tract creation techniques, new imaging modalities, evolvement of intracorporeal lithotripters and incorporation of flexible instruments for efficient collecting system screening (Sabler et al. 2018).

CONCLUSION

Percutaneous lithotripsy small tunnel 18Fr under ultrasound guidance and energy source Holmium Laser 30 – 100w lithotripsy is a safe treatment for kidney stones and has a high early 82.4% cleanliness efficiency and complication rate. After surgery, 16.7% is consistent with the characteristics of stone disease in Vietnam. This method has replaced open PT in the treatment of large and complex kidney stones.

This is a new option for the treatment of kidney stones and it is possible to do it routinely in the country with the existing equipment conditions.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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