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Case Report

A hybrid approach in surgical treatment of kidney stone disease

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Summary

Nephrolithiasis is a disease that occurs with the formation of stones in the urinary tract. The occurrence of such stones depends on geographical, climatic, ethnic, dietary, and genetic factors. Most often, they are seen in countries with warm and dry climates. The Balkans are an endemic area, and 2% of the population is estimated to have the condition annually. The frequency is the same in both sexes. It is relatively rarer in childhood. This study aimed to show the modern possibilities for surgical treatment of kidney stone disease and combinations of different surgical approaches to achieve mini-invasiveness, short-term hospital stay, and reduction of postoperative complications. We present a clinical case of a patient with kidney stone disease with multiple lithiasis with multiple localization found in the left kidney. A combined (hybrid) operative approach was used – combining the laparoscopic technique and flexible renoscopy. We combined the possibilities of the two operative procedures and achieved a one-act cure for the patient. The method was minimally invasive. The hospital stay was shorter, and no postoperative complications occurred.

Key words: Hybrid approach, kidney stones, laparoscopy, surgical treatment

Introduction

Nephrolithiasis is a disease that occurs with the formation of stones in the urinary tract. The appearance of stones depends on geographical, climatic, ethnic, dietary, and genetic factors. It occurs most often in countries with a warm and dry climate. The Balkan countries are an endemic area, and it is thought that 2% of the population have the disease annually. The condition is rarer in childhood. There is data on nephrolithiasis from ancient times found in the works of Hippocrates, Galen, Celsius, and Avicenna. Kidney stones were found in Egyptian mummies dating back 7,000 years.

Kidney stones can be classified according to size, location, X-ray characteristics, etiology of formation, composition, and risk group for recurrent formation.

1.1. The size of the stone is usually given in millimeters, two-dimensional. Stones can be divided into groups: up to 5 mm, 5–10 mm, 10–20 mm, and over 20 mm.
1.2. The stone can be classified according to its anatomical position in the urinary drainage system as located on diagnosis: in the upper calyces,

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middle calyces, lower calyces, renal pelvis, upper ureter, middle or distal ureter, and the bladder.

1.3. The stone can be classified according to its appearance on X-ray, which varies according to its mineral composition:
   1.3.1. X-ray positive: calcium oxalate monohydrate, calcium oxalate dihydrate, calcium phosphate.
   1.3.2. X-ray negative: uric acid, ammonium urate, xanthine, 2,8 dihydroxyadenine.
   1.3.3. Weakly positive: magnesium ammonium phosphate, apatite, cystine.

If we use CT for kidney stones, the stone can be graded layer by layer in Hunsfield units (HU), which provide information on the density and composition of stones.

1.4. Chemical composition. The composition of the stones is the basis for further diagnostic and management decisions. Stones are often formed from a mixture of substances (Table 1).

1.5. Risk factors are multi-component and can be divided into several groups: main factors related to stone formation, anatomical anomalies related to stone formation, genetically determined stone formation, drug-induced, diseases related to stone formation, and factors related to the environment (Table 2).

Table 1. Stone composition.

Chemical name	Mineral name	Chemical formula
Calcium oxalate monohydrate	Whewellite	CaC2O4.H2O
Calcium oxalate dehydrate	Weddelite	CaC2O4.2H2O
Basic calcium phosphate	Apatite	Ca10(PO4)6.(OH)2
Calcium hydroxyl phosphate	Carbonate apatite	Ca5(PO4)3(OH)
b-tricalcium phosphate	Whitlockite	Ca3(PO4)2
Carbonate apatit	Dahllite	Ca5(PO4)3OH
Calcium hydrogen phosphate	Brushite	CaHPO4.2H2O
Calcium carbonate	Aragonite	CaCO3
Octacalcium phosphate	-	Ca8H2(PO4)6.5H2O
Uric acid	Uricite	C5H4N4O3
Uric acid dihydrate	Uricite	C5H4O3.2H20
Ammonium urate	-	NH4C5H3N4O3
Sodium acid urate monohydrate	-	NaC5H3N4O3.H2O
Magnesium ammonium phosphate	Struvite	MgNH4PO4.6H2O
Magnesium acid phosphate trihydrate	Newberyite	-
Magnesium ammonium phosphate monohydrate	Dittmarite	-
Cystine	-	-
Xantine	-	-
2,8 Dihydroxyadenine	-	-
Proteins	-	-
Cholesterol	-	-
Calcite	-	-
Potassium urate	-	-
Trimagnesium phosphate	-	-
Matrix	-	-
Drug stones	Active compounds crystallising in urine	-

Table 2. High-risk stone formers (Part from EAU guidelines).

General factors
Early onset of urolithiasis (especially children and teenager
Familial stone formation
Recurrent stone formers
Short time since last stone episode
Infection stones
Chronic Kidney Disease (CKD)
Diseases associated with stone formation
Hyperparathyroidism
Metabolic syndrome
Mineral Bone Disorder (MBD)
Polycystic kidney disease (PKD)
Genetically determined stone formatio
Cystinuria (type A, B and AB)
Xanthinuria
Primary hyperoxaluria (PH)
Anatomical abnormalities associated with stone formatio
Ureteropelvic junction (UPJ) obstructio
Ureteral stricture
Vesico-uretero-renal reflux
Horseshoe kidney
Ureterocele
Drug-induced stone formation
Environmental and professional factor

Case presentation

We present a clinical case of a middle-aged patient with a BMI of 31.2, admitted to the Urology Clinic complaining of pain in the left lumbar region. The patient was diagnosed with two stones in the left kidney pelvis (a well-defined extrarenal pelvis) and three single stones in the upper, middle, and lower calyx groups. The stones in the renal pelvis were about 25 mm in size, and those located in the calyces - were about 5–6 mm (Fig. 1).

The patient had no accompanying diseases. The modern surgical treatment of kidney stone disease follows the trends for treating most conditions: aspiration for mini-invasiveness, reduced hospital stay and possible complications, and cost-effectiveness. Thus, the widely used operative interventions for the treatment of kidney stone disease, such as nephrolithotomy, pyelolithotomy, ureterolithotomy, and cystolithotomy, have given way to endoscopic lithotripsy with all its varieties PSNL, RIRS, cystolithotripsy. Currently, many urologists recommend laparoscopic pyelolithotomy for solitary stones over 2 cm in size and an extrarenal renal pelvis (Pearle et al. 2005). Extracorporeal lithotripsy should be included in modern lithotripsy methods despite the decline in using it these days.

The choice to use a particular operative approach depends on several factors, and first of all, the size and location of the stone in the kidney. Also critical are the capabilities of the operating team, the patient's desire, and the available equipment. For this reason, our choice is different in each specific case.

Figure 1. CT reconstruction-stones in left kidney.

Naturally, we should also keep in mind the recommendations of the EAU when choosing an appropriate operative approach. According to these recommendations, the choice of an operative technique depends on the size of the stones and their anatomical location (Figs 2, 3) (Skolarikos et al. 2023).

Extracorporeal lithotripsy, PNL, and RIRS are treatment methods for kidney stones. While the efficacy of PNL is almost unaffected by stone size, SFRs after SWL or URS are inversely proportional to the stone size. Although multiple treatments or sessions may be required, SWL achieves good SFRs for stones up to 20 mm, except those in the lower pole (Xiao et al. 2018).

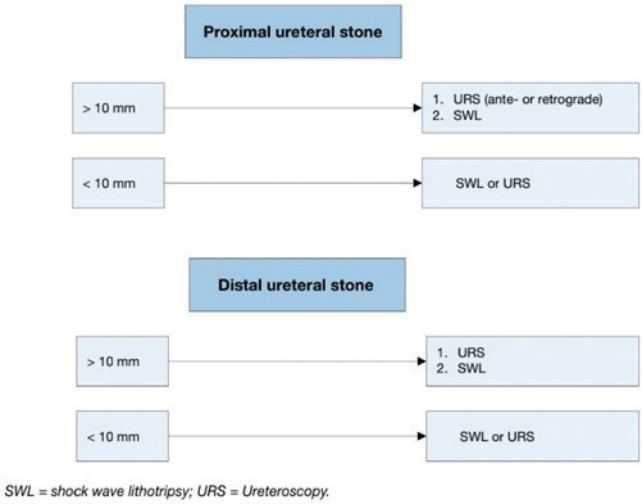

Figure 2. Recommendations of the EAU.

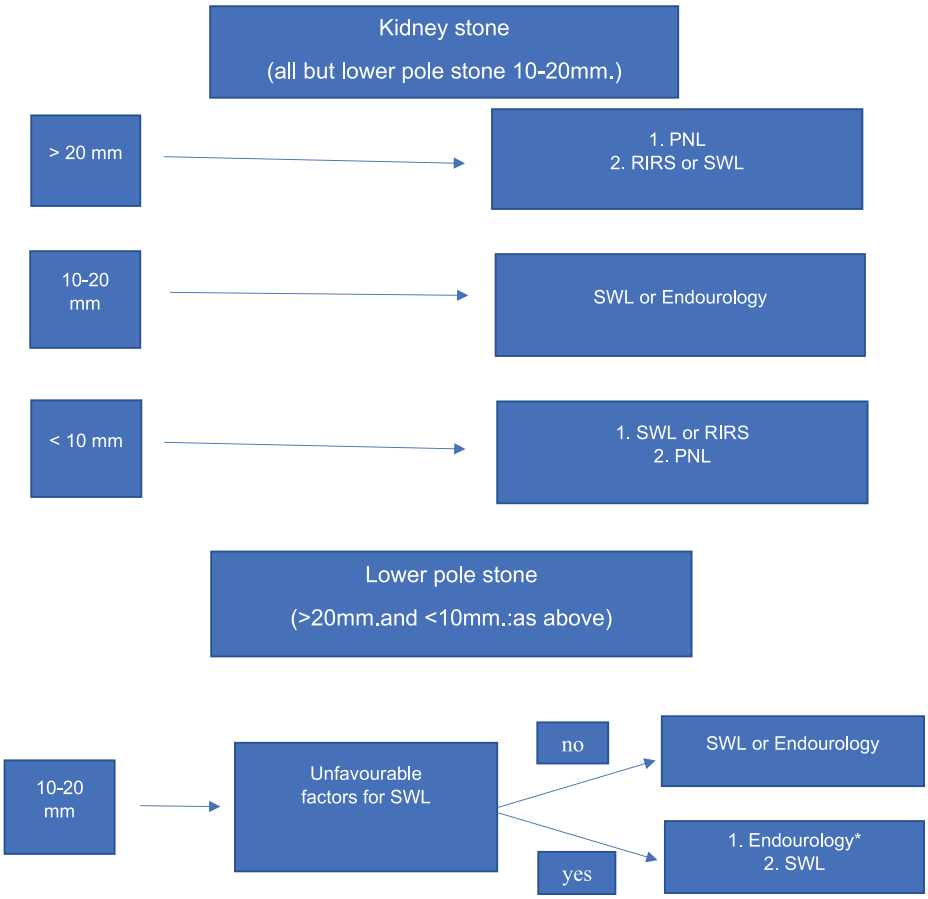

Figure 3. Treatment algorithm for ureteral stone-EAU guidline. *The term 'Endourology' encompasses all PNL and URS interventions. PNL = percutaneous nephrolithotomy; RIRS = retrograde intrarenal surgery; SWL = shock wave lithotripsy; URS = ureteroscopy.

Endourology is considered an alternative because of the reduced need for repeat procedures and a shorter time to stone-free status. For stones larger than 10 mm, mini-PNL (mPNL) achieves a higher SFR than RIRS or ESWL but carries a higher risk of bleeding and is associated with a more extended hospital stay. There is a high degree of heterogeneity among the included studies. Stones

> 20 mm should be treated primarily with PNL, as SWL often requires multiple treatments and is associated with an increased risk of ureteral obstruction (colic or steinstrasse) with the need for additional procedures. Retrograde renal surgery cannot be recommended as first-line treatment for stones > 20 mm in uncomplicated cases, as SFRs decrease and staged procedures will be required (Skolarikos et al. 2023).

Considering the appropriate operative approach in this case and the desire for mini-invasiveness, short hospital stay, and one-act surgical intervention, we decided to use a combined (hybrid) treatment approach. We performed a laparoscopic pyelolithotomy. We used a retroperitoneal method - the access we prefer when performing laparoscopic pyelolithotomy and plastics of the pyeloureteral segment.

In this operative approach, the correct positioning of the patient on the operating table is crucial, as well as creating a space for placing the laparoscopic trocars. The patient is positioned in the lateral (lumbar) position. The first incision is at the top of the 12th rib or 1 cm dorsally. Here, we can later place the port for the camera. After reaching the retroperitoneal space, we use a self-made glove dilator to create the necessary space for placing the remaining two ports. We place one 12 mm and one 5 mm port (Stolzenburg et al. 2011). A retroperitoneal approach has certain advantages over the traditional transperitoneal approach, which includes quick access to the renal artery and vein. This approach is particularly useful in obese patients and those who have undergone previous abdominal surgery. Also, in this way, we protect the abdominal cavity from possible complications in case of likely urine leakage in the early postoperative period. The disadvantage of access is the small working space and the more difficult orientation. For these reasons, it is more suitable for a team of surgeons more experienced in laparoscopy.

During the preparation and reaching of the left kidney pyelon, we extracted the two stones located there. Because we noticed stenosis of the pyeloureteral segment (Fig. 4), U-V plastic surgery was also performed to remove the stones after we completed the surgical intervention.

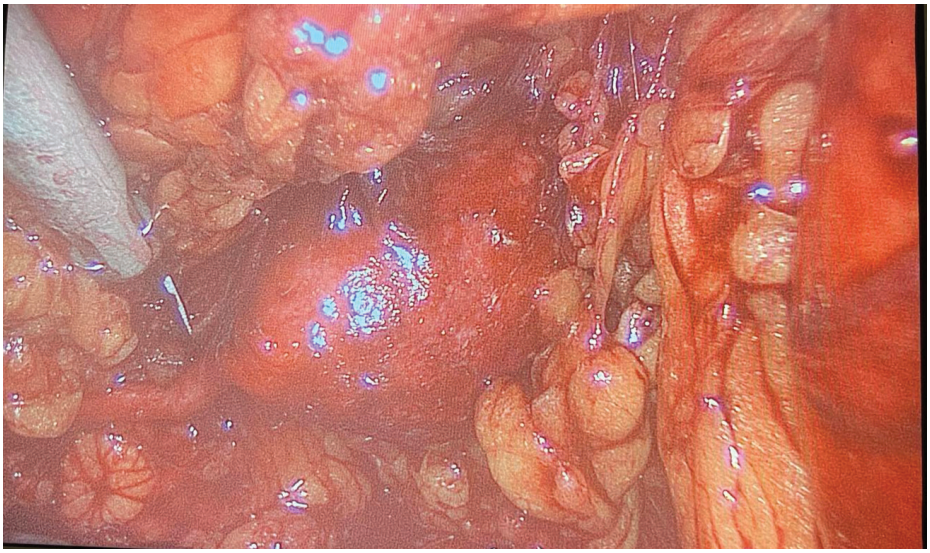

Figure 4. Laparoscopic view of left PUJ.

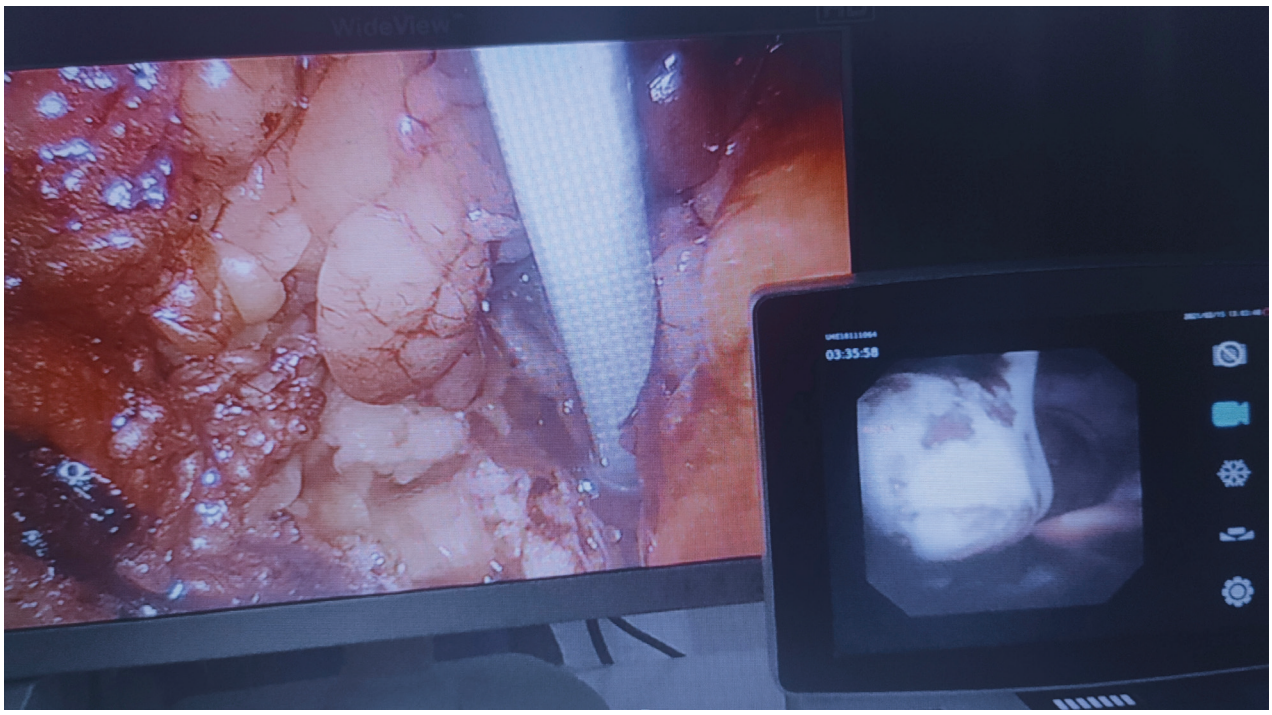

Figure 5. Hybrid extraction of stones.

After the extraction of the stones in the pyelon of the kidney, we proceeded with the extraction of the three stones in the calyces of the kidney. For this purpose, we inserted a metal guidewire through one of the working ports and positioned it in the pyelon of the kidney. We placed a flexible renoscope along the guidewire (Fig. 5), which helped to reach the pyelocalyx system. Under visual and X-ray control, we gradually reached the upper, middle, and lower calyx groups, and the stones were extracted with a basket. We placed a double J stent at the end of the operative intervention.

Pyelon suture (Y-V plastic). We inserted a contact drain. The operative intervention was about 150 minutes. The blood loss was 80 ml. The early postoperative period was without complications and urine leakage. The patient was administered standard antibiotic therapy. There was a need for postoperative anesthesia on the first postoperative day. The patient was discharged from the hospital on the 5th postoperative day. A month later, the patient was admitted for extraction of the endoprosthesis. No residual stones were found.

Discussion

The treatment of kidney stone disease follows the current trends in surgical treatment, aiming at mini-invasiveness, shorter hospital stays, and minimizing the risks of complications. For this reason, the transition from open-surgical treatment to endoscopic surgery is also gradual. Using RIRS, PCNL has repeatedly shortened patient trauma, hospital stay, and recovery. Laparoscopic pyelolithotomy is not a standard procedure. It is also considered a minimally invasive surgical treatment but is more traumatic than PSNL. However, it is a good alternative for a large single stone and an extrarenal pyelon in the case of anomalies like obstruction of the PUJ and an ectopic kidney. Many studies have found that 88.9–100% of patients are freed of residual stones when using LP for a single stone (Pastore et al. 2016).

When using the method, we achieve a complete elimination of the stones. However, it should be taken into account that in such cases, the operating time is longer. In our case, it was 150 minutes, and there was a need for a qualified team in laparoscopy.

When performing the operative intervention, choosing the access for laparoscopic pyelolithotomy - transperitoneal or retroperitoneal is also essential. The two approaches are often compared in the surgical treatment of kidney diseases, with contradictory results. In some studies, the authors did not report a significant difference in using the two approaches (Khalil et al. 2015). According to other studies, the two approaches have comparable results despite the longer operative time and many conversions to open surgery (Abuanz et al. 2010). In our opinion, the retroperitoneal approach is more appropriate in properly selected clinical cases.

Furthermore, this approach applies to an experienced laparoscopic team because of the difficulties associated with orientation and working in a more limited working space. This approach can give us additional security: it avoids intra-abdominal access and possible iatrogenic damage to abdominal organs. It also helps prevent the possibility of postoperative urine leakage in the abdominal cavity. When the team has enough experience, a shorter operative time and hospital stay can be expected (Al-Hunayan et al. 2009).

Conclusion

We report a clinical case in which a modern, combined method was applied for treating kidney stone disease. The goals set in surgical treatment were achieved: mini-invasiveness, shortened hospital stay, and minimal risks for complications. Our case illustrates the transition from open-surgical treatment to endoscopic. Using RIRS, PCNL repeatedly reduces patient trauma, hospital stay, and recovery, though laparoscopic pyelolithotomy is not a standard procedure. It is also considered a minimally invasive surgical treatment but is more traumatic than PSNL. However, it is a good alternative for large solitary stones and an extrarenal renal pelvis in anomalies such as PUJ obstruction and an ectopic kidney. Many studies have reported 88.9–100% of patients freed of residual calculi when using LP for single stones, thus confirming the main trends in modern surgical treatment.

Acknowledgements

The study was conducted following principles for human experimentation as defined in the Declaration of Helsinki, local Good Clinical Practice guidelines, and local institution guidelines. The study was approved by the Medical Ethics Commission, Medical University – Varna (Decision No14/11.11.2022).

References

Abuanz S, Gamé X, Roche J-B, Guillotreau J, Mouzin M, Sallusto F, Chaabane W, Malavaud B, Rischmann P (2010) Laparoscopic pyeloplasty: Comparison between retroperitoneoscopic and transperitoneal approach. Urology 76: 877–881. https://doi.org/10.1016/j.urology.2009.11.062

Al-Hunayan A, Abdulhalim H, El-Bakry E, Hassabo M, Kehinde EO (2009) Laparoscopic pyelolithotomy: Is the retroperitoneal route a better approach? International Journal of Urology 16: 181–186. https://doi.org/10.1111/j.1442-2042.2008.02210.x

Khalil M, Omar R, Abdel-Baky S, Mohey A, Sebaey A (2015) Laparoscopic ureterolithotomy; which is better: Transperitoneal or retroperitoneal approach? Turkish Journal of Urology 41: 185–190. https://doi.org/10.5152/tud.2015.03442

Pastore AL, Palleschi G, Silvestri L, Leto A, Ripoli A, Fuschi A, Al Salhi Y, Autieri D, Petrozza V, Carbone A (2016) Combined laparoscopic pyelolithotomy and endoscopic pyelolithotripsy for staghorn calculi: long-term follow-up results from a case series. Therapeutic Advances in Urology 8: 3–8. https://doi.org/10.1177/1756287215607417

Pearle MS, Lingeman JE, Leveillee R, Kuo R, Preminger GM, Nadler RB, Macaluso J, Monga M, Kumar U, Dushinski J, Albala DM, Wolf JS, Assimos D, Fabrizio M, Munch LC, Nakada SY, Auge B, Honey J, Ogan K, Pattaras J, McDougall EM, Averch TD, Turk T, Pietrow P, Watkins S (2005) Prospective, randomized trial comparing shock wave lithotripsy and ureteroscopy for lower pole caliceal calculi 1 cm or less. Journal of Urology 173: 2005–2009. https://doi.org/10.1097/01.ju.0000158458.51706.56

Skolarikos A, Jung H, Neisius A, Petřík A, Somani B, Tailly T (2023) EAU guidelines on urolithiasis EAU-Pocket-on-Urolithiasis-2023 pdf (d56bochluxqnz.cloudfront.net).

Stolzenburg JU, Türk IA, Liatsikos EN (2011) Laparoscopic and Robot-Assisted Surgery in Urology. Springer Berlin, Heidelberg, XV, 386 pp. https://doi.org/10.1007/978-3-642-00891-7

Xiao Y, Li Q, Huang C, Wang P, Zhang J, Fu W (2018) Perioperative and long-term results of retroperitoneal laparoscopic pyelolithotomy versus percutaneous nephrolithotomy for staghorn calculi: a single-center randomized controlled trial. World Journal of Urology 37: 1441–1447. https://doi.org/10.1007/s00345-018-2526-x