Difficulties in Laparoscopic Surgery for Urinary Stones

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Introduction

For centuries, stone disease has been a common health problem – in fact, one of the first surgeries performed on humans was for stones – and traditional open surgery was utilized to manage the problems it caused [1]. Stone disease is still common today, but the pattern of practice in stone management has undergone a revolution in the last few decades. Nowadays, open surgery for stone disease is considered obsolete and has been almost totally abandoned [2]. The biggest blow to open stone surgery (OSS) occurred when extracorporeal shock wave lithotripsy (SWL) was applied successfully by Chaussy in Berlin [3]. Percutaneous nephrolithotomy (PCNL) and ureteroscopic lithotripsy (URL) were also great steps forward, and these procedures have major roles in managing large renal and ureteral stone disease in most parts of the world today. Pneumolithotripsy and laser lithotripsy technologies were another important achievement in dealing with stone disease during PCNL and URL. It is used commonly in many countries due to its efficacy, and especially because of its cost effectiveness. The introduction of flexible instruments also has facilitated navigation through the collecting system. Disposable flexible endoscopes seem to be promising alternative to the costly fiberoptic ones, and solve problems related to their cost and maintenance. All of the above measures, which are today referred to as "endourology," have resulted in putting the knife aside in almost all cases of stone disease.

The original version of this chapter was revised. An erratum to this chapter can be found at https://doi.org/10.1007/978-3-319-52581-5_36

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A. Al-Kandari et al. (eds.), *Difficult Conditions in Laparoscopic Urologic Surgery*,
https://doi.org/10.1007/978-3-319-52581-5_26

In the era of minimally invasive endoscopic procedures and SWL, laparoscopy has a limited role in the urologist's armamentarium for surgical stone management [4]. However, in cases of large stones, single or combined endourologic procedures may not be more cost effective than a single, one-session approach for complete stone removal [5]. Therefore, OSS, including open ureterolithotomy, pyelolithotomy, and nephrolithotomy, still has a role in many centers. Laparoscopic stone removal is a valuable option in these situations, and offers a less morbid modality for removing large stones in the urinary tract. This chapter focuses on the potential difficulties and complications that may occur during laparoscopic stone surgery. Various approaches to deal with these difficulties will be discussed.

Laparoscopic Ureterolithotomy (LU): Difficulties and Their Management

Laparoscopic ureterolithotomy (LU) is an alternative option for removal of impacted ureteric stones larger than 15 mm, [6, 7] or may be used as a salvage procedure in failures of SWL and/or ureteroscopic lithotripsy [8]. This technique usually results in complete stone removal through a single minimally invasive surgery with a reasonable operative time and short hospital stay [9]. Thus, the indications for laparoscopic ureterolithotomy in the era of modern endourology include stones that cannot be accessed ureteroscopically or cannot be fragmented (Fig. 26.1).

LU can be accomplished through a transperitoneal (TP) or retroperitoneal (RP) route. Although the preferred approach is mainly defined by a surgeons preference and experience, the authors prefer a TP approach, especially for the beginner or average laparoscopic surgeons. In comparison to the RP route, the TP approach provides a larger working space with familiar anatomic landmarks. Moreover, difficulties and complications may be handled better in a TP approach [10] In the absence of dense retroperitoneal fibrosis, laparoscopic ureterolithotomy is almost an easy procedure, especially for beginners. However, laparoscopic ureterolithotomy for distal ureteral stones, especially those lodged behind the bladder and very close to ureterovesical junction, is more difficult and requires more expertise.

Stone Migration During LU

The ideal case for LU is a large, impacted ureteral stone. However, as in open ureterolithotomy, there is always a potential risk of upward stone migration during the procedure. To decrease the chance of stone migration to the kidney, ureteric dissection should be accomplished as gently as possible in a proximal to distal direction. Once the dilated ureter above the site of the impacted stone is identified, placement of a laparoscopic Babcock prevents stone migration during further ureter dissection. Placing the patient in a head up position, keeping the patient well hydrated, and intravenous infusion of 0.5mg/kg furosemide may also help prevent stone migration.

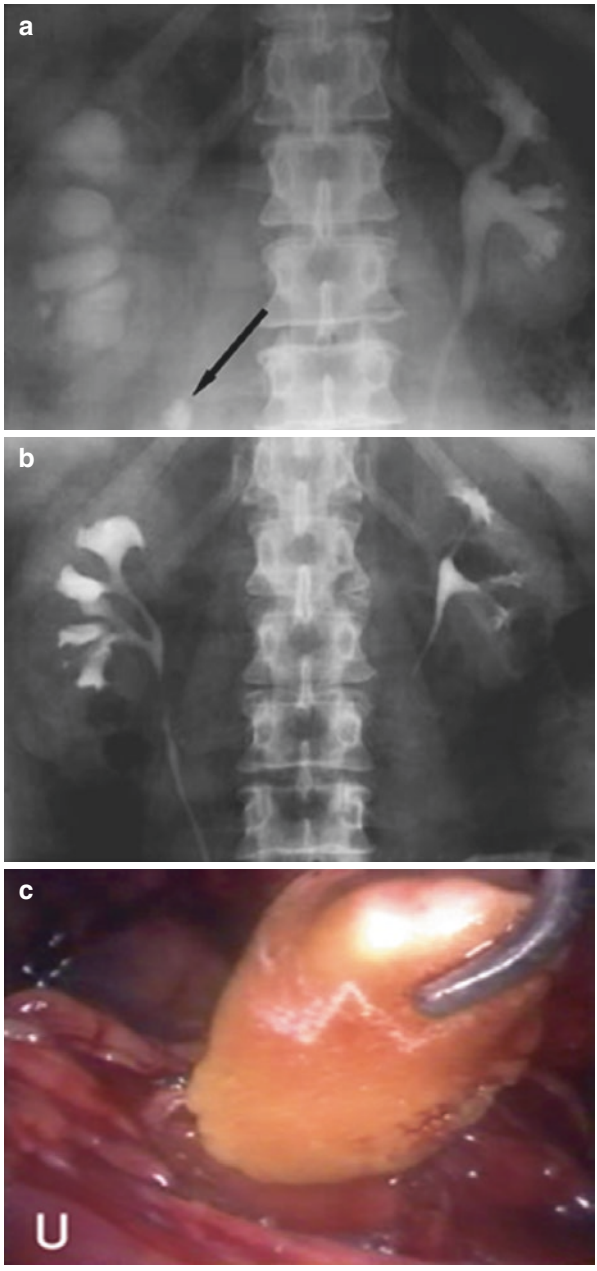


Fig. 26.1 Preoperative (**a**) and postoperative (**b**) intravenous urography (IVU) following laparoscopic ureterolithotomy (**c**). Significant relief of obstruction is noted. (*Arrow* on **a** indicates the proximal ureteral stone, *U* ureter)

In cases of stone migration, the surgeon should open the ureter at the site of stone impaction. By passing a rigid or flexible ureteroscope through the lower abdominal 5-mm laparoscopic port, ureteroscopy can be easily performed up to the renal

calices. Then, the migrated stone can be pushed back to the site of the ureteric incision by basketing or "milking" the ureter with the laparoscopic Babcock.

Difficulties in Stone Localization During LU

Sometimes, after the dissection of the ureter, it is difficult to localize the site of the stone. This may occur especially in obese patients and patients with dense, fibrotic adhesions around the ureter due to chronic inflammation or multiple sessions of SWL. Intermittent pressing of the dilated proximal ureter in a proximal to distal direction with the laparoscopic Babcock may help in locating the site of the impacted stone. Difficulty in localizing the stone due to severe periureteric fibrosis can be overcome by the use of fluoroscopy or intraoperative laparoscopic ultrasonography. If the stone still cannot be localized, the problem can be fixed by employing proximal and distal ureteroscopy after the ureter is opened at the site of its maximal dilation and a rigid or flexible ureteroscope is passed to the ureterotomy via the lower or upper abdominal trocars. After finding the stone, it can be removed through the ureteral incision by milking or basketing, or it can be fragmented in situ with pneumatic or laser lithotripsy.

Stone Adhering to the Mucosa

After the ureteral incision, sometimes the stone cannot be easily delivered because of its adherence to the ureteral mucosa. This is especially true in long-standing, large, impacted stones and those with multiple sessions of SWL. After proximal extension of the ureteral incision over the dilated proximal ureter, one can separate the "head" of the stone from the ureter with the aid of a laparoscopic hook. Then the rest of stone can be easily released from the ureteral mucosa using the laparoscopic Babcock. Levering the stone out of the ureter prevents its breakage and subsequent problems from small pieces. It has been recommended that direct stone grasping with the laparoscopic grasper should be avoided, especially when the stone is somewhat soft. Grasping the stone can break it with the possibility of migration [11].

Lost Stone

Sometimes, after stone extraction, the stone may be lost before it is removed from the abdomen. To avoid this possibility, it is recommended that the surgeon place an endobag or its alternate in the abdomen before incising the ureter. The stone can then be placed into the bag just after it is removed. Sometimes, the stone is already fragmented (perhaps due to the effects of previous SWL), or it may be fragmented by the force of the graspers at the time of extraction. Having the bag near the field allows the surgeon to collect the fragments and prevent loss. However, in cases where the stone is lost, the stone usually stays medial to the ureter over the reflected colon. Changing the camera port may help in locating the lost stone.

Stenting and Suturing

Classically, both ureteral stenting and suturing have been recommended. Laparoscopic antegrade ureteral stenting is feasible by placing the double J or feeding tube into the laparoscopic suction and guiding it to the ureteral incision. However, there is evidence that ureteral stenting during LU could be obviated safely. Demirci and colleagues have demonstrated the safety of leaving the sutured ureterotomy without stenting [12]. Similar findings have been demonstrated by others as well [8, 9]. Goel and Hemal recommend stenting only in cases of renal dysfunction and/or stone impaction [13].

Suturing of the ureterotomy incision is usually a simple task. Laparoscopic magnification allows clear visualization of the mucosal apposition. Sometimes suturing is not possible due to severe inflammation and fragility of the tissue. Fixing a stent in the ureter and leaving the unsutured ureteral incision with an external draining catheter can be safely implemented in these circumstances [5, 8, 9].

Ureteral Stricture

The incidence of ureteral stricture following LU has been reported between 2.5% and 20% [14, 15]. Various contributing factors may have a role in the development of ureteral stenosis. Nouira and colleagues have recommended that adhering to the principles of ureterotomy closure during open surgery (i.e., loose sutures in order to just approximate the ureteral edges) may reduce the chance of ureteral stricture following LU [14]. They also believe that using a laparoscopic cold knife is more suitable than an electrical hook. However, in the authors' opinion, the use of a cutting-mode electrical hook is much easier and more popular [5, 9]. To decrease the rate of stricture, the authors suggest that the cutting-electrical hook be applied only on the dilated ureter proximal to the stone. The extension of the hook-incision should be done with laparoscopic scissors.

Laparoscopic Pyelolithotomy (LP): Difficulties and Their Management

Compared with PCNL, the laparoscopic removal of renal pelvic stones has a limited role. Its indications also have not been clearly defined. There are a few comparative studies between PCNL and laparoscopic pyelolithotomy (LP) in the literature [16, 17]. However, in situations of failed percutaneous access due to technical reasons, a laparoscopic approach in selected cases may provide similar success rates as open surgery. In the authors' option, LP can be reserved as an alternative approach in selected cases of large renal pelvis stones, stones resistant to fragmentation, and in patients with abnormal kidney anatomy. This technique allows en bloc stone extraction in a minimally invasive milieu. The procedure is easier in patients with an extrarenal pelvis. Partial staghorn stones are also appropriate for laparoscopic pyelolithotomy.

Dissecting the Renal Pelvis

Identification and dissection of the proximal ureter is the initial step during LP. Dissection over the proximal ureter usually guides the surgeon to the renal pelvis. Aggressive dissection over the ureteropelvic junction (UPJ), especially in the presence of inflammation, may lead to UPJ avulsion. In cases of avulsion, meticulous dissection and mobilization of the renal pelvis may allow laparoscopic reanastomosis following stone removal via the pyelotomy incision.

The renal pelvis should be released and dissected completely before pyelotomy. In patients with prior retroperitoneal surgery, a transperitoneal approach is recommended (Fig. 26.2). During LP, dissection should be done over the renal pelvis to prevent inadvertent injury to the branches of the renal artery, renal vein, and aberrant vessels. Peripelvic inflammation, as well as a number of aberrant vessels, may be found while dissecting the pelvis, requiring expertise in laparoscopic dissection. Conversion to open surgery may be required due to significant perinephric adhesions and resultant difficulty in dissection.

Pyelotomy and Stone Removal

The pyelotomy incision can be made using a laparoscopic knife, or more popularly, a cutting-mode electrical hook. The incision may be longitudinal or transverse. Sometimes, especially in cases with a large, impacted stone, it is better to place two stay sutures at both ends of the pyelotomy incision to prevent incision extension during stone removal. These sutures also make pyelotomy closure easier. The pyelotomy may be well extended to the superior and inferior calyces or their infundibula. Gentle delivery of the "tail" of the stone from the UPJ, together with rotating and twisting maneuvers, help in the extraction of large stones. This invariably leads to delivering one end of the partial staghorn stone first, allowing manipulation of the other end.

One of the major limitations of the laparoscopic approach is the difficulty in retrieving the caliceal calculi.

In situations where the stone is too large for the port site, the stone can be placed in a laparoscopic sac and removed via the umbilical laparoscopic port site by extending the incision after pyelotomy closure. Alternatively, the stone can be fragmented within the endobag and removed via a lesser incision.

Stone Migration

Stone migration during LP usually occurs in the presence of a small renal pelvis stone that causes severe hydronephrosis. If the stone has migrated to the kidney, guiding a flexible or rigid ureteroscope to the pyelotomy incision via the lower abdominal laparoscopic port allows direct exploration of the calyces and stone removal under direct vision with a nitinol stone basket. Since the patient is in a lateral decubitus position, the migrated stone often falls into the upper pole calyces.

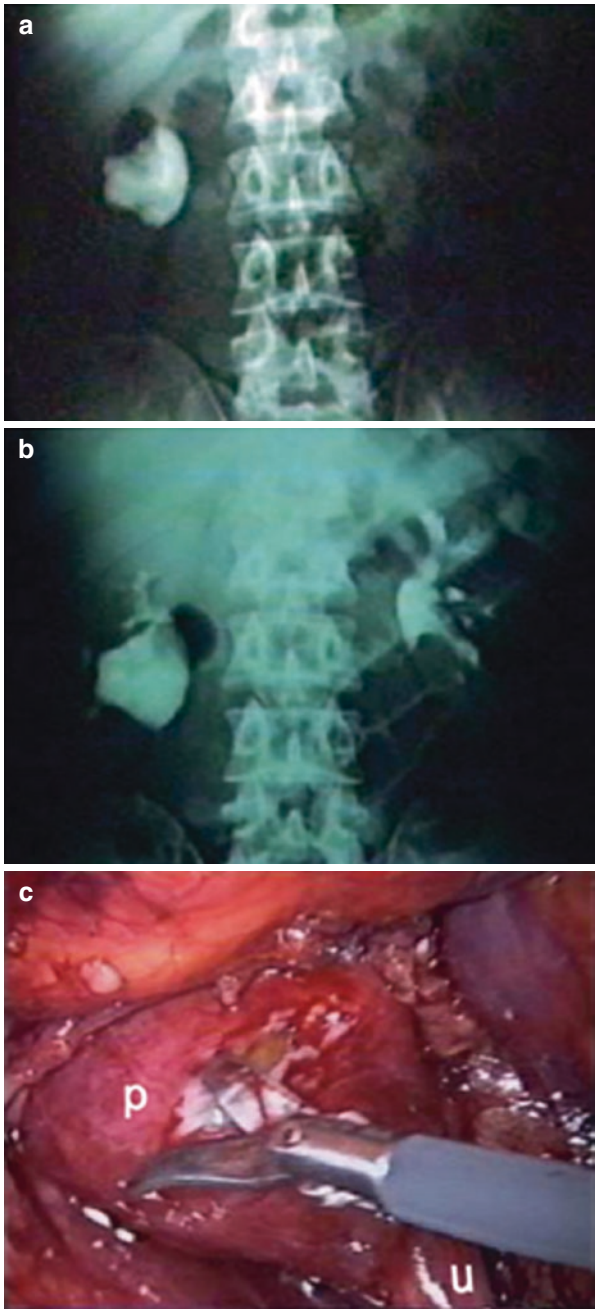
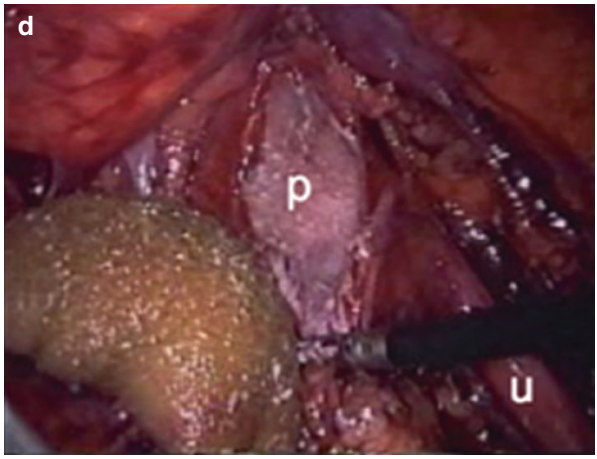


Fig. 26.2 Preoperative KUB (**a**) and IVU (**b**) of a patient with a large renal pelvis stone. Laparoscopic pelvic dissection and stone extraction have been carried out (**c**, **d**). (*U* ureter, *P* renal pelvis)

Fig. 26.2 (continued)



Micali et al. have described removal of pelvic and caliceal calculi using a flexible cystoscope through the 10-/12-mm laparoscopic port [18].

Pyelotomy Closure

Reconstructing the pyelotomy requires advanced laparoscopic skills in intracorporeal suturing. Sometimes the edges of the incised renal pelvis are inflamed and fragile, which makes suturing not possible. Antegrade placement of a ureteral stent and applying two sutures at both ends of the pyelotomy incision and tying them to each other usually fix the problem [19]. However, excessive manipulation in such situations may result in renal pelvis disruption.

Laparoscopic Nephrolithotomy

Staghorn renal stones are a challenging issue in urology. Even with the introduction of endourological methods, the management of staghorn renal stones remains difficult. Several series have considered open anatrophic nephrolithotomy for the management of staghorn renal stones, even in the era of endourology. Due to the high incidence of recurrence of staghorn stones, particularly those associated with an infective process, the complete removal of the stone is the ultimate goal in their management, a result that might not be attained even after several sessions of PCNL and/or SWL and/or retrograde intrarenal surgery [6, 20, 21].

Laparoscopic anatrophic nephrolithotomy (LAN) may be considered as an alternative to open surgery of staghorn renal stones. Currently, there are only two reports on six cases of LAN in humans in the literature [22, 23]. LAN is a complex laparoscopic procedure that requires full laparoscopic experience. Large burden, "en-bloc" (complete or partial) staghorn stones are appropriate candidates for LAN. Small burden stones, or stones with many particles in different calyces are very difficult for LAN. Renal vascular anatomy, stone size, and burden should be assessed preoperatively by computerized tomographic angiography.

After complete dissection of both renal artery and vein, Gerota's fascia is incised and the kidney fully mobilized within this fascia. Unless the renal parenchyma is atrophic, the renal artery should be clamped temporarily with a bulldog clamp. Through an incision of sufficient length on the Brodel line, the collecting system is sharply incised and the staghorn stone is mobilized intrarenally, rotated, and removed as completely as possible (Fig. 26.3).

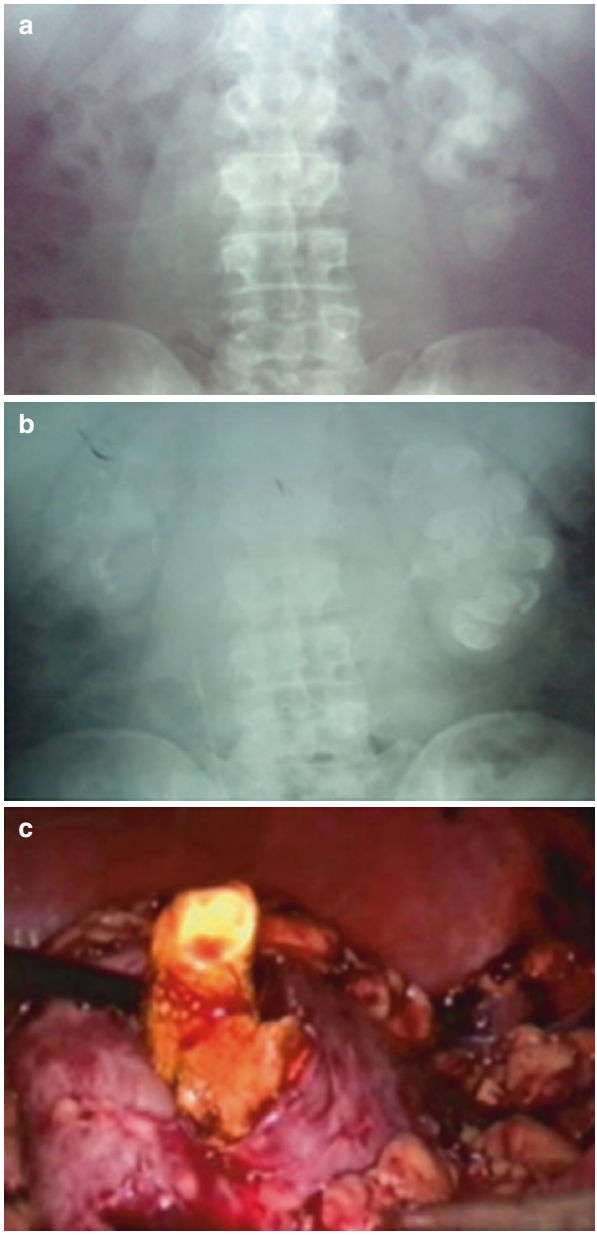


Fig. 26.3 Preoperative KUB (**a**) and IVU (**b**) of an obese patient with a large complete staghorn renal stone (**c**) extracted by laparoscopic anatrophic nephrolithotomy (**d**). Sites of trocars are shown (**e**) (From Simforoosh et al.[23] Reprinted with permission from Wiley-Blackwell)

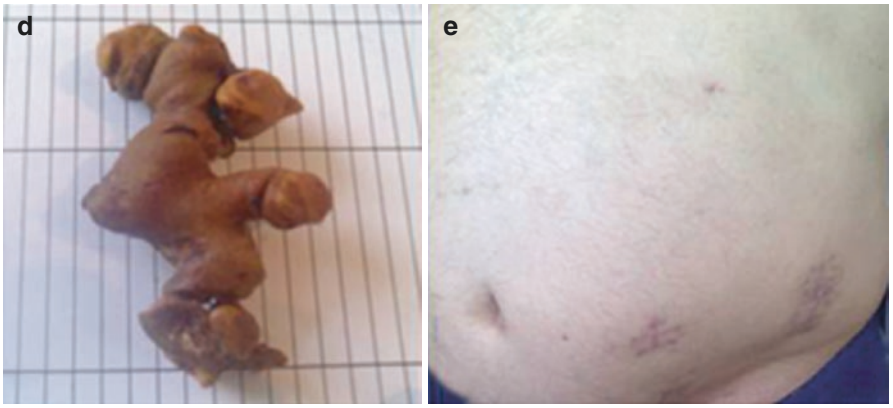


Fig. 26.3 (continued)

In order to decrease warm ischemia time, both the collecting system and renal cortex can be closed with a single row of polyglactin 2–0 running sutures. The sutures are buttressed by applying Hem-o-lok® clips (Teleflex Medical, Research Triangle Park, NC) instead of tying knots. Intraoperative laparoscopic ultrasonography may be used to identify the site of the thinnest parenchyma and to detect possible residual stones.

Laparoscopic Management of Stone Disease in Anomalous Kidneys

Relative urinary stasis imposed by anomalies in the collecting system predisposes the kidney to urolithiasis and increases the risk of stone recurrence.

Ureteropelvic Junction Obstruction (UPJO) and Stones

There is a 70-fold increased risk of renal stone formation in patients with ureteropelvic junction obstruction (UPJO) [24]. Since laparoscopy is becoming the standard of care in managing UPJO, a concomitant stone can be removed laparoscopically during a pyeloplasty procedure [25, 26]. The stone can be removed by laparoscopic instruments if it is located in the renal pelvis or at visible areas of the kidney. Furthermore, navigation within the collecting system is possible using flexible or rigid endoscopes. After localizing the hidden stone, it can be managed with basketing and/or pneumatic or laser lithotripsy under direct vision.

The authors have used a rigid ureteroscope and pneumatic lithotriptor successfully during laparoscopy for management of stones in kidneys with UPJO. In case of failure, intraoperative ultrasound can also be used to find stones in the kidney. Sometimes after stone localization with intraoperative ultrasonography,

nephrotomy over the stone is necessary for en-bloc stone extraction. This is especially true when the stone is located in inaccessible calices in the hydronephrotic system. Nephrotomy can be done without hilar clamping since the renal cortex is usually thin when it is associated with UPJO.

Horseshoe Kidney

Relative urinary stasis and abnormal anatomy of the collecting system in patients with a horseshoe kidney put them at risk of urolithiasis, with an incidence rate of 21–60%. Various single or combined endourologic procedures, such as SWL and PCNL, can provide up to 90% of stone-free rate in these patients [27–29]. Laparosopic pyelolithotomy is an alternative option in patients with a horseshoe kidney that have a large burden stone in the renal pelvis or isthmus. There are several advantages to a laparoscopic approach in removing stones from a horseshoe kidney. The whole procedure can be done under direct vision without any need of radiation exposure. There is no glomerular damage and there is a reduced chance of hemorrhage. The stone can be removed in one piece, especially if it is located in the renal pelvis (Fig. 26.4). When UPJO is associated with horseshoe kidney, pyeloplasty can be performed simultaneously. During laparoscopy, care should be taken not to injure the anomalous vascular supply to the horseshoe kidney.

Cross-Fused Kidney

The authors have successfully removed a stone from a cross-fused ectopic kidney. It was very difficult to find a bare area of pelvis for pelviotomy due to abnormal vascular anatomy, but with great care and patience, a large stone was extracted en-bloc from the kidney.

Pelvic Kidney

While laparoscopic assisted PCNL is standard of care for minimally invasive management of stones in a pelvic kidney [30], large stones, especially in the renal pelvis, can be removed by laparoscopy. Since the kidney is located in a lower anatomic position in the abdomen, transperitoneal laparoscopy is the best alternative to open surgery in these circumstances (Fig. 26.5).

The authors successfully removed a kidney stone from the renal pelvis of a pelvic kidney, but unfortunately, the stone was dropped and lost during surgery. The procedure was not converted to open surgery, and postoperative imaging revealed that the lost stone was behind the spleen. The stone did not cause any clinical problems during follow-up and was left intact.

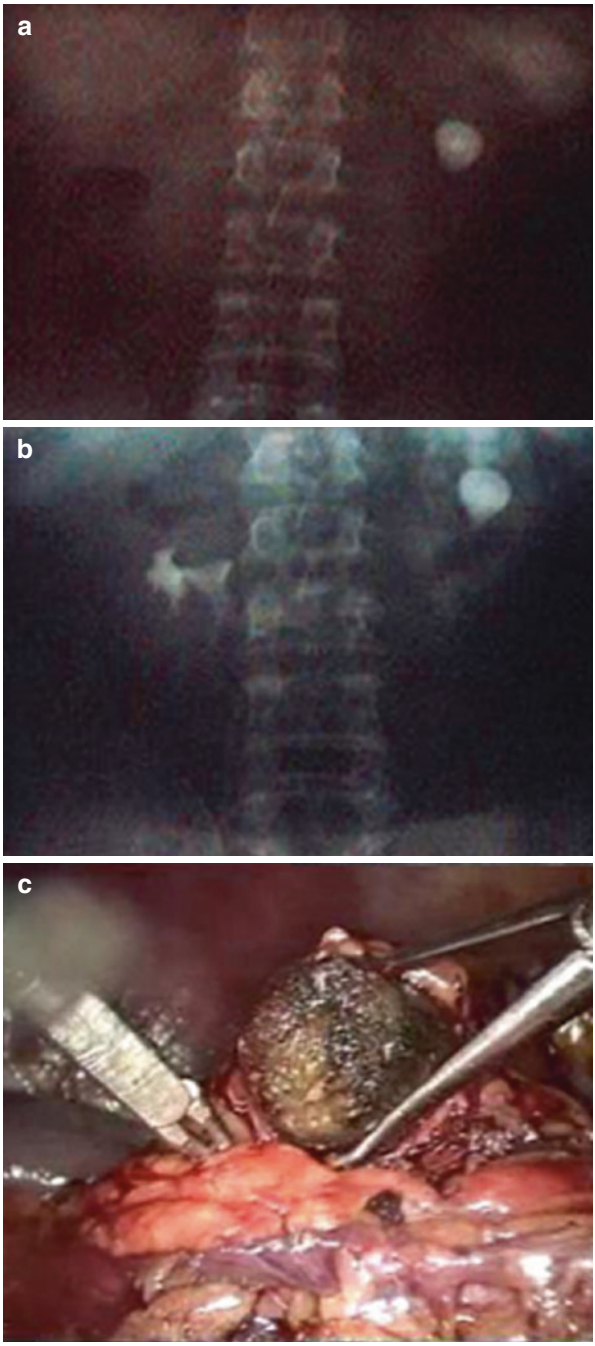


Fig. 26.4 Preoperative KUB (**a**) and IVU (**b**) of a patient with a large renal pelvis in his horseshoe kidney. The stone was removed by laparoscopic pyelolithotomy (**c**). The renal pelvis was easily accessed during laparoscopy due to its anterior position

Fig. 26.5 Preoperative KUB (*left*) and IVU (*right*) of a patient with an upper calyx stone in his ectopic kidney (indicated by *arrows*). The patient was successfully managed by laparoscopic-assisted PCNL

Retrocaval Ureter

If a stone is present in a kidney with a retrocaval ureter, laparoscopic stone removal can be performed directly, or by using another endourologic means, such as flexible or rigid ureteroscopy or a percutanous approach. The authors have reported six cases of retrocaval ureter, with one case associated with a 12mm renal pelvis stone. The stone was removed with laparoscopic grasping forceps in one piece [31].

Conclusion

Although laparoscopic stone surgery has a limited role in management of urolithiasis, it can be offered as a proper alternative to open stone surgery. Proper case selection for laparoscopic ureterolithotomy, pyelolithotomy, and especially laparoscopic anatrophic nephrolithotomy is key in preventing complications during the procedure. However, most of the difficulties during these procedures can be managed without the need for an open conversion.

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