Ther Adv Urol

1–6

DOI: 10.1177/1756287215607417

Combined laparoscopic pyelolithotomy and endoscopic pyelolithotripsy for staghorn calculi: long-term follow-up results from a case series

Antonio Luigi Pastore, Giovanni Palleschi, Luigi Silvestri, Antonino Leto, Andrea Ripoli, Andrea Fuschi, Yazan Al Salhi, Domenico Autieri, Vincenzo Petrozza and Antonio Carbone

Abstract

Purpose: Staghorn renal stones are a challenging field in urology. Due to their high recurrence rates, particularly those associated with an infective process, a complete removal is the ultimate goal in their management. We report our experience with a combined approach of laparoscopic pyelolithotomy and endoscopic pyelolithotripsy, the stone clearance rate, and long-term, follow-up outcomes.

Methods: From June 2012 to October 2014, nine adult patients with large staghorn renal calculi (mean size, 7.2 cm; range, 6.2–9.0 cm) underwent a combined laparoscopic and endoscopic approach. The technique comprised laparoscopic pyelolithotomy and holmium-YAG laser stone fragmentation with the use of a flexible cystoscope introduced through a 12 mm trocar.

Results: The average operative time was 140 min (range, 90–190 min). The mean estimated hemoglobin loss was 0.6 mmol/l (range 0.5–0.7 mmol/l). None of the patients required an open- surgery conversion. The mean hospital stay was 4 days (range, 2–6 days). A computed tomography urogram control at 6 months of follow up did not show any stone recurrence.

Conclusions: Laparoscopic pyelolithotomy combined with endoscopic pyelolithotripsy could be a therapeutic option in cases where mini-invasive procedures, that is, extracorporeal shock wave lithotripsy, ureteroscopic lithotripsy, and percutaneous nephrolithotomy (PCNL) have failed. This technique has a high stone-clearance rate (75–100%) comparable with open surgery and PCNL. However, it could be technically demanding and should be performed by skilled laparoscopy surgeons.

Keywords: endoscopic pyelolithotripsy, holmium-YAG laser, laparoscopy, pyelolithotomy, renal stone, staghorn calculi

Correspondence to:
Antonio Luigi Pastore, MD, PhD
Department of Medico-Surgical Sciences and Biotechnologies, Urology Unit, ICOT, Faculty of Pharmacy and Medicine, Sapienza University of Rome, Via Franco Faggiana 1668, Latina 04100, Italy
antopast@hotmail.com

Giovanni Palleschi, MD, PhD
Antonio Carbone, MD
Department of Medico-Surgical Sciences and Biotechnologies, Sapienza University of Rome, Latina, Italy and Uroresearch, No Profit Association for Scientific Research in Urology, Latina, Italy

Luigi Silvestri, MD
Antonino Leto, MD
Andrea Ripoli, MD
Andrea Fuschi, MD
Yazan Al Salhi, MD
Domenico Autieri, MD
Vincenzo Petrozza, MD
Department of Medico-Surgical Sciences and Biotechnologies, Sapienza University of Rome, Latina, Italy

Introduction

The management of staghorn renal stones is still debated and represents a challenge in urology. The success rates and widespread application of endourological, percutaneous, and ureteroscopic techniques have limited the open surgical nephrolithotomy to cases with complex staghorn calculi. Minimally invasive techniques such as percutaneous nephrolithotomy (PCNL) and extracorporeal shockwave lithotripsy (ESWL) might have limited efficacy in preventing stone recurrence and frequently require multiple operative sessions [Matlaga and Assimos, 2002; Esen *et al.* 1994; Assimos, 2001; Paik *et al.* 1998; Melissourgos *et al.* 2002]. Staghorn stones associated with an infective process, in particular, have a high recurrence rate and a complete removal is the ultimate goal in their management [Lingeman *et al.* 2007]. Simforoosh and colleagues, in a large case series, have reported laparoscopic anatrophic nephrolithotomy (LAN) as an alternative for managing large staghorn calculi [Simforoosh *et al.* 2008].

Currently, laparoscopic pyelolithotomy (LP) is advisable for large renal pelvic calculi, but should be limited for capacious extrarenal pelves [Nambirajan *et al.* 2005].

Herein we report the feasibility and outcomes of our experience on a combined LP and endoscopic pyelolithotripsy technique for large staghorn calculi in nine patients with monolateral intrapelvic staghorn calculus more than 6 cm in size, and present the therapeutic and follow-up outcomes.

Patients and methods

From June 2012 to October 2014, nine adult White patients (mean age, 47.8 ± 9.7 years; range, 42–66 years; body mass index, 26.4–33.4 kg/m^2) with large staghorn renal stone underwent LP. The study was performed according to the Ethical Principles for Medical Research Involving Human Subjects (World Medical Association, The Declaration of Helsinki Principles, 2000). A local ethical committee approval was obtained (ASL Lt/no.131568/2012). Written informed consent was obtained from all patients. Three of these patients, with complicated staghorn calculus and previous unsuccessful PCNL, preferred laparoscopic stone removal to a second percutaneous lithotripsy. The remaining six patients, in whom percutaneous access had failed, opted to undergo LP after a detailed description of all possible surgical and minimally invasive options. Preoperative evaluation included a routine urinalysis, renal function test, and an intravenous urogram to assess the stone burden and shape. In particular, the renal pelvicalyceal anatomy was evaluated with regard to the extension of the stone into the infundibulum, configuration of renal pelvis (degree of intra-/extrarenal component), and the degree of hydronephrosis. All the patients had a negative preoperative urine culture and received a single dose of broad-spectrum antibiotic prophylaxis. The patients had no history of ipsilateral upper urinary tract surgery for stones except one, who had had an endoscopic ureteral lithotripsy. Postoperative evaluation included ultrasound for all patients, and computed tomography urography (CTU) until the patient was stone free. Treatment outcomes were assessed by being stone free on CTU performed 1 month and 6 months after the combined surgical approach.

Description of the technique

First the patients were placed in a lithotomy position. Using a flexible cystoscope and C-arm fluoroscopy, a retrograde pyelography was performed to evaluate the anatomy of the upper urinary tract, stone number, location, and concomitant pathology (such as tumors and distal strictures). Subsequently the patient was moved to the slight flank position with the ipsilateral side rotated by approximately 30 degrees. The transperitoneal approach was used to maximize the working space and anatomical orientation.

Next, the patient was rotated to the full flank position, and using a 14 gauge Veress needle, a pneumoperitoneum was established and maintained at 12–15 mmHg throughout the procedure. After insufflating the abdomen, three ports were placed in the midline, namely, a 10 mm trocar (1 cm lateral to the umbilicus for the camera), a 5 mm trocar (between the xiphoid process and umbilicus), and a 12 mm trocar (between the umbilicus and pubic symphysis).

The renal–colic ligaments were released from the abdominal wall, and the colon medially reflected to expose the uretero-pelvic junction (UPJ). The proximal ureter was identified by following the psoas muscle, and the renal pelvis and hilum, along with the UPJ. The renal pedicle was not clamped. After exposing the renal pelvis adequately, a 2–3 cm incision was made on the pelvis using a cold blade. Next, the upper portion of the renal pelvis was held open using noncrushing graspers, a flexible cystoscope was introduced through the inferior laparoscopic port and pyeloscopy performed under direct vision. Subsequently the staghorn calculi were identified and fragmented with the holmium-YAG laser, 400 μm fiber (Medilas H20, Dornier Medical Systems, Inc., Marietta, GA, USA). Cystoscope fluid irrigation was used to flush out the stone dust in the calices, and laparoscopic suction/irrigation system and/or grasping forceps used to remove the smaller stone fragments from the renal pelvis or retroperitoneum. After an accurate suction-irrigation of the renal pelvis (to wash out further tiny stone particles), a double-J ureteral stent was inserted through the renal pelvis into the bladder. At the end of the procedure, a fluoroscopy control was performed in order to check the correct stent positioning, the complete stone particles removal, and to prevent any loss of stones or fragments in the abdominal/retroperitoneal space. Finally, the renal pelvis was closed using a 3–0 absorbable barbed suture in a running fashion. The Foley catheter was removed 24 h after the operation, and the suction drain (inserted through one of the

port sites) was removed when its daily output decreased to less than 20 ml. The double-J ureteral stent was removed under local anesthesia 4 weeks later and the complete removal of stones was confirmed by postoperative fluoroscopy. Herein, we report the two most representative cases.

Case 1

A 44-year-old White woman was admitted to our hospital with a diagnosis of complete left ureteral detachment after gynecological surgery for hysteroannessiectomy, and contralateral 8.2 cm staghorn calculi diagnosed by the CTU (Figure 1). The patient previously underwent two endoscopic left ureteral rendezvous and after 30 days underwent the combined laparoscopic and endoscopic technique to remove the staghorn calculi (Figure 2).The intra-operative abdominal X-ray showed no residual stones. The patient was discharged after 5 days. At 6 months, the right kidney showed a normal excretory phase at CTU check.

Case 2

A 66-year-old White man, with three previous endoscopic procedures for left recurrent ureteral cystine stones, was admitted to our hospital for a 7 cm left staghorn calculus located in the renal pelvis, as shown by the CTU. The patient underwent the combined laparoscopic and endoscopic technique to remove the staghorn calculi. The patient was discharged on the third postoperative day, and the ultrasonographic check showed complete stone removal.

The CTU scans performed 6 months after the surgery showed complete stone clearance.

Results

The results are summarized in Table 1. The mean operative time was 140 min (range, 90–190 min). The mean estimated hemoglobin loss was 0.6 mmol/l (range, 0.5–0.7 mmol/l), and no patients required blood transfusion. The mean hospital stay was 4 days (range, 2–6 days). The mean stone size was 7.24 cm (range, 6.20–9.00 cm). No intra- and postoperative complications occurred. After calculus removal, the stone culture resulted negative in all cases, except one in which *Escherichia coli* was isolated and treated according to the antibiogram.

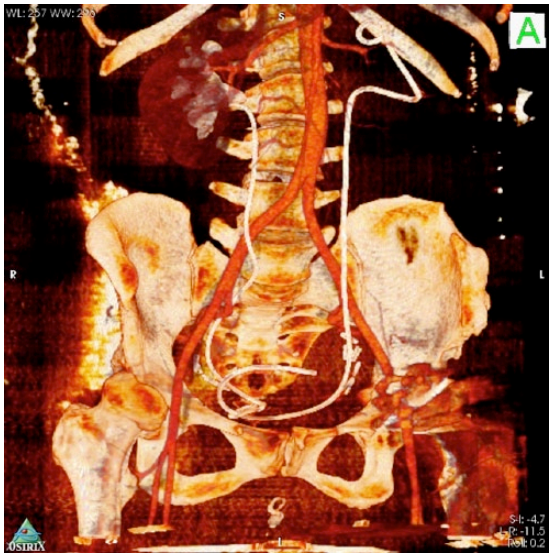

Figure 1. Computed tomography urography showing the large staghorn calculus.

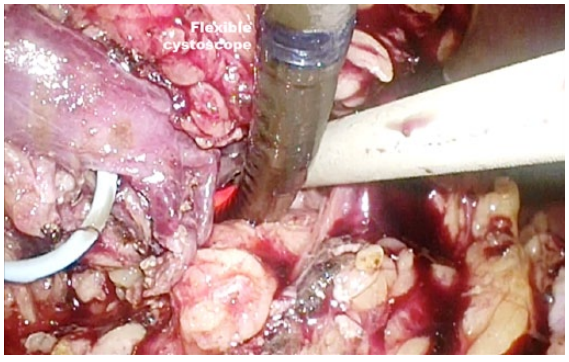

Figure 2. The combined laparoscopic and endoscopic technique. The flexible cystoscope is inserted through the pelvis to fragment the staghorn calculus.

At 1 month of follow up, the stone-free rate was 80% as shown by CTU scan, and only one patient developed a 9 mm residual stone of the lower calyx, which was subsequently treated with ESWL. The CTU control performed at 12 months of follow up did not show any residual stone.

Discussion

The surgical management of urinary stone disease has evolved from an open surgical approach to various minimally invasive options. Despite reports of safety and feasibility, LP to treat renal stones is still not clearly defined, partly because PCNL and ESWL are well-established, minimally invasive, and effective treatments. The indications for LP are essentially the same as for open surgery. However, due to the high success

Table 1. Table showing the patient profile and selected surgical outcomes.

Patient	Mean	1	2	3	4	5	6	7	8	9
Age	47.8	54	66	44	42	43	53	44	42	43
Gender	–	M	M	F	F	M	M	F	M	F
Body mass index	26	26	27.3	28.2	21.4	25.8	27.4	25	27	26
Side	–	L	L	R	R	L	L	R	R	L
Stone size (cm)	7.24	6.20	7.00	8.20	6.80	6.36	9.00	7.30	6.95	7.35
Hemoglobin mmol/l	Δ 0.6	9.5/8.8	8.3/7.9	8.6/7.8	9.4/9.1	9.6/8.8	9.5/8.8	8.7/8.2	9.3/8.9	8.6/8.0
Operative time (min)	140	90	140	190	150	120	190	130	125	125
Residual stone	–	No	9 mm	No	No	No	No	No	No	No
Stone- free status assessment	–	US (1, 3, and 6 months postop) CTU (1 and 6 months postop)	US (1, 3, and 6 months postop) CTU (1, 6, and 12 months postop)	US (1, 3, and 6 months postop) CTU (1 and 6 months postop)	US (1, 3, and 6 months postop) CTU (1 and 6 months postop)	US (1, 3, and 6 months postop) CTU (1 and 6 months postop)	US (1, 3, and 6 months postop) CTU (1 and 6 months postop)	US (1, 3, and 6 months postop) CTU (1 and 6 months postop)	US (1, 3, and 6 months postop) CTU (1 and 6 months postop)	US (1, 3, and 6 months postop) CTU (1 and 6 months postop)
Stone composition	–	Calcium oxalate (100%)	Cystine (100%)	Calcium oxalate (100%)	Uric acid (30%) and calcium oxalate (70%)	Phosphate calcium (40%) and calcium oxalate (60%)	Uric acid (80%) and phosphate calcium (20%)	Calcium oxalate (100%)	Calcium oxalate (100%)	Phosphate calcium (20%) and calcium oxalate (80%)

CTU, computed tomography urography; US, ultrasound.

rates of minimally invasive procedures, open surgery is now considered a last resort mainly due to its higher morbidity. The choice of treatment might depend on the surgeon's decision, experience, and instrument availability [Nambirajan *et al.* 2005]. Some patients in whom previous ESWL and/or PCNL had failed might still require open surgery, and in recent years the laparoscopic approach has reported the same results with a significant morbidity reduction and rapid recovery [Nambirajan *et al.* 2005; Meria *et al.* 2005].

LP is not a common procedure but provides the benefits of a minimally invasive treatment. The most accepted clinical indications for LP are large single renal stones and the concomitant management of renal anomalies such as UPJ obstruction or ectopic kidney [Stein *et al.* 2008; Srivastava *et al.* 2008].

Since LP is more invasive and less cosmetic than PCNL, it is not considered as the standard in the field of urinary-stone disease. Recently, some studies have reported favorable results using LP, with stone-free rates of 88.9–100% in managing solitary renal pelvic stones [Al-Hunayan *et al.* 2009, 2011; Tefekli *et al.* 2012]. A recent meta-analysis which evaluated 7 nonrandomized controlled clinical trials (a total of 363 patients) compared the efficacy and safety of LP with PCNL for the management of large renal pelvic stones [Wang *et al.* 2013]. It revealed a longer operative time and hospitalization for LP. This might be due to the lesser popularity of LP among urologists compared with the PCNL technique, which is widely distributed and well established. LP is safe and minimizes blood loss and postoperative fever, compared with PCNL [Tefekli *et al.* 2012; Goel and Hemal, 2003]. The lower incidence of bleeding might be explained by the lower risk of injury to the renal parenchyma from LP when compared with PCNL. Furthermore, LP has a high stone-clearance rate [Wang *et al.* 2013]. The other safe and effective laparoscopic procedure reported for large stone burden is LAN. Kaouk and colleagues, in 2003, first demonstrated

the feasibility of LAN in a porcine model [Kaouk *et al.* 2003], and Deger and colleagues reported the first case of LAN in a human in the same year [Deger *et al.* 2004]. Simforoosh and colleagues published their five case series with LAN in 2008 [Simforoosh *et al.* 2008]. Although they confirmed the feasibility of LAN, only three patients (60%) were completely stone free. LAN involves clamping of the renal hilum and incision of the renal parenchyma, which is associated with loss of functional parenchyma and possible subsequent renal insufficiency. Gieselman and colleagues reported a case series of eight patients with staghorn calculi, concluding that LAN is feasible and effective, but should be limited to complex stones requiring multiple renal access tracks and secondary procedures [Gieselman *et al.* 2012]. Despite the proven efficacy in open procedures, further investigations with long-term follow up are necessary before recommending LAN. Furthermore, the large stone burden would have made the surgery nearly impossible to perform with a reasonable warm ischemia time. To overcome this difficulty, several case series have evaluated LP with encouraging results [Srivastava *et al.* 2008; Al-Hunayan *et al.* 2009, 2011].

Our case series is the first describing a combined technique with laser lithotripsy in more than 6 cm staghorn calculi. The laparoscopic approach combined with percutaneous ultrasonic pyelolithotripsy in a pelvic kidney was first reported by Eshghi and colleagues in 1985, and has been performed many times since then [Eshghi *et al.* 1985]. El-Kappany and colleagues, in 2007, presented one of the largest related series [El-Kappany *et al.* 2007]. They treated five patients using laparoscopy-assisted percutaneous nephrolithotomy (LAP) with an 80% stone-free rate. Although LAN represents an effective option for these patients, LAP has the advantage of avoiding vascular complications secondary to renal parenchyma puncture. However, it remains more time consuming and technically challenging. Ureteroscopic lithotripsy (URS) and PCNL are the favored treatments for a large stone burden, but require multiple access sites or procedures, which can have consequences. LAP could be an alternative therapeutic option when endoscopic procedures, ESWL, URS, and PCNL have failed. Our case series also confirms that LAP has a high stone-free rate (75–100%), comparable with open surgery and PCNL. Thus, in patients refractory to traditional mini-invasive procedures, laparoscopic surgery can be an alternative therapeutic option.

As reported by Nadu and colleagues, in a recent review on laparoscopic management of urinary stones, endourology has revolutionized the treatment of urinary calculi. However, in several particular cases characterized by anatomic anomalies, extremely large stone burdens, or a combination of them, the success rate of endourology can significantly decrease. The open classic surgical approach in these cases could efficiently address both the large stones and associated malformation in one single procedure. Although open surgery remains an effective alternative, laparoscopy might represent a feasible option with the additional advantages of minimally invasive surgery. In this review the authors conclude that although classical endourological procedures should remain the gold standard for the great majority of renal stones, patients with large stone burdens and underlying malformations might benefit from a combined laparoscopic and endourological procedure solution [Nadu *et al.* 2009].

In our limited experience, the combined laparoscopic and endoscopic approach had a satisfactory stone-clearance rate, and showed no stone recurrences at long-term follow up (12 months). However, this technique is time consuming (mean operative time, 140 min) and should be performed only by skilled laparoscopic surgeons, as it is technically demanding.

Conclusion

Our case series shows that the combined laparoscopic and endoscopic technique for the removal of large staghorn calculi is feasible and repeatable, with a stone-free rate similar to open surgery. We recommend this surgery in patients refractory to traditional mini-invasive procedures, as an alternative therapeutic option, to be performed in well-equipped operating theaters and by experienced hands.

Acknowledgements

All authors contributed equally to the drafting of the manuscript. All authors read and approved the final version of the manuscript.

Conflict of interest statement

All authors certify that all conflicts of interest, including specific financial interests and relationships and affiliations relevant to the subject matter or materials discussed in the manuscript (e.g. employment/affiliation, grants or funding, consultancies, honoraria, stock ownership or options,

expert testimony, royalties, or patents filed, received, or pending), are the following: none.

Funding

The authors declare that the development of the manuscript was not supported by an honorarium, a grant, or any other sources of support, including sponsorship or any material sources of support.

References

Al-Hunayan, A., Abdulhalim, H., El-Bakry, E., Hassabo, M. and Kehinde, E. (2009) Laparoscopic pyelolithotomy: is the retroperitoneal route a better approach? *Int J Urol* 16: 181–186.

Al-Hunayan, A., Khalil, M., Hassabo, M., Hanafi, A. and Abdul-Halim, H. (2011) Management of solitary renal pelvic stone: laparoscopic retroperitoneal pyelolithotomy *versus* percutaneousnephrolithotomy. *J Endourol* 25: 975–978.

Assimos, D. (2001) Anatrophic nephrolithotomy. *Urology* 57: 161–165.

Deger, S., Tuellmann, M., Schoenberger, B., Winkelmann, B., Peters, R. and Loening, S. (2004) Laparoscopic anatrophicnephrolithotomy. *Scand J Urol Nephrol* 38: 263–265.

El-Kappany, H., El-Nahas, A., Shoma, A., El-Tabey, N., Eraky, I. and El-Kenawy, M. (2007) Combination of laparoscopy and nephroscopy for treatment of stones in pelvic ectopic kidneys. *J Endourol* 21: 1131–1136.

Esen, A., Kirkali, Z. and Güler, C. (1994) Open stone surgery: is it still a preferable procedure in the management of staghorn calculi? *Int Urol Nephrol* 26: 247–253.

Eshghi, A., Roth, J. and Smith, A. (1985) Percutaneous transperitoneal approach to a pelvic kidney for endourological removal of staghorn calculus. *J Urol* 134: 525–527.

Gieselman, C., Arriaga, J., Carmona, O., de Andrade, R., Banda, E., Lopez, R. *et al.* (2012) Laparoscopic anatrophicnephrolithotomy: developments of the technique in the era of minimally invasive surgery. *J Endourol* 26: 444–450.

Goel, A. and Hemal, A. (2003) Evaluation of role of retroperitoneoscopic pyelolithotomy and its comparison with percutaneous nephrolithotripsy. *Int Urol Nephrol* 35: 73–76.

Kaouk, J., Gill, I., Desai, M., Banks, K., Raja, S., Skacel, M. *et al.* (2003) Laparoscopic anatrophicnephrolithotomy: feasibility study in a chronic porcine model. *J Urol* 169: 691–696.

Lingeman, J., Matlaga, B. and Evan, A. (2007) Surgical management of upper urinary tract calculi. In: Wein, A. and Kavoussi, L. (eds), *Campbell–Walsh Urology*, 9th edition. Philadelphia, PA: Saunders Elsevier, pp. 1431–1507.

Matlaga, B. and Assimos, D. (2002) Changing indications of open stone surgery. *Urology* 59: 490–493.

Melissourgos, N., Davilas, E., Fragoulis, A., Kiminas, E. and Farmakis, A. (2002) Modified anatrophicnephrolithotomy for complete staghorn calculus disease: does it still have a place? *Scand J Urol Nephrol* 36: 426–430.

Meria, P., Milcent, S., Desgrandchamps, F., Mongiat-Artus, P., Duclos, J. and Teillac, P. (2005) Management of pelvic stones larger than 20 mm: laparoscopic transperitoneal pyelolithotomy or percutaneous nephrolithotomy? *Urol Int* 75: 322–326.

Nadu, A., Schatloff, O., Morag, R., Ramon, J. and Winkler, H. (2009) Laparoscopic surgery for renal stones: is it indicated in the modern endourology era? *Int Braz J Urol* 35: 9–17.

Nambirajan, T., Jeschke, S., Albqami, N., Abukora, F., Leeb, K. and Janetschek, G. (2005) Role of laparoscopy in management of renal stones: single-center experience and review of literature. *J Endourol* 19: 353–359.

Paik, M., Wainstein, M., Spirnak, J., Hampel, N. and Resnick, M. (1998) Current indications for open stone surgery in the treatment of renal and ureteral calculi. *J Urol* 159: 374–378.

Simforoosh, N., Aminsharifi, A., Tabibi, A., Noor-Alizadeh, A., Zand, S., Radfar, M. *et al.* (2008) Laparoscopic anatrophicnephrolithotomy for managing large staghorn calculi. *BJU Int* 101: 1293–1296.

Srivastava, A., Singh, P., Gupta, M., Ansari, M., Mandhani, A., Kapoor, R. *et al.* (2008) Laparoscopic pyeloplasty with concomitant pyelolithotomy is it an effective mode of treatment? *Urol Int* 80: 306–309.

Stein, R., Turna, B., Nguyen, M., Aron, M., Hafron, J., Gill, I. *et al.* (2008) Laparoscopic pyeloplasty with concomitant pyelolithotomy: technique and outcomes. *J Endourol* 22: 1251–1255.

Tefekli, A., Tepeler, A., Akman, T., Akçay, M., Baykal, M., Karadağ, M. *et al.* (2012) The comparison of laparoscopic pyelolithotomy and percutaneous nephrolithotomy in the treatment of solitary large renal pelvic stones. *Urol Res* 40: 549–555.

Wang, X., Li, S., Liu, T., Guo, Y. and Yang, Z. (2013) Laparoscopic pyelolithotomy compared to percutaneous nephrolithotomy as surgical management for large renal pelvic calculi: a meta-analysis. *J Urol* 190: 888–893.