NATIONAL INSTITUTE FOR HEALTH AND CLINICAL EXCELLENCE

INTERVENTIONAL PROCEDURES PROGRAMME

Interventional procedures overview of laparoscopic nephrolithotomy and pyelolithotomy

Renal (kidney) stones can form in one or both kidneys. In laparoscopic nephrolithotomy and pyelolithotomy, small incisions are made in the abdomen and the stones are removed from the kidney using a fine fibreoptic tube to see and perform simple movements inside the body (also known as 'keyhole surgery').

Introduction

This overview has been prepared to assist members of the Interventional Procedures Advisory Committee (IPAC) in making recommendations about the safety and efficacy of an interventional procedure. It is based on a rapid review of the medical literature and specialist opinion. It should not be regarded as a definitive assessment of the procedure.

Date prepared

This overview was prepared in August 2006.

Procedure name

- Laparoscopic nephrolithotomy and laparoscopic pyelolithotomy

Specialty societies

- British Association of Urological Surgeons

Description

Indications

Nephrolithiasis (renal stones)

Renal stones are hard masses that form from crystals in urine. Their composition varies but the most common types are largely made up of different forms of calcium. Other types of stone are made of uric acid, struvite and cystine. Renal stones range in size from small gravel-like stones to large stones that extend into more than one calyx (staghorn calculi). Although

nephrolithiasis is often asymptomatic, the most common symptoms are pain in the abdomen, lower back or groin, and blood in the urine. Depending on its size and position, an untreated stone can lead to obstruction to the passage of urine, infection and permanent kidney damage.

Current treatment and alternatives

Small renal stones will usually pass out of the kidney and are excreted with the urine without any treatment. However, larger stones and those causing persistent symptoms may need to be broken into smaller pieces or removed.

Extracorporeal shockwave lithotripsy (ESWL) uses high energy ‘shockwaves’ from a machine outside the body, to shatter the stones into small fragments that can be passed with the urine. Several sessions of ESWL may be needed for larger stones.

If ESWL does not work or a stone is particularly large, percutaneous nephrolithotomy (PCNL) may be performed. Under general anaesthetic, a small incision is made in the back over the kidney and a nephroscope is inserted into the kidney. The stone may be fragmented with laser or ultrasound and removed in pieces.

When neither ESWL nor PCNL are available, open surgery may be performed. This was the traditional treatment for symptomatic stones.

What the procedures involve

Laparoscopic nephrolithotomy and pyelolithotomy are similar procedures performed under general anaesthetic, using either a transperitoneal or retroperitoneal approach. In the transperitoneal approach, the abdomen is insufflated with carbon dioxide and several small abdominal incisions are made. In the retroperitoneal approach, a small incision is made in the back and a dissecting balloon is inserted to create a retroperitoneal space. Two or three additional small incisions are made in the back. In a nephrolithotomy, once the kidney has been mobilised, the stone is located by ultrasound or by evidence of a bulge, or depression secondary to scarring. The renal capsule and parenchyma are incised and the stone or stones are removed from the affected calices. The nephrotomy site may or may not be closed with sutures. A double-J stent may be inserted through the kidney, running from the kidney to the bladder, and left in place for several weeks after surgery. In a pyelolithotomy, the stone is accessed through an incision in the renal pelvis (pyelotomy). Once the stone is removed, the pyelotomy is usually closed with sutures, with or without a stent.

A recent development is the use of laparoscopic assistance to perform a conventional PCNL.

Efficacy

The Specialist Advisers stated that key efficacy outcomes included stone-free rates and length of hospital stay.

Length of hospital stay

Three non-randomised controlled trials, including 149 patients, reported mean lengths of hospital stay of 3.9, 6.5 and 3.8 days for laparoscopic pyelolithotomy, compared with 5.4, 5.6 and 3.0 days, respectively, for percutaneous nephrolithotomy.[1–3]

Mean operative time

Two non-randomised controlled trials, including 60 patients, reported significantly longer mean operative times for laparoscopic pyelolithotomy than for PCNL (184 versus 139 minutes, respectively, $p = 0.02$; and 142 versus 72 minutes, respectively, $p < 0.0001$).[2,3] A third non-randomised controlled trial of 89 patients reported a mean operative time of 116 minutes for laparoscopic pyelolithotomy, compared with 152 minutes for PCNL (p value not stated).[1]

Stone-free rates

Two non-randomised controlled trials reported similar proportions of stone-free patients after laparoscopic pyelolithotomy compared with PCNL (88% [14/16] versus 81% [13/16] and 100% [16/16] versus 100% [12/12], respectively).[2,3] A third non-randomised controlled trial of 89 patients reported that none of those treated with laparoscopic pyelolithotomy had residual stones compared with 13% of patients treated with percutaneous nephrolithotomy.[1]

One case series reported that all patients (15/15) were stone free after the procedure and in another case series, six out of seven patients were stone free after treatment.[7,5] In a third case series of eight patients, all were stone free 3 months after the procedure and seven out of eight patients were still stone-free after 12 months' follow-up.[4]

Return to normal activities

Two non-randomised controlled trials reported that the mean number of days taken to return to normal activities was 13 for laparoscopic pyelolithotomy (in both studies), compared with 14 and 10 days for percutaneous nephrolithotomy.[2,3]

Safety

The Specialist Advisers listed potential adverse events as the need for nephrectomy, urinary fistula and urinary leakage (around the kidney), haemorrhage, infection and conversion to open surgery.

Conversions to open surgery

Three non-randomised controlled trials reported that 16% (7/43), 12.5% (2/16) and 12.5% (2/16) of laparoscopic pyelolithotomies had to be converted to open surgery compared with 2% (1/48), 0% (0/16) and 0% (0/12) of percutaneous procedures.[1–3]

In two case series, 0% (0/8) and 20% (4/20) laparoscopic procedures were converted to open surgery.[5,6]

Peritoneal tear

Two non-randomised controlled trials reported peritoneal tear in 12% (5/43) and 19% (3/16) of patients. This was not reported in any of the patients treated with PCNL in the same studies.[1,3]

Urinary leakage

Three studies reported urinary leakage (usually defined by symptoms and imaging) in 7% (1/15), 10% (2/20) and 12.5% (2/16) of patients.[2,6,7]

Literature review

Rapid review of literature

The medical literature was searched to identify studies and reviews relevant to laparoscopic nephrolithotomy or pyelolithotomy. Searches were conducted via the following databases, covering the period from their commencement to 25 April 2006: MEDLINE, PREMEDLINE, EMBASE, Cochrane Library and other databases. Trial registries and the Internet were also searched. No language restriction was applied to the searches. (See appendix B for details of search strategy.)

The following selection criteria (Table 1) were applied to the abstracts identified by the literature search. Where these criteria could not be determined from the abstracts the full paper was retrieved.

Table 1 Inclusion criteria for identification of relevant studies

Characteristic	Criteria
Publication type	Clinical studies were included. Emphasis was placed on identifying good quality studies. Abstracts were excluded where no clinical outcomes were reported, or where the paper was a review, editorial, laboratory or animal study.
Patient	Patients with renal stones
Intervention/test	Laparoscopic nephrolithotomy or laparoscopic pyelolithotomy
Outcome	Articles were retrieved if the abstract contained information relevant to the safety and/or efficacy. Key efficacy outcomes included operative time, intraoperative blood loss, length of hospital stay, time to return to normal activities and stone-free rates. Key safety outcomes included conversions to open surgery and urinary leakage rates.
Language	Non-English-language articles were excluded unless they were thought to add substantively to the English-language evidence base.

List of studies included in the overview

This overview is based on three non-randomised controlled trials and four case series.[1–7] The three non-randomised controlled trials compare laparoscopic pyelolithotomy with percutaneous nephrolithotomy.[1–3] One case series describes children treated with laparoscopic pyelolithotomy.[4] Another includes patients treated with one of a range of laparoscopic techniques, including pyelolithotomy and nephrolithotomy.[5] A third case series describes a percutaneous technique performed with laparoscopic assistance.[7]

Other studies that were considered to be relevant to the procedures but were not included in the main extraction table (table 2) have been listed in appendix A.

Existing reviews on these procedures

There were no published reviews identified at the time of the literature search.

Related NICE guidance

There is no NICE guidance related to these procedures.

Table 2 Summary of key efficacy and safety findings on laparoscopic nephrolithotomy

Abbreviations used: ESWL, extracorporeal shockwave lithotripsy; NS, not stated; PCNL, percutaneous nephrolithotomy.

Study details	Key efficacy findings	Key safety findings	Comments
Gaur DD (2001)[1] Non-randomised controlled trial India Study period: not stated n = 91 procedures (89 patients) Population: patients with renal stones • 47% (43/91) retroperitoneal laparoscopic pyelolithotomy • 53% (48/91) PCNL Mean age (years) • Laparoscopic pyelolithotomy = 39 (range 8–65) • PCNL = 34 (range not stated) Mean primary stone size (mm) • Laparoscopic pyelolithotomy = 19.6 (range 10–48) • PCNL = 28.5 (range 20–38) Indications: inclusion criteria for laparoscopy included failed PCNL, the need for another concurrent retroperitoneoscopic procedure, large hard stones and patient request. Follow-up: not stated Conflict of interest: none stated	Residual stone rate: • Laparoscopic pyelolithotomy = 0% • PCNL = 12.8% Mean hospital stay (days): • Laparoscopic pyelolithotomy = 3.9 • PCNL = 5.4 Mean operative time (minutes): • Laparoscopic pyelolithotomy = 116.2 • PCNL = 152 Mean blood loss (ml): • Laparoscopic pyelolithotomy = 39.2 • PCNL = 325 Mean analgesic intake (days): • Laparoscopic pyelolithotomy = 2.7 • PCNL = 7 Mean drainage time (days): • Laparoscopic pyelolithotomy = 7.2 • PCNL = 2.5	Conversions to open surgery • Laparoscopic pyelolithotomy = 16.3% (7/43) • PCNL = 2.1% (1/48) Peritoneal tear: • Laparoscopic pyelolithotomy = 11.6% (5/43) • PCNL = 0% (0/48) Ileus: • Laparoscopic pyelolithotomy = 4.6% • PCNL = 4.2% Major bleeding requiring transfusion: • Laparoscopic pyelolithotomy = 0% • PCNL = 12.8% Subcutaneous emphysema: • Laparoscopic pyelolithotomy = 2.3% • PCNL = 0% Hypercarbia: • Laparoscopic pyelolithotomy = 4.6% • PCNL = 0% Renal pelvis injury: • Laparoscopic pyelolithotomy = 2.3% • PCNL = 0% Port skin necrosis: • Laparoscopic pyelolithotomy = 2.3% • PCNL = 0% High fever: • Laparoscopic pyelolithotomy = 2.3% • PCNL = 10.6% Septicaemia: • Laparoscopic pyelolithotomy = 0% • PCNL = 2.1% Renal parenchymal injury: • Laparoscopic pyelolithotomy = 0% • PCNL = 10.6%	The mean stone size is larger in the PCNL group than the laparoscopic group. All patients with retroperitoneal laparoscopic pyelolithotomy over a 10-year period were included in the study. 48 PCNL procedures performed during the last 2 years were included for comparison. The authors noted that there were no open conversions in the last 14 patients treated and suggested that a lack of experience and proper instrumentation contributed to the earlier complications. The authors state that the laparoscopic procedure is suitable for patients with large non-staghorn stones without a history of recurrent pyelonephritis or prior surgery.

Abbreviations used: ESWL, extracorporeal shockwave lithotripsy; NS, not stated; PCNL, percutaneous nephrolithotomy.

Study details	Key efficacy findings	Key safety findings	Comments
Meria P (2005)[2] Non-randomised controlled trial France Study period: 1999–2004 n = 32 Population: patients with single pelvic stones • 50% (16/32) transperitoneal laparoscopic pyelolithotomy • 50% (16/32) PCNL Mean age (years) • Laparoscopic pyelolithotomy = 42 (range 21–63) • PCNL = 45 (range 24–69) Indications: Inclusion criteria included single pelvic stone > 20 x 10 mm. Patients with kidney malformations were excluded. Follow-up: 3 months Conflict of interest: none stated	Patients were considered stone free when no residual stone was demonstrated on plain abdominal film and ultrasonography. Stone-free: • Laparoscopic pyelolithotomy = 88% (14/16) • PCNL = 81% (13/16), p = NS Mean hospital stay (days): • Laparoscopic pyelolithotomy = 6.5 (range 4–16) • PCNL = 5.6 (range 4–11), p = 0.17 Mean operative time (minutes): • Laparoscopic pyelolithotomy = 129 (range 60–210) • PCNL = 75 (range 35–140), p = 0.001 Mean total operative time (with stenting and changing position) (minutes): • Laparoscopic pyelolithotomy = 184 (range 120–300) • PCNL = 139 (range 100–210), p = 0.02 Mean operative blood loss (ml): • Laparoscopic pyelolithotomy = 15 (range 10–150) • PCNL = Not applicable Mean return to normal activity (days): • Laparoscopic pyelolithotomy = 13.2 (range 4–30) • PCNL = 14.4 (range 5 to 26), p = NS	Conversions to open surgery • Laparoscopic pyelolithotomy = 12.5% (2/16) • PCNL = 0% (0/16) Urinary leakage: • Laparoscopic pyelolithotomy = 12.5% (2/16) • PCNL = 0% (0/16) Postoperative bleeding: • Laparoscopic pyelolithotomy = 0% (0/16) • PCNL = 18.8% (3/16) (1 required transfusion) Parietal haematoma: • Laparoscopic pyelolithotomy = 6.2% (1/16) • PCNL = 0% (0/16) Urinary infection: • Laparoscopic pyelolithotomy = 6.2% (1/16) • PCNL = 0% (0/16) In one patient, stone manipulation with forceps led to fragmentation in the pelvis. Fragments migrated to middle and upper calyces and could not be removed. Patient was later treated successfully with PCNL.	No randomisation. Consecutive patients in each group. The laparoscopic procedure was considered to be very difficult by the surgeon in three cases. The authors state that the indications for laparoscopic pyelithotomy still need to be evaluated. They note that stones with struvite are particularly fragile and may be involuntarily fragmented during removal. They also note that the presence of intrasinusal pelvis or previous acute pyelonephritis increases the technical difficulty of the laparoscopic procedure.

Abbreviations used: ESWL, extracorporeal shockwave lithotripsy; NS, not stated; PCNL, percutaneous nephrolithotomy.

Study details	Key efficacy findings	Key safety findings	Comments
Goel A (2003)[3] Non-randomised controlled trial (retrospective) India Study period: 1995–2002 n = 28 patients Population: patients with solitary renal pelvic stones • 57% (16/28) Laparoscopic pyelolithotomy • 43% (12/28) PCNL Mean age (years) • Laparoscopic pyelolithotomy = 39 (range 21–60) • PCNL = 41 (range 20–62) Mean stone size (cm) • Laparoscopic pyelolithotomy = 3.6 (range 3.2–4.5) • PCNL = 4.1 (range 3.5–5.2), p < 0.006 Indications: no inclusion and exclusion criteria were stated. Technique: retroperitoneal approach and peritoneoscope used for laparoscopic procedure. Follow-up: not stated Conflict of interest: none stated	Complete clearance was achieved in all cases. Mean hospital stay (days): • Laparoscopic pyelolithotomy = 3.8 (range 1–10) • PCNL = 3 (range 2–5) Mean operative time (minutes): • Laparoscopic pyelolithotomy = 142.2 (range 45–280) • PCNL = 71.6 (range 50 to 100), p < 0.0001 Mean estimated blood loss (ml): • Laparoscopic pyelolithotomy = 173.1 (range 60–400) • PCNL = 147.9 (range 75–200) Mean duration of return to full activity in days: • Laparoscopic pyelolithotomy (results for 9 patients only) = 12.7 (range 7–20) • PCNL = 9.8 (range 7–12)	Conversions to open surgery: • Laparoscopic pyelolithotomy = 12.5% (2/16) • PCNL = 0% (0/12) One conversion was due to stone migration into the calyx and the other was due to an inability to dissect the pelvis because of adhesions. Peritoneal tear: • Laparoscopic pyelolithotomy = 18.8% (3/16) • PCNL = 0% (0/12) Mild wound infection: • Laparoscopic pyelolithotomy = 6.2% (1/16) • PCNL = 0% (0/12) Prolonged drainage (72 hours): • Laparoscopic pyelolithotomy = 6.2% (1/16) • PCNL = 0% (0/12) Fever: • Laparoscopic pyelolithotomy = 0% (0/16) • PCNL = 8.3% (1/12)	The mean stone size was significantly larger in the percutaneous group than the laparoscopic group. A total of 18 patients were treated with laparoscopic pyelolithotomy during the study period. Two patients treated with pyeloplasty as well were excluded from the study. Consecutive cases of percutaneous nephrolithotripsy performed in the year 2000 were used for comparison.

Abbreviations used: ESWL, extracorporeal shockwave lithotripsy; NS, not stated; PCNL, percutaneous nephrolithotomy.

Study details	Key efficacy findings	Key safety findings	Comments
Casale P (2004)[4] Case series USA Study period: not stated n = 8 Population: paediatric patients with symptomatic nonobstructing renal stones in whom percutaneous access failed Mean age = 4 years (range 3 months to 10 years) Indications: Inclusion criteria included failed percutaneous access secondary to a nondilated system and/or stone occlusion of the lower pole system, and failed shockwave lithotripsy or a stone burden > 2.5 cm^2. There were no exclusion criteria. Technique: transperitoneal laparoscopic pyelolithotomy Mean follow-up: 12 months Conflict of interest: none stated	All eight patients were stone free at 3 months. Mean hospital stay = 2.15 days (range 2–3) Mean operative time = 1.6 hours (range 0.8–2.3) Mean estimated blood loss = 15 ml (range 0–50) Mean time to return to normal activities = 2 weeks (range 0.5–6) All patients were pain free at mean follow-up of 12 months. At 12 months, ultrasonography showed that seven of eight patients had no evidence of stones.	No intraoperative complications were noted.	Patient selection not described.

Abbreviations used: ESWL, extracorporeal shockwave lithotripsy; NS, not stated; PCNL, percutaneous nephrolithotomy.

Study details	Key efficacy findings	Key safety findings	Comments
Nambirajan T (2005)[5] Case series Austria Study period: not stated n = 8 procedures (7 patients) Population: patients with upper-pole caliceal-diverticular stones (n = 3), staghorn calculi (n = 3), bilateral matrix stones (n = 1). Indications: inclusion and exclusion criteria not stated. Technique: 3 laparoscopic nephrolithotomy and 5 laparoscopic pyelolithotomy procedures; 7 transperitoneal approach, 1 retroperitoneal approach. Follow-up: not stated Conflict of Interest: none stated	Mean operative time for laparoscopic nephrolithotomy = 190 minutes. Mean operative time for laparoscopic pyelolithotomy = 193 minutes. One patient in the laparoscopic nephrolithotomy group had a 5-mm residual stone that was inaccessible. This was subsequently treated successfully with ESWL.	There were no conversions to open surgery. Three of five laparoscopic pyelolithotomies were complicated by postoperative fever and signs of obstruction necessitating pigtail-catheter drainage of the collecting system. In one patient who had pyelolithotomy, the pelvis was found to be friable and difficult to close with sutures. The defect was closed with a perirenal fat flap and the patient required a postoperative stent for a prolonged urinary leak.	The paper describes a total of 19 laparoscopic procedures, including pyeloplasty, pyelolithotomy, partial nephrectomy and nephrectomy. Laparoscopy was chosen as the primary option for anterior caliceal diverticula and after failed PCNLfor the posterior diverticulum.

Abbreviations used: ESWL, extracorporeal shockwave lithotripsy; NS, not stated; PCNL, percutaneous nephrolithotomy.			
Study details	**Key efficacy findings**	**Key safety findings**	**Comments**
Sinha R (1997)[6] Case series India Study period: not stated n = 20 patients Population: patients with solitary pelvic stones Stone size varied from 1.6 cm to 2.5 cm Indications: patients had solitary pelvic stones, had no history of previous operation on the same side and agreed to laparoscopic surgery. Technique: laparoscopic retroperitoneal pyelolithotomy; lithotomy site left unstitched in 14 patients. Mean follow-up: not stated Conflict of interest: none stated	Mean operative time = 80 minutes (range 56–122)	Conversions to open surgery = 20% (4/20) Urinary leak = 10% (2/20)	There were no nearby centres doing PCNL or ESWL so patients had the choice of laparoscopic or open surgery.

Abbreviations used: ESWL, extracorporeal shockwave lithotripsy; NS, not stated; PCNL, percutaneous nephrolithotomy.			
Study details	**Key efficacy findings**	**Key safety findings**	**Comments**
Holman E (1998)[7] Case series Yemen and Hungary Study period: 1992–1997 n = 15 Population: patients with stone-holding pelvic dystopic kidneys Median age = 34.2 years (range 10–54) Stones ranged in size from 0.8 to 4.5 cm Indications: patients were described as having large, dense and/or complicated stones; inclusion and exclusion criteria not stated. Technique: Laparoscopically assisted transperitoneal PCNL procedure; kidney punctured under simultaneous laparoscopic and fluoroscopic control; stones were disintegrated ultrasonically and/or removed via a rigid nephroscope. Follow-up: not stated Conflict of interest: none stated	Mean operating time = 55 minutes (range 40–85) Mean hospital stay = 4.8 days (range 4–11) All stones were removed completely and there were no residual fragments.	'Severe complications did not occur' Delayed urine leakage through abdominal drain = 6.7% (1/15)	Patient selection not described. ESWL had previously failed in four cases.

Validity and generalisability of the studies

- There were no randomised controlled trials identified.
- The operative technique used for laparoscopic pyelolithotomy or nephrolithotomy varied within and between studies.
- One study decribed a laparoscopically assisted technique, which used a conventional percutaneous approach together with laparoscopy.
- In one non-randomised controlled trial, patients who had previously been unsuccessfully treated with PCNL were included in the laparoscopic arm.[1]
- In two non-randomised controlled trials, patients treated with a percutaneous technique had larger stones than those treated with a laparoscopic technique.[3]
- One study only included paediatric patients.

Specialist advisers' opinions

Specialist advice was sought from consultants who have been nominated or ratified by their Specialist Society or Royal College.

Mr F Keeley, Mr M Wright.

- The appropriate comparator is percutaneous nephrolithotomy.
- Stone size and complexity of stone load should determine whether a percutaneous or laparoscopic approach should be undertaken.
- These procedures are likely to be suitable for only a small proportion of patients with renal stones.
- Appropriate outcome measures include operative time, blood loss, hospital stay, analgesic use, stone-free rates, transfusion rates and rates of conversion to open surgery.
- Extensive laparoscopic training and experience with laparoscopic nephrectomy, intracorporeal suturing and stone management is necessary for anyone carrying out the procedures.
- The potential impact of these procedures on the NHS, in terms of number of patients and use of resources, is minor.

Issues for consideration by IPAC

There are no additional issues for consideration.

References

1. Gaur DD, Punjani HM, Madhusudhana HR et al. (2001) Retroperitoneal laparoscopic pyelolithotomy: how does it compare with percutaneous nephrolithotomy for larger stones? *Minimally Invasive Therapy & Allied Technologies* 10: 105–9.
2. Meria P, Milcent S, Desgrandchamps F et al. (2005) Management of pelvic stones larger than 20 mm: laparoscopic transperitoneal pyelolithotomy or percutaneous nephrolithotomy? *Urologia Internationalis* 75: 322–6.
3. Goel A, Hemal AK (2003) Evaluation of role of retroperitoneoscopic pyelolithotomy and its comparison with percutaneous nephrolithotripsy. *International Urology and Nephrology* 35: 73–6.
4. Casale P, Grady RW, Joyner BD et al. (2004) Transperitoneal laparoscopic pyelolithotomy after failed percutaneous access in the pediatric patient. *Journal of Urology* 172: 680–3.
5. Nambirajan T, Jeschke S, Albqami N et al. (2005) Role of laparoscopy in management of renal stones: single-center experience and review of literature. *Journal of Endourology* 19: 353–9.
6. Sinha R, Sharma N (1997) Retroperitoneal laparoscopic management of urolithiasis. *Journal of Laparoendoscopic & Advanced Surgical Techniques* 7: 95–8.
7. Holman E, Tóth C (1998) Laparoscopically assisted percutaneous transperitoneal nephrolithotomy in pelvic dystopic kidneys: experience in 15 successful cases. *Journal of Laparoendoscopic & Advanced Surgical Techniques* 8: 431–5.

Appendix A: Additional papers on laparoscopic nephrolithotomy or pyelolithotomy not included in summary table 2

The following table outlines the studies that are considered potentially relevant to the overview but were not included in the main data extraction table (table 2). It is by no means an exhaustive list of potentially relevant studies.

Article title	Number of patients/ follow-up	Direction of conclusions	Reasons for non-inclusion in table 2
Gaur DD, Agarwal DK, Purohit KC et al. (1994) Retroperitoneal laparoscopic pyelolithotomy. *Journal of Urology* 151: 927–9.	Case series n = 8	62.5% (5/8) successful. One peritoneal tear during balloon inflation.	A larger, more recent case series from the same centre is included.
Gaur DD, Trivedi S, Prabhudesai MR et al. (2002) Retroperitoneal laparoscopic pyelolithotomy for staghorn stones. *Journal of Laparoendoscopic & Advanced Surgical Techniques* 12: 299–303.	Case series n = 3	Staghorn stones. All stones were removed successfully with no complications.	Larger case series are included.
Hemal AK, Goel A, Kumar M et al. (2001) Evaluation of laparoscopic retroperitoneal surgery in urinary stone disease. *Journal of Endourology* 15: 701–5.	Case series n = 7	Two conversions to open surgery.	Same study centre and study period as Goel et al (2003), included in table 2.
Maheshwari PN, Bhandarkar DS, Andankar MG et al. (2004) Laparoscopically guided transperitoneal percutaneous nephrolithotomy for calculi in pelvic ectopic kidneys. *Surgical Endoscopy* 18: 1151	Case series n = 3 Follow up = 2–38 months	No intraoperative or postoperative morbidity. All patients asymptomatic and recurrence free at follow-up.	Published as abstract only.
Matlaga BR, Kim SC, Watkins SL et al. (2006) Percutaneous nephrolithotomy for ectopic kidneys: over, around or through. *Urology* 67: 513–7.	Case series n = 6	Laparoscopically assisted PCNL. All patients were stone free. Mean length of hospital stay = 3 days.	Larger studies are included.

Appendix B: Literature search for laparoscopic nephrolithotomy or pyelolithotomy

Database	Date searched	Version searched
Cochrane Library	25.4.06	Issue 2: 2006
CRD databases	"	-
Embase	"	1980–2006 week 18
Medline	"	1966–April week 2 2006
Premedline	"	-
CINAHL	"	1982–April week 2 2006
British Library Inside Conferences	26.4.06	-
NRR	"	-
Controlled Trials Registry	"	-

The following search strategy was used to identify papers in Medline. A similar strategy was used to identify papers in other databases.

1 ((kidney$ or renal) adj3 stone$).tw.
2 ((kidney$ or renal) adj3 calcul$).tw.
3 Kidney Calculi/
4 Ureteral Calculi/
5 (ureteral adj3 (calcul$ or stone$)).tw.
6 (pelvic adj3 (calcul$ or stone$)).tw.
7 or/1-6
8 nephrostom$.tw.
9 nephrolithotom$.tw.
10 ureterolithotom$.tw.
11 pyelolithotom$.tw.
12 or/8-11
13 laparoscop$.tw.
14 laparoscopy/
15 laparoscope/
16 or/13-15
17 12 and 16
18 nephrolithiasis.tw.
19 ureterolithiasis.tw.
20 7 or 18 or 19
21 17 and 20
22 animal/
23 human/
24 22 not 23
25 21 not 24