NATIONAL INSTITUTE FOR HEALTH AND CLINICAL EXCELLENCE

INTERVENTIONAL PROCEDURES PROGRAMME

Interventional procedure overview of single-port laparoscopic nephrectomy

Removing a kidney using single-incision keyhole surgery

If a kidney is affected by cancer or irreversibly damaged, it may need to be removed. Removal of a kidney (nephrectomy) can be done as an open operation or through 'keyhole surgery' using several small incisions (laparoscopic). This procedure aims to produce less scarring and discomfort than traditional open or laparoscopic nephrectomy, by using a single 'keyhole'.

Introduction

The National Institute for Health and Clinical Excellence (NICE) has prepared this overview to help members of the Interventional Procedures Advisory Committee (IPAC) make 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 March 2011.

Procedure name

- Single-port laparoscopic nephrectomy
- Laparoendoscopic single-site nephrectomy

Specialty societies

- British Association of Urological Surgeons
- British Transplantation Society.

Description

Indications and current treatment

Indications for nephrectomy (including nephroureterectomy) include cancer, such as renal cell cancer or upper urinary tract urothelial cancer (transitional cell carcinoma), and benign conditions that lead to poor functioning or non-functioning of the kidney. These benign conditions may be due to, or associated with, symptomatic hydronephrosis, chronic infection, polycystic kidney disease, dysplastic kidney, hypertension or renal calculus.

The standard treatment for an irreversibly damaged kidney or localised kidney cancer is nephrectomy, either open or laparoscopic. A simple nephrectomy is the removal of just the kidney whereas a radical nephrectomy also involves the removal of the adrenal gland and sometimes lymph nodes. A nephroureterectomy involves removal of the ureter and a cuff of bladder along with the kidney, and is used to treat transitional cell carcinoma of the upper urinary tract.

Open or laparoscopic nephrectomy is also used to retrieve healthy kidneys from live donors for transplantation.

What the procedure involves

The claimed benefits of this procedure over standard laparoscopic nephrectomy are less pain, shorter recovery time, fewer wound complications and improved cosmesis.

Single-port laparoscopic nephrectomy is performed with the patient under general anaesthetic, usually with a transperitoneal approach. A single umbilical skin incision is used to insert multiple instruments, typically via a specially designed system. A laparoscope is used for visualisation and surgical dissection. As with conventional laparoscopic nephrectomy, the procedure includes exposure of the kidney, ureter mobilisation, and dissection and ligation of the renal artery and vein. The kidney may then be enclosed in a retrieval bag and removed through the umbilicus or vagina, either intact or morcellated.

Literature review

Rapid review of literature

The medical literature was searched to identify studies and reviews relevant to single port laparoscopic nephrectomy. Searches were conducted of the following databases, covering the period from their commencement to 21 February 2011: 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 C for details of search strategy). Relevant published studies identified during consultation

or resolution that are published after this date may also be considered for inclusion.

The following selection criteria (table 1) were applied to the abstracts identified by the literature search. Where selection 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, or a laboratory or animal study. Conference abstracts were also excluded because of the difficulty of appraising study methodology, unless they reported specific adverse events that were not available in the published literature.
Patient	Patients with malignant or benign kidney disease; patients undergoing donor nephrectomy.
Intervention/test	Single-port laparoscopic nephrectomy.
Outcome	Articles were retrieved if the abstract contained information relevant to the safety and/or efficacy.
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 approximately 218 patients treated by single-port laparoscopic nephrectomy from 2 randomised controlled trials (RCTs), 3 non-randomised comparative studies and 4 case series[1–9].

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

Table 2 Summary of key efficacy and safety findings on single-port laparoscopic nephrectomy

Abbreviations used: NR, not reported

<table>
<tr><th>Study details</th><th>Key efficacy findings</th><th>Key safety findings</th><th>Comments</th></tr>
<tr>
<td>Tugcu V (2010)[1]

Randomised controlled trial

Turkey

Recruitment period: 2008–9

Study population: patients with benign kidney disease

n = 27 (14 single-port laparoscopic simple nephrectomy vs 13 conventional transperitoneal laparoscopic simple nephrectomy)

Mean age: 39 years
Sex: 56% (15/27) female

Patient selection criteria: not reported. All patients had benign lesions or non-functioning kidneys.

Technique: all single-port procedures were done through an intraumbilical single-access multichannel laparoscopic port (SILS™ Port, Covidien, USA). All specimens were morcellated before removal.

Mean follow-up: 3 months

Conflict of interest/source of funding: none</td>
<td>Number of patients analysed: 27 (14 vs 13)

Comparison of perioperative values and short-term measures of convalescence
<table>
<tr><th></th><th>Single-port laparoscopy</th><th>Conventional laparoscopy</th><th>p</th></tr>
<tr><td>Mean operative time (mins)</td><td>117.5</td><td>114.0</td><td>0.52</td></tr>
<tr><td>Mean estimated blood loss (ml)</td><td>50.7</td><td>47.2</td><td>0.60</td></tr>
<tr><td>Mean length of hospital stay (days)</td><td>2.1</td><td>2.1</td><td>0.74</td></tr>
<tr><td>Mean return to normal activities (days)</td><td>10.7</td><td>13.5</td><td>0.001</td></tr>
</table>
Postoperative pain perception and analgesia requirement
<table>
<tr><th></th><th>Single port laparoscopy</th><th>Conventional laparoscopy</th><th>p</th></tr>
<tr><td colspan="4">Mean pain score (visual analogue scale, range 1–10)</td></tr>
<tr><td>Day of operation</td><td>3.1 ± 1.1</td><td>4.1 ± 1.3</td><td>0.03</td></tr>
<tr><td>First postoperative day</td><td>2.4 ± 0.6</td><td>3.1 ± 0.7</td><td>0.009</td></tr>
<tr><td>Second postoperative day</td><td>1.6 ± 0.6</td><td>2.5 ± 0.6</td><td>0.001</td></tr>
<tr><td>Third postoperative day</td><td>0.9 ± 0.6</td><td>1.6 ± 0.6</td><td>0.01</td></tr>
<tr><td colspan="4">Average consumption of morphine sulphate equivalent (mg)</td></tr>
<tr><td>Day of operation</td><td>64.3 ± 23.3</td><td>76.0 ± 24.2</td><td>0.21</td></tr>
<tr><td>First postoperative day</td><td>50.0 ± 20.0</td><td>67.4 ± 21.4</td><td>0.04</td></tr>
<tr><td>Second postoperative day</td><td>21.4 ± 25.7</td><td>44.8 ± 21.4</td><td>0.01</td></tr>
</table>
On follow-up, all patients were symptom free.
‘Compared with conventional laparoscopy, single-port laparoscopic nephrectomy had a better cosmetic result and patient satisfaction’.</td>
<td>All single-port procedures were completed successfully with no conversions to conventional laparoscopic or open surgeries.

There were no conversions to open surgery in the conventional laparoscopy group.

No blood transfusions required by either group.

The report stated that no significant intraoperative or postoperative complications occurred in either group.</td>
<td>Follow-up issues:
• No losses to follow-up were described.

Study design issues:
• Although the study is described as a randomised controlled trial, consecutive patients were assigned alternately to each treatment group. This does not constitute true randomisation.
• All procedures were done by the same surgeon.
• The method of assessing patient satisfaction was not described.

Study population issues:
• The 2 groups were comparable with regard to age, sex, body mass index, and the affected side.</td>
</tr>
</table>

Abbreviations used: NR, not reported

<table>
<tr><th>Study details</th><th>Key efficacy findings</th><th>Key safety findings</th><th>Comments</th></tr>
<tr>
<td>Kurien A (2011)[2]

Randomised controlled trial

India

Recruitment period: 2009–10.

Study population: live kidney donors

n = 50 (25 single-port laparoscopic donor nephrectomy vs 25 standard laparoscopic donor nephrectomy_

Mean age (years): 46
Sex: 70% (35/50) female

Patient selection criteria: exclusion criteria were right-sided nephrectomy and any abnormal renal vascular anomaly. Patients with a body mass index >25 kg/m^2 were also excluded from the study for the first 30 patients (cut off was later extended to 27 kg/m^2).

Technique: Single-port access was achieved using an R-port (Advanced Surgical Concepts). The graft was retrieved through the umbilical incision after removing the R-port, sometimes requiring minimal extension of the incision. In the last 3 patients, a retrieval bag was used.

Follow-up: 9 months

Conflict of interest/source of funding: none</td>
<td>Number of patients analysed: 50 (25 vs 25)

All patients in the single-port group required an accessory 3-mm port for inserting an instrument for retraction.

<table>
<tr><th></th><th>Single-port laparoscopy</th><th>Standard laparoscopy</th><th>p value</th></tr>
<tr><td>Operating time (minutes)</td><td>172.2 ± 38.3</td><td>175.8 ± 47.6</td><td>0.38</td></tr>
<tr><td>Estimated blood loss (ml)</td><td>84.0 ± 29.1</td><td>92.4 ± 28.3</td><td>0.16</td></tr>
<tr><td>Graft ureter length (mm)</td><td>123.0 ± 18.4</td><td>114.0 ± 24.8</td><td>0.08</td></tr>
<tr><td>Length of incised wounds (mm)</td><td>51.5 ± 14.4</td><td>133.6 ± 17.0</td><td><0.0001</td></tr>
<tr><td>Hospital days</td><td>3.9 ± 0.76</td><td>4.6 ± 0.8</td><td>0.003</td></tr>
<tr><td>Mean postoperative physical component score</td><td>54.2 ± 5.1</td><td>55.0 ± 3.3</td><td>0.27</td></tr>
<tr><td>Mean postoperative mental component score</td><td>56.3 ± 4.1</td><td>55.8 ± 5.6</td><td>0.34</td></tr>
<tr><td>Body image score</td><td>19.4 ± 0.8</td><td>19.6 ± 1.2</td><td>0.25</td></tr>
<tr><td>Cosmesis score</td><td>18.3 ± 1.7</td><td>18.0 ± 2.6</td><td>0.32</td></tr>
<tr><td>Warm ischaemia time (minutes)</td><td>7.2 ± 1.8</td><td>5.1 ± 1.0</td><td><0.0001</td></tr>
<tr><td>Total ischaemia time before revascularisation (minutes)</td><td>62.7 ± 12.1</td><td>62.6 ± 9.5</td><td>0.48</td></tr>
</table>

There were no statistically significant differences in estimated glomerular filtration rates, acute rejection episodes, acute tubular necrosis, ureteral complications, or graft loss between the groups at 1-year follow-up.

Postoperative pain score (visual analogue scale 1 to 10)
<table>
<tr><th>Time (postoperative</th><th>Single-port laparoscopy</th><th>Standard laparoscopy</th><th>p value</th></tr>
</table>
</td>
<td>There were no conversions to open surgery in either group.

8% (2/25) single-port procedures were converted to multiple ports.

Intraoperative complications:
• Single-port = 16% (4/25)
• Standard = 8% (2/25)

Complications in single-port group: 2 minor splenic capsule tear, 2 diaphragmatic tear and 1 small renal upper pole tear (NB 5 complications are listed, presumably affecting 4 patients although this is not stated).

Complications in standard group: 1 bladder injury and 1 minor splenic capsule tear.

All complications were managed immediately without any postoperative sequel.

Postoperative complications:
• Single-port = 16% (4/25)
• Standard = 20% (5/25)

Complications in single-port group: 2 fever necessitating antipyretics, 2 minimal purulent discharge from umbilical wound.

Complications in standard</td>
<td>Study design issues:
• Sample size was calculated to detect a significant mean pain score difference of 1.
• Block randomisation was used.
• The primary outcome was pain score assessed for 96 hours following surgery.
Study population issues:
• The two groups were similar with regard to age, sex, body mass index, and physical and mental component scores.
• Highly selected patient population.
Other issues:
• The graft retrieval technique evolved during the study, with the aim of reducing warm ischaemia time. The mean warm ischaemia time in the last 3 patients in whom a retrieval bag was used, was 5.5 minutes.</td>
</tr>
</table>

Abbreviations used: NR, not reported

Study details	Key efficacy findings	Key safety findings	Comments

hours)			
12 hours	6.04 ± 2.17	5.57 ± 1.53	0.17
24 hours	5.08 ± 1.15	5.20 ± 1.19	0.36
36 hours	4.96 ± 1.31	4.52 ± 1.23	0.12
48 hours	3.68 ± 0.75	3.84 ± 1.68	0.33
60 hours	2.36 ± 1.19	3.40 ± 1.73	0.009
72 hours	1.72 ± 0.68	2.76 ± 1.16	0.0002
96 hours	1.24 ± 0.72	2.08 ± 0.91	0.0004
Total analgesic requirement (mg of tramadol)	118.0 ± 96.7	120.0 ± 73.6	0.47

group: 2 fever necessitating antipyretics, 2 minimal purulent discharge from surgical incision, 1 subacute intestinal obstruction (managed conservatively).

Abbreviations used: NR, not reported

<table>
<tr><th>Study details</th><th>Key efficacy findings</th><th>Key safety findings</th><th>Comments</th></tr>
<tr>
<td>Mir SA (2011)[3]

Non-randomised comparative study

USA

Recruitment period: 2007–9

Study population: patients with benign or malignant kidney disease

n = 64 (30 single-port laparoscopic nephrectomies vs 34 conventional laparoscopic nephrectomies

Median age (years): 47 (single-port); 64 (conventional laparoscopy), p = 0.004
Sex: 56% (36/64) female

Patient selection criteria: not reported.

Technique: For right sided nephrectomies, an additional 3-mm trocar was used for liver retraction. In patients treated by simple nephrectomy for symptomatic, non-functioning kidneys, the specimen was removed through the umbilical port using morcellation.

Follow-up: not reported

Conflict of interest/source of funding: not reported.</td>
<td>Number of patients analysed: 64 (30 vs 34)

Comparison of perioperative values and short-term measures of convalescence
<table>
<tr><th></th><th>Single-port laparoscopy</th><th>Conventional laparoscopy</th><th>p</th></tr>
<tr><td>Median operative time (range, mins)</td><td>128 (72–220)</td><td>133.5 (84–287)</td><td>0.973</td></tr>
<tr><td>Median estimated blood loss (range, ml)</td><td>22.5 (0–600)</td><td>50 (0–500)</td><td>0.119</td></tr>
<tr><td>Median length of hospital stay (range, hours)</td><td>42.7 (19.4–75.4)</td><td>46.1 (28.1–355.2)</td><td>0.006</td></tr>
</table>
</td>
<td>There was 1 conversion to conventional laparoscopy because the renal hilum was inaccessible using the single-port technique.

Complications
• Single-port laparoscopy = 13% (4/30)
• Conventional laparoscopy = 15% (5/34)

Single-port laparoscopy:
• Transient right deltoid neuropraxia = 3.3% (1/30)
• Hyperkalaemia (treated with medication) = 3.3% (1/30)
• Postoperative bleeding requiring transfusion = 3.3% (1/30)
• Constipation requiring readmission (treated with medication) = 3.3% (1/30)

Conventional laparoscopy:
• Transient left-hand neuropraxia = 2.9% (1/34)
• Postoperative bleeding requiring transfusion = 5.9% (2/34)
• Ileus = 2.9% (1/34)
• Retroperitoneal haematoma requiring percutaneous drainage = 2.9% (1/34)</td>
<td>Study design issues:
• Retrospective design.

Study population issues:
• Patients in the single-port group were statistically significantly younger and had a lower median body mass index than patients in the standard laparoscopy group. Patients in the single-port group were more likely to undergo nephrectomy for benign indications (50% vs 15%, p = 0.006).

Other issues:
• The authors noted a downward trend in the percentage of nephrectomies being done using the single-port approach and concluded that this may be due to the limited advantages of the technique, beyond cosmesis.</td>
</tr>
</table>

Abbreviations used: NR, not reported

<table>
<tr><th>Study details</th><th>Key efficacy findings</th><th>Key safety findings</th><th>Comments</th></tr>
<tr>
<td>Park YH (2010)[4]

Non-randomised comparative study

Korea

Recruitment period: 2009

Study population: patients with localised renal cell carcinoma

n = 57 (19 single-port laparoscopic radical nephrectomies vs 38 conventional laparoscopic radical nephrectomies)

Mean age (years): 51 (range 22–78)
Sex: 26% (15/57) female

Patient selection criteria: patients with localised renal cell carcinoma, staged on abdominal CT. None of the patients were considered suitable for partial nephrectomy.

Technique: For single-port laparoscopic nephrectomy, a custom-made single-port device or Octoport® (DalimSurgnet, Korea) was used in a single vertical incision around the umbilicus. For both techniques, the kidneys were removed through the abdominal incision without morcellation.

Follow-up: not reported

Conflict of interest/source of funding: none</td>
<td>Number of patients analysed: 57 (19 vs 38)

Comparison of perioperative values
<table>
<tr><th></th><th>Single-port laparoscopy</th><th>Conventional laparoscopy</th><th>p</th></tr>
<tr><td>Mean operative time (mins)</td><td>190.8 (125–335)</td><td>172.4 (110–250)</td><td>0.25</td></tr>
<tr><td>Mean estimated blood loss (ml)</td><td>143.2 (100–300)</td><td>199.5 (50–500)</td><td>0.24</td></tr>
<tr><td>Transfusion (%)</td><td>1 (5.3)</td><td>1 (2.6)</td><td>1.00</td></tr>
<tr><td>Resumption of oral intake (days)</td><td>1.0 (1–2)</td><td>1.0 (1–2)</td><td>0.48</td></tr>
<tr><td>Analgesics (mg of pethidine)</td><td>39.5 (0–100)</td><td>45.4 (0–125)</td><td>0.58</td></tr>
<tr><td>Pain score – day 1</td><td>4.7 (3–6)</td><td>5.8 (3–8)</td><td>0.001</td></tr>
<tr><td>Pain score – day 2</td><td>3.4 (2–4)</td><td>4.6 (2–6)</td><td><0.001</td></tr>
<tr><td>Pain score – day 3</td><td>2.7 (2–3)</td><td>4.0 (2–6)</td><td>0.008</td></tr>
<tr><td>Mean length of hospital stay (days)</td><td>2.7 (2–4)</td><td>3.9 (3–7)</td><td><0.001</td></tr>
</table>
Pathological examination revealed renal cell carcinoma in all cases.</td>
<td>There were no conversions to open surgery in the single-port group. There was 1 conversion to open surgery in the conventional group, due to extensive bleeding from the inferior vena cava branch.

Complications (all described as minor):
• Single-port = 15.8% (3/19)
• Conventional = 21.1% (8/38), p = 0.635

Wound infection
• Single-port = 5.3% (1/19)
• Conventional = 2.6% (1/38)
Postoperative fever
• Single-port = 5.3% (1/19)
• Conventional =5.3% (2/38)
Postoperative urinary retention:
• Single-port = 5.3% (1/19)
• Conventional = 5.3% (2/38)
Ileus
• Single-port = 0% (0/19)
• Conventional = 2.6% (1/38)
Drug eruption
• Single-port = 0% (0/19)
• Conventional = 2.6% (1/38)
Chylus ascites
• Single-port = 0% (0/19)
• Conventional = 2.6% (1/38)</td>
<td>Study design issues:
• Retrospective design.
• Matched controls were selected from the cohort of patients treated by conventional laparoscopic radical nephrectomy between 2000 and 2009.
• Postoperative pain was measured using a visual analogue scale.

Study population issues:
• The two groups were similar with regard to age, sex, body mass index, and American Society of Anesthesiologists score.

Other issues:
• The authors noted that operative time reduced with experience and reached statistical significance within the initial 13 cases.</td>
</tr>
</table>

Abbreviations used: NR, not reported			
Study details	**Key efficacy findings**	**Key safety findings**	**Comments**
Irwin BH (2010)[5] **Case series** USA, UK Recruitment period: 2007–8 Study population: patients with benign or malignant kidney disease **n = 62 (37 simple nephrectomy, 18 donor nephrectomy, 5 radical nephrectomy, 2 nephroureterectomy)** Mean age (years): not reported Sex: not reported Patient selection criteria: not reported Technique: a single 2-mm needlescopic port was allowed within the definition of a single-port procedure. **Follow-up: not reported** Conflict of interest/source of funding: several authors disclosed that they were consultants for manufacturers.	Number of patients analysed: **62**	1 simple nephrectomy was converted to standard laparoscopy to aid in dissection (2 added ports – one 5-mm and one 12-mm) 1 nephroureterectomy was converted to standard laparoscopy to control bleeding (2 added ports – one 5-mm and one 12-mm) Complications **Simple nephrectomy (n = 37):** • Postoperative fever = 2.7% (1/37) • Port-site haematoma = 2.7% (1/37) • Deep venous thrombosis = 2.7% (1/37) • Duodenal injury = 2.7% (1/37) **Donor nephrectomy (n = 18):** • Corneal abrasion = 5.6% (1/18) • Anti-emetic induced dyskinesia = 5.6% (1/18)	**Study design issues**: • Includes data from 6 study centres.
Abbreviations used:			
Study details	**Key efficacy findings**	**Key safety findings**	**Comments**

Abbreviations used: NR, not reported

<table>
<tr><th>Study details</th><th>Key efficacy findings</th><th>Key safety findings</th><th>Comments</th></tr>
<tr>
<td>Canes D (2010)[6]

Non-randomised comparative study

USA

Recruitment period: 2007–8

Study population: live kidney donors

n = 35 (17 single-port laparoscopic donor nephrectomies vs 18 conventional laparoscopic donor nephrectomies)

Mean age (years): 38.5 (range 21–65)
Sex: 71% (25/35) female

Patient selection criteria: all potential donors were evaluated by a multidisciplinary team and met usual criteria for donation.

Technique: all single-port procedures were performed through an intraumbilical single-access multichannel laparoscopic port (R-Port, Advanced Surgical Concepts, Ireland). A 2-mm needle port was inserted via direct skin puncture to enable use of a needlescopic grasper.

Follow-up: 3 months

Conflict of interest/source of funding: none</td>
<td>Number of patients analysed: 35 (17 vs 18)

Comparison of perioperative values and convalescence data
<table>
<tr><th></th><th>Single-port laparoscopy</th><th>Conventional laparoscopy</th><th>p</th></tr>
<tr><td>Mean operative time (mins)</td><td>269 (180–495)</td><td>239 (150–331)</td><td>0.3</td></tr>
<tr><td>Mean estimated blood loss (ml)</td><td>108 (50–200)</td><td>141 (50–250)</td><td>0.2</td></tr>
<tr><td>Warm ischaemia time (mins)</td><td>6.1 (2.8–10.3)</td><td>3.0 (2.0–4.2)</td><td><0.0001</td></tr>
<tr><td>Mean length of hospital stay (days)</td><td>3.0 (1–6)</td><td>3.5 (2–7)</td><td>0.2</td></tr>
<tr><td>Morphine equivalents (mg)</td><td>100 (2–201)</td><td>97 (5–204)</td><td>0.9</td></tr>
<tr><td>Visual analogue pain score at discharge</td><td>2.7 (0–8)</td><td>1.4 (0–5)</td><td>0.2</td></tr>
<tr><td>Days on oral pain pills</td><td>6 (0–21)</td><td>20 (2–70)</td><td>0.01</td></tr>
<tr><td>Days to return to work</td><td>18 (5–45)</td><td>46 (14–90)</td><td>0.0009</td></tr>
<tr><td>Days to 100% physical recovery</td><td>29 (14–60)</td><td>83 (14–300)</td><td>0.03</td></tr>
<tr><td colspan="4">Patient satisfaction</td></tr>
<tr><td>Mean patient-reported overall satisfaction score (scale 1–10)</td><td>9.5</td><td>8.5</td><td>0.053</td></tr>
<tr><td>Mean patient-reported scar satisfaction (scale 1–10)</td><td>9.7</td><td>7.7</td><td>0.003</td></tr>
<tr><td>Would recommend to a friend</td><td>100%</td><td>100%</td><td></td></tr>
</table>
Allograft outcomes - there were no differences in mean serum creatinine levels between the groups at 3-month follow-up (excluding the patient with allograft thrombosis).</td>
<td>No single-port laparoscopic procedure was converted to open surgery. One right-sided procedure was converted to conventional laparoscopy and excluded from the single-port group for analysis.

No intraoperative complications occurred in either group.

There were 2 postoperative complications in the single-port laparoscopic group:
• Corneal abrasion = 5.9% (1/17)
• Allograft thrombosis = 5.9% (1/17) (recipient patient underwent allograft nephrectomy at 1 week postoperatively, after renal scans demonstrated no flow and biopsy revealed cortical necrosis. History-pathology revealed nonviable glomeruli without evidence of rejection. The authors noted that they could not identify any clear-cut reason for the thrombosis.)</td>
<td>This study includes the same patients as Desai MM (2009)

Study design issues:
• The single-port laparoscopy group included consecutive patients. A contemporary matched-pair cohort of patients undergoing standard laparoscopic nephrectomy was selected for retrospective comparison.
• Patients were subject to recall bias when recounting their convalescence variables.
• Convalescence was assessed using a specially developed questionnaire rather than a standardised quality-of-life questionnaire.
Study population issues:
• The two groups were similar with regard to age, sex, body mass index, kidney volume, anatomic complexity and surgical date.
Other issues:
• The authors stated that the increased operative time with single-port laparoscopic nephrectomy was attributable to the learning curve with instrument clashing.</td>
</tr>
</table>

Abbreviations used: NR, not reported

<table>
<tr><th>Study details</th><th>Key efficacy findings</th><th>Key safety findings</th><th>Comments</th></tr>
<tr>
<td>Jeon HG (2010)[7]

Case series

Korea

Recruitment period: 2008–9

Study population: patients with kidney cancer or non-functioning kidney

n = 24 (9 simple nephrectomy, 9 radical nephrectomy, 6 nephroureterectomy)

Mean age: not reported separately for nephrectomy patients

Sex: not reported

Patient selection criteria: not reported

Technique: all procedures were performed using a homemade single-port device. 5 procedures were robotic single port laparoscopic procedures (1 simple nephrectomy, 1 radical nephrectomy and 3 nephroureterectomies).

Follow-up: not reported

Conflict of interest/source of funding: not reported.</td>
<td>Number of patients analysed: 18

Operative and postoperative data (mean values)
<table>
<tr><th></th><th>Simple nephrectomy (n = 9)</th><th>Radical nephrectomy (n = 9)</th><th>Nephroureter-ectomy (n = 6)</th></tr>
<tr><td>Operative time (mins)</td><td>217 (robotic = 190)</td><td>186 (robotic = 273)</td><td>150 (robotic = 240)</td></tr>
<tr><td>Estimated blood loss (ml)</td><td>74 (robotic = 100)</td><td>405 (robotic = 150)</td><td>105 (robotic = 110)</td></tr>
<tr><td>Hospital stay (days)</td><td>4.2 (robotic = 7.0)</td><td>5.5 (robotic = 3.0)</td><td>4.2 (robotic = 3.0)</td></tr>
</table>
</td>
<td>Complications:
• Diaphragm injury = 5.6% (1/18) (radical nephrectomy, sutured successfully using the single port).
• Bowel injury = 5.6% (1/18) (robotic simple nephrectomy, serosal tearing occurred during manipulation of adhesions; sutured successfully using the single port).</td>
<td>Other issues:
• The report included other single-port laparoscopic procedures, including cyst decortications.
• Data include 2 procedures using a robotic single-port approach.
• The authors noted that in Korea, most patients do not leave the hospital until they can return to normal activity.</td>
</tr>
</table>

Abbreviations used: NR, not reported

<table>
<tr><th>Study details</th><th>Key efficacy findings</th><th>Key safety findings</th><th>Comments</th></tr>
<tr>
<td>Lee SY (2010)[8]

Case series

Korea

Recruitment period: 2009–10

Study population: patients with benign or malignant kidney disease

n = 12 (7 nephrectomy [2 simple, 5 radical]; 5 nephroureterectomy)

Mean age: 63 years

Sex: 50% (6/12) female

Patient selection criteria: not reported. Patients with a history of previous abdominal surgery were excluded.

Technique: a custom made single-port device was used. All specimens were removed intact.

Follow-up: not reported

Conflict of interest/source of funding: none</td>
<td>Number of patients analysed: 12

Operative and postoperative data (mean values)
<table>
<tr><th></th><th>Simple nephrectomy (n = 2)</th><th>Radical nephrectomy (n = 5)</th><th>Nephroureter-ectomy (n = 5)</th></tr>
<tr><td>Operative time (mins)</td><td>277.5</td><td>177.0</td><td>336.0</td></tr>
<tr><td>Estimated blood loss (ml)</td><td>1175.0</td><td>320.0</td><td>320.0</td></tr>
<tr><td>Incision length (cm)</td><td>3.5</td><td>4.2</td><td>5.2</td></tr>
<tr><td>Hospital stay (days)</td><td>6.0</td><td>7.0</td><td>8.4</td></tr>
<tr><td>Pain scale (operation day)</td><td>8.0</td><td>5.8</td><td>6.2</td></tr>
<tr><td>Pain scale (postoperative day 1)</td><td>4.5</td><td>3.0</td><td>3.6</td></tr>
</table>
</td>
<td>Complications:
• Conversion to conventional laparoscopic removal = 8.3% (1/12) (simple nephrectomy; patient had xanthogranulomatosis pyelonephritis and severe adhesion to adjacent tissue. Two additional ports were inserted and the patient required blood transfusion).
• Conversion to open surgery = 16.7% (2/12) (nephroureterectomies for ureteral tumours; 1 incision extension was performed because of complete renal lymphadenectomy by the open technique and 1 open conversion was performed because of severe adhesion around the distal ureter.)
• Ileus = 16.7% (2/12)</td>
<td>Study design issues:
• Retrospective analysis.
• All procedures were done by a single surgeon.

Other issues:
• The report included other single-port laparoscopic procedures (4 ureterolithotomy, 8 marsupialisation and 6 varicocelectomy).</td>
</tr>
</table>

Abbreviations used: NR, not reported			
Study details	**Key efficacy findings**	**Key safety findings**	**Comments**
Berkowitz JR (2010)[9] **Case series** USA Recruitment period: 2008–10 Study population: patients with kidney tumours not amenable to partial nephrectomy or non-functioning kidney **n = 15 (11 radical, 4 simple)** Mean age: not reported Sex: not reported Patient selection criteria: not reported Technique: several techniques are described but details of those used in the case series are not provided. **Follow-up: not reported** Conflict of interest/source of funding: none	Number of patients analysed: **15** **Single-port laparoscopic radical nephrectomy (n = 11)** Mean operative time = 116 min (included 1 patient undergoing bilateral single-port laparoscopic nephrectomy) Estimated blood loss = 75 ml (range 25 – 150)	There were no conversions to standard laparoscopy and all margins of resection were negative for tumour. **Complications:** *Single-port radical nephrectomy (n =11)* There were no intraoperative complications. 1 patient who had bilateral nephrectomy developed severe abdominal distension and subsequently suffered dehiscence of his umbilical extraction site (the authors noted that the patient suffered from multiple comorbidities and was on chronic steroid therapy). *Single port simple nephrectomy (n = 4)* 1 patient had a postoperative small bowel obstruction. The patient presented with severe abdominal pain 14 days after uncomplicated single port laparoscopic simple nephrectomy. A CT scan showed significant persistent pneumoperitoneum. An upper gastrointestinal study with follow-through confirmed the integrity of the bowel. The pain resolved but the patient returned 1 week later with a small bowel obstruction due to an adhesive band away from the nephrectomy site requiring surgical exploration.	**Other issues**: • Although the study reports some primary data, the main focus is to review other studies. Few details are provided for the results presented.

Efficacy

Operative time

An RCT of 27 patients treated by single-port laparoscopic nephrectomy or conventional laparoscopic nephrectomy reported operative times of 118 and 114 minutes respectively ($p = 0.52$)[1]. An RCT of 50 renal donors reported operative times of 172 minutes for single-port laparoscopic donor nephrectomy and 176 minutes for standard laparoscopic donor nephrectomy ($p = 0.38$)[2]. Three non-randomised comparative studies, including a total of 156 patients, also reported similar operative times for single-port laparoscopic nephrectomy compared with conventional laparoscopic nephrectomy [3,4,6].

Analgesia requirements and pain scores

The RCT of 27 patients reported significantly lower postoperative use of analgesics in patients treated by single-port laparoscopic nephrectomy compared with those treated by conventional laparoscopic nephrectomy (21 mg equivalent of morphine sulphate vs 45 mg equivalent on postoperative day 2, $p = 0.01$)[1]. The RCT of 50 renal donors reported improved pain scores after 48 hours in the single-port laparoscopic donor nephrectomy group compared with the standard laparoscopic donor nephrectomy group (1.24 versus 2.08 at 96 hours postoperatively on a visual analogue scale of 1–10, $p = 0.0004$)[2].

A non-randomised comparative study of 57 patients treated by single-port laparoscopic nephrectomy or conventional laparoscopic nephrectomy reported no significant difference in analgesic use (40 mg vs 45 mg of pethidine), although the pain score was significantly lower on postoperative days 1–3 for patients in the single-port group (4.7, 3.4 and 2.7 vs 5.8, 4.6 and 4.0, respectively [$p = 0.001$, $p < 0.001$ and $p = 0.008$])[4]. A non-randomised comparative study of 35 patients treated by single-port laparoscopic nephrectomy or conventional laparoscopic nephrectomy also reported that there was no significant difference in analgesic use (100 mg vs 97 mg morphine equivalent, $p = 0.9$)[6].

Patient recovery time

The RCT of 27 patients reported a significantly faster return to normal activities in patients treated by single-port laparoscopic nephrectomy compared with those treated by conventional laparoscopic nephrectomy (11 days vs 14 days, $p = 0.001$)[1].

A non-randomised comparative study of 35 patients treated by single-port laparoscopic nephrectomy or conventional laparoscopic nephrectomy reported a faster return to work and shorter time to complete physical recovery for patients in the single-port group compared to conventional laparoscopy (18 days vs 46 days, $p = 0.0009$ and 29 days vs 83 days, $p = 0.03$, respectively)[6].

Patient satisfaction

A non-randomised comparative study of 35 patients treated by single-port laparoscopic nephrectomy or conventional laparoscopic nephrectomy reported mean patient-reported overall satisfaction scores of 9.5 and 8.5 (scale 1–10), respectively ($p = 0.053$)[6]. The mean patient-reported scar satisfaction was statistically significantly higher in the single-port group compared to the conventional laparoscopy group (9.7 vs 7.7 [scale 1–10], respectively, $p = 0.003$). All patients in both groups would recommend the procedure to a friend.

Safety

Allograft thrombosis

A non-randomised comparative study including 17 single-port laparoscopic donor nephrectomies reported 1 allograft thrombosis (the patient underwent an allograft nephrectomy at 1 week postoperatively; no reason for the thrombosis was identified)[6].

Intraoperative complications

A case series of 62 patients reported 1 case of duodenal injury[5]. A case series of 18 patients reported 1 diaphragm injury and 1 bowel injury; both were successfully sutured using the single-port[7].

A case series of 12 patients reported that 1 single-port laparoscopic simple nephrectomy was converted to conventional laparoscopy because of adhesions and bleeding. Two single-port laparoscopic nephroureterectomies were converted to open surgery; 1 because of complete renal hilar lymphadenectomy by the open technique and the other because of severe adhesions[8]. A case series of 62 patients reported that 1 single-port laparoscopic simple nephrectomy was converted to conventional laparoscopy to aid in dissection and 1 single-port nephroureterectomy was converted to conventional laparoscopy to control bleeding[5].

Wound infection

A non-randomised comparative study including 19 patients treated by single-port laparoscopic nephrectomy reported 1 wound infection[4].

Other complications

A non-randomised comparative study including 17 single-port laparoscopic donor nephrectomies reported 1 corneal abrasion[6].

A case series of 15 patients reported 1 dehiscence of the umbilical extraction site (the authors noted that the patient suffered from multiple comorbidities and was on chronic steroid therapy) and 1 postoperative small bowel obstruction (due to an adhesive band away from the nephrectomy site)[9].

Validity and generalisability of the studies

- The patient populations are heterogenous both within and between studies. They include live kidney donors, patients with kidney cancer and those with benign kidney disease.
- In the study described as a randomised controlled trial, patients were assigned alternately to each treatment group. This does not constitute true randomisation[1].
- None of the studies blinded patients to their treatment allocation and some of the subjective outcomes such as pain scores may be subject to bias.
- The port incision may be extended if the kidney is extracted with a mass or for donation. This may blunt the demonstrable differences in postoperative analgesic requirements.
- Most of these data include the initial series of patients treated by single-port laparoscopic nephrectomy and there may be a learning curve effect.
- There is some patient overlap between two studies[5, 6].
- None of the studies report recurrence-free survival data.

Existing assessments of this procedure

The Australia and New Zealand Horizon Scanning Network (ANZHSN) published a Prioritising Summary Update of single-incision laparoscopic surgery (SILS) for appendectomy and nephrectomy in June 2010[9]. The report concluded:

'In summary, based on the findings of three case series studies and one case control study, it appears that SILS is a feasible, safe and effective approach for patients undergoing appendectomy and nephrectomy. However, further prospective randomised controlled trials are required in order to substantiate the benefits of the SILS technique beyond cosmesis.'

Related NICE guidance

Below is a list of NICE guidance related to this procedure. Appendix B gives details of the recommendations made in each piece of guidance listed.

Interventional procedures

- Single-incision laparoscopic cholecystectomy. NICE interventional procedures guidance 346 (2010). Available from www.nice.org.uk/guidance/IPG346.
- Laparoscopic partial nephrectomy. NICE interventional procedures guidance 151 (2006). Available from www.nice.org.uk/guidance/IPG151.
- Laparoscopic nephrectomy (including nephroureterectomy). NICE interventional procedures guidance 136 (2005). Available from www.nice.org.uk/guidance/IPG136.
- Laparoscopic live donor simple nephrectomy. NICE interventional procedures guidance 57 (2004). Available from www.nice.org.uk/guidance/IPG57.

Specialist Advisers' opinions

Specialist advice was sought from consultants who have been nominated or ratified by their Specialist Society or Royal College. The advice received is their individual opinion and does not represent the view of the society.

Mr P Butterworth, Mr A Rane, Mr P Rimington (British Association of Urological Surgeons).

- Two Specialist Advisers perform the procedure regularly and 1 has performed it at least once.
- One Adviser considers the procedure to be definitely novel and of uncertain safety and efficacy, 1 describes it as first in a new class of procedure and 1 describes it as a minor variation on an existing procedure, which is unlikely to affect the procedure's safety and efficacy.
- The comparator is standard multi-port laparoscopic nephrectomy.
- Theoretical adverse events include injury to the great vessels with major haemorrhage and injury to organs adjacent to the kidney, particularly the duodenum and spleen.
- Adverse events reported in the literature include bleeding requiring transfusion.
- Key efficacy outcomes include cosmesis; reduced postoperative analgesia requirements, reduced postoperative pain and earlier return to normal activity compared with multi-port laparoscopic nephrectomy; oncological safety when the procedure is performed for cancer.
- Specific training in single-port laparoscopic techniques is required.

- One Adviser commented that there is some controversy over the use of the procedure in oncological cases.
- All 3 Specialist Advisers thought that the procedure would have a minor impact on the NHS, in terms of numbers of patients eligible for treatment and use of resources.

Patient Commentators' opinions

NICE's Patient and Public Involvement Programme was unable to gather patient commentary for this procedure.

Issues for consideration by IPAC

None other than those described above.

References

1. Tugcu V, Ilbey YO, Mutlu B et al. (2010) Laparoendoscopic single-site surgery versus standard laparoscopic simple nephrectomy: a prospective randomized study. Journal of Endourology 24: 1315–20.

2. Kurien A, Rajapurkar S, Sinha L et al. (2011) Standard laparoscopic donor nephrectomy versus laparoendoscopic single-site donor nephrectomy: a randomised comparative study. Journal Endourology 25: 365–70.

3. Mir SA, Best SL, Donnally CJ III et al. (2011) Minimally invasive nephrectomy: the influence of laparoendoscopic single-site surgery on patient selection, outcomes, and morbidity. Urology 77: 631–5.

4. Park YH, Park JH, Jeong CW et al. (2010) Comparison of laparoendoscopic single-site radical nephrectomy with conventional laparoscopic radical nephrectomy for localized renal-cell carcinoma. Journal of Endourology 24: 997–1003.

5. Irwin BH, Cadeddu JA, Tracy CR et al. (2010) Complications and conversions of upper tract urological laparoendoscopic single-site surgery (LESS): multicentre experience: results from the NOTES working group. BJU International 107: 1284–9.

6. Canes D, Berger A, Aron M et al. (2010) Laparo-endoscopic single site (LESS) versus standard laparoscopic left donor nephrectomy: matched-pair comparison. European Urology 57: 95–101.

7. Jeon HG, Jeong W, Oh CK et al. (2010) Initial experience with 50 laparoendoscopic single site surgeries using a homemade, single port device at a single center. Journal of Urology 183: 1866–71.

8. Lee SY, Kim YT, Park HY (2010). Initial experience with laparoendoscopic single-site surgery by use of a homemade transumbilical port in urology. Korean Journal of Urology 51: 613–8.

9. Berkowitz JR, Allaf ME (2010) Laparoendoscopic single-site surgery: complications and how to avoid them. BJU International 106: 903–7.

10. Australia and New Zealand Horizon Scanning Network. Single incision laparoscopic surgery (SILS) for appendectomy and nephrectomy. Horizon Scanning Technology Prioritising Summary Update. Adelaide, South Australia, June 2010.

Appendix A: Additional papers on single-port laparoscopic nephrectomy

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	Number of patients/ follow-up	Direction of conclusions	Reasons for non-inclusion in table 2
Andonian S, Rais-Bahrami S, Atalia MA et al. (2010) Laparoendoscopic single-site Pfannenstiel versus standard laparoscopic donor nephrectomy. Journal of Endourology 24: 429–32.	Non-randomised comparative study n = 12	**Donor nephrectomy** No difference between the groups in terms of operative time, warm ischaemia time, narcotic requirements and VAS scores.	Larger studies are included.
Andonian S, Herati AS, Atalia MA et al. (2010) Laparoendoscopic single-site Pfannenstiel donor nephrectomy. Urology 75: 9–13.	Case series n = 6	**Donor nephrectomy** Median warm ischaemia time = 5 min Median hospital stay = 2 days Median pain score at discharge = 0	Larger studies are included.
Autorino R, Cadeddu JA, Desai MM (2011) Laparoendoscopic single-site and natural orifice transluminal endoscopic surgery in urology: A critical analysis of the literature. European Urology 59: 26–45.	Review	The technique is safe and feasible in the hands of experienced laparoscopic surgeons.	No meta-analysis.
Bayazit Y, Aridogan IA, Abat D et al. (2009) Pediatric transumbilical laparoendoscopic single-site nephroureterectomy: initial report. Urology 74: 1116–9.	Case report n = 1	**Paediatric patient** Excellent cosmetic result.	Case report.
Brown CT, Kooiman G, Sharma DM et al. (2010) Scarless single-port laparoscopic pelvic kidney nephrectomy. Journal of Laparoendoscopic & Advanced Surgical Techniques 9: 743–6.	Case report n = 1	No complications.	Case report.
Cadeddu J, Fernandez R, Bergs R et al. (2009) Novel magnetically guided intra-abdominal camera to facilitate laparoendoscopic single-site surgery: Initial human experience. Surgical Endoscopy and Other Interventional Techniques 23: 1894–9.	Case report n = 1	Use of magnetically guided intra-abdominal camera improved surgical working space.	Case report.

Article	Number of patients/ follow-up	Direction of conclusions	Reasons for non-inclusion in table 2
Choi KH, Ham WS, Rha K et al. (2011) Laparoendoscopic single-site surgeries: a single-center experience of 171 consecutive cases. Korean Journal of Urology 31–8.	n = 64 (nephrectomy/ nephro-ureterectomy)	Laparoendoscopic single-site surgery is technically feasible and safe for various urologic diseases; however, surgical experience and long-term follow-up are needed to test the superiority of laparoendoscopic single-site surgery.	Includes a range of urological single-port procedures.
Derweesh IH, Silberstein JL, Bazzi W et al. (2010) Laparo-endoscopic single-site surgery for radical and cytoreductive nephrectomy, renal vein thrombectomy, and partial nephrectomy: a prospective pilot evaluation. Diagnostic & Therapeutic Endoscopy 2010: 107482.	Case series n = 6 Median follow-up = 10 months	Procedures were technically feasible and safe with low discharge pain scores.	Larger studies are included.
Desai MM, Berger AK, Brandina RS et al. (2009) Laparoendoscopic single-site surgery: initial hundred patients. Urology 74 (4) 805–812.	Case series n = 36	With proper patient selection, conversion and complications rates are low. Improvement in instrumentation and technology is likely to expand the role of LESS in minimally invasive urology.	Larger studies are included.
Ganpule AP, Dhawan DR, Kurien A et al. (2009) Laparoendoscopic single-site donor nephrectomy: a single-center experience. Urology 74: 1238–41.	Case series n = 13	**Donor nephrectomy** 11 patients required extra ports. Cosmesis was excellent.	Larger studies are included.
Gill IS, Canes D, Aron M et al. (2008) Single port transumbilical (E-NOTES) donor nephrectomy. Journal of Urology 180: 637–41.	Case series n = 4	**Donor nephrectomy** No intraoperative complications. All allografts functioned on transplantation.	Larger studies are included.
Ham WS, Im YJ, Jung HJ et al. (2011) Initial experience with laparoendoscopic single-site nephrectomy and nephroureterectomy in children. Urology 77: 1204–1208.	Case series n = 6	Paediatric There were no intraoperative or postoperative complications. All children were discharged on postoperative day 2.	Larger studies are included.
Han WK, Park YH, Jeon HG et al. (2010) The feasibility of laparoendoscopic single-site nephrectomy: initial experience using home-made single port device. Urology 76: 862–5.	Case series n = 14	All procedures were completed successfully. No major complications.	Larger studies are included. Likely to be some patient overlap with Jeon HG et al, 2010.
Johnson KC, Cha DY, DaJusta DG (2009) Pediatric single-port-access nephrectomy for a multicystic, dysplastic kidney. Journal of pediatric urology 5: 402-404.	Case report n = 1	**Paediatric patient**	Case report.
Kopp RP, Silberstein JL, Derweesh IH (2010) Laparo-endoscopic single-site (LESS) radical nephrectomy with renal vein thrombectomy: initial report. BMC Urology 10: 8.	Case series n = 2	No complications.	Larger studies are included.

Article	Number of patients/ follow-up	Direction of conclusions	Reasons for non-inclusion in table 2
Lee SW, Lee JY. (2011) Laparoendoscopic single-site urological surgery using a homemade single port device: the first 70 cases performed at a single center by one surgeon. Journal of Endourology 25: 257–64.	Case series n = 4 (nephrectomy)	1 conversion to conventional laparoscopic surgery.	Case series of all urological single-port procedures; only 4 nephrectomies are included.
Leveillee RJ, Castle SM, Gorin MA et al. (2011) Initial experience with laparoendoscopic single-site simple nephrectomy using the TransEnterix SPIDER surgical system: assessing feasibility and safety. Journal of Endourology 25: 923–5.	Case report n = 1	Operative time = 210 minutes Blood loss = 50 ml No intraoperative or postoperative complications.	Case report.
Marietti S, DeCambre M, Fairbanks T et al. (2010) Early experience with laparoendoscopic single-site surgery in the pediatric urology patient population. Journal of Endourology 24: 1321–4.	Case series n = 4	**Paediatric population** 1 conversion to open surgery secondary to bleeding.	Larger studies are included.
Marietti S, Holmes N, Chiang G. (2011) Laparoendoscopic single-site (LESS) bilateral nephrectomy in the pretransplant pediatric population. Pediatric Transplantation 15: 396–399.	Case series n = 4	There were no conversions to conventional laparoscopy or to open surgery. Estimated blood loss was minimal.	Larger studies are included.
Page T, Soomro NA (2010) Bilateral simultaneous single-port (LESS) laparoscopic nephrectomy (laparoendoscopic single site surgery). Indian Journal of Urology 26: 590–2.	Case report n = 1	Successful procedure.	Case report.
Ponsky LE, Steinway ML, Lengu I et al. (2009) A Pfannenstiel single-site nephrectomy and nephroureterectomy: a practical application of laparoendoscopic single-site surgery. Urology 74: 482–5.	Case series n = 2	No complications.	Larger studies are included.
Patel HD, Mullins JK, Pierorazio PM et al. (2011) Laparoendoscopic single-site surgery of the kidney: an initial experience. Canadian Journal of Urology 18: 5745–50.	Case series n = 18 (nephrectomy) Follow-up = 6 months	12% postoperative complications. 1 intraoperative transfusion and 1 conversion to open surgery. Postoperative outcomes and pain scores appear comparable to standard laparoscopy.	Larger studies are included.
Rais-Bahrami S, Montag S, Atalla M et al. (2009) Laparoendoscopic single-site surgery of the kidney with no accessory trocars: an initial experience. Journal of Endourology 23: 1319–24.	Case series n = 6	There were no intraoperative complications.	Larger studies are included.

Article	Number of patients/ follow-up	Direction of conclusions	Reasons for non-inclusion in table 2
Raman JD, Bagrodia A, Cadeddu JA. (2009) Single-incision, umbilical laparoscopic versus conventional laparoscopic nephrectomy: a comparison of perioperative outcomes and short-term measures of convalescence. European Urology 55: 1198–204.	Non-randomised comparative study n = 33	Single-port laparoscopic nephrectomy is feasible with perioperative outcomes and short-term measures of convalescence comparable to conventional laparoscopic nephrectomy. Although it may offer a subjective cosmetic advantage, prospective comparison is needed to more clearly define its role	Larger studies are included.
Rane A, Ahmed S, Kommu SS et al. (2009) Single-port 'scarless' laparoscopic nephrectomies: the United Kingdom experience. BJU International 104: 230–3.	Case series n = 5	All procedures were completed successfully. Convalescence was rapid.	Larger studies are included.
Raybourn JH III, Rane A, Sundaram CP. (2010) Laparoendoscopic single-site surgery for nephrectomy as a feasible alternative to traditional laparoscopy. Urology 75 (1) 100–103.	Non-randomised comparative study n = 21	With no significant difference in operative time and relatively few complications, this is a feasible technique for simple nephrectomy.	Larger studies are included.
Ryu DS, Park WJ, Oh TH (2009) Retroperitoneal laparoendoscopic single-site surgery in urology: initial experience. Journal of Endourology 23: 1857–62.	Case series n = 5	2 nephroureterectomy, 3 nephrectomy Wound dehiscence and bleeding were noted in 2 patients.	Larger studies are included.
Seo IY, Lee JW, Rim JS. (2011) Laparoendoscopic single-site radical nephrectomy: a comparison with conventional laparoscopy. Journal of Endourology 25 (3) 465–469.	Case series n = 22	Procedure is comparable to conventional laparoscopy. Long-term follow-up is needed.	Larger studies are included.
Stein RJ, White WM, Goel RK et al. (2010) Robotic laparoendoscopic single-site surgery using GelPort as the access platform. European Urology 57: 132–6.	Case series n = 1 (nephrectomy)	Procedure completed successfully without complication.	Larger studies are included.
Stoddard D, Marshall J, Wu G et al. (2010) Single incision nephrectomy in an 8-year-old child using umbilical laparoendoscopic single-site surgery (U-LESS). Canadian Journal of Urology 17: 5226–8.	Case report n = 1	**Paediatric patient** Successful procedure.	Case report.
Stolzenburg JU, Hellawell G, Kallidonis P et al. (2009) Laparoendoscopic single-site surgery: early experience with tumor nephrectomy. Journal of Endourology 23: 1287–92.	Case series n = 8	There were no intraoperative or postoperative complications.	Larger studies are included.

Article	Number of patients/ follow-up	Direction of conclusions	Reasons for non-inclusion in table 2
Stolzenburg JU, Do M, Haefner T et al. (2011) Laparoendoscopic single-site surgery radical nephrectomy. Journal of Endourology 25: 159–165.	Case series n = 30	The results indicate that, in experienced hands, LESS-RN is feasible and safe, with results comparable to those of conventional laparoscopic radical nephrectomy. Nevertheless, larger series of patients are needed to prove if the increased technical difficulty of LESS-RN justifies its use in routine urologic practice.	Larger studies are included.
Tam YH, Lee KH, Sihoe JD et al. (2010) Initial experience in children using conventional laparoscopic instruments in single-incision laparoscopic surgery. Journal of Pediatric Surgery 45: 2381–5.	Case series n = 1 (nephrectomy)	**Paediatric patient** There were no complications.	Larger studies are included.
Tam YH, Sihoe JD, Cheung ST et al. (2011) Single-incision laparoscopic nephrectomy and heminephroureterectomy in young children using conventional instruments: first report of initial experience. Urology 77: 711–715.	Case series n = 3	There were no intraoperative complications or need for conversion.	Larger studies are included.
Vricella GJ, Ross JH, Vourganti S et al. (2010) Laparoendoscopic single-site nephrectomy: initial clinical experience in children. Journal of Endourology 24: 1957–61.	Case series n = 3	**Paediatric patients** There were no additional trocars placed or conversion to open surgery. 1 fever and pseudomembranous colitis in a patient with dialysis who also required a blood transfusion.	Larger studies are included.
White MA, Haber GP, Kaouk JH (2010) Robotic single-site surgery. Current Opinion in Urology 20: 86–91.	Case series n = 1 (nephrectomy)	Robotic procedure. There were no intraoperative complications.	Larger studies are included.
White MA, Autorino R, Spana G et al. (2011) Robotic laparoendoscopic single-site radical nephrectomy: Surgical technique and comparative outcomes. European Urology 59: 815–822.	Non-randomised comparative study n = 20	Single-port laparoscopic radical nephrectomy offers comparable perioperative outcomes to conventional laparoscopic radical nephrectomy. Prospective comparison is needed to definitively establish the position of single-port laparoscopic surgery in minimally invasive urologic surgery.	Larger studies are included.
Yu HS, Ham WS, Rha KH et al. (2011) Laparoendoscopic single-site nephrectomy using a modified umbilical incision and a home-made transumbilical port. Yonsei Medical Journal 52: 307–13.	Case series n = 18	All procedures were completed successfully.	Larger studies are included. Likely to be some patient overlap with Jeon HG et al, 2010.

Appendix B: Related NICE guidance for single-port laparoscopic nephrectomy

Guidance	Recommendations
Interventional procedures	**Single-incision laparoscopic cholecystectomy. NICE interventional procedures guidance 346 (2010).** 1.1 Current evidence on the safety and efficacy of single-incision laparoscopic cholecystectomy (SILC) is limited to small numbers of patients. Since the main potential advantage to patients of this procedure is cosmetic, there is a particular need for good safety data. Therefore this procedure should only be used with special arrangements for clinical governance, consent and audit or research. 1.2 Clinicians wishing to undertake SILC should take the following actions. • Inform the clinical governance leads in their Trusts. • Ensure patients and their carers understand the uncertainty about the procedure's safety and efficacy and provide them with clear written information. In addition, the use of NICE's information for patients ('Understanding NICE guidance') is recommended (available from www.nice.org.uk/guidance/IPG346/publicinfo). • Audit and review clinical outcomes of all patients having SILC (see section 3.1). 1.3 SILC is technically challenging and should only be carried out by experienced laparoscopic surgeons who have received specific training in the procedure. 1.4 NICE encourages publication of further evidence on the incidence of complications and comparison of the outcomes of this procedure with standard laparoscopic cholecystectomy, to inform future judgments about the balance of risks and benefits. NICE may review this guidance when further evidence has been published. **Laparoscopic partial nephrectomy. NICE interventional procedures guidance 151 (2006).** 1.1 Current evidence on laparoscopic partial nephrectomy suggests that it is safe and efficacious when undertaken by surgeons with special expertise in this technique. Surgeons undertaking laparoscopic partial nephrectomy should have specific training and regular experience in laparoscopic renal surgery. 1.2 Clinicians wishing to undertake this procedure should ensure that patients fully understand the risks, including that of serious haemorrhage. In addition, use of the Institute's *Information for the public* is recommended (available from www.nice.org.uk/IPG151/publicinfo).

	1.3 Clinicians should audit and review their results. The British Association of Urological Surgeons runs a cancer registry, and clinicians are encouraged to enter all patients undergoing laparoscopic partial nephrectomy onto this database (www.baus.org.uk/Display.aspx?item=319). **Laparoscopic nephrectomy (including nephroureterectomy). NICE interventional procedures guidance 136 (2005).** 1.1 Current evidence on the safety and efficacy of laparoscopic nephrectomy (including nephroureterectomy) appears adequate to support the use of this procedure provided that the normal arrangements are in place for consent, audit and clinical governance. 1.2 Patient selection is important when this procedure is being considered for the treatment of malignant disease. Long-term follow-up data are lacking, and clinicians are encouraged to collect data on rates of recurrence in patients with malignant disease. **Laparoscopic live donor simple nephrectomy. NICE interventional procedures guidance 57 (2004).** 1.1 Current evidence on the safety and efficacy of laparoscopic live donor simple nephrectomy appears adequate to support the use of this procedure, provided that the normal arrangements are in place for consent, audit and clinical governance.

Appendix C: Literature search for single-port laparoscopic nephrectomy

Databases	Date searched	Version/files	No. retrieved
Cochrane Database of Systematic Reviews – CDSR (Cochrane Library)	26/07/2011	July 2011	1
Database of Abstracts of Reviews of Effects – DARE (CRD website)	26/07/2011	N/A	0
HTA database (CRD website)	26/07/2011	N/A	0
Cochrane Central Database of Controlled Trials – CENTRAL (Cochrane Library)	26/07/2011	July 2011	1
MEDLINE (Ovid)	26/07/2011	1948 to July Week 2 2011	84
MEDLINE In-Process (Ovid)	26/07/2011	July 25, 2011	36
EMBASE (Ovid)	26/07/2011	1980 to 2011 Week 29	314
CINAHL (NLH Search 2.0 or EBSCOhost)	26/07/2011	N/A	6
Zetoc	26/07/2011	N/A	11

Trial sources searched on 22/02/2011

- Current Controlled Trials *meta*Register of Controlled Trials – *m*RCT
- Clinicaltrials.gov
- National Institute for Health Research Clinical Research Network Coordinating Centre (NIHR CRN CC) Portfolio Database

Websites searched on 22/02/2011

- National Institute for Health and Clinical Excellence (NICE)
- Food and Drug Administration (FDA) - MAUDE database
- French Health Authority (FHA)
- Australian Safety and Efficacy Register of New Interventional Procedures – Surgical (ASERNIP – S)
- Australia and New Zealand Horizon Scanning Network (ANZHSN)
- Conference search
- General internet search

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

1	exp Nephrectomy/	23692
2	nephrectom*.tw.	21089

3	exp Laparoscopy/	54250
4	exp laparoscopes/	3094
5	exp laparotomy/	13721
6	exp surgical procedures, Minimally Invasive/	294657
7	(laparo$ or telescop$ or peritoneo$).tw.	8975
8	or/1-7	367703
9	exp Kidney Diseases/ or exp Kidney Neoplasms/	355520
10	((kidney* or renal*) adj3 (neoplasm$ or cancer$ or carcinoma$ or adenocarcinom$ or tumour$ or tumor$ or malignan$)).tw.	37445
11	((kidney* or renal*) adj3 diseas*).tw.	60244
12	or/9-11	376591
13	8 and 12	28317
14	("laparo-endoscopic single site surg$" or "laparo endoscopic single site surg$" or "laparoendoscopic single site surg$").tw.	84
15	("single-incision laparoscopic surg$" or "single incision laparoscopic surg$" or sils).tw.	370
16	("single incision surg$" or "single-incision surg$").tw.	7
17	("single-site laparoscopic surg$" or "single site laparoscopic surg$" or ssl).tw.	365
18	("single-incision treatment$" or "single incision treatment$").tw.	0
19	(("natural orifice trans-umbilical" or "natural orifice transumbilical" or "natural orifice trans umbilical") adj3 surg$).tw.	7
20	("e-notes" or notus).tw.	15
21	("trans-umbilical endoscop$ surg$" or "transumbilical endoscop$ surg$" or "trans umbilical endoscop$ surg$").tw.	8
22	("trans-umbilical laparoscop$ assist$" or "transumbilical laparoscop$ assist$" or "trans umbilical laparoscop$ assist$").tw.	8
23	("one-port umbilical surg$" or "one port umbilical surg$").tw.	2
24	opus.tw.	232
25	"single port access".tw.	60

26	or/14-25	1117
27	13 and 26	21
28	8 and 26	303
29	12 and 26	39
30	or/27-29	321
31	animals/ not humans/	3450666
32	30 not 31	311