NATIONAL INSTITUTE FOR HEALTH AND CARE EXCELLENCE

INTERVENTIONAL PROCEDURES PROGRAMME

Interventional procedure overview of single-incision laparoscopic cholecystectomy

Gallstones form in the gallbladder and can cause recurrent pain, jaundice and inflammation (cholecystitis). They can be treated by removing the gallbladder, normally by keyhole surgery (laparoscopic cholecystectomy) through a number of tiny cuts. This procedure aims to remove the gallbladder through a single cut beside the umbilicus (tummy button).

Introduction

The National Institute for Health and Care Excellence (NICE) has prepared this interventional procedure (IP) 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 IP overview was prepared in December 2013 and updated in September 2014.

Procedure name

- Single-incision laparoscopic cholecystectomy

Specialist societies

- Association of Laparoscopic Surgeons of Great Britain and Ireland
- Association of Upper Gastrointestinal Surgeons of Great Britain and Ireland
- British Society of Gastroenterology.

Description

Indications and current treatment

Gallstones form in the gallbladder from cholesterol or bile pigments: they may be small and multiple, or large and sometimes single. They are more common in women and in people who are obese. Most people with gallstones are asymptomatic but some may develop recurrent symptoms, typically abdominal pain after eating a meal. In some people, gallstones may lead to episodes of acute inflammation of the gallbladder (acute cholecystitis) that can cause pain, fever, nausea and vomiting. Other presentations (resulting from displacement of gallbladder stones into the common bile duct) include biliary colic, obstructive jaundice and acute pancreatitis.

The usual treatment option for symptomatic gallstones is cholecystectomy. This is typically done laparoscopically, using several small incisions in the abdomen, although open surgery through a larger incision is sometimes necessary.

What the procedure involves

Single-incision laparoscopic cholecystectomy (SILC) aims to remove the gallbladder through a single incision, which is usually made near the umbilicus. The claimed benefits of this procedure over standard laparoscopic cholecystectomy include less pain, shorter recovery time, fewer wound complications and improved cosmesis.

SILC is done with the patient under general anaesthesia. There are 2 surgical approaches. One uses a single umbilical skin incision with skin flaps to insert ports through multiple fascial punctures. The other uses a specifically designed device that allows multiple instruments to be passed through a single port placed in or near the umbilicus. A pneumoperitoneum is established and the gallbladder is retracted with a laparoscopic instrument (‘grasper’) or by a transabdominal suture. The hilum of the gallbladder is dissected using endoscopic instruments. The cystic artery and cystic duct are clipped and divided, and the gallbladder is separated from the liver. At least 1 additional port in the epigastrium may be needed if a cholangiogram is performed or if the common bile duct is explored. The gallbladder is removed through the umbilical incision.

Literature review

Rapid review of literature

The medical literature was searched to identify studies and reviews relevant to single-incision laparoscopic cholecystectomy. Searches were conducted of the following databases, covering the period from their commencement to 1 September 2014: 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 symptomatic gallstones.
Intervention/test	Single-incision laparoscopic cholecystectomy.
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 IP overview

This IP overview is based on 7800 of patients from 2 systematic reviews, 3 randomised controlled trials, 1 non-randomised comparative study and 1 non-systematic review of complications.

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-incision laparoscopic cholecystectomy

Study 1 Geng L (2013)

Details

Study type	**Systematic review**
Country	Multiple countries
Recruitment period	January 1997 to February 2013
Study population and number	Patients with benign gallbladder disease n=**1841 patients from 25 randomised controlled trials (944 single-incision laparoscopic cholecystectomy [SILC] versus 897 conventional multiport laparoscopic cholecystectomy [CMLC])**
Age and sex	Not reported
Study selection criteria	Inclusion criteria: randomised controlled trials that compared SILC with CMLC were included. Exclusion criteria: retrospective studies, non-randomised comparative studies and animal studies were excluded. Studies with considerable overlap were also included.
Technique	Four different techniques were used to perform SILC (details not provided). CMLC was performed using 3 or 4 ports.
Follow-up	**Not reported**
Conflict of interest/source of funding	Not reported

Analysis

Follow-up issues: None identified

Study design issues: The use of additional instruments was defined as situations when it was necessary to use more trocars than initially planned or when additional instruments were needed to enhance the exposure of the Calot's triangle for gallbladder retraction.

Study population issues: None identified

Other issues: There is an overlap between the studies included in this systematic review and studies included in another systematic review in this overview: Qiu (2013).

- The number of studies and patients analysed in each meta-analysis were not clearly reported.
- Continuous variables were pooled using weighted mean differences. Binary variables were pooled using odds ratios.
- I^2 values exceeded 90%, indicating very high heterogeneity between studies, in the meta-analyses that assessed pain at 24 hours, cosmesis scores, length of incisions, length of stay and time to return to work.
- Authors stated in the text that the conversion rate was lower in the SILC group; however, this did not correlate with what was displayed in the forest plot. The forest plot results are reported.

Key efficacy and safety findings

Efficacy

Number of patients analysed: **1841 patients (944 SILC versus 897 CMLC); however, numbers varied according to the outcome measure assessed**

Meta-analyses

Outcome measure	Effect	Effect size	95% CI	Direction of effect	p value	I^2 (%)
Conversion to open surgery	OR	0.686	0.132 to 3.576	Favours SILC	0.655	0
Additional instrument needed [a]	OR	7.448	3.821 to 14.518	Favours CMLC	**<0.001**	90.1
Operative time (minutes) [a]	WMD	13.613	9.047 to 18.179	Favours CMLC	**<0.001**	90.1
Blood loss (mL)	WMD	1.506	−1.666 to 4.679	Favours CMLC	0.352	72.0
Length of incision (mm) [a]	WMD	−3.285	−6.232 to −0.338	Favours SILC	**0.029**	96.6
Time to initial oral intake (days)	WMD	−0.196	−1.204 to 0.813	Favours SILC	0.704	0
Length of stay (days)	WMD	−0.127	−0.384 to 0.129	Favours SILC	0.331	91.8
Time to return to work (days)	WMD	−0.527	−2.122 to −1.065	Favours SILC	0.517	94.5
Pain at 3−4 hours [a]	WMD	−0.704	−1.323 to −0.085	Favours SILC	**0.026**	56.1
Pain at 6−8 hours [a]	WMD	−0.613	−1.077 to −0.149	Favours SILC	**0.010**	74.5
Pain at 12 hours	WMD	−0.580	−1.404 to 0.244	Favours SILC	0.168	77.8
Pain at 24 hours	WMD	−0.457	−0.963 to 0.048	Favours SILC	0.076	93.8
Cosmesis score [a b]	WMD	1.155	0.607 to 1.703	Favours SILC	**<0.001**	92.0

[a] Significant differences were observed between groups
[b] Authors reversed the direction of the forest plot so that WMDs above 0 favoured SILC

Safety

Meta-analyses

Outcome measure	Effect	Effect size	95% CI	Direction of effect	p value	I^2 (%)
Postoperative complications						
Wound complications	OR	1.336	0.842 to 2.119	Favours CMLC	0.219	0
Incisional hernia	OR	1.937	0.658 to 5.706	Favours CMLC	0.230	0
Bile leakage	OR	1.329	0.451 to 3.912	Favours CMLC	0.606	0
Retained gallstones	OR	2.149	0.554 to 8.329	Favours CMLC	0.269	0
Bile duct injury	OR	1.000	0.165 to 6.066	SILC = CMLC	1.000	0
Bleeding	OR	0.586	0.074 to 4.639	Favours SILC	0.613	0
Overall morbidity	OR	1.220	0.888 to 1.676	Favours CMLC	0.704	0

[a] Significant differences were observed between groups

Abbreviations used: CMLC, conventional multiport laparoscopic cholecystectomy; OR, odds ratio; SILC, single-incision laparoscopic cholecystectomy; WMD, weighted mean difference

Study 2 Qiu J (2013)

Details

Study type	**Systematic review**
Country	Multiple countries
Recruitment period	January 1997 to December 2012
Study population and number	Patients with benign gallbladder disease n=**3711 patients from 16 randomised controlled trials and 24 non-randomised comparative studies (1865 SILC versus 1846 CMLC)**
Age and sex	Not reported
Study selection criteria	Inclusion criteria: comparative studies that compared the efficacy of SILC with CMLC (3 or 4 ports) were included. When two studies were reported by the same institution only the latest, the most detailed, or the article with the best quality in methodology was included. Exclusion criteria: studies with considerable overlap or involving robotic laparoscopic cholecystectomies were excluded.
Technique	In all included studies SILC was performed through a single skin incision regardless of the device used. CMLC was performed using 3 or 4 ports.
Follow-up	**Up to 29.9 months**
Conflict of interest/source of funding	Not reported

Analysis

Follow-up issues: Most of the included studies did not report a follow-up period.

Study design issues: In the SILC group, conversion was defined as 1) conversion to CMLC, 2) conversion to open surgery, or 3) the use of an additional trocar. In the CMLC group, conversion was defined as 1) conversion to SILC, 2) conversion to open surgery, or 3) the use of an additional trocar.

Study population issues: Indications for surgery of patients in the included studies varied: symptomatic cholelithiasis, gallbladder polyp, acute cholecystitis, chronic cholecystitis, pancreatitis, biliary dyskinesia, incidental cancer, cholesterolosis, choledocholithiasis and unknown gallbladder disease.

Other issues: There is an overlap between the studies included in this systematic review and studies included in Geng (2013).

- Most I^2 square values were greater than 75%, indicating considerable heterogeneity between studies.
- Continuous variables were pooled using mean differences (MDs). Binary variables were pooled using odds ratios.
- Authors stated in the text that the overall complication rate was lower in the SILC group; however, this did not correlate with what was displayed in the forest plot. The forest plot results are reported.

Key efficacy and safety findings

Efficacy

Number of patients analysed: **3711 patients (1865 SILC versus 1846); however, numbers varied according to the outcome measure assessed**

Meta-analyses

Outcome measure	Number of studies included	Number of patients included	Effect	Effect size	95% CI	Direction of effect (note: does not imply statistical significance)	p value	I^2 (%)
Conversions [a]	19	2011	OR	4.21	2.71 to 6.56	Favours CMLC	**<0.001**	48
Operative time (minutes) [a]	32	2947	MD	16.10	9.93 to 22.26	Favours CMLC	**<0.001**	97
Blood loss (mL)	7	569	MD	0.44	−0.96 to 1.85	Favours CMLC	0.54	81
Length of incision (mm) [a]	5	304	MD	−7.70	−14.15 to −1.25	Favours SILC	**0.02**	99
Analgesia use (mg)	4	410	MD	−3.78	−13.78 to 6.22	Favours SILC	0.46	66
Length of stay (days) [a]	21	1700	MD	−0.16	−0.28 to −0.04	Favours SILC	**0.01**	57
Time to return to work (days)	4	336	MD	−0.23	−0.80 to 0.34	Favours SILC	0.43	62
Pain score at 24 hours	11	901	MD	−0.06	0.83 to 0.71	Favours SILC	0.88	97
Pain score at 48 hours	3	290	MD	0.26	−1.01 to 1.54	Favours CMLC	0.69	99
Pain score at 72 hours	4	262	MD	−0.11	−0.65 to 0.44	Favours SILC	0.70	87
Pain score at 1 week	2	119	MD	−0.05	−0.30 to 0.20	Favours SILC	0.71	60
Cosmesis score at 1 month [a]	3	258	MD	−1.30	−2.05 to −0.55	Favours SILC	**<0.001**	83
Cosmesis score at 3 months	2	123	MD	0	−0.62 to 0.61	SILC = CMLC	1	13
Cosmesis score at 6 months	2	149	MD	−0.02	−1.59 to 1.55	Favours SILC	0.98	85

[a] Significant differences were observed between groups

Safety

Meta-analyses

Outcome measure	Number of studies included	Number of patients included	Effect	Effect size	95% CI	Direction of effect (note: does not imply statistical significance)	p value	I^2 (%)
Wound infections	15	1105	OR	1.03	0.53 to 2.00	Favours CMLC	0.92	0
Wound haematoma	7	570	OR	2.07	0.90 to 4.74	Favours CMLC	0.09	0
Incision hernia	9	1058	OR	1.67	0.65 to 4.27	Favours CMLC	0.29	0
Bile duct injury	5	691	OR	0.52	0.22 to 1.25	Favours SILC	0.14	0
Bile leakage	8	1047	OR	1.33	0.81 to 2.11	Favours CMLC	0.22	0
Pneumonia	3	180	OR	0.72	0.14 to 3.74	Favours SILC	0.70	0
Retained gallstone	6	525	OR	1.11	0.35 to 3.49	Favours CMLC	0.86	0
Overall complications [b]	30	2857	OR	1.21	0.92 to 1.61	Favours CMLC	0.18	0

[a] Authors stated in the text that the overall complication rate was lower in the SILC group; however, this did not correlate with what was displayed in the forest plot. The forest plot results are reported.

Abbreviations used: CMLC, conventional multiport laparoscopic cholecystectomy; OR, odds ratio; MD, mean difference; SILC, single-incision laparoscopic cholecystectomy

Study 3 Marks JM (2011)

Details

Study type	**Multicentre randomised controlled trial**
Country	United States
Recruitment period	Not reported
Study population and number	Patients with biliary colic or biliary dyskinesia n=**200 (119 SILC versus 81 CMLC)**
Age and sex	Mean age: SILC group, 45.8; CMLC group, 44 Sex: SILC group, 70.4% female; CMLC group, 76.5% female
Study selection criteria	Inclusion criteria: patients with biliary colic and radiographic confirmation of either gallstones or polyps, and patients with biliary dyskinesia and an ejection fraction <30% were included. All patients were between 18 and 85 years of age and had a BMI <45 kg/m^2. Exclusion criteria: patients with acute cholecystitis, a previous right subcostal or midline incision, a preoperative indication for endoscopic retrograde cholangiopancreatography, an indication for intraoperative biliary imaging, receiving ongoing peritoneal dialysis, the presence of an umbilical hernia or previous umbilical hernia repair were excluded.
Technique	SILC was performed through a 20 mm umbilical incision. Intraoperative cholangiography was performed at the digression of the surgeon. 5 ml of 1% marcaine was injected into the skin around each incision at the conclusion of the procedure. CMLC was performed with the use of 2 or 3 5 mm and 1 or 2 10-12 mm ports. Again, intraoperative cholangiography was performed at the digression of the surgeon and 5 ml of 1% marcaine was injected into the skin around each incision at the conclusion of the procedure.
Follow-up	**12 months**
Conflict of interest/source of funding	Not reported

Analysis

Follow-up issues: Nineteen patients in the SILC group and 17 patients in the CMLC group were lost to follow-up.

Study design issues: Ten sites were invited to recruit 20 to 25 patients to participate in the study. Patients were randomised to SILC and CMLC in a 1.5 to 1 ratio and randomisation was performed at the time of arrival to theatre. Patients were blinded to their group allocation for the first postoperative week, assuming bandages stayed place as instructed. The authors state that their primary end point was safety, but they also acknowledge that their sample size was too small to detect any differences in major adverse events between the 2 groups.

Study population issues: None identified.

Other issues: Conversion to standard laparotomy or the placement of additional laparoscopic ports was considered a conversion.

- Pain scores ranged from 1 to 10, with lower scores indicating less pain.
- Cosmesis scores ranged from 3 to 24, with higher scores indicating better outcomes.
- Quality of life scores ranged 0 to 100, with higher scores indicating better outcomes: SF-8 questionnaire was used at preoperative assessment through to 1 week. SF-12 questionnaire was used at 2-week and 1-month follow-up assessments.
- In the SILC group, there were discrepancies between the number of total wound complications reported and the numbers reported in each wound complication subcategory.

Key efficacy and safety findings

Efficacy

n=164 (100 SILC versus 64 CMLC)

Conversions

- Conversion to CMLC was required in 1 patient from the SILC group.
- No conversions to open surgery were required in any patients from either group.

Operative results

Outcome	SILC	CMLC	p value
Mean blood loss (mL)	14.9	14.1	0.75
Mean operation time (mins)	56.8	45.3	<0.0001

Pain scores (Mean)

	SILC	CMLC	p value
Preoperative	2.5	2.5	0.699
Postoperative	4.8	4.5	0.631
Day 1	5.0	4.4	0.077
Day 7	2.7	2.3	0.006
Day 14	1.6	1.6	0.416
Day 30	1.6	1.3	0.024

- Despite the differences in pain, no significant difference in pain medication was reported at any follow-up assessment.

Cosmesis scores (Mean ±SD)

	SILC	CMLC	p value
1 week	20.5±3.6	18.6±3.9	0.0004
2 weeks	21.5±3.1	18.5±3.9	<0.0001
1 month	22.1±2.7	19.2±3.8	<0.0001
3 months	22.5±2.6	20.0±3.3	<0.0001
12 months	22.6±2.4	20.2±3.7	0.003

Physical quality of life scores (Mean ±SD)

	SILC	CMLC	p value
Preoperative	49.1±10.3	50.1±9.2	0.50
Day 1	31.0±9.9	31.8±8.3	0.38
Day 3	36.8±9.2	40.1±8.8	0.01
Day 5	42.0±8.6	44.1±9.2	0.13
1 week	44.4±9.3	47.5±6.5	0.03
2 weeks	47.5±10.4	49.7±7.6	0.32
1 month	51.1±8.9	54.1±6.7	0.03

NB: SF-8 questionnaire was used at preoperative assessment through to 1 week. SF-12 questionnaire was used at 2-week and 1-month follow-up assessments.

Safety

Complication	SILC % (n)	CMLC % (n)	p value
Bile duct injury	0	1.2 (1/81)	1.00
Retained gallstones	0.8 (1/119)	1.2 (1/81)	1.00
Wound complications			
Erythema	4.2 (5/119)	0	0.08
Cellulitis	1.6 (2/119)	0	0.52
Induration	0	1.2 (1/81)	1.00
Ecchymosis	0.8 (1/119)	0	1.00
Wound infection	2.6 (3/119)	2.4 (2/81)	1.00
Suture related complications	1.6 (2/119)	0	0.52
Seroma	0.8 (1/119)	0	1.00
Other	0.8 (1/119)	1.2 (1/81)	1.00
Total wound complications	11.7 (14/119)	4.9 (4/81)	0.13
Incisional hernias			
Mild	6.7 (8/119)	1.2 (1/81)	NR
Moderate	0.8 (1/119)	0	NR
Severe	0.8 (1/119)	0	NR
Total incisional hernias	8.4 [a] (10/119)	1.2 (1/81)	0.03

[a] In the SILC group, 5 out of 10 incisional hernias required surgical repair.

Abbreviations used: CMLC, conventional multiport laparoscopic cholecystectomy; SILC, single-incision laparoscopic cholecystectomy

Study 4 Bucher P (2011)

Details

Study type	**Randomised controlled trial**
Country	Switzerland
Recruitment period	June 2009 to September 2010
Study population and number	Patients with symptomatic gallstones n=**150 (75 SILC versus 75 CMLC)**
Age and sex	Mean age: SILC group, 42; CMLC group, 44 Sex: Not reported
Study selection criteria	Inclusion criteria: patients >18 years with symptomatic gallstones, a history of cholecystitis, a history of common bile duct stone migration and/or biliary pancreatitis were included. Exclusion criteria: patients presenting as an emergency, with acute gallbladder disease, contraindications to pneumoperitoneum, cirrhosis or mental impairment were excluded.
Technique	SILCs were performed through a single 15 mm umbilical incision using a multiport trocar transumbilical incision. Dissection of the cystic artery and duct were performed using a flexible endoscope and an intracorporeal grasper. Cystic artery and duct control were achieved using 5 mm laparoscopic clips. Intraoperative cholangiography was attempted in all patients. CMLCs were performed using a 4-port approach with 2×10 mm ports and 2×5 mm ports. Cholangiography was attempted in all patients.
Follow-up	**1 month**
Conflict of interest/source of funding	Not reported

Analysis

Follow-up issues: No patients were lost to follow-up.

Study design issues: Patients were allocated to groups by using a randomisation table. More than 1 surgeon (number not specified) performed the procedure; each had performed a minimum of 50 SILCs and 100 CMLCs.

Study population issues: Indications for treatment included symptomatic gall stones, acute or chronic cholecystitis and biliary pancreatitis. One patient had incidental cancer.

Other issues: All patients received the same postoperative analgesia: paracetamol and ibuprofen, with morphine on demand until their pain score measured <3 on a Visual Analogue Scale (VAS). Patients in each group received the same prescription. No postoperative antibiotics were given.

- VAS scores for pain ranged from 1 to 10 with lower scores indicating less pain.
- Body image scores ranged from 5 to 20 with lower scores indicating better outcomes.
- Scar satisfaction scores ranged from 3 to 15 with lower scores indicating better outcomes.
- SF-12 scores range from 0 to 100 with higher scores indicating better outcomes.

Key efficacy and safety findings

Efficacy

n=150 (75 SILC versus 75 CMLC)

Additional ports

- An additional port was required in 3% (2/75) of patients in the SILC group and no patients in the CMLC group.

Operative results

Outcome	SILC	CMLC	p value
Median operation time (mins) [range]	66 [32-109]	64 [38-117]	NR
Proportion of patients who underwent cholangiography (%) [n/N]	76 [57/75]	83 [62/75]	0.42

NR: not reported

Pain and analgesia

	SILC	CMLC	p value
Median VAS scores for pain			
6 hours [range]	2 [0-4]	3 [2-7]	<0.001
24 hours [range]	1 [0-4]	3 [2-5]	<0.001
10 days [range]	1 [1-3]	2 [1-4]	<0.001
Analgesia			
Median morphine during the first 24 hours (mg) [range]	0 [0-7.5]	3 [0-12.5]	0.002
Proportion of patients taking analgesic at day 10 (%) [n/N]	65 [45/75]	92 [69/75]	<0.001
Proportion of patients taking analgesics at day 30 (%) [n/N]	0 [0/75]	13 [10/75]	0.014

Cosmesis

	SILC	CMLC	p value
Median body image scores			
At discharge [range]	6 [5-7]	8 [7-11]	<0.001
10 days [range]	5 [5-7]	7 [6-9]	<0.001
1 month [range]	5 [5-6]	6 [5-7]	0.003
Median scar satisfaction scores			
10 days [range]	4 [3-5]	6 [4-9]	<0.001
1 month [range]	3 [3-4]	4 [3-6]	0.002

Other outcome measures

Outcome	SILC	CMLC	p value
Quality of life(SF-12) scores			
Preoperative score [range]	35 [27-41]	34 [28-40]	0.473
30 days [range]	40 [35-43]	35 [28-41]	0.028
Change in score [range]	5 [1-8]	2 [-3-4]	<0.001
Length of stay (days) [range]	0 [0-2]	1 [0-5]	0.014
Time to return to work (days) [range]	10 [5-14]	12 [11-15]	0.003

Safety

- Enlargement of an umbilical incision was reported in 4% (3/75) of patients in the SILC group and 25% (19/75) of patients in the CMLC group.
- Gallbladder perforation was reported in 12% (9/75) of patients in the SILC group and 8% (6/75) of patients in the CMLC group.
- Haematoma or seroma at the umbilical port was reported in 4% (3/75) of patients in the SILC group and 3% (2/75) of patients in the CMLC group.
- Haematoma or seroma at working port sites was reported in 0% (0/75) of patients in the SILC group and 3% (2/75) of patients in the CMLC group.
- No umbilical hernias were reported in any patients from the SILC or CMLC groups.

Abbreviations used: CMLC, conventional multiport laparoscopic cholecystectomy; SILC, single-incision laparoscopic cholecystectomy

Study 5 Saad S (2011)

Details

Study type	**Randomised controlled trial**
Country	Germany
Recruitment period	June 2010 to May 2011
Study population and number	Patients with gallbladder disease **n=105 (35 SILC versus 35 mini-incision laparoscopic cholecystectomy [MILC] versus 35 CMLC)**
Age and sex	Mean age: SILC group, 45; MILC group, 44; CMLC, 49 Sex: SILC group, 20 % female; MILC group, 25.7% female; CMLC group, 25.7% female
Study selection criteria	Inclusion criteria: patients >18 years with indications for elective cholecystectomy and uncomplicated symptomatic cholecystolithiasis were included. Exclusion criteria: patients with acute cholecystitis, gallbladder empyema, pancreatitis, neuromuscular disease, previous abdominal laparotomy with suspicion of peritoneal adhesions, allergies to paracetamol or piritramide, a history of pain medication abuse or a history of alcohol abuse were excluded. Patients >80 years or patients with BMs >45 kg/m^2 were also excluded.
Technique	SILC was performed through a single 20 mm intra-umbilical incision. If good visualisation of the Calot's triangle was obtained, a 5 mm laparoscope with 5 mm straight dissection instruments were inserted. When visualisation and triangulation of the Calot's triangle were insufficient, a 2 mm Kirschner was used to retract the fundus of the gallbladder ventrally. For MILC and CMLC, trocar positions were identical in both procedures. One 10 mm and 3×3 mm trocars were used in MILC, whereas 2×10 mm and 2×5 mm trocars were used in CMLC. A 10 mm rigid 30° laparoscope was inserted through the umbilical port in both techniques. Intraoperative cholangiography was not performed in any patients and postoperative care followed the same clinical pathway in all patients.
Follow-up	**Up to 12 months**
Conflict of interest/source of funding	Not reported

Analysis

Follow-up issues: At 12 months, 3 patients in the SILC group, 2 in the MILC group and 1 patient in the CMLC group were lost to follow-up.

Study design issues: Double blinded study – all patients received non-transparent dressings that reflected incisions necessary for CMLC. Blinding was broken on the day of discharge from hospital (day 3). Patients were allocated groups by block randomisation using a computer. CMLCs and MILCs were performed by 1 of 5 laparoscopic surgeons; each had carried out over 100 CMLCs and over 50 MILCs. SILCs were performed by a single surgeon with experience of more than 50 SILCs. Operating surgeons were excluded from postoperative treatment and evaluations.

Study population issues: None identified.

Other issues: Sample size calculations were performed: 90 patients were required to confer 90% power.

- Pain scores ranged from 0 to 10 with lower scores indicating less pain.
- Cosmesis scores ranged from 1 to 5 with lower scores indicating better outcomes.
- Patient satisfaction scores ranged from 1 to 5 with lower scores indicating more satisfaction.
- Quality of life was assessed using the gastrointestinal quality of life index (GIQLI): scores range from 0 to 144 with higher scores indicating a better quality of life.

Key efficacy and safety findings

Efficacy

n=150 (35 SILC versus 35 MILC versus 35 CMLC); however, the number of patients analysed varied with each outcome measure

Technical performance

	Mean±SD			
Outcome	SILC	MILC	CMLC	p value
Mean operation time (mins)	45.7±10.9	47.3±17.7	35.0±14.0	0.001
Mean length of stay (days)	3.1±0.6	3.0±0.3	3.0±0.2	0.455

- A Kirschner wire was required to enhance exposure of the Calot's triangle for gallbladder retraction in 17.4% of patients in the SILC group and no patients in the MILC or CMLC groups.

Pain scores (mean) [Results obtained from a graph]

	SILC	MILC	CMLC	p value
Post-surgery (day 0) *	3.2	2.8	3.2	NR
Day 3 *	1.4	1.2	1.0	0.865
Day 7	1.0	0.6	0.8	0.911

* Patients were blinded to group allocation

- NR – Not reported
- In the SILC, MILC and CMLC groups, 22.9% (8/35), 20% (7/35) and 25.7% (9/35) of patients required additional analgesics respectively (p=0.85).

Cosmesis scores (Mean ±SD)

	SILC	MILC	CMLC	p value
Rated by physician				
Day 10	1.62±1.18	1.41±0.66	1.51±0.56	0.604
Rated by patient				
Day 10	1.65±1.18	1.44±0.61	1.57±0.61	0.595
3 months	1.30±0.59	1.34±0.48	1.56±0.82	0.228
6 months	1.15±0.36	1.19±0.40	1.46±0.74	0.043
12 months	1.09±0.30	1.00±0	1.12±0.41	0.229

Patient satisfaction scores (Mean ±SD)

	SILC	MILC	CMLC	p value
Day 10	1.41±0.66	1.26±0.45	1.40±0.55	0.485
3 months	1.30±0.64	1.25±0.51	1.29±0.76	0.939
6 months	1.32±0.64	1.25±0.51	1.29±0.72	0.907
12 months	1.09±0.30	1.00±0	1.12±0.41	0.229

Quality of life scores – assessed by GIQLI questionnaire (Mean ±SD)

	SILC	MILC	CMLC	p value
Day 10	101.6±19.1	102.5±19.0	105.9±14.0	0.567

Safety

- Perforation of the gallbladder was reported in 2.9% (1/35) of patients in the SILC group and no patients in the MILC or CMLC groups.
- Wound infection was reported in 14.3% of patients in the SILC group and no patients in the MILC or CMLC groups.
- Retained gallstones were reported in 2.9% (1/35) of patients in the SILC group and no patients in the MILC or CMLC groups.
- Incisional hernia was reported in 2.9% (1/35) of patients in the SILC group and no patients in the MILC or CMLC groups.

Abbreviations used: CMLC, conventional multiport laparoscopic cholecystectomy; MILC, mini-incision laparoscopic cholecystectomy; SILC, single-incision laparoscopic cholecystectomy

Study 6 Cheng Y (2013)

Details

Study type	**Non-randomised comparative study (retrospective cohort study)**
Country	China
Recruitment period	January 2005 to July 2008
Study population and number	Patients with cholecystolithiasis or cystic polyps n=**613 (298 SILC versus 315 CMLC)**
Age and sex	Mean age: SILC group, 41.5; CMLC group, 42.3 Sex: SILC group, 57 % female; CMLC group, 60.6% female
Study selection criteria	Inclusion criteria: not reported. Exclusion criteria: patients with signs of acute cholecystitis, such as fever, right upper quadrant tenderness with or without Murphy's sign, elevated white blood cell counts, imaging findings suggestive of pericholecystic fluid, gallbladder wall thickening >4 mm and gallstones >3 cm were excluded to avoid bias. Patients with a BMI >35 kg/m^2 and a history of upper abdominal surgery were also excluded.
Technique	SILC was performed through a 20 mm umbilical incision with 10 mm and 5 mm ports placed on the left and right hand sides respectively. The gallbladder was removed through the umbilical incision and the incision was closed without a drainage tube in place. CMLC was performed using a 3-port approach. A 10 mm trocar was inserted into the sub-umbilical incision to allow insertion of a laparoscope and 2 additional trocars: a 10 mm and a 5mm trocar. The cystic artery was divided and cut using a harmonic scalpel rather than being clipped and divided.
Follow-up	**Not reported**
Conflict of interest/source of funding	Not reported

Analysis

Follow-up issues: None identified.

Study design issues: Retrospective data were obtained from both case notes and the operating theatre database. The procedure was performed by 2 surgeons who had performed over 200 cholecystectomies each.

Study population issues: Inclusion criteria were not reported.

Other issues: VAS scores for pain ranged from 0 to 10 with lower scores indicating less pain.

Key efficacy and safety findings

<table>
<tr><th>Efficacy</th><th>Safety</th></tr>
<tr><td>

n=613 (298 SILC versus 315 CMLC)

Conversions and the need for additional ports

- Conversion to open surgery was required in 0.7% (2/298) of patients in the SILC group and 0.6 (2/315) of patients in the CMLC due to unusual anatomy.
- An additional port was required in 1.3% (4/298) of patients in the SILC group and no patients in the CMLC group.

Operative results

<table>
<tr><th>Outcome</th><th>SILC (mean±SD)</th><th>CMLC (mean±SD)</th><th>p value</th></tr>
<tr><td>Estimated blood loss (mL)</td><td>14.0±6.0</td><td>15.0±4.0</td><td>0.2643</td></tr>
<tr><td>Operating time (min)</td><td>54.8±11.0</td><td>33.5±9.0</td><td><0.001</td></tr>
<tr><td>Operating time of the last 100 cases (min)</td><td>34.3±6.0</td><td>32.7±8.7</td><td>0.1589</td></tr>
<tr><td>VAS score for pain at 8 hours</td><td>2.3±1.4</td><td>2.3±1.3</td><td>1.0</td></tr>
<tr><td>VAS score for pain on postoperative day 1</td><td>1.2±0.4</td><td>1.3±1.2</td><td>0.2</td></tr>
</table>

- Patient satisfaction, in the cosmetic outcome of surgery, was reported in 98% and 85% of patients in the SILC and CMLC groups, respectively (p<0.001).

</td><td>

- Gallbladder perforation was reported in 8.7% (56/298) of patients in the SILC group and 1.9% (6/315) of patients in the CMLC group.
- Contusion was reported in 6.4% (19/298) of patients in the SILC group and 7.9% (25/315) of patients in the CMLC group.
- Haematoma was reported in 3.7% (11/298) of patients in the SILC group and 6.0% (19/315) of patients in the CMLC group.

</td></tr>
<tr><td colspan="2">Abbreviations used: CMLC, conventional multiport laparoscopic cholecystectomy; SILC, single-incision laparoscopic cholecystectomy</td></tr>
</table>

Study 7 Fransen S (2012)

Details

Study type	**Non-systematic review of complications**
Country	Netherlands
Recruitment period	1997 to 2010
Study population and number	Patients with gallbladder disease n=**38 studies (1180 patients)**
Age and sex	Mean age: not reported Sex: not reported
Study selection criteria	Inclusion criteria: studies included patients with cholecystolithiasis, biliary colic, acute cholecystitis, biliary polyps, biliary dyskinesia and biliary pancreatitis. Seven studies explicitly stated that patients with BMIs <35 kg/m^2 were included. Exclusion criteria: not reported.
Technique	In 87.8% (1037/1180) of patients, SILC was performed through 1 umbilical skin incision with several separate fascial incisions. The length of the umbilical incision ranged from 12 mm to 20 mm.
Follow-up	**Not reported**
Conflict of interest/source of funding	Not reported

Analysis

Follow-up issues: None identified

Study design issues: Unclear if study selection was performed using a systematic review protocol.

Study population issues: None identified

Other issues: None identified

Key efficacy and safety findings

Safety

n=1180

Complication	% (n)
Wound infection *	0.7 (8)
Umbilical abscess	0.25 (3)
Seroma *	1.40 (17)
Skin laceration	0.08 (1)
Sub-umbilical haematoma	0.40 (5)
Perihepatic fluid collection	0.08 (1)
Ileus	0.17 (2)
CBD-stricture requiring ERCP	0.08 (1)
Retained gallstones requiring ERCP	0.90 (11)
Postoperative laparotomy	0.08 (1)
Incarcerated umbilical hernia	0.08 (1)
Urinary retention	0.08 (1)
Renal failure	0.08 (1)
Readmission due to pain	0.80 (9)
Intraoperative bile leakage	1.50 (18)
Postoperative bile leakage	0.60 (7)

* Discrepancies between tabulated result and result stated in the prose. The result reported in the prose is reported.

Abbreviations used: CBD, common bile duct; ERCP, endoscopic retrograde cholangiopancreatography

Study 8 MAUDE Adverse event reports

Details

Study type	**Case report**
Country	USA
Recruitment period	Event occurred on July 15 2010
Study population and number	1
Age and sex	Not reported
Study selection criteria	Not relevant
Technique	Transenterix Inc – spider single port laparoscopic surgery device
Follow-up	**Not reported**
Conflict of interest/source of funding	Not reported

Analysis

- The adverse event was related to the mechanical failure of the device.

Safety findings

During the procedure, the surgeon inserted a rigid suction/irrigation instrument through the same incision as the spider device. The surgeon accidentally tangled the suction/irrigation instrument around the spider device and broke or snapped loose the upper right link arm of the spider device. A piece of the link arm connector fell into the surgical bed. The surgeon was able to locate and retrieve the piece from the patient. No injury or impact to patient care was reported. The device was returned to the manufacturer for evaluation.

Efficacy

Conversions

In a systematic review of 25 randomised controlled trials that included 1841 patients treated by single-incision laparoscopic cholecystectomy (SILC) or conventional multiport laparoscopic cholecystectomy (CMLC), meta-analysis of the proportion of procedures that were converted to open surgery revealed no significant difference between groups (odds ratio of 0.69; 95% confidence interval [CI] 0.13 to 3.58, p=0.655)[1].

Additional ports/instruments

In the systematic review of 25 randomised controlled trials that included 1841 patients treated by SILC or CMLC, meta-analysis of the proportion of procedures that needed an additional surgical instrument (defined as the use of more trocars than initially planned or where additional instruments were needed to enhance the exposure of the Calot's triangle) revealed an odds ratio of 7.45 in favour of CMLC (95% CI 3.82 to 14.52). The proportion of procedures that needed additional surgical instruments was significantly lower in the CMLC group (p<0.001)[1].

An additional port was required in 3% (2/75) of patients in the SILC group and 0% of patients in the CMLC group, in a randomised controlled trial of 150 patients treated by SILC or CMLC[4].

Operative times

In a systematic review of 40 studies that included 3711 patients treated by SILC or CMLC, meta-analysis of operative times revealed a pooled mean difference of 16.1 in favour of CMLC (95% CI 9.93 to 22.26). Operative times were significantly lower in the CMLC group (p<0.001)[2].

Length of incision

In the systematic review of 40 studies that included 3711 patients treated by SILC or CMLC, meta-analysis of the length of umbilical incisions revealed a pooled mean difference of −7.70 in favour of SILC (95% CI −14.15 to −1.25). Umbilical incisions were significantly shorter in the SILC group (p=0.02)[2].

Blood loss

In the systematic review of 40 studies that included 3711 patients treated by SILC or CMLC, meta-analysis of intraoperative blood loss revealed no significant

difference between groups (pooled mean difference of 0.44; 95% CI −0.96 to 1.85, p=0.54)[2].

Pain

In the systematic review of 25 randomised controlled trials that included 1841 patients treated by SILC or CMLC, meta-analysis of postoperative pain scores revealed a pooled mean difference of −0.70 in favour of SILC at 3–4 hours (95% CI −1.32 to −0.09). Pain scores were significantly better in the SILC group (p=0.026). At 6–8 hours, the pooled mean difference was −0.613 in favour of SILC (95% CI −1.077 to −0.149, p=0.01)[1].

In the systematic review of 40 studies that included 3711 patients treated by SILC or CMLC, meta-analysis of postoperative pain scores at 1-week follow-up revealed no significant difference between groups (pooled mean difference of −0.05; 95% CI −0.30 to 0.20, p=0.71)[2].

Postoperative use of analgesia

In the systematic review of 40 studies that included 3711 patients treated by SILC or CMLC, meta-analysis of the postoperative use of analgesics revealed no significant difference between groups (pooled mean difference of −3.78; 95% CI −13.78 to 6.22, p=0.46)[2].

In the randomised controlled trial of 150 patients treated by SILC (n=75) or CMLC (n=75), the proportions of patients receiving analgesics were 65% (46/75) and 92% (69/75) respectively, at 10-day follow-up (p<0.001). At 30-day follow-up, no patients in the SILC group and 13% (10/75) of patients in the CMLC group were receiving analgesics (p=0.014)[4].

Cosmesis

In the systematic review of 40 studies that included 3711 patients treated by SILC or CMLC, meta-analysis of cosmesis scores at 1-month follow-up revealed a pooled mean difference of −1.30 in favour of SILC (95% CI −2.05 to −0.55). Cosmesis scores were significantly better in the SILC group (p<0.001). In the same study, no significant differences in pooled cosmesis scores were reported between the SILC and CMLC groups at 3- and 6-month follow-up intervals[2].

In the systematic review of 25 randomised controlled trials that included 1841 patients treated by SILC or CMLC, meta-analysis of cosmesis scores at final follow-up revealed a pooled mean difference of 1.16 in favour of SILC (95% CI 0.61 to 1.70). Cosmesis scores were significantly better in the SILC group (p<0.001)[1].

In a randomised controlled trial of 200 patients treated by SILC (n=119) or CMLC (n=81), cosmesis scores (ranging from 3 to 24 with higher scores indicating better outcomes) were 22.6±2.4 and 20.2±3.7 respectively, at 12-month follow-up (p=0.003)[3].

Quality of life

In the randomised controlled trial of 200 patients treated by SILC (n=119) or CMLC (n=81), preoperative SF-8 scores (ranging from 0 to 100 with higher scores indicating a better outcomes) were 49.1±10.3 and 50.1±9.2 respectively (p=0.5). At 1-month follow-up, SF-12 scores (ranging from 0 to 100 with higher scores indicating better outcomes) were 51.1±8.9 in the SILC group and 54.1±6.7 in the CMLC group (p=0.03)[3].

In the randomised controlled trial of 150 patients treated by SILC (n=75) or CMLC (n=75), mean improvements in SF-12 scores were 5 (range: 1 to 8) and 2 (range: −3 to 4) respectively, at 1-month follow-up (p<0.001)[4].

Time to return to work

In the systematic review of 25 randomised controlled trials that included 1841 patients treated by SILC or CMLC, meta-analysis of the time taken for patients to return to work revealed no significant differences between groups (pooled mean difference of −0.53; 95% CI −2.12 to −1.0, p=0.517)[1].

Safety

Bile duct injuries

In the systematic review of 25 randomised controlled trials that included 1841 patients treated by SILC or CMLC, meta-analysis of the incidence of bile duct injuries revealed no significant difference between groups (odds ratio of 1.00; 95% CI 0.165 to 6.066, p=1.0)[1].

Gallbladder perforation

Gallbladder perforation was reported in 12% (9/75) of patients in the SILC group and 8% (6/75) of patients in the CMLC group in the randomised controlled trial of 150 patients (no p values reported)[4].

Gallbladder perforation was reported in 9% (56/298) of patients in the SILC group and 2% (6/315) of patients in the CMLC group in a non-randomised comparative study of 613 patients (no p values reported)[6].

Wound haematomas

In the systematic review of 40 studies that included 3711 patients treated by SILC or CMLC, meta-analysis of the incidence of wound haematomas revealed no significant difference between groups (odds ratio of 2.07; 95% CI 0.90 to 4.74, p=0.09)[2].

Wound infections

In the systematic review of 40 studies that included 3711 patients treated by SILC or CMLC, meta-analysis of the incidence of wound infections revealed no significant difference between groups (odds ratio of 1.03; 95% CI 0.53 to 2.0, p=0.92)[2].

Incisional hernias

In the systematic review of 40 studies that included 3711 patients treated by SILC or CMLC, meta-analysis of the incidence of incisional hernias revealed no significant difference between groups (odds ratio of 1.67; 95% CI 0.65 to 4.27, p=0.29)[2].

Retained gallstones

In the systematic review of 25 randomised controlled trials that included 1841 patients treated by SILC or CMLC, meta-analysis of the incidence of retained gallstones revealed no significant difference between groups (odds ratio of 2.15; 95% CI 0.55 to 8.33, p=0.269)[1].

Other complications

Contusion was reported in 6% (19/298) of patients in the SILC group and 8% (25/315) of patients in the CMLC group in the non-randomised comparative study of 613 patients[6].

Erythema was reported in 4% (5/119) of patients in the SILC group and 0% of patients in the CMLC group in the randomised controlled trial of 200 patients[3].

Cellulitis was reported in 2% (2/119) of patients in the SILC group and 0% of patients in the CMLC group in the randomised controlled trial of 200 patients[3].

Ecchymosis was reported in 1% (1/119) of patients in the SILC group and 0% of patients in the CMLC group in the randomised controlled trial of 200 patients[3].

Umbilical abscess was reported in 0.25% (3/1180) of patients in a review (not systematic) of 38 studies that included 1180 patients treated by SILC[7].

Seroma was reported in 1% (17/1180) of patients in the review (not systematic) of 38 studies that included 1180 patients treated by SILC[7].

Renal failure was reported in 0.08% (1/1180) of patients in the review (not systematic) of 38 studies that included 1180 patients treated by SILC[7].

Ileus was reported in 0.17% (2/1180) of patients in the review (not systematic) of 38 studies that included 1180 patients treated by SILC[7].

Validity and generalisability of the studies

- The literature search identified a large number of systematic reviews, randomised controlled trials, non-randomised comparative studies and case series that were published after NICE's initial evaluation of SILC in 2010.
- There were numerous indications for SILC, such as symptomatic cholelithiasis, gallbladder polyps, acute cholecystitis, chronic cholecystitis, pancreatitis, biliary dyskinesia, incidental cancer, cholesterolosis, choledocholithiasis (gallstones) and unknown gallbladder disease.
- There are many variations in technique between and within the studies included in the systematic reviews and individual studies included in table 2; these are principally in relation to using either 'proprietary' multi-port system solutions or more than 1 trocar through 1 incision point. In addition, different instruments and techniques (approaches) have been used in retracting the gallbladder.
- Most studies did not explicitly state the time points of follow-up assessments.

Existing assessments of this procedure

The Australia and New Zealand Horizon Scanning Network (ANZHSN) published a report on SILC, in August 2009. This document summarised various approaches in performing SILC and outlined the efficacy and safety profile of the procedure using information from published case series and non-randomised comparative studies. ANZHSN stated that there was insufficient evidence to establish any substantial clinical benefits of SILC over CMLC at the time of publication of the review (2009).

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.

There is currently no NICE guidance related to this procedure.

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 Irfan Ahmed (Association of Upper Gastrointestinal Surgeons of Great Britain and Ireland), Mr Tony Dixon and Mr Donald Menzies (Association of Laparoscopic Surgeons of Great Britain and Ireland).

- Two specialist advisers stated that they perform the procedure regularly, whereas the other specialist adviser stated that he had performed the procedure at least once.
- Two specialist advisers described the procedure as novel and of uncertain safety and efficacy. The other specialist adviser described the procedure as a minor variation on an existing procedure, which is unlikely to alter that procedure's safety and efficacy.
- Specialist advisers stated that multiport laparoscopic cholecystectomy was a comparator to SILC.
- All specialist advisers highlighted that fewer than 10% of specialists engaged in this area of work.
- Specialist advisers did not highlight any additional adverse events reported in the literature.
- Retained gallstones, incisional hernias, as well as visceral and vascular injuries (such as bile duct injuries) were identified as theoretical adverse events.

- Specialist advisers listed key efficacy outcomes as cosmesis, patient satisfaction and pain scores.
- Specialist advisers stated that the main uncertainty about the efficacy of SILC is related to whether surgeons have been adequately trained to perform the procedure.
- One specialist adviser considered the procedure to have a potentially major impact on the NHS while the other 2 specialist advisers considered the procedure likely to have a moderate impact on the NHS.

Patient commentators' opinions

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

Issues for consideration by IPAC

Ongoing trials:

- NCT01709877: EndoCone single port versus conventional multiport laparoscopic approach; study type: randomised controlled trial; location: Italy; estimated enrolment: 300; estimated study completion date: November 2014.
- NCT01932216: Cosmesis, patient satisfaction and quality of life after da vinci single site and multiport laparoscopic cholecystectomy; study type: randomised controlled trial; location: USA; estimated enrolment: 154; estimated study completion date: March 2014.
- NCT01740973: Risk of umbilical trocar-site hernia after SILC cholecystectomy versus conventional cholecystectomy (UMBI-SILS); study type: non-randomised comparative study; location: Denmark; estimated enrolment: 700; estimated study completion date: September 2014.
- NCT01278472: Cosmesis and body image after single port or 4-port laparoscopic cholecystectomy; study type: randomised controlled trial; location: Switzerland; estimated enrolment: 110; estimated study completion

date: December 2012 (the recruitment status of this study is unknown because the information has not been verified recently).

- NCT01104727: Multiport versus single-port cholecystectomy (MUSIC); study type: randomised controlled trial; location: USA; estimated enrolment: 600; estimated study completion date: October 2012 (the recruitment status of this study is unknown because the information has not been verified recently).
- NCT01348620: Single-port laparoscopic cholecystectomy versus 4-port laparoscopic cholecystectomy: impact on postoperative pain; study type: randomised controlled trial; location: Italy; estimated enrolment: 58; estimated study completion date: January 2012 (the recruitment status of this study is unknown because the information has not been verified recently).
- NCT00974194: Safety and cost-effectiveness study of single-port laparoscopic cholecystectomies (SPoCOT); study type: randomised controlled trial; location: Switzerland; estimated enrolment: 260; estimated study completion date: January 2013 (the recruitment status of this study is unknown because the information has not been verified recently).
- NCT01268748: Single-port versus 4 ports laparoscopic cholecystectomy and early postoperative pain (UMBI-CHOL); study type: randomised controlled trial; location: Germany; estimated enrolment: 120; estimated study completion date: January 2011 (the recruitment status of this study is unknown because the information has not been verified recently).
- NCT00832767: Prospective randomised controlled trial of traditional laparoscopic cholecystectomy versus single-incision laparoscopic surgery port laparoscopic cholecystectomy; study type: randomised controlled trial; location: USA; estimated enrolment: 200; estimated study completion date: August 2012 (the recruitment status of this study is unknown because the information has not been verified recently).
- NCT01094379: A randomised comparison between single-incision laparoscopic cholecystectomy and standard laparoscopic cholecystectomy; study type: randomised controlled trial; location: Greece; estimated enrolment:

40; estimated study completion date: April 2011 (the recruitment status of this study is unknown because the information has not been verified recently).

- NCT01383031: Safety and efficacy study of transumbilical laparoendoscopic single site cholecystectomy; study type: randomised controlled trial; location: China; estimated enrolment: 600; estimated study completion date: December 2012 (the recruitment status of this study is unknown because the information has not been verified recently).

References

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2. Geng L., Sun C., Bai J. (2013) Single incision versus conventional laparoscopic cholecystectomy outcomes: a meta-analysis of randomized controlled trials. World Journal of Gastroenterology 19 (26): 4209-4213
3. Marks JM., Phillips,MS., Tacchino R., Roberts K., Onders R., DeNoto G., Gecelter G., Rubach E., Rivas H., Islam A., Soper N., Paraskeva P., Rosemurgy A., Ross S., Shah S. (2013) Single-incision laparoscopic cholecystectomy is associated with improved cosmesis scoring at the cost of significantly higher hernia rates: 1-year results of a prospective randomized, multicenter, single-blinded trial of traditional multiport laparoscopic cholecystectomy vs single-incision laparoscopic cholecystectomy. Journal of the American College of Surgeons 216 (6): 1037-1047
4. Bucher P., Pugin F., Buchs N. C., Ostermann S., Morel P. (2011) Randomized clinical trial of laparoendoscopic single-site versus conventional laparoscopic cholecystectomy. British Journal of Surgery 98 (12): 1695-1702
5. Saad S., Strassel V., Sauerland S. (2013) Randomized clinical trial of single-port, minilaparoscopic and conventional laparoscopic cholecystectomy. British Journal of Surgery 100 (3): 339-349.
6. Cheng Y., Jiang Z. S., Xu X. P., Zhang Z., Xu T. C., Zhou C. J., Qin J. S., He G. L., Gao Y., Pan M. X. (2013) Laparoendoscopic single-site cholecystectomy vs three-port laparoscopic cholecystectomy: a large-scale retrospective study. World Journal of Gastroenterology 19 (26): 4209-4213
7. Fransen S., Stassen L., Bouvy N. (2012) Single incision laparoscopic cholecystectomy: A review on the complications. Journal of Minimal Access Surgery 8 (1): 1-5

Appendix A: Additional papers on single-incision laparoscopic cholecystectomy

The following table outlines the studies that are considered potentially relevant to the IP 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
Tamini, N, Rota M, Bolzonaro E, Nespoli L, Nespoli A, Valsecchi MG, Gianotti L. (2014) Single-incision versus standard multiple-incision laparoscopic cholecystectomy: a meta-analysis of experimental and observational studies. Surg Innov. 21: 528-545	Systematic review n=7489 (2131 single incision laparoscopic cholecystectomy [SILC] vs 5367 multiple-incision laparoscopic cholecystectomy [MLC]) Follow-up: not reported	Mean operative times were significantly lower in the MLC group (61.6 mins) compared against the SILC (76.9 mins; p<0.001). Postoperative pain scores at 24 hours, length of stay, estimated blood loss, time to return to work and cosmetic outcomes were significantly better in the SILC group; however, I^2 results indicated very high heterogeneity between studies included in each meta-analysis. No significant differences were observed between groups in relation to conversion, bile spillage and complication rates.	Table 2 already includes 2 large, high quality systematic reviews which reported similar efficacy outcome measures. Unlike the systematic reviews already in table 2, this study did not stratify complications according to type.
Trastulli S., Cirocchi R., Desiderio J., Guarino S., Santoro A., Parisi A., Noya G., Boselli C. (2013) Systematic review and meta-analysis of randomized clinical trials comparing single-incision versus conventional laparoscopic cholecystectomy. British Journal of Surgery 100 (2) 191-208.	Systematic review n=923 Follow-up: not reported	SILC had a significantly higher procedure failure rate than CMLC (OR 8.16, p<0.001), required a longer operating time (WMD 16.55, p<0.001) and was associated with greater intraoperative blood loss (WMD 1.58, p=0.007).	Larger, more recent, systematic reviews that included the same studies and reported similar outcome measures were included in table 2.
Hao L., Liu M., Zhu H., Li Z. (2012) Single-incision versus conventional laparoscopic cholecystectomy in patients with uncomplicated gallbladder disease: a meta-analysis. Surgical Laparoscopy, Endoscopy & Percutaneous Techniques 22 (6): 487-497	Systematic review n=1113 Follow-up: not reported	Operating times were significantly longer in the SILC group compared with the CMLC group (p<0.00001). Cosmesis was improved in SILC patients at 1 month (p<0.00001). The pooled mean difference in pain scores at 24 hours was -0.75 in favour of the SILC technique (p=0.04). There was no significant difference in the conversion rates, adverse events, analgesia requirements, or the length of hospital stay between the 2	Larger, more recent, systematic reviews that included the same studies and reported similar outcome measures were included in table 2.

		groups.	
Pisanu A., Reccia I., Porceddu G., Uccheddu, A. (2012) Meta-analysis of prospective randomized studies comparing single-incision laparoscopic cholecystectomy (SILC) and conventional multiport laparoscopic cholecystectomy (CMLC). Journal of Gastrointestinal Surgery 16 (9): 1790-1801.	Systematic review n=353 Follow-up: not reported	Operating times and patient satisfaction scores were significantly better the in SILC group (p values<0.05). No significant differences in conversion rates, pain scores and length of stay were observed between groups.	Larger, more recent, systematic reviews that reported similar outcome measures were included in table 2.
Wang Z., Huang X., Zheng Q. (2012) Single-incision versus conventional laparoscopic cholecystectomy: a meta-analysis. ANZ Journal of Surgery 82 (12): 885-889	Systematic review n=923 Follow-up: not reported	Operating times were significantly longer in SILC than CMLC (WMD 7.72, p=0.02). Additionally, wound satisfaction scores were significantly higher in SILC than CMLC (WMD 1.40, p<0.00001)	Larger, more recent, systematic reviews that reported similar outcome measures were included in table 2.
Jørgensen LN, Rosenberg J, Al-Tayar H, Assaadzadeh S, Helgstrand F, Bisgaard T. (2014) Randomized clinical trial of single- versus multi-incision laparoscopic cholecystectomy. Br J Surg.101(4): 347-55	Randomised controlled trial n=117 (59 SILC vs 58 MLC) Follow-up: 12 months	No significant differences in analgesia usage and the proportions of patients who experienced pain or discomfort were observed between groups. Furthermore, no significant differences in VAS scores for pain at rest or pain upon movement were observed between groups. Excellent cosmetic results were reported in 57% (34/59) of patients in the SILC group and 17% (10/58) of patients in the MLC group at 12 month follow-up (p<0.001).	Larger randomised controlled trials that reported similar outcome measures are included in table 2.
Bresadola F, Pasqualucci A, Donini A et al. (1999) Elective transumbilical compared with standard laparoscopic cholecystectomy. European Journal of Surgery 165: 29–34.	Randomised controlled trial n=90 (45 SILC vs 45 CMLC) Follow-up: 48 hours	No conversions to open surgery were reported in either group. Mean operative times were better in the SILC group whereas mean analgesia use was better in the CMLC group.	Larger studies that reported similar outcome measures were included in table 2. Included in table 2 of original overview.
Pan MX., Jiang ZS., Cheng Y., Xu X P., Zhang Z., Qin JS., He G. L., Xu TC., Zhou CJ., Liu HY., Gao Y. (2013) Single-incision vs three-port laparoscopic cholecystectomy: prospective randomized	Randomised controlled trial n=102 (49 SILC vs 53 CMLC) Follow-up: not reported	The SILC group exhibited significantly better VAS scores for pain than the CMLC group, at 8 h follow-up (p<0.001). Cosmesis scores were also significantly better in the CMLC group (p<0.001) No significant differences were observed between	Larger studies that reported similar outcome measures were included in table 2.

study. World Journal of Gastroenterology 19 (3) 394-398.		groups in terms of estimated blood loss, operation duration, port-site complications.	
Khorgami Z, Shoar S, Anbara T, Soroush A, Nasiri S, Movafegh A, Aminian A. (2014) A randomized clinical trial comparing 4-port, 3-port, and single-incision laparoscopic cholecystectomy. J Invest Surg. (3):147-54	Randomised controlled trial n=90 (30 SILC vs 30 4-port laparoscopic cholecystectomy [4PLC] vs 30 3-port laparoscopic cholecystectomy [3 PLC]) Follow-up: 12 months	Operative times were significantly longer in the SILC group (63.7±9.8 mins) compared against the 4PLC group (53±13.5 mins) and the 3PLC group (54.2±14.4 mins). Mean Visual Analogue Scale (VAS) scores for pain were significantly better in the SILC group at 24 hour follow-up (p=0.03). No significant differences in analgesia intake, cosmesis scores and satisfaction scores were observed between groups. No significant differences in intraoperative and postoperative adverse event rates were observed between groups.	Larger randomised controlled trials that reported similar outcome measures are included in table 2.
Lee PC., Lo C., Lai PS., Chang JJ., Huang SJ., Lin M., and Lee, PH. (2010) Randomized clinical trial of single-incision laparoscopic cholecystectomy versus minilaparoscopic cholecystectomy. British Journal of Surgery. 97 (7): 1007-1012	Randomised controlled trial n=70 (35 SILC vs 35 CMLC) Follow-up: not reported	Length of stay, wound lengths and cosmesis scores were significantly better in the SILC group (p values<0.05). No significant differences in surgical complications, postoperative pain scores, analgesic requirements and time to return to work were reported between groups.	Study was included in one of the systematic reviews in table 2. Furthermore, larger studies that reported similar outcome measures were available.
Asakuma M., Hayashi M., Komeda K., Shimizu T., Hirokawa F., Miyamoto Y., Okuda J., Tanigawa N. (2011) Impact of single-port cholecystectomy on postoperative pain. British Journal of Surgery 98 (7): 991-995	Randomised controlled trial n=49 (25 SILC vs 24 CMLC) Follow-up: 1 week	VAS scores for pain on day 1 after surgery were significantly worse in the SILC group. Fewer patients in the SILC group required analgesia than the CMLC group.	Study was included in one of the systematic reviews in table 2. Furthermore, larger studies that reported similar outcome measures were available.
Aprea G., Coppola Bottazzi E., Guida F., Masone S., Persico G.(2011) Laparoendoscopic single site (LESS) versus classic video-laparoscopic cholecystectomy: a randomized prospective study. Journal of Surgical Research 166 (2): e109-e112	Randomised controlled trial n=50 (25 SILC vs 25 CMLC) Follow-up: not reported	Mean operative time was significantly longer in the SILC group (p=0.04). Wound satisfaction scores were significantly better in the SILC group p<0.05). No significant differences in pain scores were observed between groups.	Study was included in one of the systematic reviews in table 2. Furthermore, larger studies that reported similar outcome measures were available.
Ostlie DJ., Juang OO., Iqbal CW., Sharp SW.,	Randomised controlled trial	Operative times and degree of difficulty were significantly	Larger studies that reported similar

Snyder CL., Andrews WS., Sharp R. J., Holcomb GW., St Peter S. D. (2013) Single incision versus standard 4-port laparoscopic cholecystectomy: a prospective randomized trial. Journal of Pediatric Surgery 48 (1): 209-214.	n=60 (30 SILC vs 30 CMLC) Follow-up: not reported	greater in the SILC group (p=0.03). No significant differences in use of analgesics were observed between groups.	outcome measures were available.
Madureira F. A., Manso JE., Madureira Fo D., Iglesias A C. (2013) Randomized clinical study for assessment of incision characteristics and pain associated with LESS versus laparoscopic cholecystectomy. Surgical Endoscopy 27 (3): 1009-1015	Randomised controlled trial n=57 (25 SILC vs 25 CMLC) Follow-up: not reported	Umbilical incision lengths were significantly shorter in the SILC group (p<0.001). The mean VAS score for pain at hour 3 was 2 in the SILC group and 4 in the CMLC group (p=0.07). At postoperative hour 24 the mean VAS score for pain was 0.3 for SILC group and 2.3 in the CMLC group (p=0.03).	Study was included in one of the systematic reviews in table 2. Furthermore, larger studies that reported similar outcome measures were available.
Gangl O., Hofer W., Tomaselli F., Sautner T., Fugger R. (2011) Single incision laparoscopic cholecystectomy (SILC) versus laparoscopic cholecystectomy (LC)-a matched pair analysis. Langenbecks Archives of Surgery 396 (6): 819-824	Non-randomised comparative study n=134 (67 SILC vs 67 CMLC) Follow-up: not reported	There were no significant differences between SILC and CMLC groups in terms of postoperative pain scores at 24 h, use of analgesics, and length of stay. The completion rate in the SILC group was 85.1% (57/67). The rate of incisional hernias was 1.9% (1/53) in the SILC and 2.1% (1/48) in the CMLC group	Study was included in one of the systematic reviews in table 2. Furthermore, larger studies that reported similar outcome measures were available.
Hernandez JM, Morton CA, Ross S et al. (2010) Laparoendoscopic single site cholecystectomy: the first 100 patients. The American Surgeon75: 681–5.	Non-randomised comparative study n=130 (100 SILC vs 30 CMLC) Follow-up: not reported	Conversion to open surgery was required in 1% (1/100) of patients in the in the SILC group, due to intense pericholecystic inflammation. Six patients undergoing SILC required placement of one of more additional trocars to aid in dissection or control minor bleeding.	Larger studies that reported similar outcome measures were included in table 2. Included in table 2 of original overview.
Philipp SR, Miedema BW, Thaler K. (2009) Single-incision laparoscopic cholecystectomy using conventional instruments: early experience in comparison with the gold standard. Journal of the American College of Surgeons. 209: 632–7.	Non-randomised comparative study n=20 (29 SILC vs 22 CMLC) Follow-up: up to 4 weeks	52% (15/29) of patients in the SILC group required 1 – 3 additional skin incisions and ports, to improve retraction of the gallbladder.	Larger studies that reported similar outcome measures were included in table 2. Included in table 2 of original overview.
Kravetz AJ, Iddings D, Basson MD et al. (2009) The learning curve with single-port cholecystectomy. Journal of the Society of	Non-randomised comparative study n=20 (20 SILC vs 20 CMLC)	No conversions to open surgery or additional ports were required in the SILC or CMLC groups. Operating times were shorter in the SILC group.	Larger studies that reported similar outcome measures were included in table 2.

Laparoendoscopic Surgeons. 13: 332–6.	Follow-up: not reported		Included in table 2 of original overview.
Wagner MJ., Kern H., Hapfelmeier A., Mehler J., Schoenberg MH. (2013) Single-port cholecystectomy versus multi-port cholecystectomy: a prospective cohort study with 222 patients. World Journal of Surgery 37 (5): 991-998.	Non-randomised comparative study n=222 (122 SILC vs 100 CMLC) Follow-up: not reported	The SILC group exhibited significantly longer operating times than the CMLC group. Additional trocars were used in 6.5% (8/122) of SILC procedures and no conversion to open surgery was necessary.	Larger studies that reported similar outcome measures were available.
Joseph S., Moore BT., Sorensen GB., Earley JW., Tang F., Jones P., Brown, KM. (2011) Single-incision laparoscopic cholecystectomy: a comparison with the gold standard. Surgical Endoscopy 25 (9) 3008-3015	Non-randomised comparative study n=285 (177 SILC vs 108 CMLC) Follow-up: not reported	SILC was associated with a 15% longer operative time (p=0.053) and a 66% shorter hospital stay (p=006) than CMLC. Biliary dyskinesia and biliary colic were independently associated with shorter operative times and a reduced hospital stay. No significant differences were noted in pain scores, narcotics used in the postanaesthesia care unit or 30-day complication rates .	Larger studies that reported similar outcome measures were available.
Kim BS., Kim KC., Choi, YB. (2012) A comparison between single-incision and conventional laparoscopic cholecystectomy. Journal of Laparoendoscopic & Advanced Surgical Techniques 22 (5): 443-447	Non-randomised comparative study n=285 (177 SILC vs 108 CMLC) Follow-up: not reported	The SILC group had a longer operation time, less postoperative pain, and a shorter hospital stay than the CMLC group ($p<0.05$ for all variables)	Study was included in one of the systematic reviews in table 2. Furthermore, larger studies that reported similar outcome measures were available.
Kim MJ, Kim TS, Kim KH, An CH, Kim JS (2014) Safety and feasibility of needlescopic grasper-assisted single-incision laparoscopic cholecystectomy in patients with acute cholecystitis: comparison with three-port laparoscopic cholecystectomy. J Laparoendosc Adv Surg Tech 24(8):523-7	Non-randomised comparative study n=96 (SILC vs 3PLC) FU=Not reported	No significant differences in operative times, length of stay, conversion rates, bile spillage rates and port-site seroma rates were observed between groups.	Larger studies that reported similar outcome measures are included in table 2.
Lee SK, You YK, Park JH et al. (2009) Single-port transumbilical laparoscopic cholecystectomy: a	Case series n=37	The addition of one or more trocars was necessary in 13.5% (5/37) of patients, in most cases converting the procedure to a three-port	Larger studies that reported similar outcome measures were included in table 2.

preliminary study in 37 patients with gallbladder disease. Journal of Laparoendoscopic & Advanced Surgical Techniques 19: 495–9.	Follow-up: 48 hours	laparoscopic cholecystectomy.	Included in table 2 of original overview.
Kagaya T (2001) Laparoscopic cholecystectomy via two ports, using the "Twin-Port" system. Journal of Hepato-Biliary-Pancreatic Surgery 8: 76–80.	Case series n=40 Follow-up: Not reported	In 3 patients, an additional trocar was inserted because of difficulty in removing the gallbladder from the gallbladder fossa. The gallbladder was removed through the umbilicus in all patients (the bile was aspirated and the large stones were crushed).	Larger studies that reported similar outcome measures were included in table 2. Included in table 2 of original overview.

Appendix B: Related NICE guidance for single-incision laparoscopic cholecystectomy

Guidance	Recommendations
Interventional procedures	**Single-incision laparoscopic cholecystectomy. NICE interventional procedure guidance 346 (2010)** **(Previous guidance)** 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. • 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.

Appendix C: Literature search for single-incision laparoscopic cholecystectomy

Databases	Date searched	Version/files
Cochrane Database of Systematic Reviews – CDSR (Cochrane Library)	01/09/2014	Issue 9 of 12, September 2014
Database of Abstracts of Reviews of Effects – DARE (Cochrane Library)	01/09/2014	Issue 3 of 4, Jul 2014
HTA database (Cochrane Library)	01/09/2014	Issue 3 of 4, Jul 2014
Cochrane Central Database of Controlled Trials – CENTRAL (Cochrane Library)	01/09/2014	Issue 8 of 12, August 2014
MEDLINE (Ovid)	01/09/2014	1946 to August Week 3 2014
MEDLINE In-Process (Ovid)	01/09/2014	August 29, 2014
EMBASE (Ovid)	01/09/2014	1974 to 2014 Week 34
PubMed	01/09/2014	n/a
JournalTOCS	01/09/2014	n/a

Trial sources searched on 18/12/2013:

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

Websites searched on 18/12/2013:

- National Institute for Health and Clinical Excellence (NICE)
- NHS England
- 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)
- 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.

	Searches
1	Gallstones/
2	gallstone*.tw.
3	gall stone*.tw.
4	((gall bladder* or gall-bladder*) adj3 diseas*).tw.

5	gallbladder diseases/
6	(gallbladder* adj3 diseas*).tw.
7	cholecystolithiasis/ or choledocholithiasis/
8	Cholecystitis/ or cholelithiasis/
9	(cholelithias* or cholecystolithias* or choledocholithias* or Cholecystitis*).tw.
10	biliary tract disease/
11	(biliary* adj3 colic*).tw.
12	(biliary* adj3 calculi*).tw.
13	(bile* adj3 duct* adj3 calculi*).tw.
14	or/1-13
15	Cholecystectomy, Laparoscopic/
16	cholecystectom*.tw.
17	Cholecystectomy/
18	16 or 17
19	exp Laparoscopy/
20	Laparoscopes/
21	exp surgical procedures, minimally invasive/
22	laparoscop*.tw.
23	celioscop*.tw.
24	endoscopes/
25	endoscop*.tw.
26	percutan*.tw.
27	or/19-25
28	18 and 27
29	28 or 15
30	(single incision or single-incision).tw.
31	((one or single) adj3 (port or site)).tw.
32	Umbilicus/
33	(transumbilic* or trans-umbilic* or trans umbilic*).tw.
34	(natural* adj3 orifice*).tw.
35	or/30-34
36	14 and 29 and 35
37	animals/ not humans/
38	36 not 37
39	**limit 38 to ed=20091001-20131223**