J Minim Invasive Surg Sci. 2014 August; 3(3): e11720.

Published online 2014 June 18. **Research Article**

Feasibility of Routine Single Incision Laparoscopic Appendectomy in UK District General Hospitals: A Prospective Study

Emma Rose McGlone [1,*]; Christian Wakefield [2]; Amjad Parvaiz [3]; Omar Khan [1]

[1]Department of General Surgery, St George's Healthcare NHS Trust, London, UK
[2]Department of Upper Gastrointestinal Surgery, Royal Hampshire County Hospital, Winchester, UK
[3]Department of Colorectal Surgery, Queen Alexandra Hospital, Portsmouth Hospitals NHS Trust, Portsmouth, UK

*Corresponding author: Emma Rose McGlone, Department of General Surgery, St George's Healthcare NHS Trust, London, UK. Tel: +44-7949565678 Fax: +44-2087253466, E-mail: ermcglone@gmail.com

Received: April 27, 2013; **Revised:** September 10, 2013; **Accepted:** June 10, 2014

Background: Although many studies have demonstrated the feasibility of single-incision laparoscopic (SILS) appendectomy, this procedure has not become routine. In part this maybe due to the perception that SILS appendectomy has additional resource requirements compared to conventional laparoscopic appendectomy in terms of personnel, time and equipment.
Objectives: The purpose of this prospective study was to assess the feasibility of a UK trainee performing routine SILS appendectomy with standard equipment.
Patients and Methods: Prospective analysis of all consecutive adults who underwent laparoscopy for presumed appendicitis was performed. Cases were performed either by a senior trainee who exclusively performed SILS appendectomy on all patients using standard laparoscopic equipment, or other senior or junior trainees performing a conventional three-port laparoscopic appendectomy.
Results: Seventeen patients had SILS operations: 15 appendectomies, one resection of inflamed Meckel's diverticulum and one appendectomy with oophorectomy. SILS was successfully completed in 14 cases whilst in three cases one extra port was added. Comparison of the 15 SILS operations that involved an appendectomy only with consecutive cohorts of three-port appendectomies performed by junior and senior trainees showed no significant difference in complications or length of hospital stay. There was no significant difference in operating time between SILS and junior trainee ($P = 0.54$), however the senior trainees had a significantly reduced operating time as compared to both SILS and junior trainee groups ($P = 0.01$).
Conclusions: SILS appendectomy can be successfully performed by trainees on all-comers with comparable resource utilisation and clinical outcomes to those achieved by junior trainees performing a conventional three-port laparoscopic approach.

Keywords: Appendectomy; Laparoscopy; Minimally Invasive Surgery; Surgery

1. Background

Appendectomy is one of the most common emergency operations performed worldwide (1). The benefits of laparoscopic as compared to open appendectomy in reducing surgical trauma and aiding post-operative recovery have been demonstrated in a number of studies (2). Single incision laparoscopic surgery (SILS) is a further innovation allowing minimal access surgery to be performed through a single umbilical incision; it has been described as virtually "scarless" due to the healed scar being concealed within the umbilicus (3). Apart from cosmetic advantages, the SILS technique potentially further reduces the trauma of surgical access, which has theoretical advantages for the incidence of wound complications, postoperative pain and recovery time as compared with conventional laparoscopic surgery (4).

Although the technical feasibility and patient satisfaction with SILS appendectomy over conventional laparoscopy has been well documented (4-6), this technique has not to date been routinely adopted in widespread clinical practice in the UK. Part of the reason for this reluctance may lie in the perceived technical difficulty of single-port surgery, largely due to the loss of three-port triangulation. In addition, the majority of descriptions of SILS procedures utilise specialised and expensive ports and roticulated instruments (7). Moreover with specific reference to United Kingdom practice, previous audits have demonstrated that appendectomy is typically performed by trainees without direct consultant supervision (1). Given the perceived technical difficulty associated with SILS, there may be a reluctance to allow trainees to undertake these procedures without direct supervision. In an attempt to develop our SILS service, we instituted a policy of allowing suitably trained surgical trainees to undertake appendectomies using a cost-effective SILS technique.

Implication for health policy/practice/research/medical education:
Single-Incision Laparoscopic Surgery (SILS) appendectomy is a feasible and practical alternative to three port laparoscopic appendectomy. SILS appendectomy can be performed by a trainee with similar clinical outcomes and resource utilisation, in terms of cost and time, to those of junior trainees performing conventional three port laparoscopic appendectomy.

Copyright © 2014, Minimally Invasive Surgery Research Center and Mediterranean & Middle Eastern Endoscopic Surgery Association. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

[Downloaded from annbsurg.iums.ac.ir on 2025-02-01]

2. Objectives

The purpose of this prospective study was to assess the feasibility of a single trainee performing routine SILS appendectomy on all adults with the clinical diagnosis of appendicitis, using standard laparoscopic ports and instruments, and to prospectively compare the clinical outcomes with those of a consecutive cohort of patients undergoing conventional three-port laparoscopic appendectomy.

3. Patients and Methods

This study was conducted in the Queen Alexandra Hospital, Portsmouth, (from July - September 2010) and the Royal Hampshire County Hospital, Winchester (from October-December 2010). In both institutions, all adult patients with suspected appendicitis were reviewed by the admitting consultant and in cases where the decision was made to perform surgery the patient was placed on a dedicated daily emergency list. The emergency list was staffed by a rostered duty surgical registrar together with a supervising consultant. Whilst the consultant was expected to be present within the theatre complex for all cases, the consultant was not expected to directly supervise the registrar for simple cases including routine appendectomies. It should be noted that prior to this study the default surgical approach in both institutions was to attempt a laparoscopic three-port appendectomy in adult patients.

3.1. Surgical Technique

3.1.1. Conventional Three-Port Laparoscopic Appendectomy (LA)

Using a Hasson technique to access the peritoneum, a 12 mm blunt laparoscopic port is inserted in the infra-umbilical position. Two additional 5 mm laparoscopic ports are inserted in the suprapubic and left iliac fossa positions under direct vision. Using standard laparoscopic equipment, the appendix is mobilized. A window is created in the mesoappendix adjacent to the appendix base. The mesoappendix is divided using monopolar diathermy; the appendix base ligated using two Endoloop ligatures (Covidien) and the appendix then divided between the two ligatures and removed through the 12 mm port with the aid of a retrieval bag (Espiner standard E-sac).

3.1.2. Single-Incision Laparoscopic Surgery Appendectomy Technique

Having everted the umbilicus, a transverse trans-umbilical skin incision is made and the umbilical stalk elevated with a Kochers forceps. The junction between the umbilical stalk and the linea alba is identified and a 1.5 cm micro-laparotomy performed under direct vision. A small wound protector (Alexis®, Applied Medical) is then inserted into the peritoneal cavity. A glove is prepared with three of the finger tips cut and three 5 mm ports inserted into the fingers of the glove and secured with 0 vicryl ties. The glove is then attached to the outer ring of the wound protector and a pneumoperitoneum established. A 30-degree 5 mm telescope and standard straight instruments are introduced into the peritoneal cavity; in this series placement of instruments was crossed-over, although the method allows parallel positioning of instruments as the glove can be rotated and/or instruments placed into alternative glove fingers. After a diagnostic laparoscopy, the appendix is mobilised in a standard fashion; the mesoappendix divided using monopolar diathermy and the base of the appendix ligated typically with two Endoloop ligatures (Covidien). In cases of technical difficulty an additional supra-pubic 5-mm port may be inserted. Appendectomy is then performed by cutting between the two ligatures using laparoscopic scissors and the appendix removed via the Alexis wound protector and placed in one of the empty fingers of the glove. The wound protector is removed and the fascial defect closed with interrupted 1 ethibond sutures with 4-0 Monocryl (Ethicon) for skin. It should be noted that in cases where gynaecological pathology such as pelvic inflammatory disease was noted, in cases of sigmoid diverticulitis and in cases where no abnormality was found, routine prophylactic appendectomy was undertaken. All resected specimens were sent to the laboratory for routine pathological analysis. Based on a combination of operative and histological findings a diagnosis of simple or complex (perforated appendix or the presence of an intra-abdominal abscess) appendicitis was made.

3.2. Case Selection

A single ST 7-level upper gastrointestinal surgical trainee (OK) was taught the technique for performing SILS appendectomy as described above by a national laparoscopic colorectal trainer (AP). After being assessed and certified as competent by this trainer, over a six month period between July 2010- December 2010, all adults placed on the theatre list for diagnostic laparoscopy for presumed appendicitis when this trainee was the rostered emergency theatre surgeon were listed for SILS appendectomy. All these patients were approached prior to surgery and underwent a fully informed consent for the SILS approach. It should be noted that during the period of the study, all patients approached consented to SILS appendectomy and this trainee did not perform any open appendectomies or conventional three-port laparoscopic appendectomies: SILS represented the totality of practice for this trainee for cases of suspected appendicitis. Moreover, as with all appendectomies performed at each of these institutions, a supervising consultant attended only at the request of the trainee.

[Downloaded from annbsurg.iums.ac.ir on 2025-02-01]

3.3. Analysis

The demographic and clinical details of the consecutive cohort of patients undergoing SILS appendectomy were prospectively recorded on an Excel spreadsheet. In addition the data for all of the conventional three-port laparoscopic appendectomies performed in July 2010 at Queen Alexandra Hospital were also prospectively recorded. For analysis, we divided operating surgeons for these conventional laparoscopic cases into junior trainees (defined as ST1-6 or equivalent) or senior trainees (defined as ST7-8 or equivalent), in order to take into account the learning curve for this operation. It should be noted that during the period no consultant performed an appendectomy as the primary surgeon. Statistical analysis was performed using SPSS PC version 14.0 (SPSS Inc., Chicago, IL). Continuous data from the SILS appendectomy and conventional groups were expressed as mean ± standard error where appropriate. Inter-group comparisons for continuous variables were made using ANOVA or Kruskal-Wallis and two-tailed Chi-square tests or (in cases where the expected incidence of an outcome measure was less than 5) Fisher's exact tests were used for categorical variables. Significance was defined as P value < 0.05.

4. Results

4.1. Single-Incision Laparoscopic Surgery Cases

Over the six month period a total of 17 patients were listed for SILS appendectomy. Of these, seven were male and the mean age was 32 years. Four of the patients were clinically obese (BMI > 30) and one morbidly obese (BMI of 47). Of the 17 cases, the diagnoses noted at laparoscopy are summarised in Table 1.

Appendectomy was undertaken in 16 cases including one case where a concomitant oophorectomy was also performed. In one case resection of small bowel containing an inflamed Meckel's diverticulum was performed. The appendix base was secured using endoloops in 15 cases and laparoscopic suture in one.

Adverse events are summarized in Table 2. Conversions from SILS approach to a two port approach occurred in three cases: in one case where an oophorectomy was also undertaken and in two cases of complex appendicitis in order to leave an intra-abdominal drain. There were no conversions to an open procedure.

Consultant involvement was required in three cases: in two cases of complex appendicitis where the consultant was able to complete the case SILS; and in one case where an oophorectomy was also undertaken. There were two post-operative morbidities following SILS appendectomy for complex appendicitis. In one case the patient had a post-operative chest infection requiring intravenous antibiotic therapy and resulting in a delayed discharge; in the other a patient was readmitted with a pelvic collection requiring percutaneous drainage.

4.2. Comparison of Single-Incision Laparoscopic and Conventional Laparoscopic Appendectomy

Comparison of the 15 SILS operations that involved an appendectomy only with consecutive cohorts of conventional three port laparoscopic appendectomies performed by senior and junior trainees are summarised in Table 3. There were no post-operative complications for the junior trainees, for the senior trainees there were two pelvic collections and one stump blowout, which required re-operation. There was no significant difference in the length of hospital stay between groups. With regard to operating time there was no significant difference between SILS and junior trainees (P = 0.54); however

Table 1. Demographic and Operative Data of 17 Single-Incision Laparoscopic Surgery Patients

Demographic	Number
Gender	
Male	7
Female	10
Mean Age, y	32
Diagnosis at Operation	
Simple appendicitis	5
Complex appendicitis	6
Pelvic inflammatory disease	3
Meckel's diverticulum	1
Sigmoid diverticulitis	1
Torted ovarian cyst	1
Procedure at Operation	
Appendectomy	15
Small bowel resection	1
Salpingo-oophorectomy and appendectomy	1

Table 2. Need for Consultant Involvement, Conversions to 2-Port Approach and Complications by Diagnosis in Single-Incision Laparoscopic Cases

Adverse Event	Simple 'Appendicitis'	Complex 'Appendicitis'	Other Diagnosis
Consultant involvement	0	2	1
Conversion to two-port procedure	0	2	1
Post-operative complications			
Chest infection	0	1	0
Pelvic collection	0	1	0

[Downloaded from annbsurg.iums.ac.ir on 2025-02-01]

Table 3. Comparison Between SILS Appendectomy and Three Port Laparoscopic Appendectomy (LA) by Senior and Junior Trainees [a]

Operative Variable	SILS Appendectomy	LA by Senior Trainee	LA by Junior Trainee
Number of cases	15	16	14
Mean operating time, minutes ± SE	77.4 ± 6.6	55.3 ± 4.7	76.2 ± 6.8
Conversion to open	0	0	1
Need for re-operation	0	1	0
Post-operative complications	2	3	0
Mean length of hospital stay, days ± SE	1.73 ± 0.23	1.75 ± 0.4	2.58 ± 0.5
Emergency readmission within 30 days of discharge	1	3	0

[a] abbreviations: SILS, Single-Incision Laparoscopic Surgery; LA, conventional three-port laparoscopic appendectomy; SE, standard error.

senior trainees had a significantly reduced operating time as compared to the SILS and junior trainee groups (P = 0.01).

Based on the methods described above, equipment for our SILS appendectomy costs on average £6 more than for conventional laparoscopic appendectomy; included in this calculation is the fact that the SILS method requires a wound protector but is performed without use of a retrieval sac.

5. Discussion

This study suggests that the implementation of a cost effective approach for routine SILS appendectomy for all-comers is both safe and feasible. It must be noted that this series included all patients considered candidates for a conventional laparoscopic appendectomy, unlike other studies which have excluded complex cases of appendicitis (3, 8). Moreover no SILS cases were converted to open surgery even though a variety of diagnoses, including Meckel's diverticulitis and torted ovarian cyst, were encountered and treated.

There were few complications in our series. The expected incidence of complications in both open and minimally invasive appendectomy is low, however, so our cohort size is too small to appreciate potential subtle differences in complication rate between SILS and conventional laparoscopic appendectomy; such complications might affect the overall cost of employing either method as a default approach to all-comers. A recent study comparing 579 cases of SILS 'video-assisted appendectomy' with similar numbers of conventional laparoscopic and open appendectomy also reported low overall complication rates (9). In this large series, there was no difference between rates of complication in conventional laparoscopic and SILS appendectomy, but a higher rate of wound infection was found in open appendectomy compared to SILS appendectomy (6.9% vs. 2.4%). This evidence supports the notion that SILS appendectomy is a safe alternative to three-port laparoscopic appendectomy.

In addition to safety, an important aspect of our study was the need to demonstrate that SILS appendectomy could be performed within the resource constraints of the NHS. This entails a number of factors: the equipment must be cheap; and the operating time and the personnel required must be comparable to that of conventional laparoscopy. In terms of equipment, we used a wound retractor and surgical glove, a technique that has been successfully used in other centres (3). This method allows the potential insertion of up to five instruments, and each instrument has a wide axis of possible movement.

With respect to operating time, our mean SILS appendectomy operating time was 77 minutes. A recent systematic review of the literature found that reported operating times for single-incision appendectomy are highly variable (10). Closer analysis reveals that many of the so-called SILS series actually employ a laparoscopic-assisted method of extracorporeal appendectomy, in which the laparoscope is used to locate the appendix, which is then delivered through the same port and divided outside of the abdomen. This single-incision laparoscopic-assisted method differs significantly from ours, in which the entire operation is performed intracorporeally. The single-incision laparoscopic-assisted technique has mainly been performed in children (11) and it is questionable whether this technique is practical for the larger abdomens of adults, particularly the morbidly obese who make up a substantial portion of our practice. It has also been suggested that exteriorisation of the inflamed appendix may increase the rate of wound infections (10). Our mean operative time is comparable to that of other studies of true SILS appendectomy in adults (12-14) and is also comparable with the time taken in this study for conventional laparoscopic appendectomy by a junior trainee; it is significantly longer, however, than the mean time taken by a senior trainee to perform a three-port laparoscopic appendectomy. The concept of a learning curve is widely accepted for laparoscopic appendectomy, with decreases in mean operating time shown after approximately 20-30 cases (15, 16). It is likely that a learning curve also exists in SILS and as such our SILS trainee's mean operative time may be expected to reduce over time.

Finally with respect to the personnel performing surgery, the majority of published series on SILS appendec-

[Downloaded from annbsurg.iums.ac.ir on 2025-02-01]

tomy were performed by expert consultant surgeons (6, 7, 17). In the UK, however, appendectomy is typically performed by unsupervised trainees and this is one of the first studies to demonstrate the feasibility of an unsupervised trainee safely performing SILS appendectomy.

We acknowledge that there are some weaknesses in this study. For a start we accept that our cohort size, whilst comparable to previous studies, is relatively small. In addition, we accept that by analysing the results of a single senior trainee, these results may not necessarily be generalisable. With respect to the comparative data, this was not a randomised-controlled trial, although the prospective nature of the study and the lack of selection bias add weight to the validity of our findings. In conclusion, this paper provides evidence that SILS appendectomy may be feasible on all-comers with comparable clinical outcomes and resource consumption as compared with conventional three-port laparoscopic appendectomy.

Acknowledgements

The authors would like to acknowledge the staff and patients at Queen Alexandra Hospital, Portsmouth, and Royal Hampshire County Hospital, Winchester, for their assistance during the study period.

Authors' Contributions

All the authors have made substantial contributions to the following: conception/design of the study, data acquisition and analysis, drafting or revising the article and reviewing its final version before submission.

References

1. Lansdown MR, Gray AJ, Treasure T, Layer GT. Appendicectomy: who performs it, when and how? *Ann R Coll Surg Engl.* 2006;**88**(6):530–4.
2. Sauerland S, Jaschinski T, Neugebauer EA. Laparoscopic versus open surgery for suspected appendicitis. *Cochrane Database Syst Rev.* 2010(10):CD001546.
3. Livraghi L, Berselli M, Bianchi V, Latham L, Farassino L, Cocozza E. Glove technique in single-port access laparoscopic surgery: results of an initial experience. *Minim Invasive Surg.* 2012;**2012**:415430.
4. Ahmed K, Wang TT, Patel VM, Nagpal K, Clark J, Ali M, et al. The role of single-incision laparoscopic surgery in abdominal and pelvic surgery: a systematic review. *Surg Endosc.* 2011;**25**(2):378–96.
5. Gill RS, Shi X, Al-Adra DP, Birch DW, Karmali S. Single-incision appendectomy is comparable to conventional laparoscopic appendectomy: a systematic review and pooled analysis. *Surg Laparosc Endosc Percutan Tech.* 2012;**22**(4):319–27.
6. Vilallonga R, Barbaros U, Nada A, Sumer A, Demirel T, Fort JM, et al. Single-port transumbilical laparoscopic appendectomy: a preliminary multicentric comparative study in 87 patients with acute appendicitis. *Minim Invasive Surg.* 2012;**2012**:492409.
7. Chow A, Purkayastha S, Nehme J, Darzi LA, Paraskeva P. Single incision laparoscopic surgery for appendicectomy: a retrospective comparative analysis. *Surg Endosc.* 2010;**24**(10):2567–74.
8. St Peter SD, Adibe OO, Juang D, Sharp SW, Garey CL, Laituri CA, et al. Single incision versus standard 3-port laparoscopic appendectomy: a prospective randomized trial. *Ann Surg.* 2011;**254**(4):586–90.
9. Lima GJ, Silva AL, Leite RF, Abras GM, Castro EG, Pires LJ. Transumbilical laparoscopic assisted appendectomy compared with laparoscopic and laparotomic approaches in acute appendicitis. *Arq Bras Cir Dig.* 2012;**25**(1):2–8.
10. Ahmed I, Paraskeva P. A clinical review of single-incision laparoscopic surgery. *Surgeon.* 2011;**9**(6):341–51.
11. Valla J, Ordorica-Flores RM, Steyaert H, Merrot T, Bartels A, Breaud J, et al. Umbilical one-puncture laparoscopic-assisted appendectomy in children. *Surg Endosc.* 1999;**13**(1):83–5.
12. Chow A, Purkayastha S, Paraskeva P. Appendicectomy and cholecystectomy using single-incision laparoscopic surgery (SILS): the first UK experience. *Surg Innov.* 2009;**16**(3):211–7.
13. Roberts KE. True single-port appendectomy: first experience with the "puppeteer technique". *Surg Endosc.* 2009;**23**(8):1825–30.
14. Palanivelu C, Rajan PS, Rangarajan M, Parthasarathi R, Senthilnathan P, Praveenraj P. Transumbilical endoscopic appendectomy in humans: on the road to NOTES: a prospective study. *J Laparoendosc Adv Surg Tech A.* 2008;**18**(4):579–82.
15. Jaffer U, Cameron AE. Laparoscopic appendectomy: a junior trainee's learning curve. *JSLS.* 2008;**12**(3):288–91.
16. Kim SY, Hong SG, Roh HR, Park SB, Kim YH, Chae GB. Learning curve for a laparoscopic appendectomy by a surgical trainee. *J Korean Soc Coloproctol.* 2010;**26**(5):324–8.
17. Chouillard E, Dache A, Torcivia A, Helmy N, Ruseykin I, Gumbs A. Single-incision laparoscopic appendectomy for acute appendicitis: a preliminary experience. *Surg Endosc.* 2010;**24**(8):1861–5.

[Downloaded from annbsurg.iums.ac.ir on 2025-02-01]