Single-port laparoscopic rectal surgery – a systematic review

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ABSTRACT

INTRODUCTION: Single-port laparoscopic surgery (SPLS) for colonic disease has been widely described, whereas data for SPLS rectal resection are sparse. This review aimed to evaluate the feasibility, safety and complication profile of SPLS for rectal diseases.

METHODS: A systematic literature search of PubMed and Embase was performed in September 2013 according to the PRISMA guidelines. Original reports on the use of SPLS in high and low anterior resection, Hartmann's operation and abdominoperineal resection were included. Outcome measures were intra-operative details and complications, short-term oncological outcome and early complication profile.

RESULTS: No randomised studies or controlled clinical studies were identified. All studies were case series or case reports. Only five studies included more than ten patients operated with SPLS, comprising a total of 120 patients. These studies formed the basis for the final analyses of outcome. Operative times ranged from 79 to 280 min. Conversion rates to conventional laparoscopic surgery and to open surgery were 12% and 2.5%, respectively. The number of harvested lymph nodes in malignant cases was 13-18. The post-operative complication rate was 25.5%. Length of hospital stay was 1-16 days. No 30-day mortality was reported.

CONCLUSION: Short-term results suggest that SPLS for rectal disease is feasible and safe with an acceptable complication rate when performed by experienced surgeons in selected patients. Oncological safety and the possible benefits remain to be proven. Future rectal SPLS procedures should be performed in a protocolled set-up.

Laparoscopic rectal surgery has been shown to be a safe alternative to open rectal surgery in several large randomised clinical studies [1-3]. Laparoscopic procedures offer less pain, less blood loss, faster recovery, reduced hospital stay, fewer wound-related complications and better cosmesis [4]. Oncological outcomes do not differ from the traditional open procedures [5]. To reduce the surgical trauma and morbidity and improve the cosmetic outcome, new minimally invasive procedures such as natural orifice transluminal endoscopic surgery (NOTES), natural orifice specimen extraction (NOSE) and single-port laparoscopic surgery (SPLS) have evolved as alternatives to conventional laparoscopic surgery (CLS). The use of SPLS in colorectal surgery was first reported in 2008 [6, 7] and is now an emerging approach. SPLS allows colorectal procedures to be performed either through the umbilicus or through a planned stoma site. We recently reported that 15.7% of the patients who were treated laparoscopically for rectal cancer between January 2009 and October 2012 at our institution underwent SPLS, whereas 84.3% had CLS [8]. Recent years have seen several systematic reviews on SPLS for colonic resections and various colorectal resections [9-11]. The available literature, however, mainly consists of retrospective case-comparison series, case series and case reports, and the vast majority involve primarily colonic SPLS procedures. The conclusions from these studies tend to be that SPLS is safe and feasible in experienced hands and in selected patients. However, more randomised controlled trials (RCTs) are needed to assess the long-term oncological outcomes, and the potential benefits compared with CLS need to be documented. No systematic reviews have focused on rectal SPLS exclusively. This review aimed to evaluate the safety, feasibility and complication profile of rectal SPLS.

METHODS

Search strategy

A systematic search on published literature was done using the PRISMA guidelines [12, 13]. Studies were identified through searches of PubMed and Embase in September 2013. The search terms used were "single incision OR single site OR single port OR single access OR single trocar" AND "laparoscopic" – AND "colorectal surgery OR rectal surgery OR rectal resection OR anterior resection OR abdominoperineal resection". The limitations were language English and species human. For Embase, the search was further limited to "articles" and for PubMed" to case report, comparative study, clinical trial, controlled clinical trial, randomised controlled trial" as only original studies were considered. Citations from the included articles were searched, but revealed no more relevant articles. Two studies on rectal SPLS were published later than the systematic search [14, 15]. They were identified by a co-author and included.

Selection criteria

Articles were selected for detailed reading if the abstract

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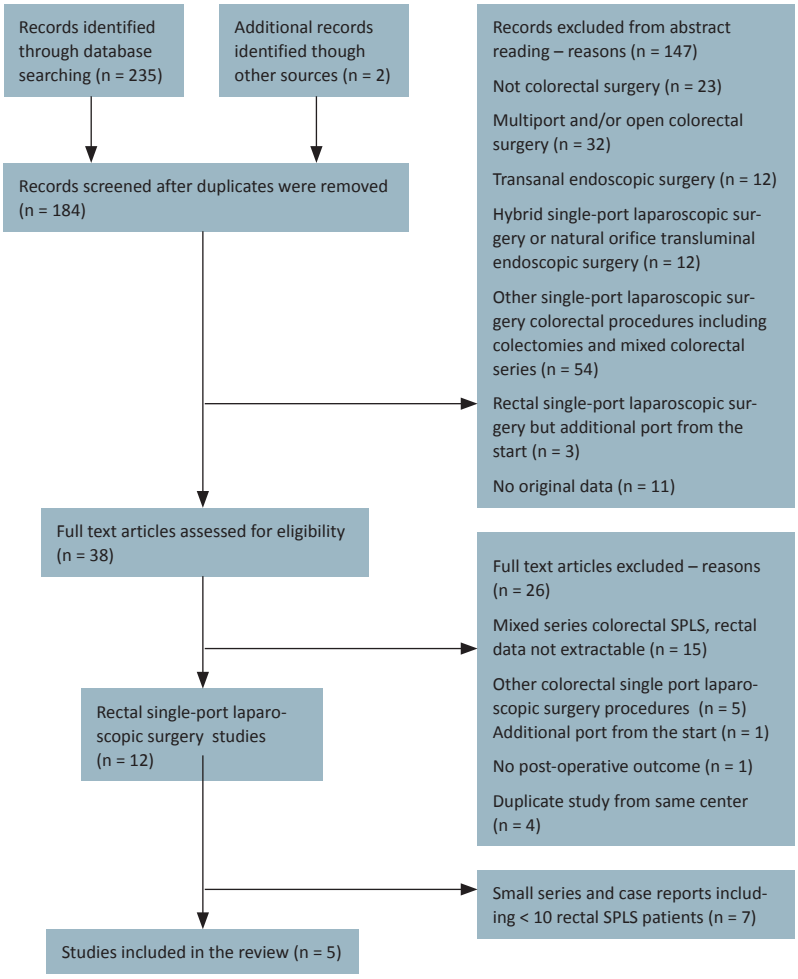
FIGURE 1

Flow chart illustrating the selection process for studies included in the systematic review.



contained data on patients operated with SPLS for benign or malignant rectal disease with high or low anterior resection (HAR/LAR), Hartmann's operation (HO) or abdominoperineal resection (APR). Only original case reports, series or trials were considered. Reviews, comments and guidelines were excluded. Full text articles of relevant studies were retrieved for further selection. Data collected for this review were taken from the published reports. Authors were not contacted to obtain raw data. Only studies with extractable data on rectal SPLS procedures were included. Studies containing mixed series of colonic and rectal SPLS were included if data on rectal SPLS could be isolated and extracted. Hybrid techniques and NOTES procedures were excluded. All included studies had to report the indication for surgery and to contain data on intra-operative, oncological and post-operative outcome. To avoid duplication of data, data from the same unit or hospital were included only once, using the most recent publication. To reduce selection bias and data reporting bias inherent to case reports and very small series, only series of more than ten patients were included for the final analyses of SPLS outcomes.

Data collection and analyses

Two authors (IL and OB) reviewed the full text articles that met the inclusion criteria and extracted information on *study population characteristics:* age, body mass index (BMI) and previous abdominal surgery; *indication for SPLS*: benign or malignant disease; *operative details and technical data*: type of resection, type of SPLS port, operating time, per-operative complications, conversion to CLS or open surgery and length of incision; *oncological data:* preoperative neoadjuvant chemoradiotherapy (CRT), number of harvested lymph nodes (LNH), resection margins (CRM), completeness of the mesorectal fascia, American Joint Committee of Cancer (AJCC) stage and tumour size; and *post-operative outcomes:* post-operative complications, reoperation, length of stay (LOS) and 30-day mortality.

RESULTS

Included studies

The systematic literature search is illustrated by a PRISMA flow diagram (**Figure 1**). A total of 12 relevant articles comprising 145 patients were identified [14-25]. Only five studies met the inclusion criteria which reduced the number of eligible patients to 120 (**Table 1**) [14, 16-19].

Quality of included studies

No randomised studies or controlled clinical studies were found (Table 1). Only two comparative case series were identified [15, 17]. All other studies were either non-comparative case series [14, 16, 18, 19, 21, 22, 25] or case reports [20, 23, 24]. Most series included relatively few patients with a mixture of both colonic and rectal SPLS procedures as well as benign and malignant diseases. Two studies included cases treated with hybrid techniques [15, 23]. Of the five case series that reported more than ten cases of pure rectal SPLS [14, 16-19], only one study was comparative [17]. All others were non-comparative studies [14, 16-19]. Due to poor study quality, significant heterogeneity, risk of selection and publication bias, and lack of prospective randomised or controlled clinical studies, these data were not found to be suitable for a meta-analysis. The five studies shown in Table 1 constitute the basis for the review.

Study population characteristics and indications and procedures for rectal single-port laparoscopic surgery

Study population characteristics are summarised in Table 1. Indications for surgery included both malignant

and benign rectal diseases. The majority of the reported indications were malignancies (74%). Diverticular disease was the most commonly reported benign indication (20%). Other benign indications were ulcerative colitis (2.5%) and polyps (< 1%). The three most frequently reported procedures were high anterior resection with or without a protective ileostomy (HAR-L/HAR): 62 out of a total of 120 procedures (52%); low anterior resection with or without a protective ileostomy (LAR-L/LAR): 27 procedures (22.5%); and abdominoperineal resection (APR): 28 procedures (23%) (Table 1). Even though surgeries were rectal procedures, they represented a heterogeneous group in terms of surgical complexity and expected post-operative outcome.

Ports and abdominal access

The most commonly used ports were SILS (Covidien), Triport (Advanced Surgical Concepts), Glove-Port-Single Port, Nelis Ltd. and GelPOINT (Applied Medical Corp) with access though the umbilicus or through a planned stoma site.

Conversion, operating times, and intra-operative outcomes

Placement of extra ports was considered conversion to CLS. All five studies specified whether conversion to open surgery had been done, and four studies gave information on conversion to CLS. In 12 out of 101 procedures (12%), conversion to CLS was done with one or more extra ports being introduced. In three out of 120 procedures (2.5%), conversion to open surgery was done. Intra-operative outcomes including conversion rates, operative time and per-operative bleeding are summarised in **Table 2**. Two studies measured incision

TABLE 1

Study characteristics of rectal single-port laparoscopic surgery studies including more than ten patients.

Reference	Year	Study design	Patients with TCS/RS, n	Procedure: n	Indication for RS: n	Age, yrs	BMI, kg/m²	PAS, %
Chew et al [16]	2011	Non-comparative case series	32/11	HAR: 7 LAR: 3 APR: 1	Malignant: 10 Benign: 1	66 (49-80)[b]	NS	NS
Osborne et al [17]	2012	Comparative case series	55/55	HAR: 53 HAR-L: 2	Malignant: 29 Benign: 26	63 ± 13[a]	26 (17-41)[b]	NS
Bulut et al [14]	2013	Non-comparative case series	25/25	LAR: 8 LAR-L: 6 APR: 8 HO: 3	Malignant	69 (49-87)[b]	24 (21.5-24.5)[b]	44
Sirikurnpiboon & Jivapaisarnpong [18]	2013	Non-comparative case series	10/10	LAR: 1 APR: 9	Malignant: 10	69 ± 11.8[a]	21.8 ± 4.48[a]	NS
Vestweber et al [19]	2013	Non-comparative case series	244/19	LAR: 9 APR: 10	Malignant: 15 Benign: 4	57 ± 14.9[a]	26.5 ± 4.7[a, c]	NS

APR = abdominoperineal resection; BMI = body mass index; HAR = high anterior resection; HAR-L = high anterior resection with a protective ileostomy; HO = Hartmann's operation; LAR = low anterior resection; LAR-L = low anterior resection with a protective ileostomy; NS = not specified; PAS = previous abdominal surgery; RS = rectal surgery; TCS = total colorectal surgery.

a) Mean ± standard deviation.

b) Median (range).

c) All patients.

TABLE 2

Intra-operative and oncological outcomes in studies reporting more than ten rectal single-port procedures.

Reference	Conversion CLS/OS, n	Operative time, min.	Per-operative bleeding, ml	LNH, malignant cases, n	Positive resection margin
Chew et al [16]	8/0	120 (60-235)[b]	NS	14 (6-16)[b]	NS
Osborne et al [17]	2/0	79 ± 37[a]	NS	18 (2-34)[b]	0
Bulut et al [14]	2/1	280 (136-397)[b]	40 (0-400)[b]	13 (3-33)[b]	0
Sirikurnpiboon & Jivapaisarnpong [18]	0/0	269 (200-300)[b]	145 (50-300)[b]	15 (8-30)[b]	0
Vestweber et al [19]	NS/0 LAR	183 ± 66 LAR[a]	NS	NS	NS
	NS/2 APR	254 ± 84 APR[a]			

APR = abdominoperineal resection; CLS = conventional laparoscopic surgery; LAR = low anterior resection; LNH = lymph node harvest; NS = not specified; OS = open surgery.

a) Mean ± standard deviation.

b) Median (range).

Post-operative photo of single-port laparoscopic surgery (low anterior resection) with access though planned stoma-site. The patient has a scar after previous abdominal surgery.

length at the end of the procedure. Chew et al [16] reported a final incision length median of 5 cm/range 3-7 cm, and Sirikurnpiboon & Jivapaisarnpong reported a final incision length mean of 5.5 cm [18]. The remaining studies only reported the incision length needed for placement of the single port (2.5-3 cm).

Oncological outcome

A total of 89 cases of rectal SPLS for malignant disease were reported. Four studies specified the number of harvested lymph nodes (LNH) (median number 13-18). All four studies reported one or more cases with less than 12 LNH. Only one study specified whether the patients had received preoperative neoadjuvant CRT [14]. One study included only patients who had rejected preoperative neoadjuvant chemotherapy, not mentioning radiotherapy [18]. AJCC stage was reported in three studies. Bulut et al [14] included 13 (52%) stage I+II cases and 12 (48%) stage III+IV cases. Chew et al [16] reported two (20%) stage I cases, five (50%) stage II cases and three (30%) stage III cases. Sirikurnpiboon & Jivapaisarnpong [18] reported two (20%) stage II and eight (80%) stage III cases. In three studies that gave information on radicality, all resections were R0 [14, 17, 18] (Table 2). Tumour size, resection margins (CRM) and completeness of the mesorectal fascia were reported in the study by Bulut et al [14]. Median tumour size was 32 mm (range 0-82 mm), and median CRM was 10 mm (range 1-25 mm). The mesorectal fascia was deemed complete or nearly complete in 92% of the patients. Sirikurnpiboon & Jivapaisarnpong [18] reported a CRM of at least 2 mm in all cases (median CRM not specified). The mesorectal excision was deemed complete or nearly complete in all patients.

Post-operative complications and length of hospital stay

The post-operative complication profile was reported in details in three studies [14, 17, 18]. The overall complication rate was (23/90) 25.5%. Osborne et al [17] reported 11 post-operative complications in 55 patients. Two had anastomotic leakage and one small-bowel obstruction due to haematoma. Other complications comprised bleeding (n = 1), pulmonary embolus (n = 1) and urinary retention (n = 4). Median LOS was one day, and five patients were readmitted. The length of the follow-up period was not specified, but one incisional hernia was reported at long-term follow-up.

In the study by Bulut et al [14] which included 25 patients, seven complications were seen in six patients: anastomotic leakage (n = 1), compartment syndrome in calf due to lower limp arterial insufficiency (n = 1) and urinary tract infections (n = 2). Three patients were readmitted because of electrolyte and fluid derangement, aseptic pelvic fluid collection and secretion from a rectal stump. No late wound complications or incisional hernias were seen in the follow-up period (median 22 months).

Sirikurnpiboon & Jivapaisarnpong [18] reported six post-operative complications among the ten included patients: Lung atelectasis (n = 2), non-organic cause delirium (n = 2), thombophlebitis on the forearm (n = 1) and perineal wound infection (n = 1). No re-admissions were reported.

Chew et al [16] did not report the complication profile but mentioned two major complications, i.e. anastomotic leakage (n = 1) and post-operative bleeding which could be managed conservatively (n = 1).

Vestweber et al [19] did not specify data on post-operative complications, 30-day mortality or readmissions. The mean/median length of hospital stay (LOS) varied from 1-16 days with the longest LOS seen in patients undergoing APR. HAR was associated with the shortest LOS. Thirty-day mortality was reported in three studies [14, 16, 17]. There were no deaths reported among the 91 patients included in the analysis.

DISCUSSION

Reducing surgical trauma has been a key issue in all new emerging surgical techniques for the past two decades. Laparoscopic surgery undoubtedly represents the most important breakthrough in this context. Today, CLS for rectal cancer is offered at many institutions around the world. New surgical approaches such as SPLS are constantly being developed to further improve cosmetic outcomes and to reduce the surgical trauma. In rectal SPLS, intra-abdominal dissection and tissue manipulation are generally not much different from CLS, but SPLS differs from CLS by using only one incision. What is known at this point is that rectal SPLS is technically feasible and safe in selected groups of patients when surgery is performed by experienced laparoscopic surgeons. RCTs from other surgical fields have examined some of

the potential benefits and harms of SPLS. A small RCT on colectomy found a lower pain score the first two days in SPLS versus CLS [26]. A recent RCT of SPLS versus CLS cholecystectomy [27] showed improved cosmetic rating, no increased rate of incisional hernia and no reduction in pain. Marks et al [28] found significantly increased hernia rates one year after SPLS cholecystectomies compared with CLS. Cosmesis scores favoured SPLS over CLS. Similar studies for rectal SPLS have not been made at this point, and the potential benefits remain to be proven.

The available evidence for SPLS is generally of poor scientific quality and stems from case reports, small case series and a single case-comparison study. Such studies are likely to suffer from inadequate reporting [29], significant bias in patient-selection, reporting bias and publication bias [30]. Several retrospective case-comparison studies of AR for sigmoid cancer and sigmoid resections [31-33] have been published over the past years. Like the rectal SPLS studies, they show that SPLS for left-sided colon lesions is feasible with short-term outcomes comparable to CLS. Detailed data on complications after rectal SPLS are limited, but available data suggest that complication rates and types of complications of rectal SPLS are comparable to what is reported for CLS in large RCTs [1, 3, 34].

SPLS cases may be converted into open surgery or into CLS by inserting one or more additional ports. In the latter case, the additional surgical trauma is minimal and hardly measureable. In this review, the conversion rate to open surgery was less than 3%, and additional ports were rarely necessary. This conversion rate is extremely low compared with similar rates reported in RCTs on rectal cancer [1, 3, 34], which probably reflects selection bias both in choice of patient and surgeon.

It is difficult to be conclusive about operative time for rectal SPLS compared with CLS at this point. The only comparative study [17] shows faster operative time for SPLS than for CLS, which is surprising and not really accounted for in the article. Depending on the procedure, the operative time varies from 79 to 280 minutes in the reviewed studies, which reflects the heterogeneity of operations. The shortest operating time was observed in a series of HAR, whereas the longest operating time was seen in a series of mixed LAR and APR. Currently, no long-term data on oncological outcomes of rectal SPLS are available. Short-term data imply that median LNH and resection margins after SPLS are acceptable. LNH, however, ranged from two to 34 lymph nodes. Obviously, two harvested lymph nodes may not be sufficient to ensure correct staging of the patient. The majority of papers on rectal SPLS did not specify if the patients had received neo-adjuvant CRT. It is well known that preoperative neoadjuvant CRT decreases LNH from proctectomy specimens [35]. Unfortunately, it is unknown if cases with few harvested lymph nodes had CRT. There has been much focus on the completeness of the mesorectal fascia after rectal resection. Muscularis propria resections are associated with poorer outcomes as completeness of the mesorectal fascia is often used as a proxy for the quality of surgery [36]. Only two studies reported these details [14, 18] as well as data on CRM, and they found that most specimens were intact and all had negative CRM. Such information is essential if the pro and cons of SPLS are to be established.

The reported median BMI ranges from 22 to 26.5 kg/m^2, which suggests that patients were highly selected for SPLS. In the study by this author [14] which included only rectal cancer patients, the following parameters affected patient selection: Tumour distance from anal verge, size of tumour, and BMI together with the patient's anatomical shape. Chew et al [16] considered BMI, tumour stage and previous abdominal surgery. It is unknown if the results of studies based on very selected populations can be generalised to all patient categories, i.e. if rectal SPLS will be as safe and feasible in patients with large tumours, narrow pelvises, high BMI, and in patients with previous abdominal surgery. Extraction and removal of large tumours will often require enlargement of the single port site, which may eliminate the benefits of a single, relatively small incision.

If SPLS has a place in cancer surgery in the future, long-term oncological outcome such as over-all and disease-free survival is by far the most important issue. Keeping in mind the limitations of the present data, they do not seem to indicate that SPLS may lead to a poorer oncological outcome and survival than CLS and open surgery. Large-scale randomised trials including unselected patients should compare CLS with rectal SPLS to establish overall feasibility and surgical and oncological safety. Long-term studies focusing on non-oncological outcomes such as hernias, adhesion-caused reoperations, quality of life and cosmesis are also needed to document any other clinically relevant advantages of SPLS compared to other methods. In that context, the possibly increased risk of parastomal and incisional her-

FACTBOX

Available data on rectal single-port laparoscopic surgery (SPLS) is sparse and of poor scientific quality due to bias, case-mix and insufficient registration of relevant outcomes.

Short-term data suggest results of rectal SPLS comparable to results of conventional laparoscopic surgery.

There is a need for long-term, large-scale randomised trials that can assess the safety of SPLS, especially in terms of oncological outcome for malignant disease.

nias must be addressed specifically as it is unknown if the single port may be associated with higher risk of hernia formation, irrespective of whether it is used only as abdominal entry site or as a stoma site. It is recommended that future SPLS procedures are done in a protocolled set-up.

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