Review

Specimen retrieval approaches in patients undergoing laparoscopic colorectal resections: a literature-based review of published studies

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Objective: To review the published studies reporting various specimen retrieval incisions being used by colorectal surgeons in patients undergoing laparoscopic colorectal resections (LCR).

Methods: Standard medical electronic databases were searched to find relevant articles and a summary conclusion was generated.

Results: There were 43 studies reporting various approaches used for the purpose of specimen retrieval in 2388 patients undergoing LCR. The most common approaches were periumbilical midline incision (1260 reported case in the literature), transverse incision (583 reported cases in the literature) in the right- or left iliac fossa, depending on the side of colonic resection, and Pfannensteil incision (293 reported cases in the literature). Periumbilical midline incision was associated with the higher risk of developing incisional hernia (odds ratio 53.72; 95% confidence interval 7.48–386.04; Z = 3.96; P = 0.0001). In terms of surgical site infection (SSI), there was no difference between the three common approaches to specimen retrieval. Transanal and transvaginal approaches were associated with higher risk of SSI.

Conclusions: Midline, transverse and Pfannensteil incisions were the most commonly used approaches for specimen retrieval following LCR. Midline incision was associated with higher risk of incisional hernia. Risk of SSI was similar in all three common approaches. The transanal and transvaginal approaches pose a higher risk of SSI. These conclusions are based on the combined outcome of published case series, case reports and comparative studies. Randomized, controlled trials with longer follow-up are required before recommending the routine use of any approach for specimen retrieval in patients undergoing LCR.

Keywords: colorectal cancer; laparoscopic colorectal surgery; umbilical incision; transverse incision; anal retrieval; vaginal retrieval

INTRODUCTION

Various types of incisions used in abdominal operations are an important source of post-operative morbidities such as pain, surgical site infections, scarring, tumour implantation and incisional hernia [1]. One of the objectives of laparoscopic- or other minimally invasive surgical approaches is to minimise incision-related complications and to improve post-operative outcomes. Laparoscopic colorectal surgery, as compared with open surgery, has been reported to improve short-term and long-term outcomes in patients suffering from various colorectal disorders. Laparoscopic colorectal resection (LCR) has therefore become a preferred technique for treating both benign and malignant conditions of the colon and rectum [2–7]. After a successful
dissection in laparoscopic colorectal surgery, the enlargement of a trocar incision, resulting in ‘minilaparotomy’, is invariably necessary for two major reasons; firstly for intestinal anastomosis, to maintain the continuity of the gastrointestinal tract, and secondly for the purpose of retrieval of the specimen. The extension of a port-site incision causes more tissue trauma than one would expect from a smaller port wound and thus potentially reduces the aforementioned advantages of LCR [8]. This poses a special challenge to operating surgeons, due to the size of the specimen and the desire to keep the retrieval incision as small as possible to retain the benefits of laparoscopic surgery. In addition, the potential problems of dissemination of tumour cells, implantation of tumour cells in the wound; metastasis and wound contamination must be kept in mind during the process of specimen retrieval [9]. A number of solutions have been reported, for the purpose of avoiding minilaparotomy altogether or placing another incision away from the port incisions to retrieve the specimen. These include transverse incision in the left iliac fossa, transverse incision in the right iliac fossa, McBurney’s incision, extension of the umbilical port incision in midline, and stoma site incision. Additionally, specimen retrieval through natural orifices—such as through the anus or vagina—has also been reported as a relatively preferable solution.

The objective of this article is to review the various specimen retrieval techniques reported in the medical literature during LCR and generate a summary conclusion based on the level of evidence available.

**METHODS**

**Data sources**

All the published articles on specimen retrieval techniques during laparoscopic colorectal resection were identified through searches of the Medline, Embase, CINAHL, Cochrane library and Pubmed databases. The search terms “colorectal surgery”, “laparoscopic”, “minimal invasive surgery”, “natural orifice retrieval”, “trocar incision”, “midline incision”, “periumbilical incision”, “Pfannenstiel incision” and “transverse incision” were used alone and in various combinations. Relevant articles referenced in these publications were also downloaded from databases. The ‘related article’ function was used to widen the search results. All abstracts, case reports, case series and published single-centre or multi-centre studies were retrieved and searched comprehensively.

**Study selection**

For inclusion in the literature review, a study had to meet the following criteria: (i) randomized, controlled trial, case controlled trial, cohort studies, all types of comparative studies, case series and case reports, (ii) laparoscopic colorectal resections for both benign and malignant conditions, (iii) evaluation of surgical site infection rate, and (iv) trials in patients undergoing any kind of surgery.

**Data extraction**

Using a predefined data format, two independent reviewers (MSS and MIB) extracted data from each study, which resulted in high and satisfactory interobserver agreement. Information collected included the name(s) of the author(s), title of the study, journal in which the study was published, country and year of the study, treatment regimen, length of the therapy, method by which specimens were retrieved, testing sample size (with sex differentiation if applicable) and the number of patients receiving each regimen. Within each arm in case of comparative study, the reviewers noted the number of patients who responded to- and the number of patients who failed to respond to treatment, the patient compliance rate in each group, the number of patients reporting complications and the number of patients with absence of complications. After completing the data extraction, the two independent reviewers discussed the results and, if discrepancies were present, a consensus was reached.

**Data synthesis and statistical analysis**

Where applicable, the RevMan 5.2 software package [10, 11], provided by the Cochrane Collaboration, was used for the statistical analysis to achieve a combined outcome. The odds ratio (OR) with a 95% confidence interval (CI) was calculated for binary data. The random- and fixed-effects models (where applicable) were used to calculate the combined outcomes of both binary and continuous variables [12, 13]. If the standard deviation was not available, then it was calculated according to the Cochrane Collaboration’s guidelines [10]. This process involved assumptions that both groups had the same variance—which may not have been true—and variance was either estimated from the range or from the P-value. The estimate of the difference between the two techniques was pooled, depending upon the effect weights in results determined by each trial estimate variance. A forest plot was used for the graphical display of the results. The square around the estimate stood for the accuracy of the estimation (sample size), and the horizontal line represented the 95% CI.

**RESULTS**

There were 43 studies reporting various approaches used for the purpose of specimen retrieval in 2388 patients undergoing LCR [14–56]. These approaches can be categorized as transvaginal, transanal, transverse incision in the right or left iliac fossa, periumbilical midline incision, Pfannenstiel incision and approach through the stoma site. The literature search strategy and methodology is given in Figure 1.
Studies reporting single technique

1) Transvaginal approach
Thirteen studies [14–26] on 143 patients reported on the use of transvaginal approach to retrieve the specimen after LCR. These included five case reports [16–18, 23, 26] and eight case series [14, 15, 19–22, 24, 25]. There was no reported incision site herniation or tumour recurrence among these 143 patients. Overall, there were eight patients (5.5%) with various complications including surgical site infection (SSI) (Table 2).

2) Transanal approach
A transanal approach to retrieve the specimen after LCR was reported in sixteen case series [27–42] recruiting 311 patients. Nine patients (2.9%) developed various complications, set out in Table 2. The risk of developing post-operative complications was higher following a transvaginal approach than with a transanal approach (OR 0.50; 95% CI 0.19–0.33).

3) Transverse incision through the right or left iliac fossa
Jones et al. [43] published data on 500 patients undergoing LCR for diverticular disease, where the specimen was retrieved through a transverse incision in the left iliac fossa (Table 3). Risk of incisional hernia was 0.4%; that for SSI was 1.2% and risk of reported anastomotic leak was 1.4%.
| Trials                  | Year  | Country   | Study type | Patient number | Age (years) | Surgery details                                                                 | Follow up (months) | Incisional hernia | Complications/incision site infection | Recurrence | Use of wound protector |
|------------------------|-------|-----------|------------|----------------|-------------|--------------------------------------------------------------------------------|---------------------|-------------------|----------------------------------------|------------|-----------------------|
| Awad et al. [14]       | 2011  | USA       | Case series| 14             | 62 (range 50–80) | Right hemicolectomy for both benign and malignant conditions                | 17.8 (range 8–32)  | 0                 | 0                                      | 0          | Hubert bag             |
| Boni et al. [15]       | 2007  | Italy     | Case series| 11             | 45 ± 12      | Rectal resection for benign conditions                                      | 4 ± 2               | 0                 | 0                                      | 0          | Standard vaginal extractor with endobag |
| Dozois et al. [16]     | 2008  | USA       | Case report | 1              | 53           | Hysterectomy Salpingo-ophorectomy Total colectomy                           | 1                   | 0                 | 0                                      | 0          | No                    |
| Franklin et al. [17]   | 2008  | USA       | Case report | 1              | 88           | Right hemicolectomy for caecal carcinoma                                      | 1 week              | 0                 | 0                                      | 0          | Specimen bag           |
| Garcia–Flórez et al. [18] | 2010 | Spain     | Case report | 1              | 86           | Anterior resection with en bloc salpingo-ophorectomy for sigmoid carcinoma    | 3                   | 0                 | 0                                      | 0          | Plastic retractor       |
| Ghezzi et al. [19]     | 2007  | Italy     | Case series | 33             | 33.4 (range 25–43) | Rectosigmoid resection for endometriosis                                     | 13 (range 3–27)    | 0                 | 1 case of pelvic seroma               | 0          | Retrieval bag          |
| McKenzie et al. [20]   | 2010  | USA       | Case series | 4              | 74 (range 68–81) | Right hemicolectomy for both benign and malignant conditions                | 3                   | 1                 | 1 case of internal hernia not related to incision | 0          | Specimen bag           |
| Palanivelu et al. [21] | 2008  | India     | Case series | 7              | 49.5 (range 34–65) | Proctocolectomy for colorectal cancer and familial adenomatosis coli        | 12                  | 0                 | 1 case of pouchitis 1 case of anastomotic leak | 0          | Endobag                |
| Park et al. [22]       | 2010  | South Korea| Case series | 14             | 66 (range 44–74) | Colectomy for colorectal carcinoma                                           | 34                  | 0                 | 0                                      | 1 case of distant metastasis | Plastic bag |
| Sanchez et al. [23]    | 2009  | USA       | Case report | 1              | 63           | Sigmoid colectomy for rectal prolapse                                        | 3                   | 0                 | 0                                      | 0          | No                    |

(Continued)
4) Periumbilical midline incision

Two studies [44, 45] reported data on 458 patients undergoing colorectal and upper gastrointestinal surgical resections where the specimen was retrieved through a periumbilical (extended port side wound) midline incision (Table 3). There were four cases of incisional hernia (0.87%), six cases of SSI (1.3%) and one case of distant recurrence. The risk of developing incisional hernia was greater in cases of periumbilical midline incision than with left iliac fossa transverse incision (OR 2.19; 95% CI 0.40–12.3).

5) Pfannensteil incision

Two articles reported on the use of Pfannensteil incision for specimen retrieval in 100 patients undergoing laparoscopic sigmoid colectomy for diverticular disease [46], and in seven patients undergoing laparoscopic panproctocolectomy for ulcerative colitis [47] (Table 3). There was only one case of incisional hernia (0.93%) and 11 cases of SSI in this case series [46].

Studies reporting comparison between two techniques

1) Transanal vs. periumbilical midline incision approach

This approach was published in two comparative studies [48, 49], in which 68 patients underwent LCR for benign colorectal conditions (Table 4). Statistically, the duration of operation [Standardized Mean Difference (SMD) 1.81; 95% CI -1.99–5.62; z = 0.93; P = 0.35] and risk of incisional hernia (OR 6.46; 95% CI 0.24–202.47; z = 1.11; P = 0.27) were similar (SMD 1.81; 95% CI -1.99–5.62; z = 0.93; P = 0.35) in both approaches. However, the transanal approach was associated with higher risk of SSI (OR 17.40; 95% CI 1.50–202.47; z = 2.28; P = 0.02) (Figure 1).

2) Pfannensteil vs. periumbilical midline incision approach

Two studies reported the comparison between Pfannensteil vs. periumbilical midline incision approach to retrieve the specimen in 462 patients undergoing LCR for both benign and malignant conditions [50, 51] (Table 4). The risk of developing incisional hernia was significantly higher (OR 53.72; 95% CI 7.48–386.04; z = 3.96; P = 0.0001) following periumbilical midline incision compared to Pfannensteil incision (Figure 2).

3) Periumbilical midline incision vs. transverse incision in iliac fossa

Two studies published data comparing the use of periumbilical midline incision against transverse incision in the right or left iliac fossa in 222 patients (Table 4). The risk of developing incisional hernia was significantly higher (OR 0.37; 95% CI 0.06–2.20; z = 1.09; P = 0.028) following periumbilical midline incision than after transverse incision but
| Trials          | Year | Country | Study type | Patient number | Age (years) | Surgery details                        | Follow up (months) | Incisional hernia | Complications/Incision site infection | Recurrence | Use of wound protector |
|-----------------|------|---------|------------|----------------|-------------|----------------------------------------|--------------------|------------------|-------------------------------|-------------|------------------------|
| Akamatsu et al. [27] | 2009 | Japan   | Case series | 16 | n/a | Anterior resection for sigmoid carcinoma | 2–15 | 0 | 0 | 0 | No |
| Awad et al. [28]  | 2012 | USA     | Case report | 1 | 27 | Colonic resections for benign disorders | 1 | 0 | 0 | 0 | No |
| Cheung et al. [29] | 2009 | China   | Case series | 10 | 66 (range 55–81) | Left colonic resections for carcinoma | 1 | 0 | 0 | 0 | TEO device |
| Co et al. [30]   | 2010 | China   | Case report | 1 | 80 | Left colonic resection for carcinoma | 1 | 0 | 0 | 0 | TEO device |
| Franklin et al. [31] | 2012 | USA     | Case series | 179 | 66.9 ± 14.4 | Anterior resection for rectal cancer | 24 | 0 | 3 cases of anastomotic leakage | 3 cases of anal stenoses | 9 | Plastic bag |
| Fuchs et al. [32] | 2012 | Germany | Case series | 14 | 61 (range 28–86) | Colonic resection for benign conditions | 6 | 0 | 0 | 0 | TEO device |
| Hara et al. [33]  | 2011 | Japan   | Case series | 8 | 71 (range 48–75) | Anterior resection for rectal carcinoma | 1 | 0 | 0 | 0 | No |
| Knol et al. [34]  | 2009 | Belgium | Case report | 1 | 20 | Rectal resection for benign condition | 1 | 0 | 0 | 0 | Novymed proctoscope |
| Lacy et al. [35]  | 2012 | Spain   | Case report | 1 | 36 | Colectomy for ulcerative colitis | 1 | 0 | 0 | 0 | Endo Catch II |
| Leroy et al. [36] | 2011 | France  | Case series | 16 | 61.2 | Anterior resection for diverticular disease | 1 | 0 | 0 | 0 | No |
| Makris et al. [37] | 2012 | USA     | Case report | 1 | n/a | n/a | n/a | n/a | n/a | n/a | No |
| Nishimura et al. [38] | 2011 | Japan   | Case series | 18 | 46–84 | Anterior resection for colorectal cancer | 5–20 | 0 | 1 case of anastomotic leakage | 1 case of umbilical port infection | 0 | Alexis wound retractor |
| Ooi et al. [39]   | 2009 | Singapore | Case report | 1 | 51 | Anterior resection for rectal cancer | 1 | 0 | 0 | 0 | No |
Table 2. Continued.

| Trials                | Year | Country | Study type | Patient number | Age (years) | Surgery details | Follow up (months) | Incisional hernia | Complications/incision site infection | Recurrence | Use of wound protector |
|-----------------------|------|---------|------------|----------------|-------------|-----------------|--------------------|-------------------|--------------------------------------|------------|------------------------|
| Saad et al. [40]      | 2011 | Germany | Case series | 15             | 61 (range 46–76) | Anterior resection for both benign and neoplastic conditions | 1                  | 0                 | 0                                    | 0          | TEO device             |
| Saad et al. [41]      | 2010 | Germany | Case series | 8              | n/a         | Anterior resection for both benign and neoplastic conditions | 1                  | 0                 | 0                                    | 0          | McCartney tube         |
| Wolthius et al. [42]  | 2011 | Belgium | Case series | 21             | 41 (34–66)  | Anterior resection for both benign and neoplastic conditions | 3.6                | 0                 | 1 case of anastomotic leakage         | 0          | Specimen retrieval pouch |

n/a = not available, TEO = transanal endoscopic operation.

Table 3. Characteristics of studies reporting various other approaches of specimen retrieval in patients undergoing laparoscopic colorectal surgery

| Trials               | Year | Country | Study type | Approach of specimen retrieval | Patient number | Age (years) | Follow up (months) | Surgery details | Incisional hernia | Complications/incision site infection | Recurrence | Use of wound protector |
|----------------------|------|---------|------------|--------------------------------|----------------|-------------|--------------------|-----------------|-------------------|--------------------------------------|------------|------------------------|
| Jones et al. [43]    | 2008 | Australia | Case series | Transverse incision in the left iliac fossa | 500            | 58          | n/a                | All types of colonic resection for diverticular disease | 2                  | 7 cases of anastomotic leakage 6 cases of wound infections | 0          | No                     |
| Casciola et al. [44] | 2008 | Italy   | Case series | Periumbilical midline incision | 352            | n/a         | 6                  | 69 splenectomies 138 right hemicolectomies 115 gastric resections | 1                  | 3                                    | n/a        | Endobag                |
| López-Köstner et al. [45] | 2008 | Chile   | Case series | Periumbilical midline incision | 106            | 54          | 27                 | Sigmoid colectomy for diverticular disease | 3                  | 3                                    | 1          | No                     |
| Wilhelm et al. [46]  | 2006 | Germany | Case series | Pfannensteil incision | 100            | 58          | 19                 | Sigmoid colectomy for diverticular disease | 1                  | 11                                   | 1 diverticulitis | n/a                   |
| Sahakitrungruang et al. [47] | 2008 | Thailand | Case series | Pfannensteil incision | 7              | na          | 1                  | Protocolectomy for ulcerative colitis | 0                  | 0                                    | 0          | n/a                   |

n/a = not available.
Table 4. Characteristics and variables of studies reporting comparisons between various approaches of specimen retrieval in patients undergoing laparoscopic colorectal surgery

| Trials            | Year | Country    | Study type          | Approach of specimen retrieval | Patient number | Age (years) | Surgery details                                      | Operation time (minutes) | Follow-up (Months) | Hernia | Infection/ complications | Recurrence |
|-------------------|------|------------|---------------------|-------------------------------|----------------|-------------|-----------------------------------------------------|--------------------------|-------------------|--------|--------------------------|------------|
| Christoforidis et al. [48] | 2012 | Switzerland | Case control       | Transanal                     | 10             | 47 (range 26–62) | Left colonic resections for benign disease          | 200 ± 60                | n/a               | 1      | 0                        | 0          |
|                   |      |            |                     | Periumbilical midline incision | 20             | 56 (range 38–81) |                                                     | 205.5 ± 49               | 0                 | 0      | 0                        | 0          |
| Eshuis et al. [49] | 2010 | Netherlands | Case control       | Transanal                     | 8              | 31 (range 19–61) | Ileocolic resections for inflammatory bowel disease | 208 ± 45.1              | 3                 | 0      | 3                        | 0          |
|                   |      |            |                     | Periumbilical midline incision | 30             |             |                                                     | 115 ± 15.1               | 0                 | 0      | 1                        | 0          |
| Lee et al. [50]   | 2012 | Canada     | Case control       | Periumbilical midline incision | 68             | 63.0        | All types of colorectal resections for malignant lesions of the colorectum | n/a                     | 37                | 20     | n/a                      | n/a        |
|                   |      |            |                     | Pfannensteil                  | 24             | 65.8        |                                                     |                         |                   |        |                          |            |
| De Souza et al. [51] | 2010 | USA        | Case control       | Periumbilical midline incision | 231            | 62.68       | All types of colorectal resections for both benign and malignant lesions of the colorectum | n/a                     | 17.5              | 56     | n/a                      | n/a        |
|                   |      |            |                     | Pfannensteil                  | 139            | 61.32       |                                                     |                         |                   |        |                          |            |
|                   |      |            |                     | LIF transverse                |                |             |                                                     |                         |                   |        |                          |            |
|                   |      |            |                     | LIF/RIF transverse            |                |             |                                                     |                         |                   |        |                          |            |
| Lim et al. [52]   | 2012 | Korea      | Case control       | Periumbilical midline incision | 92             | 63          | Left colonic resections for colorectal cancer       | 164.5 ± 8.6              | 20                | 2      | 12                       | n/a        |
|                   |      |            |                     | LIF transverse                | 55             | 66          |                                                     | 167.4 ± 8.6              | 0                 | 0      | 7                        |            |
| Lee et al. [50]   | 2012 | Canada     | Case control       | Periumbilical midline incision | 68             | 63.0        | All types of colorectal resections for malignant lesions of the colorectum | n/a                     | 37                | 20     | n/a                      | n/a        |
|                   |      |            |                     | LIF transverse                | 7              | 60.8        |                                                     |                         |                   |        |                          |            |
|                   |      |            |                     | LIF/RIF transverse            |                |             |                                                     |                         |                   |        |                          |            |
| Wolthuis et al. [53] | 2011 | Belgium    | Case control       | Periumbilical midline incision | 21             | 35 (range 30–38) | Rectal resection for benign conditions               | 90 ± 5                  | 10.3              | 0      | 1                        | 0          |
|                   |      |            |                     | LIF transverse                | 21             | 34 (range 32–35) |                                                     | 105 ± 6.4               | 18.7              | 0      | 5                        | 0          |
| Gardenbroek et al. [54] | 2012 | Netherlands | Case series        | Stoma site                    | 3              | 21.5        | Subtotal colectomy for inflammatory bowel disease   | 219                     | 7                 | n/a   | 0                        | n/a        |
|                   |      |            |                     | Transanal                     | 7              |             |                                                     |                         |                   |        |                          |            |
| Choi et al. [55]  | 2009 | Korea      | Case series        | Transanal                     | 11             | 53.6 ± 12.8 | Robot-assisted laparoscopic anterior resection for rectal and sigmoid carcinoma | 260.8 ± 62.9            | 1                 | 0      | 1 leak                   | 0          |
|                   |      |            |                     | Transvaginal                  | 2              |             |                                                     | 260.8 ± 62.9            | 0                 | 1     | bleed                    |            |
| Costantino et al. [56] | 2012 | France     | Case control       | Transanal                     | 29             | 60.1        | Left-sided colorectal resections for diverticular disease | 122 ± 25.1              | 1                 | 0      | 2                        | 0          |
|                   |      |            |                     | Pfannensteil                  | 23             | 59.5        |                                                     | 105 ± 25.1              | 0                 | 1      | 0                        | 0          |

LIF = left iliac fossa, n/a = not available, RIF = right iliac fossa.
there was no difference in the risk of SSI between the two approaches to specimen retrieval.

4) Other comparisons
There was higher risk of developing SSI in the transanal approach than in the transverse incision approach [53] for specimen retrieval (Table 4). One study [54] reported specimen retrieval through the stoma site in comparison with a transanal approach, and reported no difference in SSI. One study on 13 patients reported a comparison between transvaginal and transanal approaches [55]; there were no cases of hernia or recurrence in this study. Statistically, the complication rate and duration of operation were similar in both techniques ($P = 1.0$). The transanal approach was compared against Pfannensteil in a study of 52 patients undergoing left-sided laparoscopic colonic resection for diverticular disease [56]. The transanal approach was associated with slightly higher risk of SSI but operative time and incidence of incisional hernia were similar.

**SUMMARY AND CONCLUSION**
Colorectal surgeons employ numerous approaches to retrieve specimens following LCR. The most common of these are periumbilical midline incision (1260 reported case in the literature), transverse incision (583 reported cases in the literature) in the right or left iliac fossa depending upon the side of colonic resection and Pfannensteil incision (293 reported cases in the literature). Periumbilical midline incision is associated with the highest risk of developing incisional hernia. There is no difference between these three common approaches to specimen retrieval, in terms of SSI. Transanal and transvaginal approaches are associated with higher risk of SSI. This conclusion is based on the combined findings of published case series, case reports and comparative studies. It may therefore be considered biased, less reliable and weaker. Randomized, controlled trials with longer follow-up are required to achieve reliable evidence before recommending the routine use of any approach for specimen retrieval in patients undergoing LCR.

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