Surgery for constipation: systematic review and practice recommendations

Results I: Colonic resection

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Abstract

Aim To assess the outcomes of colectomy in adults with chronic constipation (CC).

Method Standardised methods and reporting of benefits and harms were used for all CapaCiTY reviews that closely adhered to PRISMA 2016 guidance. Main conclusions were presented as summary evidence statements (SES) with a summative Oxford Centre for Evidence-Based Medicine (2009) level.

Results Forty articles were identified, providing data on outcomes in 2045 patients. Evidence was derived almost exclusively from observational studies, the majority of which concerned colectomy and ileorectal anastomosis (CIRA) rather than other procedural variations. Average length of stay (LOS) ranged between 7–15 days. Although inconsistent, laparoscopic surgery may be associated with longer mean operating times (210 vs 167 min) and modest decreases in LOS (10–8 days). Complications occurred in approximately 24% of patients. Six (0.4%) procedure-related deaths were observed. Recurrent episodes of small bowel obstruction occurred in about 15% (95%CI: 10–21%) of patients in the long-term, with significant burden of rehospitalisation and frequent recourse to surgery. Most patients reported a satisfactory or good outcome after colectomy but negative long-term functional outcomes persist in a minority of patients. The influence of resection extent, anastomotic configuration and method of access on complication rates remains uncertain. Available evidence weakly supports selection of patients with an isolated slow-transit phenotype.

Conclusion Colectomy for CC may benefit some patients but at the cost of substantial short- and long-term morbidity. Current evidence is insufficient to guide patient or procedural selection.

Keywords Constipation, colectomy, ileorectal, slow-transit

Introduction

Background and procedural variations

The concept of resection of the colon to treat constipation originates more than a century ago [1]. Modern surgical approaches mostly continue in the historical practice of removing the whole colon with anastomosis of the terminal ileum to the upper rectum (or very distal sigmoid) usually at the level of the sacral promontory. Usually termed colectomy and ileorectal anastomosis (CIRA), the procedure is also sometimes described as colectomy with ileoproctostomy. Total colectomy is not favoured by all surgeons and other less radical colonic resections may also be employed. The simplest variation is to perform a subtotal colectomy and ileosigmoid anastomosis (SCISA) but an increasingly popular choice is subtotal colectomy with sparing of the caecum and thence caecorectal anastomosis (SCCRA). Since this is not a common procedure in routine colorectal surgical practice, it merits some background description. First described by Ogilvie (1931), retention of the ileocaecal junction has the theoretical advantage of preservation of absorptive functions (bile, vitamin B12 and electrolytes) and thus perhaps reduced diarrhoea. No standard technique exists for creating a CRA. The general principle involves colonic mobilization followed by ligation of all vascular pedicles except the ileocolic branches. In the technique proposed by

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Lillehei and Wangensteen (1955) a 180° rotation of the remaining mesentery from the right to the left is performed to place the cecum in the left iliac fossa, with apex cephalad. During the rotation the remaining mesocolon passes over the aorta, and it is sutured to the mesorectum and to the third portion of the duodenum to avoid internal hernia or intestinal obstruction, which may complicate such technique. Deloyers (1963) proposed a variation of this technique in which there is a cranio-caudal rotation of the cecum to allow a pelvic isoperistaltic CRA (IPSCCRA) but this required a retro-ileal tunnel and 180° torsion of the vascular pedicle which may result in ischemia or venous stasis. These difficulties have in part be mitigated by development of an antiperistaltic end-to-end caecorectal anastomosis (attributed to Sarli [2]) (APSCCRA) which avoids the vascular problems due to the torsion of the pedicle, obviates the need to tailor the cecum and lowers the risk of intestinal obstruction due to the rotation of the mesocolon in front of the aorta.

**Scope**

Procedures considered beyond the scope of systematic review [1–18] were:

1. Total colonic and rectal excision (proctocolectomy). These procedures have been variously employed for chronic constipation with or without ileal pouch formation in small numbers of patients and usually as a salvage after failed colectomy;

2. Subtotal colectomy and modification of the rectal reservoir (modified Duhamel procedure; Jinling procedure);

3. Colonic exclusion and ileorectal anastomosis i.e. without resection.

**Previous reviews**

Narrative reviews focused on the outcome of colectomy for constipation have been published in 1996 [10], 1999 [11], and 2006 [12]. No previous systematic review was identified.

**Summary of search results and study quality**

The search yielded a total of 85 manuscripts for full text review (Fig. 1). From these, 40 articles published between 1988 and 2015 contributed to the systematic review, providing data on outcomes in a total of 2045 patients (range 20–144 patients per study) based on 39 defined patient cohorts (Table 1). A US nationwide dataset derived from hospital episode statistics was also included covering 2377 procedures coded as colectomy for constipation indications [19]. Specific exclusions after full-text review (and after exclusion of non-English language publications: n = 10) included 27 studies where the population sample was confirmed to be less...
than 20 patients, four studies of out of scope procedures, one study where data were considered duplicate [13], one where outcomes could not be segregated by eligible procedure [14], and one where data for multiple clinical indications for colectomy were merged [15].

Table 1  All studies included in systematic review.

| Author                      | Year | Centre          | Country | Total N | FU* | Design | Level |
|-----------------------------|------|-----------------|---------|---------|------|--------|-------|
| Kamm [23]                   | 1988 | St Marks, London | UK      | 44      | >12  | RCS    | IV    |
| Vasilevsky [24]             | 1988 | Mayo Clinic, MN | USA     | 52      | 46   | RCS    | IV    |
| Yoshioka & Keighley [25]    | 1989 | Birmingham      | UK      | 40      | 36   | RCS    | IV    |
| Pemberton [26]              | 1991 | Mayo Clinic, MN | USA     | 36      | 36   | PCS    | IV    |
| Piccirillo [27]             | 1995 | Cleveland Clinic, FL | USA | 54      | 27   | RCS    | IV    |
| Redmond [21]                | 1995 | John Hopkins, Baltimore | USA | 34      | 90   | PCH    | IIB   |
| de Graaf [28]               | 1996 | Rotterdam       | Netherlands | 42   | 46   | PCH    | IV    |
| Lubowski [29]               | 1996 | Sydney          | Australia | 52 | 42   | RCS    | IV    |
| Platell [30]                | 1996 | Perth           | Australia | 96 | 60   | RCS    | IV    |
| Pluta [31]                  | 1996 | Alberta         | Canada  | 24      | 65   | RCS    | IV    |
| Ghosh [32]                  | 1996 | Edinburgh       | UK      | 21      | 96   | RCS    | IV    |
| Nyam [33]                   | 1997 | Singapore       | Singapore | 74 | 56   | PCH    | IV    |
| Ho [34]                     | 1997 | Singapore       | Singapore | 24 | 24   | RCH    | IV    |
| You [35]                    | 1998 | Taiwan          | China   | 40      | 24   | PCS    | IV    |
| Bernini [36]                | 1998 | Mayo Clinic, MN | USA     | 106     | 78   | RCH    | IV    |
| Hasegawa [37]               | 1999 | Birmingham      | UK      | 61      | 84   | RCH    | IV    |
| Fan [38]                    | 2000 | Taiwan          | China   | 24      | 23   | RCS    | IV    |
| Pikarsky [39]               | 2001 | Cleveland Clinic, FL | USA | 62     | 105  | RCH    | IV    |
| Pikarsky [40]               | 2001 | Cleveland Clinic, FL | USA | 30     | 60   | PCS    | IV    |
| Webster & Dayton [41]       | 2001 | Cancun          | Mexico  | 50      | 12   | RCS    | IV    |
| Mollen [42]                 | 2001 | Bennekom        | Netherlands | 21  | 62   | PCS    | IV    |
| Nylund [43]                 | 2001 | Gotenburg       | Sweden  | 40      | 132  | PCS    | IV    |
| Lundin [44]                 | 2002 | Uppsala         | Sweden  | 28      | 50   | PCS    | IV    |
| Fitzharris [45]             | 2003 | Mayo Clinic, MN | USA     | 75      | 47   | RCH    | IV    |
| Hassan [46]                 | 2006 | Mayo Clinic, MN | USA     | 104     | 68   | RCH    | IV    |
| Marchesi [47]               | 2007 | Parma           | Italy   | 23      | 72   | PCS    | IV    |
| Zutshi [48]                 | 2007 | Cleveland Clinic, OH | USA | 69     | 130  | RCS    | IV    |
| Feng [22]                   | 2008 | Zhejiang        | China   | 79      | 47   | RCH    | IIB   |
| Hsiao [49]                  | 2008 | Taiwan          | China   | 44      | 12   | PCS    | IV    |
| Jiang [50]                  | 2008 | Wuhuan          | China   | 37      | 48   | RCH    | IV    |
| Pinedo [51]                 | 2009 | Santiago        | Chile   | 20      | 25   | RCS    | IV    |
| Riss [52]                   | 2009 | Vienna          | Austria | 20      | 84   | RCS    | IV    |
| Sohn [53]                   | 2011 | Seoul           | Korea   | 37      | 41   | RCS    | IV    |
| Xu LS [20]                  | 2012 | Harbin          | China   | 64      | 32   | RCT    | IIB   |
| Marchesi [54]               | 2012 | Parma           | Italy   | 30      | 12   | CCS    | IV    |
| Wang [55]                   | 2013 | Zhejiang        | China   | 124     | 12   | RCH    | IV    |
| Reshef [56]                 | 2013 | Cleveland Clinic, OH | USA | 144   | 43   | RCH    | IV    |
| Li [57]                     | 2014 | Chongqing       | China   | 72      | 64   | RCH    | IV    |
| Sun [58]                    | 2015 | Shanghai        | China   | 48      | 36   | RCH    | IV    |
| Total                       |       |                 |         | 2045    | 47   |        |       |
| Dudekula [19]               | 2015 | US nationwide sample | USA | 2377** | 12   | RCH    | IV    |

RCS, retrospective cohort study; PCS, prospective cohort study; RCT, randomised controlled trial; CCS, case control study.  
*Mean follow up in months.  
†Oxford CEBM [16].  
‡Only 4 days blinded.  
§For CIRA but 32 months for APSCCRA.  
¶Median value of follow up.  
**181 for state sample and 56 with 12 months pre & post-intervention.
The general quality of studies was poor due to inadequate description of methods. The 40 included studies comprised: a single poor quality randomized trial (uncertain or high risk of bias in most domains) [20] (Oxford level IIB); one good quality prospective [21] and one retrospective cohort study [22] (level IIB); and 37 level IV studies (comprising 14 poor quality cohort studies, i.e. ‘case comparison studies’; one poor quality case-control study with non-consecutive controls; eight prospective case series; and 14 retrospective case series). A general problem was the lack of prospectively defined follow up intervals. Patient follow up ranged from 12 months to 11 years (median 47 months) but this clearly varied greatly for individual patients within studies without defined follow up periods. Eleven studies derived from US centres, 11 from European centres, nine from Chinese centres with the remaining nine split across five countries.

Perioperative data

Perioperative data were reported by 37 studies (Table 2). Reporting of procedure duration was inconsistent but mean procedural duration ranged from approximately 2–4 h. Within this variation were trends of shorter operating times for open vs laparoscopic procedures (e.g. colectomy and ileorectal anastomosis (CIRA), median open: 167 min vs median laparoscopic: 210 min), as well as for subtotal procedures: median 135 min. The average length of stay (LOS) reported was 10.4 days, ranging from 7.0 to 15.5 days duration. However laparoscopic procedures consistently reported shorter lengths of stay e.g. the median LOS for open CIRA was 10.6 days compared to 8.1 days for laparoscopic CIRA. This evidence is supported by individual cohort comparisons [34,55] and in the single RCT where mean LOS was reduced from 9.7 to 7.6 days with laparoscopy [20].

Summary evidence statements: perioperative data

1 Length of stay after colectomy for constipation is 7–15 days, even in the modern era (level IV).
2 Laparoscopic surgery may be associated with longer operating times and modest decreases in length of stay (from 10 to 8 days), however there is considerable variation between studies (level IV).

Harms

Perioperative complications

Presented meta-analyses showed considerable heterogeneity of complications, not explained by procedure or age of publication. The attentiveness to harm recording and the duration of recording were inconsistent and studies limited only to laparoscopic procedures are characterized by small numbers limiting scope for comparison with open procedures and no adjustment has been attempted for potential differences in the populations recruited into individual studies. Consequently, estimates of harm provided are necessarily tentative.

Surgical morbidity remains a concern for all types of colectomy with total complication rates. A random effects meta-analysis estimated total complications to be 24.4% (95%CI: 17.8–31.7%); \( I^2 = 88.1\% \) (Fig. 2), although findings were heterogeneous including individual study rates from 7% to 54% (Table 2). Aside from the incidence of anastomotic leaks and other general complications (high even in some recent series from expert centres [56] and including six fatalities in 1568 patients: 0.4%) the incidence of prolonged post-operative ileus (POI) and early adhesional small bowel obstruction (SBO) are known to be disproportionately high for patients undergoing colectomy for slow-transit constipation when compared to other indications [17].

A random effects meta-analysis estimated early post-op POI/SBO to be 9.7% (95%CI: 5.7–14.6%); \( I^2 = 87.9\% \) (Fig. 3), although findings were heterogeneous including individual study rates from 0% to 33%. Current findings are inconclusive as to whether laparoscopic or open surgery are safer: there is some suggestion however that the POI rate is lower in newer studies. Rates of further surgical intervention for POI in the perioperative period were similarly heterogeneous: 2.7% (95%CI: 1.0–5.0%) \( I^2 = 64.3\% \), including study rates from 0% to 15%.

These data have been put into a broader context by the recent (2015) US national database study of 2377 colectomies for constipation between 1998–2011 [19], providing 60% of all subjects within the review. This study based on registered health episodes re-affirms a high rate of perioperative complications in a national sample (42.7% patients during index hospitalisation 30-day period), with the main contribution (27%) coming from “intestinal obstruction, ileus, nausea & vomiting”.

Long-term adverse outcomes

Long-term rates of SBO reported by studies were heterogeneous: 15.2%, (95%CI: 10.2–20.9%) \( I^2 = 85.5\% \), including study rates from 0% to 71% (Table 3; Fig. 4a). Re-operation rates (principally for SBO but also other severe ongoing functional
Table 2  Perioperative data by procedure.

| Author            | Year | Operation                        | N   | Time | LOS | Bleed | Inf | Total cx | POI* | Re-op | Leak | Mort |
|-------------------|------|----------------------------------|-----|------|-----|-------|-----|----------|------|-------|------|------|
| (a) Open colectomy and ileorectal anastomosis |
| Pemberton [26]    | 1991 | 36                               | NR  | 12.0 | NR  | 8.3   | 22.2 | 13.0     | 0    | 0     | 0    | 0    |
| Piccirillo [27]   | 1995 | 54                               | NR  | 7.0  | NR  | NR    | NR  | 3.7      | 6    | 0     | 0    | 0    |
| Redmond† [21]     | 1995 | 37                               | NR  | 12.1 | NR  | NR    | 24  | NR       | 0    | 0     | 0    | 0    |
| Lubowski [29]     | 1996 | 52                               | NR  | NR   | NR  | NR    | NR  | NR       | 1.9  | 0     | 0    | 0    |
| Pluta [31]        | 1996 | 24                               | NR  | 4.2  | NR  | 12.5  | 25  | 4.2      | 0    | 0     | 0    | 0    |
| Ghosh [32]        | 1996 | 21                               | NR  | NR   | NR  | NR    | NR  | NR       | NR   | 0     | 0    | 0    |
| Nyan [33]         | 1997 | 74                               | NR  | NR   | NR  | NR    | NR  | NR       | NR   | 0     | 0    | 0    |
| Ho [34]           | 1997 | 17                               | 10.6| NR   | 12.0| 23.0  | 13.0| 13.0     | 0    | 0     | 0    | 0    |
| Bernini [36]      | 1998 | 106                              | NR  | NR   | NR  | NR    | NR  | 23.0     | 14.1 | 0     | 0    | 0    |
| Fan [38]          | 2000 | 24                               | NR  | 10.0 | NR  | NR    | NR  | 0        | 0    | 0     | 0    | 0    |
| Pikarsky [40]     | 2001 | 30                               | NR  | NR   | NR  | NR    | NR  | NR       | 0    | 0     | 0    | 0    |
| Webster & Dayton§ [41] | 2001 | 55                               | NR  | 10.0 | NR  | NR    | NR  | 42.0     | 32.0 | 4.0   | 0    | 0    |
| Mollen [42]       | 2001 | 21                               | NR  | NR   | NR  | 33.0  | 19.0| 9.5      | 0    | 0     | 0    | 0    |
| Nylund [43]       | 2001 | 40                               | NR  | 5.0  | 7.5  | 20.0  | 5.0 | 5.0      | 0    | 0     | 0    | 0    |
| Firzaharis [45]   | 2003 | 75                               | NR  | NR   | NR  | NR    | NR  | NR       | NR   | 7     | 0.9  | 0    |
| Hassan [46]       | 2006 | 65                               | NR  | NR   | NR  | NR    | NR  | NR       | NR   | 0     | 0    | 0    |
| Jiang [50]        | 2008 | 21                               | 140 | 15.5 | NR   | 14    | 43.0| 16.0     | 1.4  | 1.4   | 0    | 1    |
| Sohn [53]         | 2011 | 37                               | 203 | 12.0 | NR   | 5.4   | 13.5| 10.8     | 2.7  | 2.7   | 0    | 0    |
| Xu [20]           | 2012 | 32                               | 145 | 9.7  | NR   | NR    | 0   | 3.1      | 0    | 0     | 0    | 0    |
| Wang [55]         | 2013 | 68                               | 190 | 11.0 | 7.4  | 8.8   | 1.5 | 0        | 0    | 0     | 0    | 0    |
| Li F [57]         | 2014 | 40                               | NR  | 1.25 | 2.5  | 32.5  | 15.0| 7.5      | 2.5  | 0     | 0    | 0    |
| (b) Series including open and laparoscopic colectomy and ileorectal anastomosis |
| Zutshi [48]       | 2007 | 69                               | NR  | 10.0 | 1.4  | 7.2   | 17.4| 16.0     | 1.4  | 1.4   | 0    | 0    |
| Riss [52]         | 2009 | 20                               | 190 | 10.5 | 5.0  | 35.0  | 45.0| 5.0      | 15.0 | 5.0   | 15.0 | 0    |
| Reshef† [56]      | 2013 | 144                              | NR  | 7.8  | 3.5  | 17.0  | 54.0| 26.0     | 14.0 | 6.9   | 1.0  | 0    |
| Dudukela [19]     | 2015 | 2377                             | NR  | 8.0  | NR   | NR    | 42.7| 27.0    | NR   | NR    | NR   | 0    |
| (c) Laparoscopic colectomy and ileorectal anastomosis |
| Ho [34]           | 1997 | 7                                | NR**| 9.2  | NR   | 14    | 43.0| 29       | 0    | 0     | 0    | 0    |
| Xu [20]           | 2008 | 44                               | 197 | 7.6  | NR   | 4.5   | 18.2| 11.4     | 4.5  | 2.3   | 0    | 0    |
| P Socio [51]      | 2009 | 20                               | 248 | 7.0  | 10.0 | NR    | 15.0| 5.0      | 5.0  | 5.0   | 0    | 0    |
| Xu [20]           | 2012 | 32                               | 122 | 8.5  | NR   | NR    | 0   | 3.1      | 3.1  | 0     | 0    | 0    |
| Wang [55]         | 2013 | 56                               | 223 | 8.7  | 0    | 5.3   | 7.1 | 1.8      | 0    | 0     | 0    | 0    |
| (d) Subtotal colectomy and ileosigmoid anastomosis (ISA); isoperistaltic cæcocolic anastomosis (IPCCA); antiperistaltic cæcocolic anastomosis (APCCA); lap: laparoscopic |
| de Graaf [28]     | 1996 | ISA                              | 24  | NR   | NR   | NR    | NR  | NR       | NR   | NR    | 4.2  | 0    |
| Feng [22]         | 2008 | ISA                              | 45  | 135  | 13.1 | NR    | NR  | 20       | NR   | 0     | 0    | 0    |
| Sun [58]          | 2015 | ISA                              | 22  | NR   | NR   | NR    | NR  | NR       | NR   | 0     | 0    | 0    |
| Feng [22]         | 2008 | IPCRA                           | 34  | 120  | 12.5 | NR    | NR  | NR       | NR   | 0     | 0    | 0    |
| Li F [57]         | 2014 | IPCRA                           | 32  | NR   | NR   | 0    | 3.1 | 28.1     | 12.5 | 3.1   | 3.1  | 0    |
| Sun [58]          | 2015 | IPCRA                           | 26  | NR   | NR   | NR    | NR  | NR       | NR   | NR    | 0    | 0    |
| Marchesi [47]     | 2007 | IPCRA (5 lap)                   | 17  | NR   | 11.9 | NR    | 9.3 | 5.9      | 11.8 | 5.9   | 0    | 0    |
| Jiang [50]        | 2008 | APCRA                           | 17  | 130  | 14.5 | NR    | 5.9 | NR       | NR   | 0     | 0    | 0    |
| Marchesi [54]     | 2012 | APCRA                           | 15  | 184  | 10.9 | NR    | NR  | 13.3     | 0    | 0     | 0    | 0    |
| Marchesi [54]     | 2012 | APCRA lap                       | 15  | 232  | 9.3  | NR    | NR  | 13.3     | 0    | 0     | 6.7  | 0    |

Cx, complications; NR, not reported.
*Includes prolonged ileus and early mechanical obstruction.
†In patients with STC only.
‡70 min shorter than laparoscopic procedures in same series (actual duration not reported).
§5 patients had colostomy and end ileostomy.
¶Includes ‘intestinal obstruction, POI, nausea and vomiting, and haemorrhage’. POI, postoperative ileus.
**+/- rectopexy.
problems) were similarly heterogeneous 13.3%, (95%CI: 8.6–18.7%) \(I^2 = 87.7\%\), including study rates from 0% to 45% (Fig. 4b). Particular to colectomy for constipation is the concept that laparoscopy might reduce the well-established high incidence of post-operative SBO. The review provided only limited data from small studies comparing open with laparoscopic procedures, although SBO rates appeared much lower. Ho et al. [34] found that early adhesion formation leading to bowel obstruction was more frequent in patients undergoing laparoscopically assisted colectomy (29%) compared to open (13%). A larger series of 124 patients also showed no differences in post-operative morbidity between approaches [55]. Conversely, a low quality case-control study of 15 laparoscopic vs 15 open subtotal colectomy with antiperistaltic CRA showed that bowel obstruction rates were halved (from 13.3 to 6.7%) in the laparoscopic groups [54]. The follow up in these studies (12–20 months) was generally shorter than the average (47 months) although very high rates of SBO were reported by a study of exclusively open CIRA with 12 months follow up [52]. Finally, while the results for laparoscopic approach offer some optimism based on the small numbers of patients in these studies, no differences were observed in complication rates between open and laparoscopic procedures in the US nationwide survey of 2377 colectomies [19].

However, the most revealing conclusions can be drawn from further analysis of US national database study in which longitudinal data were recorded on 166 patients recorded on State Inpatient Databases of Florida and California (2005–2011). These data agreed with the whole national dataset \(n = 2377\) in confirming high perioperative (30-day) complication and re-admission rates, but also showed that resource utilisation in the form of emergency department visits, hospitalisation and surgical intervention remained high in the following 1 year. Excluding the colectomy itself, these 166 patients had a total of 2355 encounters, which included 1494 emergency department visits and 861 hospitalisations by 149 and 144 patients, respectively. Among the 1494 emergency department visits, the 674 that occurred postoperatively were shared across 119 (72%) patients; among the 861 hospitalisations, 488 occurred after colectomy and affected 110 (66%) patients. A breakdown of the motivation for these attendances reveals the well-described issue of ongoing abdominal pain, which as well as other gastrointestinal symptoms and postoperative complications, increased after colectomy.

Figure 2 Forest plot showing total complications (percentage of patients) after colectomy by procedure type. CIRA, colectomy and ileorectal anastomosis; lap, laparoscopic; ISA, ileosigmoid anastomosis; IPCRA, isoperistaltic caecorectal anastomosis; APCRA, antiperistaltic caecorectal anastomosis.
Summary evidence statements: harms

1. Data on harms were inconsistently reported and heterogeneous in findings, thus estimates of harm are tentative and imprecise (level IV).

2. Proportionally greater evidence for perioperative outcomes comes from studies of colectomy and ileorectal anastomosis than for other procedural variations (CIRA: 29 studies, 1321 patients; other procedures: 10 studies, 247 patients) (level IV).

3. Total perioperative complication rates vary greatly but may occur in approximately 20–30% of colectomy patients. The influence of resection extent, anastomotic configuration and method of access on complication rates remains uncertain (level IV).

4. Rates of post-operative ileus or early post-operative adhesional small bowel obstruction vary greatly but may occur in about 5–15% of patients and about one third of these patients require re-operation (level IV).

5. Mortality rate for 39 studies reporting this outcome was 6 / 1568 patients (0.4%) (level IV).

6. Long-term adverse events characterized by recurrent episodes of small bowel obstruction occur in about 10–20% of patients and may result in a significant burden of re-hospitalization and frequent recourse to surgery in most of these patients (level IV).

7. Current evidence tentatively suggests laparoscopic surgery may reduce some complications when compared to open surgery, although this needs to be confirmed by better designed studies (level IV).

Efficacy

Measurement of outcome was inconsistent, including variable use of validated and un-validated scoring instruments for symptoms e.g. Cleveland Clinic Constipation Score or quality of life (QoL), GI quality of life, individual symptom reporting and global ‘success’ or ‘satisfaction’ ratings (GSR) obtained via a variety of methods (where ‘satisfied’ or ‘very satisfied’, ‘good’, ‘very good’ and ‘excellent’ were interpreted as positive outcomes). No study documented that data were acquired objectively by using personnel not involved in the surgical care of the patient. Only one study documented that collection of data was blind to intervention status [20] and this RCT only blinded observers for 4 days while presenting follow up data to 32 months. Average
reported follow-up of studies was 4.3 years (range 1–11 years).

Accepting these methodological limitations, there are many reports supporting the assertion that most patients undergoing colectomy are satisfied; meta-analysis of studies found an overall global satisfaction rating of 85.6% (95%CI: 81.4–89.3%), \(I^2 = 76.9\%\) based on data from 1616 patients (Table 4; Fig. 5). Again study findings are heterogeneous, with no clear advantage for any particular procedure or surgical approach. However, such

Table 3 Long-term small bowel obstruction and re-operation rates.

| Author               | Year | Operation | N   | SBO | Re-operation* |
|----------------------|------|-----------|-----|-----|---------------|
| (a) Open colectomy and ileorectal anastomosis |
| Pemberton [26]       | 1991 | CIRA      | 36  | 11.1| 8.3           |
| Piccirillo [27]      | 1995 | CIRA      | 54  | 9.3 | 3.7           |
| Redmond [21]         | 1995 | CIRA      | 37  | 18.0| NR            |
| Lubowski [29]        | 1996 | CIRA      | 52  | 17.0| 14.0          |
| Pluta [31]           | 1996 | CIRA      | 24  | 21.0| 8.4           |
| Ghosh [32]           | 1996 | CIRA      | 21  | 71.0| 42.0          |
| Nyam [33]            | 1997 | CIRA      | 74  | 9.5 | 6.7           |
| Bernini [36]         | 1998 | CIRA      | 106 | 29.0| 18.0          |
| Pikarsky [39]        | 2001 | CIRA      | 62  | 7.3 | (21.4)        |
| Pikarsky [40]        | 2001 | CIRA      | 30  | 20.0| 10.0          |
| Mollen [42]          | 2001 | CIRA      | 21  | 19.0| 9.5           |
| Nylund [43]          | 2001 | CIRA      | 40  | 42.5| 42.5          |
| Fitzharris [45]      | 2003 | CIRA      | 75  | 38.0| 17.0          |
| Hassan [46]          | 2006 | CIRA      | 65  | 0   | 0             |
| Jiang [50]           | 2008 | CIRA      | 21  | 15.0| NR            |
| Sohn [53]            | 2011 | CIRA      | 37  | 10.8| 2.7           |
| Wang [55]            | 2013 | CIRA      | 68  | 2.9 | 0             |
| Kamm [23]            | 1988 | Mix       | 44  | NR  | 38.0          |
| Vasilevsky [24]      | 1988 | Mix       | 52  | 36.0| 24.0          |
| Yoshioka & Keighley [25] | 1989 | Mix       | 40  | NR  | 30.0          |
| Platell [30]         | 1996 | Mix       | 96  | 10.4| 36.0          |
| Hasegawa [37]        | 1998 | Mix       | 61  | NR  | 45.0          |
| Fan [38]             | 2000 | Mix       | 24  | 21.0| 4.2           |
| de Graaf [28]        | 1996 | Segmental on transit | 42 | 2.0 | 2.0           |
| You [35]             | 1998 | Segmental on transit | 40 | NR  | 7.5           |
| Lundin [44]          | 2002 | Segmental on transit | 28 | 19.2| 25.0          |
| Feng [22]            | 2008 | IPCRA     | 34  | 8.9 | NR            |
| Feng [22]            | 2008 | ISA       | 45  | 6.7 | NR            |
| Jiang [50]           | 2008 | APCRA     | 17  | 11.8| NR            |
| Marchesi [54]        | 2012 | APCRA     | 15  | 13.3| 13.3          |
| (b) Series including open and laparoscopic procedures |
| Marchesi [47]        | 2007 | APCRA     | 23  | 5.9 | 11.8          |
| Zutshi [48]          | 2007 | CIRA      | 69  | 20.0| 11.6          |
| Riss [52]            | 2009 | CIRA      | 20  | 65.0| 45.0          |
| Reshef [56]          | 2013 | CIRA      | 144 | NR  | 20.0          |
| Dudekula [19]        | 2015 | CIRA      | 56  | NR  | 30 additional surgeries in 12 months F up |
| (c) Laparoscopic procedures only |
| Pinedo [51]          | 2009 | APCRA     | 20  | 5.0 | 5.0           |
| Marchesi [54]        | 2012 | APCRA     | 15  | 6.7 | 0             |
| Wang [55]            | 2013 | CIRA      | 56  | 0   | 0             |

SBO, small bowel obstruction; NR, not reported.

*Includes all reported for bowel complications although majority are for adhesional SBO.

†(Values) for age 65–85 years.
levels of satisfaction can be related to marked changes in bowel frequency (generally from a mean of once per week to three times per day in the 14 studies reporting both variables) (Table 5), and where recorded (three studies only), marked changes in summative symptom scores e.g. the Cleveland Clinic Constipation score reduced from a mean of >20 points pre-operatively (indicative of severe constipation) to approx. 2–3 points (low normal range) post-operatively. Individual symptom outcomes highlighted the well documented problems of diarrhoea: 9.8% (95%CI: 4.7–16.4%), $I^2 = 76.9\%$ (Fig. 6); and incontinence: 7.4% (95%CI: 2.2–14.7%), $I^2 = 90.8\%$ following colectomy, ongoing or recurrent constipation: 18.2%, (95%CI: 9.3–29.2%), $I^2 = 91.4\%$; persistent (or worsened) abdominal pain: 39.3%, (95%CI: 28.8–50.1%), $I^2 = 89.0\%$; and bloating 23.9%, (95%CI: 11.9–38.1%), $I^2 = 92.7\%$. Poor functional outcomes contributed to further resection or permanent stoma: median 5% (range 0–28%) patients when reported (by only seven studies; data not shown).

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Meta-analyses of efficacy outcomes featured considerable heterogeneity, not explained by procedure or age of publication. Given the different duration of studies and variable follow up within studies there is also the potential for time-confounding. Studies limited only to laparoscopic procedures are characterized by small numbers limiting scope for comparison with open procedures and no adjustment has been attempted for potential differences in the populations recruited into individual studies. Consequently efficacy estimates are tentative.

Accepting the caveat that only a minority of studies reported functional variables, several observations can be made regarding functional outcomes in studies of less radical colonic resections (Tables 5b and c) compared to those for CIRA (Table 5a). The general premise of such procedures is to reduce the risk of long-term diarrhoea and incontinence and this concept is in part supported by data that, accepting small study numbers and heterogeneity, suggest potential to reduce rates of diarrhoea for segmental and subtotal resections (Fig. 6). However, this was at the cost of increased ongoing or recurrent constipation (median 8.7% for CIRA compared to 26.8% for more conservative...

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**Figure 4** Forest plot showing (a) long-term rates of small bowel obstruction (percentage of patients) after colectomy by procedure type with focus on open and laparoscopic approach; (b) rates of re-operation for small bowel obstruction (percentage of patients) after colectomy by procedure type. CIRA, colectomy and ileorectal anastomosis; lap, laparoscopic.
resections). The latter has proved a particular problem for segmental resections (right or left hemicolectomy) with generally poor results compared to colectomy mainly due to unresolved constipation requiring further intervention (Table 5c). De Graaf et al. [28] used segmental transit (radio-opaque marker) methodology to select patients for partial left sided colectomy or subtotal colectomy. Whilst results as a whole were disappointing, the study concluded that in terms of complications and functional outcome, there was little difference between procedures, and that a more limited resection was therefore a reasonable option in this selected group. You et al. [35] reported the use of left, right or subtotal colectomy based on segmental transit time measurements with excellent results. Further, in the three cases where constipation recurred following segmental resection, a subtotal colectomy was undertaken successfully at a later date. This experience was not however repeated by Lundin et al., [44] when recurrent constipation was experienced by 46% patients despite transit-guided resection. Thus, while in the laparoscopic era

where there is a greater theoretical advantage of not meeting the technical challenges of mobilizing both colonic flexures laparoscopically, the tailoring of segmental resections using these specialist investigations of transit is inconsistently supported by published data. Further, the tests required to accurately determine resection level e.g. isotope scintigraphy have limited availability.

Subtotal resection with ileosigmoid anastomosis is generally considered less effective than ileorectal anastomosis based on several relatively small case series mixing both procedures (Table 4d). Contemporary data on subtotal resections with CRA come mainly from a few institutions in Italy and China. Conclusions from these studies vary. For example, Li et al. [57] demonstrated good results for both isoperistaltic CRA and CIRA. Feng et al. [22] compared isoperistaltic CRA with SCISA. Surgical safety outcomes and length of stay were similar but patients were more satisfied after ileosigmoid anastomosis mainly due to ongoing constipation in caeco-colic group. However patients experienced slightly less
Table 4 Percentage success based on global satisfaction ratings (GSR).

| Author          | Year | FU (mean) | Operation                        | N    | % success |
|-----------------|------|-----------|----------------------------------|------|-----------|
| (a) Colectomy and ileorectal anastomosis |      |           |                                  |      |           |
| Pemberton [26]  | 1991 | 36        | Open                             | 36   | 100       |
| Piccirillo [27] | 1995 | 27        | Open +/− rectopexy                | 54   | 94        |
| Redmond [21]    | 1995 | 90        | Open                             | 34   | 90*       |
| Lubowski [29]   | 1996 | 42        | Open                             | 52   | 90        |
| Pluta [31]      | 1996 | 65        | Open                             | 24   | 92        |
| Nyam [33]       | 1997 | 56        | Open                             | 74   | 97        |
| Ho [34]         | 1997 | 24        | Open                             | 17   | 96        |
| Ho [34]         | 1997 | 24        | Laparoscopic                      | 7    | 100       |
| Bernini [36]    | 1998 | 78        | Open                             | 106  | 78†       |
| Fan [38]        | 2000 | 23        | Open‡                           | 24   | 88        |
| Pikarsky [40]   | 2001 | 60        | Open                             | 30   | 100       |
| Webster & Dayton [41] | 2001 | 12        | Open (5 ileostomy)               | 55   | 89        |
| Mollen [42]     | 2001 | 62        | Open                             | 21   | 76        |
| Nylund [43]     | 2001 | 132       | Open                             | 40   | 73        |
| Fitzharris [45] | 2003 | 47        | Open                             | 75   | 69        |
| Hassan [46]     | 2006 | 68        | Open                             | 65   | 85        |
| Zutshi [48]     | 2007 | 130       | Open & laparoscopic (n = 7)       | 69   | 79        |
| Jiang [50]      | 2008 | 48        | Open                             | 21   | 65        |
| Hsiao [49]      | 2008 | 12        | Laparoscopic                      | 44   | 89        |
| Sohn [53]       | 2011 | 41        | Open                             | 37   | 84        |
| Reshef [56]     | 2013 | 43        | Open & laparoscopic (n = 7)       | 144  | 89§       |
| Li [57]         | 2014 | 64        | Open                             | 40   | 93        |

(b) Subtotal colectomy and ileosigmoid anastomosis (ISA); isoperistaltic caecorectal anastomosis (IPCRA); antiperistaltic caecorectal anastomosis (APCRA); lap: laparoscopic

| Author          | Year | FU (mean) | Operation                        | N    | % success |
|-----------------|------|-----------|----------------------------------|------|-----------|
| de Graaf [28]   | 1996 | 46        | ISA                              | 24   | 67        |
| Feng [22]       | 2008 | 47        | ISA                              | 45   | 93        |
| Marchesi [47]   | 2007 | 72        | APCRA (lap n = 5)                | 17   | 88        |
| Jiang [50]      | 2008 | 48        | APCRA                            | 17   | 88        |
| Feng [22]       | 2008 | 47        | IPCRA                            | 34   | 74        |
| Li [57]         | 2014 | 33        | IPCRA                            | 32   | 97        |

(c) Segmental colectomy (all based on regional transit measurement)

| Author          | Year | FU (mean) | Operation                        | N    | % success |
|-----------------|------|-----------|----------------------------------|------|-----------|
| de Graaf [28]   | 1996 | 46        | Lt hemicolecction                 | 18   | 62.5      |
| You [35]        | 1998 | 24        | Segmental based on transit        | 40   | 92        |
| Lundin [44]     | 2002 | 50        | Segmental based on transit§       | 28   | 86        |

(d) Mixed procedures

| Author          | Year | FU (mean) | Operation                        | N    | % success |
|-----------------|------|-----------|----------------------------------|------|-----------|
| Kamm [23]       | 1988 | > 12      | CIRA / IPCRA (11)                | 44   | 50        |
| Vasilevsky [24] | 1988 | 46        | CIRA (5) / ISA                   | 51   | 79        |
| Yoshioka & Keighley [25] | 1989 | 36        | CIRA / ISA (1) / IPCRA (5)       | 40   | 58        |
| Platell [30]    | 1996 | 60        | CIRA / IPCRA (10)                | 96   | 81.3      |
| Hasegawa [37]   | 1999 | 84        | CIRA, ISA, IPCRA, segmental      | 61   | 39-95**   |

FU, mean follow up in months; NR, not reported.

*12.5% with generalized intestinal disorder (see text).
†56% with associated rectal evacuatory disorder.
‡2 patients had caecorectal anastomosis.
§85% with associated rectal evacuatory disorder.
*26 of 28 had left hemicolecctomy (6 with rectopexy) and 2 right.
**Outcome dependent on psychiatric disease and concomitant rectal evacuation disorder.
diarrhoea and incontinence after caecorectal anastomosis. Jiang et al. [50] compared antiperistaltic CRA with ileorectal anastomosis. Again there were no differences in post-operative course, however patients undergoing caecorectal anastomosis had less diarrhoea, higher post-operative quality of life (not recorded pre-operatively) and overall reported GSR (88 vs 65%).

Laparoscopic surgery has the theoretical advantages of better cosmesis (especially in young women) and perhaps lower long-term complication rates (see above). Such factors have not however yet translated into improved functional outcomes mainly because these have not yet been the focus of comparative studies. Ho et al. [34] found no difference in GSR between open and laparoscopic CRA (96 vs 100%). In the case-control study of Marchesi et al. [54], despite the halving of SBO rates (from 13.3 to 6.7%) in the laparoscopic groups, long-term functional outcomes and GI quality of life were very similar.

**Summary evidence statements: efficacy**

1. Proportionally greater evidence for efficacy comes from studies of colectomy and ileorectal anastomosis than for other procedural variations (CIRA: 25 studies, 1209 patients; mixed: 5 studies, 280 patients; other procedures: 9 studies, 247 patients; and segmental procedures 4 studies, 99 patients (level IV).
## Table 5: Functional outcomes by procedure.

| Author          | Year | Procedure                  | N   | BF pre | BF post | CCS pre | CCS post | D    | I    | AP   | L | B | RC |
|-----------------|------|----------------------------|-----|--------|---------|---------|----------|------|------|------|---|---|----|
| (a) Colectomy and ileorectal anastomosis |      |                            |     |        |         |         |          |      |      |      |   |   |    |
| Pemberton [26]  | 1991 | Open                       | 36  | NR     | 14.0    | NR      | NR       | 0     | 0    | 0    |   |   |    |
| Redmond [21]    | 1995 | Open                       | 37  | NR     | 26/5*   | NR      | NR       | NR    | NR   | 0/69*| 0/44*| 0/44*| NR |
| Piccirillo [27] | 1995 | Open†                      | 54  | NR     | 26      | NR      | NR       | 24    | 24   | NR   | 1.9| NR| NR |
| Lubowski [29]   | 1996 | Open                       | 52  | NR     | 28.0    | NR      | NR       | 14    | 12   | 52   | NR| NR| 26.9|
| Ghosh [32]      | 1996 | Open‡                      | 21  | NR     | NR      | NR      | NR       | NR    | 90   | NR   | NR| NR| NR |
| Nyam [33]       | 1997 | Open                       | 74  | NR     | 28 ³14  | NR      | NR       | <10  | 1    | NR   | 2³9| NR| 0   |
| Ho [34]         | 1997 | Open                       | 17  | 0.3 ∞1.2| 17 ∞15.4| NR      | NR       | 0     | 0    | NR   | 0 | 0 | 0   |
| Bernini [36]    | 1998 | Open                       | 90  | NR     | 19.6 ³14.6 DD | NR | NR      | 14 ³15 | 21 ³20 | 44 ³37 | NR| 45³43 | 4³38 |
| Fan [38]        | 2000 | Open                       | 24  | 1.4    | 22.8    | NR      | NR       | 8.3   | 0    | NR   | 8.3**| NR| 8.3**|
| Pikarsky [39]   | 2001 | Open                       | 62  | 1.4 ³1.0 | 20.3 ³26.6 | NR | NA      | 9 ³27 | 17 ³36 | NR | 0 ³9 | NR | NR |
| Pikarsky [40]   | 2001 | Open                       | 30  | NR     | 17.5    | NR      | NR       | NR    | 17   | NR   | 6  | NR| 23  |
| Webster & Dayton [41] | 2001 | Open‡‡                                          | 55  | NR     | 21.0    | NR      | NR       | 5     | 4    | 19   | NR| 10  | 9 |
| Mollen [42]     | 2001 | Open                       | 21  | 0.8    | 19.6    | NR      | NR       | NR    | 10   | 86   | 62 | 90 | 76 |
| Nylund [43]     | 2001 | Open                       | 40  | 1.1    | 3.8     | NR      | NR       | NR    | 7.5  | 38   | NR| NR| NR |
| Fitzharris [45] | 2003 | Open                       | 75  | NR     | 2.5     | NR      | NR       | NR    | 25   | 45   | 41 | 20 | NR |
| Zutshi [30]     | 2007 | Open & lap                 | 69  | 1.0    | 21.0    | NR      | NR       | NR    | NR   | 37   | NR| 66 | 51 |
| Jiang [50]      | 2008 | Open                       | 21  | 1.4    | 23.8    | NR      | NR       | 15    | NR   | 20   | NR| 25 | NR |
| Pinello [51]    | 2009 | Lap                        | 20  | NR     | NR      | 22.3    | 1.8      | NR    | NR   | 5    | NR| 5  |    |
| Ris [52]        | 2009 | Open or lap                | 20  | NR     | NR      | NR      | 11.5 ³11 | NR | NR   | NR   |      | 50³55 |
| Sohn [53]       | 2011 | Open                       | 37  | NR     | NR      | 19.3    | 2.1      | NR    | NR   | NR   | NR| NR| NR |
| Xu [20]         | 2012 | Open                       | 32  | NR     | NR      | NR      | NR       | NR    | NR   | NR   | NR| NR| NR |
| Wang [55]       | 2013 | Open or lap                | 114 | NR     | 35.0    | NR      | NR       | NR    | NR   | 6    | NR| 6  |    |
| Reshef [56]     | 2013 | Open or lap                | 144 | NR     | 31.0 (33.0) | NR | NR       | 11 (15) | 31 (33) | 13 (26) | NR| NR| NR |
| Li [57]         | 2014 | Open                       | 40  | NR     | NR      | 27.3    | NR       | 2.5   | 2.5  | 13   | NR| 7.5| NR |
| (b) Subtotal colectomy and ileosigmoid anastomosis (ISA); isoperistaltic caecorectal anastomosis (IPCRA); and antiperistaltic caecorectal anastomosis (APCRA); lap: laparoscopic | | | | | | | | | | | | | | |
| Author         | Year | Procedure                       | N   | BF pre | BF post | CCS pre | CCS post | D    | I   | AP   | L    | B    | RC   |
|----------------|------|---------------------------------|-----|--------|---------|---------|----------|------|-----|------|------|------|------|
| Sun [58]       | 2015 | IPCCRA                          | 26  | 1.1    | 16.1    | NR      | 3.2      | NR   | NR | NR   | NR   | NR   | NR   |
| (c) Segmental colectomy |     |                                 |     |        |         |         |          |      |     |      |      |      |      |
| de Graaf [28]  | 1996 | Lt hemicolectomy on transit     | 18  | NR     | NR      | NR      | 5.6      | 5.6  | 33.3| 16.7 | 22.2 | 16.7 |
| You [35]       | 1998 | Segmental on transit            | 40  | 1      | 14      | NR      | NR       | 0    | NR | NR   | NR   | 0    | 8    |
| Hasegawa [37]  | 1999 | Segmental mix                   | 13  | NR     | NR      | NR      | NR       | NR   | NR | NR   | NR   | NR   | 62   |
| Lundin [44]    | 2002 | Predom. left hemi on transit    | 28  | 1      | 7       | NR      | NR       | NR   | 50 | 0    | 67   | 46   |      |
| (d) Mixed procedures |     |                                 |     |        |         |         |          |      |     |      |      |      |      |
| Kamm [23]      | 1988 | IRA / APCRA                     | 44  | NR     | NR      | NR      | 39       | 14   | 71  | 45   | 45   | 11   |
| Vasilevsky [24]| 1988 | IRA / ISA (predom)              | 52  | NR     | 19.6    | NR      | NR       | NR   | 50 | 20   | 0    | NR   |
| Yoshioka & Keighley [25]| 1989 | IRA / ISA / IPCRA             | 40  | 0.3    | 21.0    | NR      | NR       | NR   | 33 | NR   | NR   | NR   |
| Platell [30]   | 1996 | IRA / IPCRA                    | 96  | NR     | NR      | NR      | NR       | 52   | 55 | NR   | NR   | NR   |
| Hasegawa [37]  | 1999 | IRA, ISA, IPCRA                | 48  | NR     | NR      | NR      | NR       | NR   | NR | NR   | NR   | NR   | 33   |

NR, not reported; BF, Bowel frequency/week; CCS, Cleveland Clinic Constipation score; D, diarrhoea; I, incontinence; AP, abdominal pain; L, laxatives; B, bloating; RC, recurrent constipation.

*If associated generalized intestinal disorder (GID).
†With rectopexy.
‡Includes one segmental resection.
§Values if STC associated with concomitant RED; values for laparoscopic where these differed.
**In 2/24 patients undergoing caecorectal anastomosis.
††Age 65–80 (compared to 21–61 years).
‡‡Includes one end ileostomy.
§§Based on 12 patients in follow up.

Studies not reporting a cohort average, i.e. only subgroups were excluded from the meta-analysis.
Data on efficacy were inconsistently reported and heterogeneous in findings, thus estimates were tentative and imprecise. Studies varied in their follow-up of patients, the mean follow-up in studies was 4.3 years (range 1–11 years) (level IV).

Colectomy (based on the global rating of success) benefits the majority of patients with slow transit constipation: overall mean 85.6% (95% CI: 81.4–89.3%) at > 12 months follow up (level IV).

Negative long term functional outcomes persist in a minority of patients: diarrhoea and incontinence in about 5–15% of patients; abdominal pain in 30–50% of patients; recurrent constipation in 10–30% of patients and bloating in 10–40% (level IV).

Tailoring of segmental resections using specialist regional transit measurements provides uncertain benefit (level IV).

There are insufficient data to conclude: (a) that alternative procedures (subtotal or segmental) perform better than CIRA; (b) that one type of subtotal resection (caccoecrectal vs ileosigmoid) or anastomosis (iso- or anti-peristaltic) is superior to another; (c) that laparoscopic approach has benefit over open surgery (level IV).

Subtotal colectomy may reduce long-term rates of diarrhoea compared to CIRA although this finding is tentative and should be verified with better designed studies (level IV).

**Patient selection**

While clinical experience suggests careful patient selection for procedures is important, few studies systematically addressed this issue [12]. Main findings from studies that stratified outcomes based on baseline phenotype are included in Table 6. These studies provide some information on clinical characteristics but more so on results of specialist physiological testing.

Pikarsky *et al.* [39] studied whether colectomy can be performed in elderly patients (defined 65–80 years in their series). Although overall success was diminished on the older age group (64% vs 95%, *P* = 0.01), the authors concluded that the results were acceptable and that the procedure was safe based on no increase in observed morbidity. The question of whether the presence of severe psychological problems adversely influences outcome has been discussed by studies that noted both poor outcomes and a number of post-operative psychological problems including suicide [23]. Others have made post-hoc correlations between prior psychiatric disease and poor outcome [31]. This factor was only addressed as a stated aim by Hasegawa *et al.* [37], who...
| Author       | Year | Factor studied | Op  | N   | FU | Main findings: perioperative | Main findings: functional | Main findings: long-term morbidity |
|-------------|------|----------------|-----|-----|----|-------------------------------|--------------------------|----------------------------------|
| Redmond [21]| 1995 | GID            | CIRA| 34  | 90 | Increased perioperative morbidity (44% vs 24%) with GID and increased LOS: 13.1 vs 12.1 days | GRA 12.5% vs 90% satisfied with outcome in GID group; at 2 years: BH 5 vs 28 p.w, rec. constipation & pain 56% in GID vs 5% in no GID group. Similar findings for bloating, abdominal pain and laxative requirements at 2 years and worse at 5 years | 1 death in both groups: GID secondary to TPN catheter |
| Nyam [33]   | 1997 | RED            | CIRA| 74  | 56 | NR                            | Results similar (no s.d) between RED and no RED for all studied | NR                              |
| Hasegawa [37]| 1999 | RED & psych    | Mix | 61  | 84 | NR                            | Failure in 11% without vs 39% with RED; failure in 70% with psychological problems (inc 5-fold increase in admissions, further surgery, and 5 fold increase in eventual stoma) |                                  |
| Bernini [36]| 1998 | RED            | CIRA| 106 | 78 | NR                            | GRA decreased if RED: 56 vs 78%; weekly BF 14.7 vs 19.6; no diff in other symptoms | SBO only in CI group - 23 vs 0% |
| Pikarsky [39]| 2001 | Age < or > 65 years | CIRA| 59  | 105| SBO 21% in age over 65 vs 7% in younger patient group | Weekly BF higher (n.s) in older group (26.6 vs 20.3); excellent outcome in 64% older vs 95%; increased FI in older (56% vs 17%) | 1/14 older group required stoma |
| Hassan [46] | 2006 | RED            | CIRA| 104 | 68 | NR                            | No diff in KESS and SF-12 with or without RED |                                  |
| Reshef [56] | 2013 | RED            | CIRA| 144 | 43 | LOS longer with RED 9.7 vs 7.8 days; overall morbidity otherwise similar 61 vs 54% POI; re-operation 41 vs 26% | Inc. lax use in RED group (26 vs 13%) other variables similar inc. overall satisfaction: GRA 89 vs 85 | No diff in ileostomy rates (5% both groups) or re-admissions (30% both groups) |

RED, rectal evacuation disorder; GID, generalized intestinal disorder; BF, biofeedback; CIRA, colectomy and ileorectal anastomosis; KESS, Knowles-Eccesky-Scott score; LOS, length of stay.
reported a statistically significant prejudicial influence of ‘severe psychological disorder’.

Outcomes of colectomy are improved by selection of patients with proof of slow colonic transit. Although it could be argued that other factors may have also influenced outcomes (e.g. mix of surgical approaches, surgical technique and equipment), this statement is corroborated by comparing outcome data from an era when specialist investigations of transit were variably applied [23–25,37] with subsequent studies that always performed transit studies and used these as a selection criteria. Most contemporary studies also evaluated anorectal physiology especially in relation to the diagnosis of a combined slow-transit and defaecatory disorder phenotype. The management of this patient group remains contentious. Bernini et al. [36] in a study of 106 patients demonstrated that despite preoperative biofeedback training, patients with non-relaxing pelvic floor (n = 16) had significantly higher rates of recurrent defaecatory difficulty (38 vs 4%), and lower rates of satisfaction after colectomy (56 vs 78%). However, three other studies (Table 6) found little effect on functional outcome or complication rates when functional or structural defects were addressed prior to colectomy. These studies included the contemporary Cleveland Clinic experience of 144 patients where obstructed defaecation (n = 41) had no influence on outcome from laparoscopic or open colectomy [56].

It is generally accepted that some patients with slow colonic transit also manifest upper GI symptoms (especially nausea and vomiting). Abnormalities of oesophageal, gastric and small bowel function can be demonstrated in a proportion of patients by a variety of methods [18]. Ghosh et al. [32] showed that the high proportion of patients undergoing colectomy who subsequently developed SBO episodes (71% with 42% requiring surgery in their series) were more likely to have non-colonic visceral and autonomic nervous system abnormalities on post-operative testing. This observation has been considerably strengthened by the prospective cohort study of Redmond et al. [21]. A significant fall in long-term success rate (to 10 years) as a result of persistent constipation, abdominal pain and distension) was observed in patients defined as having a generalized intestinal disorder (GID) on the basis of having both upper and lower GI dysmotility using a battery of intraluminal tests. Successful outcome was observed in only 12.5% patients with GID vs 90%: without.

**Summary evidence statements: patient selection**

1. Outcomes of colectomy may be poorer in patients with significant psychological disorder (level IV).
2. Outcomes of colectomy may be improved by selection of patients with definitive proof of slow colonic transit (level IV).
3. Outcomes of colectomy are inconsistently influenced by concomitant rectal evacuation disorder although data suggest that structural and functional defaecation disorders, if evident, should be treated prior to colectomy (level IV).
4. Outcomes of colectomy may be prejudiced by pre-operative evidence of upper gastrointestinal dysmotility (level IV).

**Conclusions**

A systematic review of evidence for the perioperative and long-term benefits and harms of colectomy identified no high quality studies. The evidence base is characterised by observational studies of variable and often uncertain methodological quality. Current data suggest a balance of harms against efficacy with evidence that outcomes are at best variable. Future studies should provide high quality evidence for clinicians to support patient decision making, both in terms of the incremental benefits and harms of colectomy and in understanding the effects of prognostic factors upon treatment success.

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Surgery for constipation

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Conflict of interest

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