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# A systematic review of pre, peri and postoperative factors and their implications for the lengths of resected bowel segments in patients with Crohn's disease

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ABSTRACT

*Aim:* Several pre, peri and postoperative factors may have implications for the lengths of resected small bowel segments in Crohn's disease patients. It might also affect patient outcome. We reviewed the current literature on factors and their implications for the lengths of resected small bowel segments and possible correlations with postoperative outcome.

*Method:* Searches were independently engineered by the authors and a research-librarian in MEDLINE and OVID databases using PubMed and EMBASE engines in compliance with PRISMA recommendations. All original articles, reviews and guidelines published in the period of 1985–2016 with last search date 13th of February 2016 on bowel resection in Crohn's disease patients were assessed for inclusion.

*Results:* We identified 52 studies for synthesis. *Preoperative*: Perforation as indication for surgery and increased visceral obesity may be factors resulting in longer lengths of resected small bowel segments. Administration of total parenteral nutrition might reduce resection lengths. *Perioperative*: No difference in resection lengths in elective versus acute surgery, laparoscopic versus open approaches or in case of intra-operative blood transfusions. Stapled anastomoses might conserve more bowel than sutured ones. *Postoperative*: The lengths of the resected small bowel segments most likely have no impact on recurrence rates.

*Conclusion:* No pre, peri or postoperative factors were found to have definitive implications for the lengths of resected small bowel segments. Correlation between the lengths of resection and recurrence is weak.



## 1. Introduction

Crohn's disease (CD) is becoming more prevalent [1] with continually higher incidence rates argued to be 3.1 to 14.6 cases per 100,000 person-years [2,3]. While both medical and surgical treatment of CD is improving, the disease still presents itself with increased morbidity and an increasing burden of disease [4]. Surgical intervention has been shown to still be required in up to two-thirds of CD patients [5]. Furthermore, early surgery can be a factor in better patient outcome [4]. While it appears that strictureplasty procedures for CD have become an accepted treatment option, small bowel (SB) resection is still widely used and considered the only option in penetrative disease phenotypes and long affected segments [6–8]. Pre, peri and postoperative factors may have implications for the lengths of resected small bowel segments in Crohn's disease patients. There are a limited number of studies on the subject with conflicting reports [9].

Repeated bowel resections can lead to intestinal failure [10], yet it appears there is a lack of quality registries and statistical data on factors that might lead to resection of longer SB segments. Although two thirds or more of CD patients undergo repeated bowel resection during a life-time [9,11], measurements and documentation of the resected bowel segments remain scarce; this makes planning for additional resections more difficult.

A recent shift in favour of laparoscopic surgical approaches - and even a single port approach - has naturally demanded research comparing the laparoscopic versus open approaches in CD-related surgery [12–14]. A recent review on this includes only a single article reporting on a possible correlation between the two approaches and lengths of the resected segments [15].

While it has been argued that lengths of resection margins do

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not affect surgical recurrence [16–18], a newer study suggests that the use of correct resection margins is crucial to avoid recurrence [19]. This further strengthens the need for data on the lengths of resected SB segments in CD patients, especially when margins can be as low as 2 cm [20].

Objectives: To review the current literature for pre, peri and postoperative factors and their implications for the lengths of resected SB segments and possible correlations with postoperative outcome.

## 2. Materials and methods

Search strategy: (KH) executed a broad-spectrum search strategy (see below) in the MEDLINE and EMBASE records with no limits using the Ovid EMBASE and PubMed search engines. An external research-assistant librarian repeated the search to ensure validity, integrity and robustness of the search strategy. All articles were screened for title and abstract by two authors (KH and SK), and select articles were included for review based on full-text assessments by two authors (KH and SK). All authors participated in the final selection of included studies (KH, SK and AE). Fig. 1 shows our PRISMA flowchart.

(KH) performed data extraction and (AE) re-checked it. Differences were resolved by discussion.

OVID EMBASE and OVID MEDLINE search by authors:

1. crohn* OR inflammatory bowel disease OR IBD.all fields.
2. resection OR resected OR small bowel length OR short bowel OR segment.keyword.
3. 1 AND 2

Yield: 336 on February 13th, 2016.

PubMed MEDLINE search by authors:

((crohn* OR inflammatory bowel disease OR IBD) AND length of resection).all fields.

Yield: 383 on February 13th, 2016.

In total 719 results of which 63 were duplicates resulting in a yield of 656 unique results for the internal searches.

PubMed MEDLINE search by external librarian:

((((((“Perioperative Period”[Mesh]) OR “Risk Factors”[Mesh]) OR “complications” [Subheading]) OR complication*[tw]) OR risk factor*[tw])) AND ((((((((resection*[tw] OR resected*[tw])) OR “Digestive System Surgical Procedures”[Mesh]) OR (“General Surgery”[Mesh] OR “surgery” [Subheading])) OR (surgery[tw] OR surgical[tw]))) AND (((“Intestine, Small”[Mesh]) OR (small bowel*[tw] OR short bowel*[tw])) OR (small intestine*[tw] OR short intestine* [tw]))) AND (((crohn*[tw] or Inflammatory Bowel Disease*[tw] or IBD[tw])) OR “Crohn Disease”[Mesh]))

Yield: 2010 results on February 13th 2016.

### 2.1. Inclusion criteria

All original articles, reviews and guidelines published in the period of 1985–2016 with last search date 13th February 2016 about bowel resection in CD patients were included. Inclusion criteria for full-text evaluation:

1. Studies/articles reporting the effect of pre, peri, and postoperative factors on the lengths of resected SB segments.
2. Studies/articles reporting the effect of resected segment length on short- and long-term postoperative outcome.

We retrieved these articles for full-length text reading and their reference lists screened for other relevant articles.

### 2.2. Exclusion criteria

We excluded articles that did not meet the above stated criteria as well as case reports, editorials, letters to editor, conference abstracts and articles where full text was not available.

### 2.3. Assessment of risk of bias

The quality of bias control in the included observational studies was assessed using the Newcastle-Ottawa scale (NOS). All the included studies present a high risk of bias.

## 3. Results

We included 52 articles in this review, please see Fig. 1 for a PRISMA flow-diagram. The following subsections and paragraphs present our findings in segments divided by types of comparisons made. Any article may appear in two or more segments if applicable. It was not possible to conduct meta-analysis of the included studies because of heterogeneity in outcome measurements, methodology and reporting of outcome measurements. An overview of the following results is available as Table 1.

### 3.1. Preoperative factors

#### 3.1.1. Studies comparing the lengths of resected SB segments and different preoperative factors [11,21–28]

One study found that structuring versus fistulising indications for surgery does not affect the lengths of the resections [21]. Another study found the difference based on perforating versus stenotic indications to be of significance, the former patient group having more lengths resected $p < 0.001$ [22]. Both studies lack adjustment for other factors that might influence resection lengths. Another factor that shows an effect on the lengths of resected SB segments is *visceral obesity* (BMI and CT-scan evaluation); longer SB segments were resected in patients with visceral obesity VFA $\geq$ 130 cm squared, $p = 0.04$ tested in univariate analysis. The results were not adjusted for other factors [23]. This appears, however, not to be related to preoperative lipid profile after adjusting for confounding factors in multivariate analysis [24]. Furthermore, the post-surgical lipid profile also seems to be unaffected [28].

Preoperative medical treatment and the lengths of resected SB segments: One study showed no link between the use of a preoperative immunosuppressant and the lengths of the resected segments $p = 0.33$ in univariate analysis [22]. However, with the added cost of longer lengths of stay, total parenteral nutrition (TPN) administration appears to reduce the lengths of resected SB segments in patients undergoing ileo-colic resection $p < 0.001$, and near-significantly in patients undergoing segmental SB resection $p < 0.09$ when tested in multivariate analyses [25].

While initial SB lengths and postoperative residual SB lengths appear not to influence the likelihood of recurrence [26,27], one study found a correlation between preoperative extent of diseased segments and extent at recurrence $r = 0.7$, $p < 0.001$ [11]. This result has however not been adjusted for other factors.

### 3.2. Perioperative factors

#### 3.2.1. Studies comparing the lengths of resected SB segments in patients undergoing elective vs acute surgery [10,22,29]

A single-centre retrospective study found no difference in the lengths of resected SB segments based on whether the surgery was elective or acute $p = 0.14$ [29]. Another retrospective study analysed patients with intestinal failure and found in agreement with this,

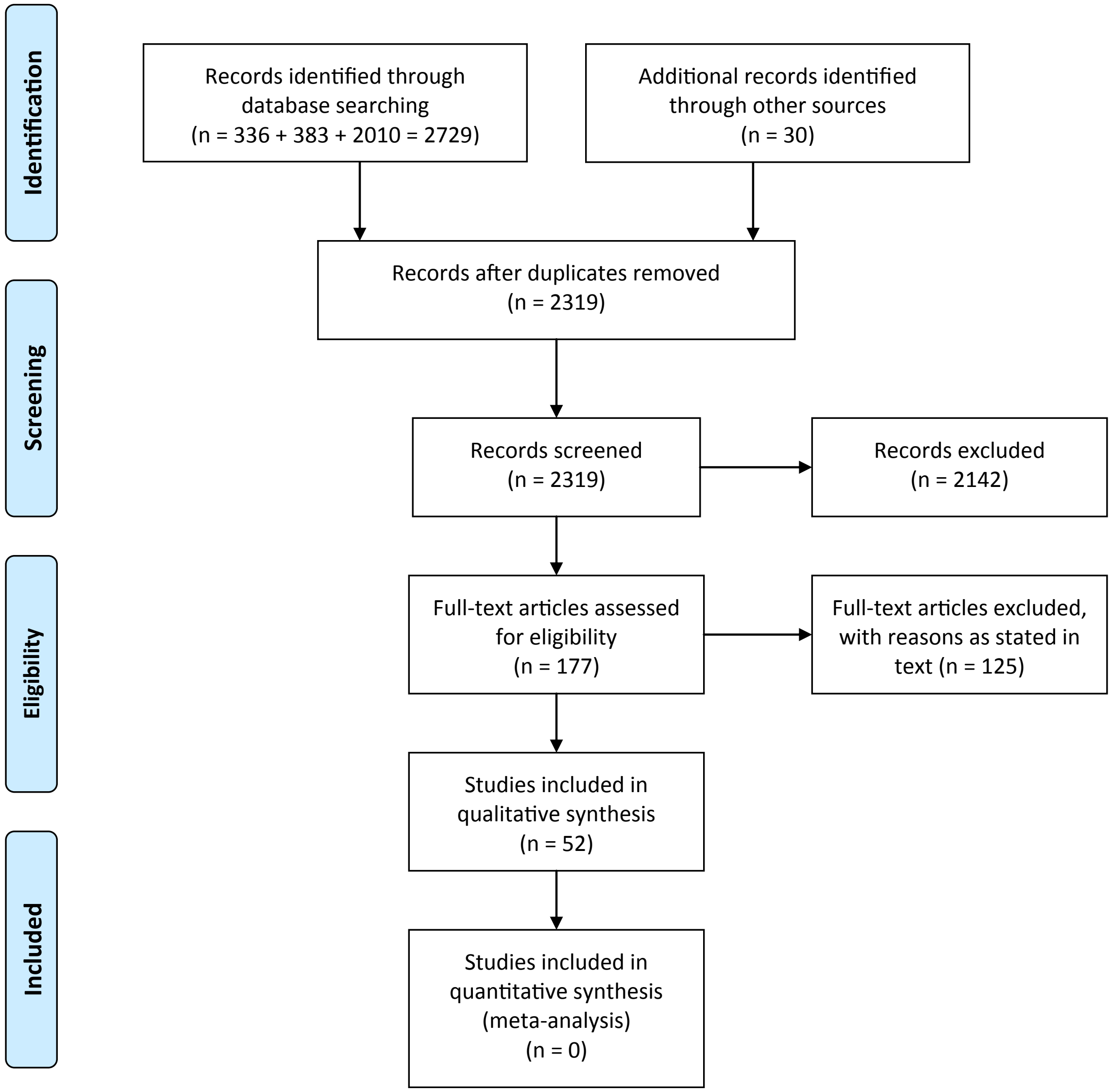


**Fig. 1.** (a) first picture; (b) second picture.

that residual lengths of SB were the same regardless of elective vs acute indication for surgery $p < 0.001$ [10]. These findings were cemented in a multi-centre retrospective study that showed no difference $p = 0.07$ [22]. All three studies failed to provide multivariate analyses.

#### 3.2.2. *Studies investigating the lengths of resected SB segments, surgical approach, anastomosis type and blood transfusion [12–14,30–39]*

Several retrospective studies have assessed the influence of open versus laparoscopic approach on the lengths of resected bowel segments and found no difference [13,14,30]. However, a Hungarian study [40] suggests that laparoscopic access resulted in shorter lengths of resected SB segments $p = 0.03$. None of these studies made correlation analyses. Two prospective studies failed to provide thorough statistical data [12,31], but came to the same conclusions as a randomised study finding no difference in multivariate analyses [32]. A systematic review also found no difference [39]. The type of laparoscopic approach whether it being a single-port or multi-port approach, had no effect on the lengths of the resected segments [33].

The only available research about anastomosis type is a retrospective study showing that shorter lengths of SB segments were resected using a stapled anastomosis vs a sutured one $p = 0.04$ [38].

Perioperative blood transfusion appears to have no effect on SB resection lengths in a retrospective study using multivariate analyses [34]. This is in agreement with a later meta-analysis [35].

### 3.3. *Postoperative outcome*

#### 3.3.1. *Studies investigating the length of resected SB segments and correlation with recurrence [9,11,17,18,26,27,34,35,39,41–64,65]*

Although symptomatic recurrence correlated to preoperative affected segment length $p = 0.001$ in one retrospective study [11], the finding could not be reproduced in two prospective studies [26,27]. None of the studies above are adjusted for possible confounders in multivariate analyses.

Surgical recurrence: Two retrospective studies on surgical recurrence [41,42] found that more extensive resections correlate with lower rates of recurrence. While the former does not provide any statistical data, the latter reported statistically significant results at $p < 0.05$ based on 45 patients that had resection of >25 cm

**Table 1**
Studies presenting pre, peri and postoperative factors and their implications on the lengths of resected small bowel segments in patients with Crohn's disease.

| Author(s) | Year | Type | No. of patients or (articles included in review) | Follow-up in months | Parameters | Results of univariate analyses | Results of multi-variate analyses |
|---|---|---|---|---|---|---|---|
| Comparing the lengths of resected SB segments or outcome in grouping elective vs acute surgery | | | | | | | |
| Brihier et al. [29] | 2005 | Retrospective | 162 | N/A | Difference | $p = 0.14$ | N/A |
| Elriz et al. [22] | 2011 | Retrospective Multi-centre | 38 | N/A | Difference | $p = 0.07$ | N/A |
| Agwunobi et al. [10] | 2001 | Retrospective | 41 | 6–324 | No difference | $p < 0.001$ | None |
| Comparing the lengths of resected SB segments and recurrence to different preoperative factors | | | | | | | |
| Cayci et al. [21] | 2015 | Retrospective | 74 | N/A | Stricture vs fistula | $p = 0.91$ | N/A |
| Elriz et al. [22] | 2011 | Retrospective | 38 | N/A | Medical treatment/Perforation vs stenosis | Ns/$p < 0.001$ | None |
| Ding et al. [23] | 2016 | Retrospective | 164 | N/A | Visceral Fat Area correlated to increased SB resection lengths | $p = 0.003$ | None |
| Romanato et al. [24] | 2008 | Prospective | 24 | N/A | Lipid profile correlation to lengths of resected SB segments | | ns |
| D'Haens et al. [11] | 1995 | Retrospective | 23 | 32–242 | Extent of disease correlation with symptomatic recurrence | $p = 0.001$ | None |
| Glehen et al. [26] | 2003 | Prospective | 93 | 24–216 | Residual SB length correlation with recurrence | ns | N/A |
| Nordgren et al. [27] | 1997 | Prospective | 155 | 192 (mean) | Initial SB length correlation with recurrence | ns | N/A |
| Lashner et al. [25] | 1989 | Prospective | 17 | N/A | TPN therapy correlation with resection lengths | | $p < 0.09$ |
| Comparing the lengths of resected segments and recurrence to perioperative factors by type of surgery, anastomosis and use of blood transfusion | | | | | | | |
| Bemelman et al. [13] | 2000 | Retrospective | 78 | N/A | Open vs laparoscopy | ns | N/A |
| Diamond et al. [14] | 2001 | Retrospective | 12 | N/A | Open vs laparoscopy | ns | N/A |
| Eshuis et al. [30] | 2009 | Retrospective | 78 | N/A | Open vs laparoscopy-assisted | ns | N/A |
| Benoist et al. [12] | 2003 | Prospective | 56 | N/A | Open vs laparoscopy | ns | N/A |
| Sica et al. [31] | 2008 | Prospective | 28 | N/A | Open vs laparoscopy | ns | N/A |
| Horvath et al. [40] | 2014 | Prospective | 133 | N/A | Open > laparoscopy | $p = 0.03$ | None |
| Dunker et al. [32] | 2003 | RCT | 34 | N/A | Open vs laparoscopy | | ns |
| Yamamoto et al. [39] | 2013 | Review | (17) | N/A | Open vs laparoscopy | No difference | |
| Yamamoto et al. [38] | 1999 | Retrospective | 123 | N/A | Stapled < sutured anastomosis | $p = 0.04$ | None |
| Gardenbroek et al. [33] | 2013 | Prospective | 63 | N/A | Single-port vs multi-port | ns | N/A |
| Silvis et al. [34] | 1994 | Retrospective | 148 | 56 (median) | Correlation to blood-transfusion | | ns |
| Hollaar et al. [35] | 1995 | Meta-analysis | (7) 622 | N/A | Correlation to blood-transfusion | | ns |
| Stebbing et al. [36] | 1995 | Retrospective | 52 | 1–182 | Lengths of resection correlation to Strictureplasty vs strictureplasty and resection | | ns |
| Yamamoto et al. [37] | 2007 | Review | (8) | | Recurrence correlation to strictureplasty vs resection | False | |
| Comparing the lengths of resected SB segments to recurrence and other defined outcomes | | | | | | | |
| Atwell et al. [42] | 1965 | Retrospective | 117 | 0–240 | Lengths of resected SB segments in correlation to recurrence | No statistics | |
| Ellis et al. [41] | 1984 | Retrospective | 45 | 280 (mean) | >25 cm resection length protective vs recurrence | $p = 0.002$ | None |
| Martin et al. [43] | 1994 | Retrospective | 286 | 55 (mean) | Recurrence correlation to conservative > extended resection | $p = 0.046$ | None |
| Said et al. [46] | 2011 | Retrospective | 52 | 1–126 | Correlation between shorter resection lengths and recurrence | $p = 0.03$ | ns |
| Welsch et al. [45] | 2007 | Prospective | 100 | 60 (mean) | Correlation between > 20 cm resection lengths and recurrence | | RR 0.42 (CI 0.21–0.84) |
| Aguas et al. [47] | 2012 | Prospective | 29 | 12 | >100 cm resection lengths correlation to endoscopic recurrence | $p = 0.03$ | N/A |
| Trnka et al. [17] | 1982 | Retrospective | 113 | 96–456 | Lengths of resected SB segments in correlation to recurrence | ns | N/A |
| Kameyama et al. [48] | 1982 | Retrospective | 8 | 36 | Lengths of resected SB segments in correlation to recurrence | ns | N/A |
| Silvis et al. [34] | 1994 | Retrospective | 148 | 56 (median) | Lengths of resected SB segments in correlation to recurrence | ns | N/A |
| Eshuis et al. [30] | 2009 | Retrospective | 71 | 50–124 | Lengths of resected SB segments in correlation to recurrence | | ns |
| Michelassi et al. [52] | 1988 | Retrospective | 582 | 120 | Lengths of resected SB segments in correlation to recurrence | | ns |
| Heimann et al. [44] | 1993 | Prospective | 164 | 36 | Lengths of resected SB segments in correlation to recurrence | | ns |
| Speranza et al. [50] | 1995 | Retrospective | 172 | 1–21 | Lengths of resected SB segments in correlation to recurrence | ns | N/A |
| Mirow et al. [51] | 2008 | Prospective | 412 | 180 | Lengths of resected SB segments in correlation to recurrence | ns | N/A |
| Buisson et al. [54] | 2012 | Review | (3) | N/A | Lengths of resected SB segments in correlation to recurrence | True | |
| Hollaar et al. [35] | 1995 | Meta-analysis | (7) 622 | 72,8 (mean) | | | ns |

(continued on next page)

**Table 1** (*continued*)

| Author(s) | Year | Type | No. of patients or (articles included in review) | Follow-up in months | Parameters | Results of univariate analyses | Results of multi-variate analyses |
|---|---|---|---|---|---|---|---|
| | | | | | Resection length and perioperative blood transfusion correlation to recurrence | | |
| Strong et al. [55] | 1998 | Review | (6) | N/A | Lengths of resected SB segments in correlation to recurrence | Inconclusive | |
| Vuitton et al. [56] | 2013 | Review | (4) | N/A | Lengths of resected SB segments in correlation to recurrence | True | |
| Yamamoto et al. [9] | 2005 | Review | (7) | N/A | Lengths of resected SB segments in correlation to recurrence | False | |
| Yamamoto et al. [39] | 2013 | Review | (17) | N/A | Lengths of resected SB segments in correlation to recurrence | False | |
| Carlstedt et al. [62] | 1987 | Prospective | 203 | 12–312 | Lengths of resected SB segments in correlation ileostomy complications | ns | N/A |
| Kangas et al. [61] | 1990 | Retrospective | 52 | 144 (median) | Longer lengths of resected SB segments in correlation presence of gallstones | $p < 0.001$ | None |
| Lapidus et al. [28] | 1991 | Retrospective | 10 | N/A | Lengths of resected SB segments on lipid profile | ns | N/A |
| Comparing the length of resection margins to recurrence | | | | | | | |
| Gump et al. [57] | 1972 | Retrospective | 64 | | Recurrence in correlation to conservative vs radical margins of resection | | ns |
| Trnka et al. [17] | 1982 | Retrospective | 113 | 96–456 | Recurrence in correlation to conservative vs radical margins of resection | ns | N/A |
| Raab et al. [18] | 1996 | Retrospective | 353 | 0–216 | Recurrence in correlation to conservative vs radical margins of resection | | ns |
| Yamamoto et al. [39] | 2013 | Review | (17) | N/A | Recurrence in correlation to conservative vs radical margins of resection | False | |
| Wettergren et al. [53] | 1991 | Retrospective | 48 | 36–324 | Recurrence in correlation to conservative vs radical margins of resection | ns | N/A |
| Bergman et al. [59] | 1977 | Retrospective | 186 | 126 (mean) | Recurrence in correlation to conservative vs radical margins of resection | No statistics | |
| Kåresen et al. [58] | 1981 | Retrospective | 59 | 12–288 | Symptomatic recurrence in correlation to conservative vs radical margins of resection | | No values |
| Nygaard et al. [60] | 1977 | Retrospective | 76 | 24–132 | Recurrence in correlation to conservative > radical margins of resection | $p < 0.01$ | None |
| Martin et al. [43] | 1994 | Retrospective | 286 | 55 (mean) | Recurrence in correlation to conservative > radical margins of resection | $p = 0.003$ | None |
| Fazio et al. [65] | 1996 | Prospective | 131 | 55 (median) | Recurrence in correlation to resection margins 2 cm vs 12 cm | ns | N/A |
| Recurrence and additional surgeries: | | | | | | | |
| Ellis et al. [41] | 1984 | Retrospective | 18 | 7–384 | Correlation between loss of length and additional hospitalisations | ns | N/A |
| Mappes et al. [63] | 1994 | Retrospective | 65 | N/A | Correlation between additional surgeries and loss of length | $r = 0{,}8$ | None |
| Elriz et al. [22] | 2011 | Retrospective | 38 | N/A | Correlation between first and last resection in loss of length | $p < 0.001$ | None |
| Pelletier et al. [64] | 2011 | Retrospective | 24 | N/A | Correlation between additional surgeries and loss of length | $p = 0.005$ | None |

correlating with lower rate of recurrence. Different literature reviews attained conflicting results [9,39,55,56], but most of these studies found no correlation between the lengths of the resected SB segments and recurrence.

Endoscopic recurrence: A prospective study of 29 patients [47] investigated endoscopic recurrence and found a correlation with extensive resection at > 100 cm ($p = 0.03$), increasing the risk of recurrence. Even less aggressive resections (>20 cm) may carry risk of recurrence RR of 0.42 (CI 0,21-0,84) as shown in another study [45].

These findings are supported by retrospective studies [17,34,35,43,44,46,48–53] that found no correlation in addition to a meta-analysis [54] reviewing three articles including one of the above cited articles [48].

On resection margins: Indirectly connected to the matter on the lengths of resected SB segments is data on resection margins. Five studies [17,18,53,57,65] found no difference in recurrence based on different lengths of resection margins, cemented by reviews of the literature [39,55]. Conversely, four studies [43,58–60] found that conservative or non-radical margins are linked to higher rates of recurrence at $p < 0.01$ and $p = 0.003$.

On gallstones: Patients undergoing >50 cm of resection are more likely to have gallstones requiring surgery $p < 0.001$ in multivariate analysis [61]. This might be due more to the total loss of length than the incremental loss of length; it is however yet another reason in favour of a conservative approach.

On ileostomy: In a patient population in need of long-term ileostomy for either CD or UC, no association was demonstrated between the lengths of resected SB segments and ileostomy complications [62].

On repeated surgeries: It is still controversial whether the lengths of resected SB segments in repeated surgeries correlates with that of resected SB segments in primary surgery. There are few studies supporting such correlation [41,63] and few that do not [27,64].

## 4. Discussion

We present a systematic review of the literature on pre, peri and postoperative factors and their implications for the lengths of resected SB segments and outcome in CD patients. Due to high risk of bias and a highly heterogeneous pool of data for comparable parameters, meta-analysis was not an option for the present review.

As shown in our results, most factors do not appear to have any implications for the lengths of resected SB segments.

However, due in part to the already stated problems with the included studies, great caution must be taken accepting this conclusion. Generally, the studies researching the same parameters differed greatly in methodology, objectives and outcome reporting. Often, investigated factors only accounted for a minor part of a greater study and many articles lacked proper multivariate analyses. Most of the included studies did not differentiate between different phenotypes of CD. These are all limitations to this review while strengths include a very broad-spectrum search strategy and very generous inclusion criteria.

Considering the above, the present review most importantly exposes a lack of homogenous well-researched data on resection surgery in CD patients. Furthermore, different practices of resection lengths, lengths of clear margin and supportive care appear to be based on speculation.

To properly research methods to increase quality of life, outcome and evaluate pharmacological treatment for CD patients in need of surgery, we believe it is of great importance to report the lengths of resected SB segments in CD surgery in addition to factors like phenotype, loss of blood and length of remaining SB. This is often neglected due to the traditional view that surgery and SB resection is only a consequence of non-response to medical treatment. In this traditional view, the surgeon's role is to resect SB and return the patient to a medical gastroenterologist for further management. This concept has been challenged in the last few years. Multi-disciplinary team management is becoming the gold standard in leading IBD centres with a IBD-surgeon as part of the team managing the patient and suggesting which modalities may suit individual patients [66]. In this context, the lengths of resected SB segments are important for the following reasons:

1. The probability of surgery is 30% during the first year of the disease and ranges between 30% and 70% in the following 10 years after diagnosis [67,68]. One third of CD patients may need repeated SB resections. It is important to report the lengths of resected SB segments as well as the total length of remaining SB to allow planning of new surgical intervention.
2. Attempts to avoid surgery by switching patients from one medical treatment to another for long periods of time may lead to poor quality of life as well as longer lengths of SB resections. This can only be confirmed or ruled out if SB length is reported.
3. Claims that biologics decrease the lengths of resected SB segments have not been properly investigated due to lack of recording of such data.
4. Postoperative recurrence and its correlation with lengths of resected SB segments have been investigated in small series studies with high risk of bias. More well-designed studies cannot be conducted properly without an emphasis on reporting resected SB lengths.

The traditional fear of repeated surgeries leading to short bowel syndrome has led to extended periods of medical treatment attempts before the patient is assessed for both initial and repeated surgical resections. In an era of bowel sparing surgery, this route of treatment options is not based on well-researched evidence; regardless of various kinds of approaches, the best course of action cannot be properly assessed without studies comparing the lengths of resected SB segments using different modalities.

Nowadays, different national and international cancer register databases exist. These databases report many factors like ASA score, performance level, perioperative blood loss and site of ligation of blood vessels etc. With a challenging disease like CD, the need for such databases is essential to provide better treatment options. Lengths of resected SB segments is one of the parameters that should be reported in such databases and be investigated in future studies.

## Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.ijso.2017.04.002.

## References


[1] Kappelman MD, Moore KR, Allen JK, Cook SF. Recent trends in the prevalence of Crohn's disease and ulcerative colitis in a commercially insured US population. Dig Dis Sci 2013 Feb;58(2):519–25.

[2] Loftus EV. Clinical epidemiology of inflammatory bowel disease: incidence, prevalence, and environmental influences. Gastroenterology 2004;126(6):1504–17.

[3] Molodecky NA, Soon IS, Rabi DM, Ghali WA, Ferris M, Chernoff G, et al. Increasing incidence and prevalence of the inflammatory bowel diseases with time, based on systematic review. Gastroenterology 2012 Jan;142(1):46–54.e42; quiz e30.

[4] Zhulina Y, Udumyan R, Tysk C, Montgomery S, Halfvarson J. The changing face of Crohn's disease: a population-based study of the natural history of Crohn's disease in Örebro, Sweden 1963–2005. Scand J Gastroenterol 2015 Oct 7:1–10.

[5] El-Hussuna A, Andersen J, Bisgaard T, Jess P, Henriksen M, Oehlenschlager J, et al. Biologic treatment or immunomodulation is not associated with postoperative anastomotic complications in abdominal surgery for Crohn's disease. Scand J Gastroenterol 2012 Jun;47(6):662–8.

[6] Reese GE, Purkayastha S, Tilney HS, Von Roon A, Yamamoto T, Tekkis PP. Strictureplasty vs resection in small bowel Crohn's disease: an evaluation of short-term outcomes and recurrence. Color Dis 2007;9(8):686–94.

[7] Yamamoto T, Fazio VW, Tekkis PP. Safety and efficacy of strictureplasty for Crohn's disease: a systematic review and meta-analysis. Dis Colon Rectum 2007;50(11):1968–86.

[8] Worsey MJ, Hull T, Ryland L, Fazio V. Strictureplasty is an effective option in the operative management of duodenal Crohn's disease. Dis Colon Rectum 1999;42(5):596–600.

[9] Yamamoto T. Factors affecting recurrence after surgery for Crohn's disease. World J Gastroenterol 2005;11(26):3971–9.

[10] Agwunobi AO, Carlson GL, Anderson ID, Irving MH, Scott NA. Mechanisms of intestinal failure in Crohn's disease. Dis Colon Rectum 2001;44:1834–7.

[11] D'Haens GR, Gasparaitis AE, Hanauer SB. Duration of recurrent ileitis after ileocolonic resection correlates with presurgical extent of Crohn's disease. Gut 1995;36(5):715–7.

[12] Benoist S, Panis Y, Beaufour A, Bouhnik Y, Matuchansky C, Valleur P. Laparoscopic ileocecal resection in Crohn's disease: a case-matched comparison with open resection. Surg Endosc Other Interv Tech 2003;17(5):814–8.

[13] Bemelman WA, Slors JF, Dunker MS, van Hogezand RA, van Deventer SJ, Ringers J, et al. Laparoscopic-assisted vs. open ileocolic resection for Crohn's disease. A comparative study. Surg Endosc 2000;14(8):721–5.

[14] Diamond IR, Langer JC. Laparoscopic-assisted versus open ileocolic resection for adolescent Crohn disease. J Pediatr Gastroenterol Nutr 2001;33(5):543–7.

[15] Tilney HS, Tekkis PP. Laparoscopic colorectal surgery and postoperative opioid requirements. Surg Endosc Other Interv Tech 2007;21(7):1251.

[16] McLeod RS. Resection margins and recurrent Crohn's disease. Hepatogastroenterology 1990;37(1):63–6.

[17] Trnka YM, Glotzer DJ, Kasdon EJ, Goldman H, Steer ML, Goldman LD. The long-term outcome of restorative operation in crohn â€™ s disease. Influence of location, prognostic factors and surgical guidelines. Ann Surg 1982;196: 345–54.
[18] Raab Y, Bergström R, Ejerblad S, Graf W, Påhlman L. Factors influencing recurrence in Crohn's disease. An analysis of a consecutive series of 353 patients treated with primary surgery. Dis Colon Rectum 1996 Aug;39(8): 918–25.
[19] Tonelli P, Martellucci J, Lucchese M, Comin CE, Bergamini C, Pedica F, et al. Preliminary results of the influence of the in vivo use of a lymphatic dye (Patent Blue V) in the surgical treatment of Crohn's disease. Surg Innov 2014;21(4):381–8.
[20] Tilney HS, Constantinides VA, Heriot AG, Nicolaou M, Athanasiou T, Ziprin P, et al. Comparison of laparoscopic and open ileocecal resection for Crohn's disease: a metaanalysis. Surg Endosc Other Interv Tech 2006;20(7):1036–44.
[21] Cayci M, Bostanci EB, Turhan N, Karaman K, Dalgic T, Ozer I, et al. The analysis of clinico-pathologic characteristics in patients who underwent surgery due to stricturing and non-perineal fistulizing forms of Crohn's disease: a retrospective cohort study. Int J Surg 2015;15(C):49–54.
[22] Elriz K, Palascak-Juif V, Joly F, Seguy D, Beau P, Chambrier C, et al. Crohn's disease patients with chronic intestinal failure receiving long-term parenteral nutrition: a cross-national adult study. Aliment Pharmacol Ther 2011;34(July):931–40.
[23] Ding Z, Wu XR, Remer EM, Lian L, Stocchi L, Li Y, et al. Association between high visceral fat area and postoperative complications in patients with Crohn's disease following primary surgery. Colorectal Dis 2016;18(2):163–72. 2015/09/24.
[24] Romanato G, Scarpa M, Ruffolo C, Marin R, Zambon S, Zanoni S, et al. Lipid and phospholipid profile after bowel resection for Crohn's disease. Int J Colorectal Dis 2008;23(10):931–8.
[25] Lashner BA, Evans AA, Hanauer SB. Preoperative total parenteral nutrition for bowel resection in Crohn's disease. Dig Dis Sci 1989;34(5):741–6. 1989/05/01.
[26] Glehen O, Lifante JC, Vignal J, Francois Y, Gilly FN, Flourié B, et al. Small bowel length in Crohn's disease. Int J Colorectal Dis October 1981;2003(18):423–7.
[27] Nordgren S, McPheeters G, Svaninger G, Oresland T, Hultén L. Small bowel length in inflammatory bowel disease. Int J Colorectal Dis 1997;12(4):230–4.
[28] Lapidus A, Einarsson K. Effects of ileal resection on biliary lipids and bile acid composition in patients with Crohn's disease. Gut 1991;32(12):1488–91. 1991/12/01.
[29] Brihier H, Nion-Larmurier I, Afchain P, Tiret E, Beaugerie L, Gendre J-P, et al. Intestinal perforation in Crohn's disease. Factors predictive of surgical resection. Gastroenterol Clin Biol 2005 Nov;29(11):1105–11. 2006/03/01.
[30] Eshuis EJ, Voermans RP, Hirsch DP, Stokkers P, Van Berge Henegouwen MI, Fockens P, et al. Endoscopic transcolonic specimen removal in laparoscopic ileocolic resection for Crohn's disease: initial experience. Gastrointest Endosc 2009;69(5):AB165.
[31] Sica GS, Iaculli E, Benavoli D, Biancone L, Calabrese E, Onali S, et al. Laparoscopic versus open ileo-colonic resection in crohn's disease: short- and long-term results from a prospective longitudinal study. J Gastrointest Surg 2008;12(6):1094–102.
[32] Dunker MS, Ten Hove T, Bemelman WA, Slors JF, Gouma DJ, Van Deventer SJ. Interleukin-6, C-reactive protein, and expression of human leukocyte antigen-DR on peripheral blood mononuclear cells in patients after laparoscopic vs. conventional bowel resection: a randomized study. Dis Colon Rectum 2003;46(9):1238–44.
[33] Gardenbroek TJ, Verlaan T, Tanis PJ, Ponsioen CY, D'Haens GRAM, Buskens CJ, et al. Single-port versus multiport laparoscopic ileocecal resection for Crohn's disease. J Crohn's Colitis 2013;7(10):e443–8.
[34] Silvis R, Steup WH, Brand A, Zwinderman KA, Lamers CB, Griffioen G, et al. Protective effect of blood transfusions on postoperative recurrence of Crohn's disease in parous women. Transfusion 1994 Mar;34(3):242–7.
[35] Hollaar GL, Gooszen HG, Post S, Williams JG, Sutherland LR. Perioperative blood transfusion does not prevent recurrence in Crohn's disease. A pooled analysis. J Clin Gastroenterol 1995 Sep;21(2):134–8. 1995/09/01.
[36] Stebbing JF, Jewell DP, Kettlewell MG, Mortensen NJ. Recurrence and reoperation after strictureplasty for obstructive Crohn's disease: long-term results [corrected]. Br J Surg 1995 Nov;82(11):1471–4.
[37] Yamamoto T, Fazio VW, Tekkis PP. Safety and efficacy of strictureplasty for Crohn's disease: a systematic review and meta-analysis. Dis Colon Rectum 2007;50(11):1968–86.
[38] Yamamoto T, Bain IM, Mylonakis E, Allan RN, Keighley MRB. Stapled functional end-to-end anastomosis versus sutured end-to-end anastomosis after ileocolonic resection in Crohn disease. Scand J Gastroenterol 1999;34(7): 708–13. http://dx.doi.org/10.1080/003655299750025921.
[39] Yamamoto T, Watanabe T. Strategies for the prevention of postoperative recurrence of Crohn's disease. Colorectal Dis 2013;15(12):1471–80. 2013/07/03.
[40] Horvath G, Simonka Z, Lazar G. Comparison of the results of laparotomy and laparoscopic surgery in patients with Crohn's disease. [Hungarian]. Orv Hetil 2014;155(1):24–9.
[41] Ellis L, Calhoun P, Kaiser DL, Rudolf LE, Hanks JB. Postoperative recurrence in Crohn's disease. The effect of the initial length of bowel resection and operative procedure. Ann Surg 1984 Mar;199(3):340–7.
[42] Atwell JD, Duthie HL, Goligher JC. The outcome of Crohn's disease. Br J Surg 1965 Dec;52(12):966–72.
[43] Martin G, Heyen F, Dubé S. Factors of recurrence in Crohn disease. Ann Chir 1994;48(8):685–90. 1994/01/01.
[44] Heimann TM, Greenstein AJ, Lewis B, Kaufman D, Heimann DM, Aufses AH. Prediction of early symptomatic recurrence after intestinal resection in Crohn's disease. Ann Surg 1993 Sep;218(3):294–8. 9.
[45] Welsch T, Hinz U, Loffler T, Muth G, Herfarth C, Schmidt J, et al. Early re-laparotomy for post-operative complications is a significant risk factor for recurrence after ileocaecal resection for Crohn's disease. Int J Color Dis 2007;22(9):1043–9. 2007/03/29.
[46] Said Y, Dabbabi A, Bettaieb J, Trabelsi S, Debbeche R, Bouzaidi S, et al. Risk factors of postoperative recurrence after ileocecal resection for Crohn's disease. [French]. J Afr d'Hepato-Gastroenterol 2011;5(3):198–204.
[47] Aguas M, Bastida G, Cerrillo E, Beltran B, Iborra M, Sanchez-Montes C, et al. Adalimumab in prevention of postoperative recurrence of Crohn's disease in high-risk patients. World J Gastroenterol 2012;18(32):4391–8. 2012/09/13.
[48] Kameyama J, Sasaki I, Imamura M, Naito H, Sato T. Surgical treatment for Crohn's disease, with special reference to operative procedures and their relationship to recurrence. Tohoku J Exp Med 1982;137(3):245–51. 1982/07/01.
[49] Eshuis EJ, Polle SW, Slors JF, Hommes DW, Sprangers MAG, Gouma DJ, et al. Long-term surgical recurrence, morbidity, quality of life, and body image of laparoscopic-assisted vs. open ileocolic resection for Crohn's disease: a comparative study. Dis Colon Rectum 2008;51(6):858–67.
[50] Speranza V. Risk factors for recurrence of Crohn disease after intestinal resection. Chir Z Geb Oper Medizen 1995 Aug;66(8):751–6. 1995/08/01.
[51] Mirow L, Hauenschild L, Hildebrand P, Kleemann M, Keller R, Franke C, et al. Recurrence of Crohn's disease after surgery—causes and risks. Zentralbl Chir 2008;133(2):182–7. 2008/04/17.
[52] Michelassi F, Balestracci T, Chappell T, Block. Primary and Recurrent Crohn â€TM s Disease Experience With 1379 Patients. 1988, 230–238.
[53] Wettergren A, Christiansen J. Risk of recurrence and reoperation after resection for ileocolic Crohn's disease. Scand J Gastroenterol 1991;26(12):1319–22.
[54] Buisson A, Chevaux JB, Allen PB, Bommelaer G, Peyrin-Biroulet L. Review article: the natural history of postoperative Crohn's disease recurrence. Aliment Pharmacol Ther 2012;35(6):625–33.
[55] Strong SA. Prognostic parameters of Crohn's disease recurrence. Baillieres Clin Gastroenterol 1998;12(1):167–77.
[56] Vuitton L, Koch S, Peyrin-Biroulet L. Preventing postoperative recurrence in Crohn's disease: what does the future hold? Drugs 2013;73(16):1749–59.
[57] Gump FE, Sakellariadis P, Wolff M, Broell JR. Clinical-pathological investigation of regional enteritis as a guide to prognosis. Ann Surg 1972 Aug;176(2): 233–42.
[58] Kåresen R, Serch-Hanssen A, Thoresen BO, Hertzberg J. Crohn's disease: long-term results of surgical treatment. Scand J Gastroenterol 1981 Jan;16(1): 57–64.
[59] Bergman L, Krause U. Crohn's disease. A long-term study of the clinical course in 186 patients. Scand J Gastroenterol 1977 Jan;12(8):937–44.
[60] Nygaard K, Fausa O. Crohn's disease. Recurrence after surgical treatment. Scand J Gastroenterol 1977 Jan;12(5):577–84.
[61] Kangas E, Lehmusto P, Matikainen M. Gallstones in Crohn's disease. Hepatogastroenterology 1990;37(1):83–4.
[62] Carlstedt A, Fasth S, Hulten L, Nordgren S, Palselius I. Long-term ileostomy complications in patients with ulcerative colitis and Crohn's disease. Int J Color Dis 1987;2(1):22–5. 1987/02/01.
[63] Mappes HJ, Ruf G, Baumgartner U, Farthmann EH. Intestine saving surgery in Crohn disease—results of limited resection and stricture-plasty. Helv Chir Acta 1994;60(5):717–21. 1994/07/01.
[64] Pelletier AL, Stefanescu C, Vincent C, Etienney I, Mentre F, Soule JC. Is the length of postoperative recurrence on the neo ileum terminal ileum predictable in Crohn's disease? J Crohns Colitis 2011;5(1):24–7. 2011/01/29.
[65] Fazio VW, Marchetti F, Church M, Goldblum JR, Lavery C, Hull TL, et al. Effect of resection margins on the recurrence of Crohn's disease in the small bowel. A randomized controlled trial. Ann Surg 1996 Oct;224(4):563–71. 3.
[66] Calvet X, Panés J, Alfaro N, Hinojosa J, Sicilia B, Gallego M, et al. Delphi consensus statement: quality indicators for inflammatory bowel disease comprehensive care units. J Crohn's Colitis 2014;8(3):240–51. http://dx.doi.org/10.1016/j.crohns.2013.10.010.
[67] Vester-Andersen MK, Prosberg MV, Jess T, Andersson M, Bengtsson BG, Blixt T, et al. Disease course and surgery rates in inflammatory bowel disease: a population-based, 7-year follow-up study in the era of immunomodulating therapy. Am J Gastroenterol 2014;109(5):705–14.
[68] Vind I, Riis L, Jess T, Knudsen E, Pedersen N, Elkjaer M, et al. Increasing incidences of inflammatory bowel disease and decreasing surgery rates in Copenhagen City and County, 2003-2005: a population-based study from the Danish Crohn colitis database. Am J Gastroenterol 2006 Jun;101(6):1274–82.