

Colorectal Disease

ACPGBI Position Statement on Elective Resection
for Diverticulitis

Guest editor
Ian Lindsey



Position Statements

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ACPGBI Position Statement on Elective Resection for Diverticulitis

J. B. J. Fozard*, N. C. Armitage†, J. B. Schofield‡ and O. M. Jones§

*Royal Bournemouth Hospital, Bournemouth, UK, †Department of Colorectal Surgery, Queens Medical Centre, Nottingham, UK, ‡Department of Cellular Pathology, Preston Hall Hospital, Kent, UK and §Surgery and Diagnostics Centre, Churchill Hospital, Oxford, UK

Introduction

Diverticular disease is common, with a frequency that increases with age. Most patients with diverticulosis do not develop symptoms, though a number will develop inflammation or diverticulitis. This inflammation may develop into an abscess or free perforation. Whilst the prevalence of perforation has increased from 2.4 per 100 000 in 1986 to 3.8 per 100 000 in 2000 according to one study [1], the majority of patients with diverticulitis follow an indolent clinical course. There has been controversy, therefore, as to whether elective resection after acute diverticulitis is justified [2].

This position statement is presented in sections dealing with the pathology, symptomatology and investigation of diverticular disease and its consequences. It then examines the evidence and indications for surgical intervention and its timing. The issue of laparoscopic versus open resection is then considered. The evidence is briefly summarized under the heading 'Findings' and this is followed where relevant by 'Recommendations'.

Methodology

Organized searches of the Cochrane Database, MEDLINE and PUBMED were performed using the keywords relevant to each section of this Position Statement. Searches were limited predominantly to English language articles. Additional publications were retrieved from the references cited in articles identified from the primary search of the literature. All evidence was classified according to an accepted hierarchy of evidence and recommendations graded A–C on the basis of level of associated evidence and/or noted as Good Practice and/or part of NICE/SIGN recommendation for Rapid Technology Appraisal (Table 1).

Correspondence to: J. B. J. Fozard, Royal Bournemouth Hospital, Castle Lane East, Bournemouth BH7 7DW, UK.
E-mail: basil.fozard@rbch.nhs.uk

The pathophysiology of diverticular disease

Disease aetiology and prevalence

In Western countries, the prevalence of diverticular disease has dramatically increased over the last century. There is a close link between diverticulosis and a low-fibre diet. The refining of flour with removal of dietary fibre that became increasingly frequent in the late 19th century has been implicated in the aetiology of this disease [3]. Diverticular disease is much less common in the developing world where a high-roughage diet is commonplace. In western populations, vegetarians have a lower frequency of diverticulosis, supporting the hypothesis that a high-roughage diet protects against diverticular disease [4]. In addition, animal studies have also shown that a life-long low-fibre diet is associated with diverticulosis [5] and studies of immigrants demonstrate development of the western pattern of disease when a western diet is adopted. Multiple other factors have been implicated in the aetiology of diverticular disease, including obesity [6], lack of exercise [7], smoking [8] and immunosuppression.

The high prevalence of diverticulosis is in part due to an increase in detection of the disorder. However, diverticular disease of the colon increases with age and these increases may also reflect our ageing population [9]. In western countries, over half of the population over 80 years of age has diverticula involving the colon. The incidence increases from about 5% in the fifth decade to 60% in the ninth decade. There appears to be a small female predominance [10] although some older papers suggested male predominance and this might represent a changing distribution of disease.

Pathology of diverticulosis

Colonic diverticula are formed by a combination of increased intraluminal pressure in the colon and weakness of the muscular wall. In the weak areas of the colonic wall where blood vessels enter, mucosal herniation occurs. A low-fibre diet results in small-volume stools that require high intraluminal pressures for propulsion (≥ 150 mgHg).

Table 1 Grading scheme for assessing submitted evidence. All evidence was classified according to an accepted hierarchy of evidence that was originally adapted from the US Agency for Healthcare Policy and Research Classification.

Level of evidence	Grade of recommendation
I. Evidence obtained from a single randomized controlled trial or from a systematic review or meta-analysis of randomized controlled trials	A. Evidence of type I or consistent findings from multiple studies of type IIa, IIb or III
IIa. Evidence obtained from at least one well-designed controlled study without randomization	B. Evidence of type IIa, IIb or III and generally consistent findings
IIb. Evidence obtained from at least one other well-designed quasi-experimental study	C. Evidence of type IIa, IIb or III but inconsistent findings
III. Evidence obtained from well-designed nonexperimental descriptive studies, such as comparative studies, correlation studies and case studies	D. Little or no systemic evidence
IV. Evidence obtained from expert committee reports or opinions and/or clinical experiences of respected authorities, case reports	GP. Recommended good practice based on the clinical experience of the expert group and other professionals

Colonic manometry studies undertaken in the 1960s confirmed higher luminal pressures in patients with diverticulosis than in controls [11]. Subsequently, Painter *et al.* suggested a theory of segmentation in which muscle contraction results in a series of discrete segments of bowel with high intraluminal pressures [12]. This disordered motility is likely to have a major role in the pathogenesis of both left-sided and right-sided diverticula. Patients with ulcerative colitis have reduced bowel wall muscle tone and contractility. This may explain the lower prevalence of diverticulosis in patients with ulcerative colitis [13].

Increased cholinergic neural activity and decreased noncholinergic activity has been demonstrated in diverticulosis [14]. This alteration could lead to increased tonicity but it is unclear whether this finding is causally related [4]. Decreased numbers of glial cells and interstitial cells of Cajal have also been recently described in patients with diverticular disease. This finding might explain some of the large bowel motility disturbances [15].

Solitary caecal diverticulum is an uncommon congenital condition; caecal diverticula are seen more commonly as part of generalized diverticular disease and were seen in 16% of patients in the postmortem study reported by Hughes [16]. Right-sided diverticulosis in the absence of left-sided disease is considered to be a different condition with a genetic predisposition. It is seen rarely in Caucasians but more commonly found in Asians and is the predominant site in Japanese patients [17].

Pathology of diverticulitis and diverticular colitis

Diverticulitis is acute inflammation of one or more diverticula and usually the inflammatory changes involve the apex of the diverticulum rather than the neck. It is

likely that acute inflammation is caused by impaction of faecal material within the diverticulum, leading to mucosal ulceration with associated acute inflammation [7]. It has also been suggested that a fibre-deficient diet may be associated with a change in the bacterial flora and alteration of local immunity, resulting in low grade chronic inflammation. This could predispose to acute diverticulitis [18]. Acute inflammation may rapidly involve the serosal surface, leading to peritonitis because of the thinness of the diverticular wall, and there may be localized abscess formation or perforation due to damage of the diverticular wall by acute inflammation. An inflammatory mass may develop with or without involvement of other pelvic organs and fistulation most often to the bladder or vagina occurs particularly in patients who have had previous hysterectomy. Massive rectal bleeding may occur related to erosion of a blood vessel by the inflammatory process, usually at the neck of the diverticulum [19].

Symptoms and signs of diverticulitis

In clinical practice, patients present with abdominal pain, most usually in the left iliac fossa. On occasion, pain may be in other areas of the abdomen, either because of a long redundant sigmoid loop lying on the right side of the abdomen or because of diverticular disease located away from the sigmoid colon. The pain may be associated with systemic symptoms such as nausea and vomiting or anorexia. Physical signs will usually include localized tenderness and guarding, fever, and there may be a palpable mass either in the abdomen or per rectum.

Where an inflammatory mass is present in the absence of an abscess, this is generally termed a phlegmon. The

Table 2 Hinchey classification for perforated diverticulitis [20].

Hinchey stage	Features
Stage I	Diverticulitis with pericolic abscess
Stage II	Diverticulitis with distant abscess (retroperitoneal or pelvic)
Stage III	Purulent peritonitis
Stage IV	Faecal peritonitis

condition may progress to an abscess or a free perforation. Where an abscess or free perforation develops, the classification proposed by Hinchey [20] can be useful, as shown in Table 2.

Other complications of diverticulitis include fistulation, where an abscess ruptures into an adjacent organ or the skin. The common sites are the bladder (colovesical) or the vagina (colovaginal) and are characterized by the passage of flatus or faeces per urethra or vagina. Rarely, other sites such as the uterus, fallopian tube, ureter and small bowel may be involved. Obstruction may occur due to narrowing of the bowel lumen from chronic inflammation. Haemorrhage is a rarer complication, characterized by dark, painless and usually self-limiting bleeding. Angiography may be helpful, with surgery only rarely required for this indication.

Diverticulitis without abscess, perforation or fistulation is described as uncomplicated, whilst the presence of any of these features, stenosis or bleeding is termed complicated diverticulitis.

Differential diagnosis

Findings

Many conditions mimic diverticulitis. The presence of incidental diverticulosis is common. Irritable bowel syndrome often co-exists with diverticulosis and may account for the high rate of recurrent symptoms in some series of patients undergoing resection for diverticular disease (IV).

Recommendation

The clinician always needs to consider the differential diagnosis of diverticulitis. Patients should not be told that they have diverticulitis unless there is colonoscopic and/or radiological evidence of inflammation in the presence of diverticular disease (GP).

The differential diagnosis for diverticulitis and its sequelae is extensive. Of particular importance are three conditions: colitis, malignancy and irritable bowel syndrome.

Diverticular colitis is a distinct but under-recognized entity in patients with sigmoid diverticular disease [21]. It manifests as patchy or confluent inflammation in the

sigmoid colon, often sparing the orifices of diverticula. Histological features can closely resemble ulcerative colitis, Crohn's disease, mucosal prolapse or ischaemic colitis [22]. Diverticulitis and diverticular colitis may be associated with histological evidence of granuloma formation. Diverticular colitis may respond to therapy used for chronic inflammatory bowel disease, further confusing the picture [23].

Diverticular strictures may pose a difficult diagnostic conundrum, especially if they are impassable with a colonoscope. CT and barium enema have a significant false negative rate in detecting underlying carcinoma and if there is any doubt, then resection is recommended. In one series of 19 patients with a sigmoid stricture, 15 patients underwent resection, of whom, six had an underlying cancer. In the remainder, the aetiology of the stricture was diverticular disease [24].

The prevalence of irritable bowel syndrome (IBS) is quoted as 5–11% [25] in western populations. One report indicates that in a group of individuals with diverticular disease 14% exhibited characteristics of IBS [26]. Clearly, with symptoms of pain and bowel disorder with both conditions, it is difficult to attribute pain to diverticular change without clear evidence of inflammation. Even after resection of diverticulitis, up to 27% of patients continue with pain. This may be related to co-existing IBS but it has been suggested that IBS types of symptoms may be a sequelae to diverticulitis in some patients. An alternative reported by Horgan *et al.* [27] is what they label as 'smoldering' diverticular disease with evidence of acute or chronic inflammatory change in the resected specimen. However, while most of their patients benefitted from resection, 24% continued with some symptoms. In advising patients on treatment for diverticular disease, the crossover in symptoms with IBS needs to be borne in mind and form part of the counselling of the patient.

Breen *et al.* reviewed 100 consecutive elective resections for presumed diverticular disease and showed that 24% of resected specimens had no histological evidence of inflammation [28]. Patients without histological evidence of inflammation were significantly more likely to present with abdominal symptoms and suffer persistent postoperative pain, suggesting that the underlying initial pathology was not one of diverticulitis but rather an alternative diagnosis such as IBS.

Investigation and assessment

Findings

The diagnosis of diverticulitis should be confirmed during the acute attack by radiological means. The modality should

be CT or ultrasound depending on local expertise (Level IIb). Barium enema or colonoscopy after resolution of the acute episode is essential to rule out alternative diagnoses or second pathologies.

Recommendation

CT or ultrasound should be undertaken during the acute presentation of diverticulitis. This helps to confirm the diagnosis, guide management of the acute attack and occasionally will demonstrate other pathologies. Investigation of the colonic lumen by endoscopic means or barium enema after the acute attack is mandatory (Grade C).

Radiographic evaluation of diverticulitis during the acute attack heightens the precision of the decision making process. Evaluation in the first 72 h of an acute attack will help confirm the diagnosis and may give some prognostic information. Confirming the diagnosis is particularly important in the younger patient group, in whom the alternative diagnoses (particularly appendicitis) need to be considered. In patients in whom elective resection is being contemplated, evidence of definite inflammation during the acute attack is essential. Colonoscopic or barium enema evaluation some weeks after the acute attack may show diverticulosis but will not prove the diagnosis of diverticulitis.

The optimum radiological modality for evaluation of acute diverticulitis has been the subject of a recent systematic review [29]. This appraised 20 articles evaluating ultrasound, CT, barium enema and MRI. It concluded that the studies were generally of poor quality and suggested that the best study evaluating ultrasound and CT reached only level IIb. Whilst the best evidence in the literature supports ultrasound, the appropriateness of this modality will depend on local expertise. Ultrasound and CT are superior to contrast enema or colonoscopy in that they evaluate the extraluminal extent of the disease and may be more useful in picking up other pathologies.

Extraluminal air/contrast and abscess may predict poor outcome (see Table 3). The outcome, however, is mixed and individual predictions are difficult on purely radiological grounds, as 24% with successful conservative management had severe CT diverticulitis and 19% with severe CT diverticulitis, had no further problems, within the context of this study [30].

The diagnostic and therapeutic approach, however, has clearly changed with CT [31–33]. This particularly relates to the confirmation of diagnosis, but also the distinction between uncomplicated, phlegmonous diverticulitis and complicated diverticulitis, involving fistula, peritonitis, obstruction and abscess [34,35]. It is in the treatment of abscesses that a difference of opinion emerges. Ambrosetti and colleagues state that mesocolic abscesses can be

Table 3 The role of CT and gastrograffin enema (GE) in the assessment of mild and severe diverticulitis.

Mild diverticulitis	Severe diverticulitis
CT	CT
Localized wall thickening (> 5 mm)	Same as mild + at least one of the following
Inflammation of pericolic fat	Abscess
	Extraluminal air
	Extraluminal enema
GE	GE
Segmental lumen narrowing	Same as mild + at least one of the following
Tethered mucosa ± mass effect	Extraluminal air
	Extraluminal enema

managed conservatively without percutaneous drainage [36]. This can be either as a bridge to one-stage resection, or more intriguingly as totally conservative treatment. Longer term follow up of mesocolic and pelvic diverticular abscess, with initial nonsurgical management, shows that 51% of patients with mesocolic and 71% with pelvic abscess eventually require surgery [37]. In this respect, CT acts as a guide to ultimate failure of conservative treatment. Pelvic abscesses, on the other hand, will usually require surgery [35].

Natural history of diverticular disease

Findings

The majority of patients presenting with acute diverticulitis can be managed with a conservative, medical approach in the longer term. Previous blanket recommendations for elective resection following acute diverticulitis can be challenged (Level III).

Recommendation

The decision on elective resection should be made on an individual basis after the assessment of the particular circumstances of the patient (Grade C).

The evaluation of recurrent or persistent symptoms is difficult due to the overlap of symptomatology with conditions such as irritable bowel syndrome, as previously described. Furthermore, it would be reasonable to argue that the medical treatment of acute diverticulitis was transformed in UK practice in the mid 1970s with the introduction of metronidazole [38]. The situation was somewhat different in the US, where the perceived genotoxicity of metronidazole limited its early uptake. The alternatives at that time for treatment of anaerobic infection, lincomycin and clindamycin, were both associated with an associated risk of *Clostridium difficile*

infection. Care should therefore be exercised, when interpreting historical outcomes. The pivotal paper, informing previous recommendations, was that of Parks in 1970 [39]. This was a hospital-based study from 1951 to 1965 with significant exclusions. One can take issue with the diagnostic criteria employed, because barium enema in particular has largely been supplanted by the use of CT. Interestingly, despite the paper's recommendation of elective resection, the evidence at that time could have supported the opposite view, given that only 6% of patients following a first attack of acute diverticulitis required surgery for subsequent recurrent attacks.

Farmakis *et al.* reported on GP questionnaires giving follow-up data from a UK national audit in the 1980s and argued the case for interval sigmoid colectomy based on recurrent symptoms, complications and death [40]. Unfortunately, there were methodological problems acknowledged in the discussion, particularly incomplete follow up, deaths at home and significantly high rates of death from intercurrent disease.

In collating all the evidence, we make a clear distinction between elective surgery for persistence of symptoms and the risk of recurrent acute attacks, particularly severe and complicated, and focus especially on objective, hard evidence of recurrent inflammation, based on CT or surgical findings. We then factor in operative mortality [41], morbidity including stoma formation and death from other causes/anticipated life expectancy. Such an approach gives a clearer picture of the natural history of diverticulitis and best informs surgical decision making on elective resection. The main issues are therefore prevention of death, or an adverse outcome (e.g. permanent stoma), due to a second or subsequent attack of diverticulitis.

The need for elective surgery is influenced in part by the primary resection rate at index attack and this can vary from 15% to 38% [42]. With reference to UK practice, Sarin showed that conservative medical therapy is effective in 85%, with a calculated recurrence rate of 2% per patient-year [43]. The rate for primary surgery will differ internationally, influenced by referral practice from primary care to secondary care, admission criteria, diagnostic criteria (clinical, ultrasound [44], contrast enema [45] and CT), indications (persistent diverticulitis, perforation, fistula, stricture, bleeding and residual abscess) [46], surgical thresholds and utilization of CT guided drainage [47,48].

A high emergency surgical mortality has been used in the past to justify elective surgical intervention but it is incorrect to extrapolate outcomes of primary surgery to secondary acute surgery. Indeed the data presented by Elliot *et al.* [48] can be manipulated in a contrary fashion to support a conservative approach, as with a blanket recommendation for interval elective colectomy, 78% of the study group could potentially be subjected to

'unnecessary surgery'. Furthermore, 90% of patients who die with perforation have no prior history of diverticulitis [49] and 60% of patients undergoing surgery for acute diverticulitis have no antecedent history [50]. Of patients presenting with acute diverticulitis, only 3% have had a previous episode of acute diverticulitis [51]. The inference is that complicated diverticulitis tends to occur *de novo* and that the majority of patients have no previous history of disease, though this has not been widely accepted.

Further confusion arises from a general failure to distinguish truly prophylactic interval colectomy (asymptomatic patients), secondary elective colectomy (patients with symptoms or complications, e.g. fistula or obstruction) and secondary acute colectomy (recurrent diverticulitis, with or without complications). Prophylactic colectomies are unlikely to prevent late major complications. Use of radiological criteria can aid this process (Table 3). For instance, in a paper by Ambrosetti [52] on the evaluation of 160 patients after first hospitalization, 23 had a complication requiring operation (11 persistent diverticulitis, 4 recurrent diverticulitis, 6 symptomatic stenosis, 1 residual abscess and 1 colovesical fistula). Eighteen with no radiological evidence of a residual diverticulitis underwent surgery for persistent pain or 'fear of recurrence'. This latter group of resections is unlikely to prevent late major complications [53]. Comparing medically and surgically treated groups, 73% and 79%, respectively, did not have further problems after treatment of the index attack [54].

The most reliable data on the role of elective resection come from a limited number of studies with adequate follow up of expectant management. Chautems and Ambrosetti showed that 68% of patients whose first attack was treated nonoperatively did not suffer a complication, at a median follow up of 9.5 years. Death from unrelated causes (18%) was common [55].

In a later prospective study of the prognostic role of CT scanning, randomization to elective resection or expectant management had to be abandoned because only 8% of patients developed recurrent diverticulitis, albeit after a limited follow up of 19 months [31]. Mueller and colleagues conducted telephone interview follow up at 7 and 13 years on a retrospective cohort of 252 patients, initially treated conservatively. Only 25 patients subsequently came to surgery and lethal complications were rare [56].

Timing of elective colectomy has been subjected to Markov modelling [57], which incorporates probabilities of clinical end-points over time (e.g. death, recurrent diverticulitis, death from unrelated causes, surgical mortality/morbidity and stoma formation). The risk of recurrent diverticulitis is not eliminated by surgery (2.6–10.4%)

[43,58,59] and elective colectomy has a mortality of 2.3% and colostomy rate of 11.4% [60]. Overall, Markov modelling suggests that expectant management should be associated with lower rates of death and colostomy and incurs lower costs. We can thus conclude that there is good clinical and experimental evidence against the previous recommendations for elective resection.

Clinical course in younger patients

Findings

There is no clear evidence that younger patients presenting with diverticulitis exhibit a more aggressive form of the disease. The higher rates of surgery in younger patients in some studies may relate to misdiagnosis or a perception that they are lower risk for surgical intervention (Level III).

Recommendation

With the natural history of diverticulitis in younger patients not being well understood, there is little evidence to support a different management strategy in young patients compared to older ones (Grade C).

It has previously been suggested that diverticulitis in the younger patient pursues a more aggressive course. This in itself has been used to justify a recommendation that such patients should undergo elective colectomy following medical management of a first attack of diverticulitis [61–65]. This literature, dating up to 1997, suffers from a number of methodological flaws that compromise the validity of the conclusions. Over time, the age of the reported younger group has been extended from those aged under 40 years to those aged under 50 years. Given the influence of comorbid factors, it may be more appropriate to take age 50 as the cut off. The quoted studies involve relatively small numbers and are generally retrospective case note reviews, with variable, often inadequate duration of follow up. There is a problem with lack of definition of severity of disease. Later work by Spivak *et al.* in 1997 [66] uses the Hinchey classification. Of note, misdiagnosis is more apparent in the younger age group (particularly appendicitis) and this is likely to influence the surgical approach. It has led to high ‘urgent’ surgery rates in the past.

The real problem, however, is a failure to address adequately the issue of ‘decision to treat’ (i.e. the original indications for surgical or medical management and also indications for subsequent elective or urgent surgery). For instance, Shauer [62] uses the proportion undergoing surgery as justification for elective colectomy – a somewhat self-fulfilling prophecy. Recurrent symptoms and frequency of emergency presentation are other criteria that can be inappropriately used [65].

An aggressive course in the young could be defined by a high rate of recurrent diverticulitis, high mortality, high rate of emergency surgery or high rates of complications. Biondo [67] showed that the recurrence rate at 7.4–8.4 months was similar; 25.5% (< 50 years) compared with 22.3% (> 50 years). Furthermore, the mortality rate for both elective and emergency colectomy is higher in the > 50 years age group. With a low emergency colectomy mortality rate for those aged < 50 years, there is justification for adopting an expectant approach, as this is unlikely to lead to compromise [67]. Early use of CT in the diagnosis and management of acute diverticulitis in the younger patient is particularly helpful [42]. It provides a more confident diagnosis and allows for grading between mild and severe diverticulitis (Table 3). As a consequence, surgery was performed less frequently in younger patients than older patients (15% vs 33%) and this in spite of a trend towards increased severity in the young. Ambrosetti defined poor secondary outcome as persistent diverticulitis, recurrent diverticulitis, symptomatic stenosis, colovesical fistula or residual abscess. The young were more likely to have a poor secondary outcome (29% vs 5%) [67]. At longer term follow up (9.5 years), there was a 32% rate of ‘remote complication’. The complication frequency (54% at 5 years) was highest in young patients with CT severe diverticulitis and this was used to justify a recommendation for elective colectomy in this group [55]. However, reliable prediction for the individual is elusive and timing of surgery only truly matters if it prevents avoidable mortality or emergency surgery. It is reassuring that of patients treated medically for a first or subsequent attack of diverticulitis, none suffered an untoward outcome [55].

Further evidence against elective resection is provided by Guzzo and colleagues [69]. Of patients aged < 50 years with acute diverticulitis, 60% never had surgery and of a total of 196 patients with medium follow up of 5 years, only one re-presented with perforation.

In conclusion, younger patients with acute diverticulitis do not pursue a more aggressive course. Decisions on the place of elective colectomy in the younger patient should remain based on individual circumstances [70].

Resection margins in elective diverticulitis surgery

Findings

Resection of diverticular disease should involve resection back to soft compliant bowel proximally with anastomosis onto the rectum. It may not be feasible to remove all diverticular disease. The splenic flexure should be routinely mobilized (Level IIb).

Recommendation

The splenic flexure should be mobilized routinely for diverticular disease resections. This facilitates the anastomosis being made from soft, compliant bowel being brought down to the rectum (Grade C)

The margins of resection of diverticular disease may affect recurrence. The distal anastomosis should be made onto the rectum, as the presence of sigmoid colon distal to the anastomosis is an independent predictor of recurrence [71,72]. The proximal margin of resection is more controversial, though there is no evidence to support radical resection of all diverticulosis. The proximal part of the anastomosis should be made in soft, compliant colon. This advice is in accordance with the recommendations of the Standards Committee of the American Society of Colon and Rectal Surgeons Practice Parameters for Sigmoid Diverticulitis [70].

This approach is facilitated by routine mobilization of the splenic flexure in all patients. In a recent paper reporting higher rates of disease recurrence after both open and laparoscopic resection, the rate of splenic flexure mobilization was low [73]. There is some evidence that patients with more limited diverticular resections have a greater tendency to have recurrent symptoms [72].

The role of laparoscopy in the management of diverticulitis

Elective resection of uncomplicated diverticulitis

Findings

Laparoscopic resection of uncomplicated diverticulitis confers benefits to patients when performed in centres with the appropriate expertise compared with open resection (Level I).

Recommendation

In centres with the appropriate expertise, laparoscopic resection should be offered for uncomplicated diverticulitis as it is safe and provides a faster recovery time from surgery (Grade A).

Laparoscopic resection for uncomplicated diverticulitis is a safe alternative to open resection and may be associated with a lower rate of morbidity and shorter hospital stay. There have been two randomized trials comparing laparoscopic and open resection of diverticular disease, one reported in abstract form only at this time. The Sigma Trial randomized 104 patients between open and laparoscopic approaches [74]. Though surgery took significantly longer and the conversion rate was 19%, there was less blood loss,

morbidity, pain and analgesic requirement and a significant reduction in hospital stay from 10 to 8 days in the laparoscopic group.

A further randomized trial from Geneva has been reported [75]. After exclusions, 113 patients were randomized. Median operation time was 55 min longer in the laparoscopic group. Time to first bowel movement was quicker in the laparoscopic group, pain was less and hospital stay 2 days shorter (5 vs 7 days; $P < 0.0001$). The conversion rate was 9%.

Similar findings have been reported for a prospective observational study that showed a reduction in hospital stay from 18 to 10 days in favour of laparoscopic resection [76], though the length of stay in the open group does appear to be excessive. A recent meta-analysis of a number of nonrandomized studies also suggested a reduction in hospital stay and complications [77]. This meta-analysis included a large number of patients from a database study by Guller *et al.* [78], in which an unknown number of the patients recorded as having had an open operation were in fact initially laparoscopic and converted to open, potentially skewing the data in favour of the minimally invasive approach. Both this observational study and the meta-analysis may be subject to bias from the easier cases (likely to attract less morbidity) being treated laparoscopically. There has recently been a report from a single centre of 500 consecutive patients presenting with complicated and uncomplicated diverticulitis undergoing laparoscopic resection [79]. Mortality was 0.2% and major morbidity occurred in 11%. Median operating time was 120 min, the conversion rate was 2.8% and median hospital stay was 4 days. This study showed what can be achieved in centres with laparoscopic expertise but the applicability of these results is certainly not universal.

Elective resection of complicated diverticulitis

Findings

The laparoscopic approach is appropriate for complicated diverticulitis (Level III).

Recommendation

In centres with appropriate expertise, laparoscopic resection could be offered for complicated diverticulitis. It may confer benefits to patient recovery (Grade D).

Patients with complicated (fistulating or stenosing) diverticulitis undergoing laparoscopic resection are at higher risk of conversion compared with those with uncomplicated diverticulitis [80]. In a recent study comparing conversion rates between 112 patients with uncomplicated and 91 with complicated diverticular disease, there

was a trend towards more postoperative morbidity in patients with complicated diverticulitis, with a greater likelihood of conversion, though over 90% of patients in this group were still managed laparoscopically [81].

The decision about whether to tackle complicated diverticulitis laparoscopically requires the surgeon to take into account his own surgical expertise. These cases can be very challenging and though excellent results are reported in the literature, these outcomes may not be universally applicable.

Acute versus elective laparoscopic resection for diverticulitis

Findings

Patients undergoing laparoscopic resection of diverticulitis should be treated after recovery from the acute episode of inflammation (Level III).

Recommendation

When possible, the patient with acute diverticulitis should be managed medically with surgery being deferred until after recovery from the acute illness. Conversion rates are lower in the delayed surgery patients and there may be a trend towards a lower rate of complications (Grade D).

There are few data in the literature to support laparoscopic resection in the acute phase of diverticulitis in preference to delayed resection, in patients whose acute illness can be managed conservatively. A recent retrospective, single centre review examined 178 patients, of whom 77 had early attempted laparoscopic resection with the remainder having delayed resection [82]. Although morbidity and mortality did not differ between the two groups, the conversion rate in the early surgery group was three times higher at nearly 38%. A similar study of 210 patients compared 116 patients having early resection with 94 having delayed resection. It found less morbidity in the delayed surgery group and a lower rate of conversion [81].

The roles of laparoscopic lavage in the acute setting, and subsequent elective resection

Findings

The role of laparoscopic intervention in the patient presenting with diverticular peritonitis unsuitable for, or not responding to, conservative management remains incompletely evaluated. It is uncertain whether these patients should undergo interval resection (Level IIb).

Recommendation

Laparoscopic lavage with and without laparoscopically placed drains may play a role in some patients with acute

diverticulitis. Whilst this is an alternative to resection in the acute setting for some patients, it is not certain whether it is an acute alternative to delayed resection (Grade C).

Laparoscopy can be helpful for diagnosis of acute diverticulitis but in practical terms is rarely required, in the era of cross-sectional imaging. There have been a number of reports of laparoscopic lavage for patients with acute diverticulitis. The largest series in the literature, by Myers *et al.*, reports 100 patients with perforated diverticulitis and generalized peritonitis [83]. Eight patients with Hinchey IV disease required conversion to an open procedure. Mortality was 4% overall (one patient in the converted group). Similar results, albeit in smaller case series, have been reported in the literature [84–86]. Few studies report their denominator and so it is unclear what percentage of patients would have settled without any surgical intervention. The selection of patients for laparoscopic lavage and its timing in relation to presentation vary between studies. It has to be concluded therefore that the place of laparoscopic washout and drain placement in the algorithm of treatment for acute diverticulitis is not yet established.

Despite the paucity of data on laparoscopic lavage for diverticular peritonitis, this approach is becoming more commonly employed in this setting. It avoids an acute resection and probable stoma in most patients. It remains unclear, however, whether an elective resection after recovery from the acute illness should be recommended. In the Myers series of 100 patients, this was not generally undertaken and indeed at median follow up of 3 years, only two patients required resection [83].

General comments

The majority of the evidence for elective resection in diverticular disease is of poor quality. The decision regarding whether to offer resection should be made on an individual basis and the surgeon should involve the radiologists and pathologists in this decision, in addition to the patients themselves. It is difficult to make firm comments about the decision to undertake elective resection because of the lack of data and consensus on the natural history of unresected diverticulitis. When surgery is undertaken, laparoscopically or open, this can be challenging due to the inflammation and fibrosis.

Conflict of interest

The authors declare no conflict of interest.

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