Colorectal obstruction

R. Bhardwaj and M.C. Parker

Darent Valley Hospital, Dartford, Kent, United Kingdom

Introduction

The assessment of a patient with evidence of colonic obstruction requires a systematic approach; incorporating a careful history, focused clinical examination and targeted investigation. In the case of an acutely unwell patient resuscitation is critical as colonic obstruction still has a high rate of mortality. An accurate preoperative evaluation of co-morbidity may permit a mortality-based risk stratification and help in the decision-making process for treatment. Therapeutic options, which may not initially include surgery, can then be instituted after comprehensive consent of the patient and discussion with clinicians both within and allied to the surgical unit.

Aetiology

The most common way to classify colorectal obstruction is to relate the aetiology to its position to the bowel wall – intraluminal, intramural or extrinsic. This has little bearing on a clinical approach, which should link the speed of onset of symptoms (acute, subacute or chronic), the degree of obstruction (partial or complete) and the progression (open versus closed loop, simple versus strangulated) to initial management. Therefore, practically, physicians can stratify the aetiology of colorectal obstruction as pathological, mechanical or physiological. The three most common causes of colonic obstruction are neoplasms, volvulus and complications of diverticular disease (Table 1).

Table 1
Aetiology of colorectal obstruction

Pathological (complications of disease)	Colorectal carcinoma Diverticular disease Inflammatory bowel disease
Mechanical (related to anatomical distortion of the colon)	Volvulus Intussception Herniation Adhesions
Physiological (disorders of motility and vascularity)	Pseudo-obstruction Faecal impaction Ischaemic strictures Post radiotherapy strictures

Physiology of obstruction

Obstruction serves to disrupt the complex interplay between the intrinsic (enteric) and extrinsic (sympathetic and parasympathetic) neural supply. This disturbs the local neural circuits, which control motility, secretion, blood flow and immune function. The concomitant disruption of the brain–gut axis modulates the perception of visceral stimuli and results in modification of colonic motility. Following obstruction there is accumulation of fluid within the bowel lumen, bacterial overgrowth within the colon, and oedema of the bowel wall. Though there is an early increase of blood flow to the colonic wall as part of an inflammatory response, progressive distension results in colonic ischaemia with risk of perforation. These physiological responses can rapidly alter cardiac, renal and respiratory function. Whilst organ dysfunction may be tolerated in a young previously fit patient, in those with pre-existing systemic disease and the elderly such physiological reserve may not exist.

Initial assessment

The classical symptoms and signs of bowel obstruction are colicky pain, vomiting abdominal distension and absolute constipation. The relative predominance of these features may aid the clinician in determining the precise level of obstruction within the hindgut. It should be noted with large bowel obstruction that pain may not be colicky in nature and vomiting may be a late feature. An account of a change in bowel habit may indicate significant colorectal pathology. Generalised clinical examination may elicit features of widespread malignant disease and rectal examination

Fig. 1. Abdominal distension from an obstructing caecal carcinoma (see Fig. 2). Note the cachetic appearance of the torso and pectoral girdle. (By kind permission of Mr H Wegstapel, Consultant Surgeon, Medway Maritime Hospital, Gillingham, UK.)

is mandatory (Fig. 1). Furthermore, observation of basic cardiac and nutritional parameters may provide information of the level of resuscitation that is necessary. Simple haematological and biochemical investigations also provide useful information to aid initial treatment in the emergency setting. Biondo et al. [1] examined investigated predictive factors for postoperative mortality by examining a range of factors:

- gender
- age
- American Society of Anaesthesiologists score
- nature of obstruction (benign vs. malign)
- location of the lesion (proximal vs. distal)
- associated proximal colonic damage and/or peritonitis
- preoperative transfusion
- preoperative renal failure
- laboratory data (haematocrit $\leqslant$30%, haemoglobin $\leqslant$10 g/dl, and leukocyte count >15,000 mm^3).

Univariate and multivariate forward stepwise logistic regression analysis showed no differences between proximal and distal obstruction, though age (>70 years), American Society of Anaesthesiologists III–IV score, preoperative renal failure and the presence of proximal colon damage with or without peritonitis were significantly associated with postoperative mortality [1].

Radiological investigation

A plain supine abdominal radiograph may show dilated, gas-filled colonic loops proximal to the obstruction and reduced gas patterns distally. In the presence of a competent ileocaecal valve colonic distension occurs rapidly, though with an incompetent valve distention of the small bowel may also be noted (Fig. 2). It is not always possible to determine the level of obstruction from this investigation, though a volvulus of a sigmoid colon segment is one exception and can be rapidly identified [2]. It is generally agreed that a caecal diameter between 9 and 12 cm in colonic obstruction indicates an increased risk of perforation. The value of an erect chest radiograph is debated as the distended colonic flexures splint the diaphragm, and may confuse the appreciation of subdiaphragmatic air, which indicates visceral perforation. A water-soluble single-contrast enema can aid the rapid differentiation of mechanical from pseudo-obstruction (Fig. 3). Computerised tomography (CT) used in

Fig. 2. X-ray showing dilated small bowel extending to the right iliac fossa. In this case the obstruction was a caecal carcinoma. (By kind permission of Mr H Wegstapel, Consultant Surgeon, Medway Maritime Hospital, Gillingham, UK.)

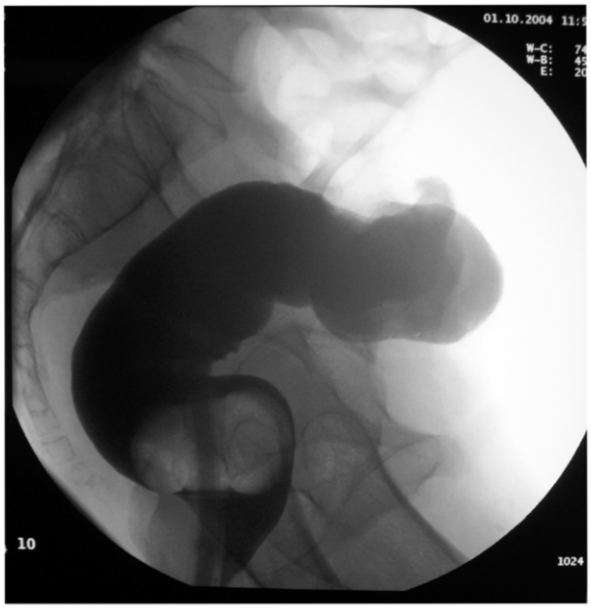

Fig. 3. Single contrast enema demonstrating rectosigmoid obstruction.

isolation or with a contrast enema can not only identify the cause and anatomical position of the obstruction but can highlight visceral perforation, intra-abdominal sepsis and in the case of a colorectal malignancy, distant metastases. In this latter respect, a CT scan is particularly useful in influencing management and is regarded as superior to a plain radiograph. Magnetic resonance imaging (MRI) to investigate colorectal obstruction is emerging as a useful alternative to CT, though has it not been widely adopted outside clinical trials. Beall et al. [3] compared the accuracy of fast MR imaging and helical CT in diagnosing bowel obstruction in 44 patients. The sensitivity, specificity and accuracy for MR imaging was 95%, 100% and 96% respectively as compared with 71%, 71% and 71% for helical CT.

Malignant obstruction

Colorectal malignancies account for the majority of cases of colonic obstruction. The acute angle at the splenic flexure results in half of these tumours obstructing, whilst the proportions for right-sided and left-sided colonic malignancies are a third and a quarter respectively. Because of the capaciousness of the rectum, few rectal cancers present with obstruction. A curative surgical procedure is the aim in those without disseminated disease, though surgery even in this group may not be appropriate in all cases. Surgery is not without risk in this group as Caiazzo et al. [4] showed that in 81 patients with malignant colonic obstruction treated surgically the mortality was 32% – 2.4% from anastomotic dehiscence, 4.9% from cardiovascular complications, 1.2% from sepsis and 23.4% from metastases. Though widespread metastases in the presence of an obstructing colonic lesion pose a particular clinical dilemma and may require minimal intervention improvements in treatments for isolated metastases may still allow resectional surgery.

Curative therapies for obstructing colorectal carcinoma

The aim is to perform an oncologically sound resection whilst not allowing tumour dissemination as a result of inadvertent perforation of the distended colon during mobilisation and division.

Curative surgery and malignant colonic obstruction

The choice of surgical procedure is dependent on the site of the cancer. For right-sided colonic lesions and lesions close to the splenic flexure a single-stage resection is the treatment of choice (Figs. 4, 5). In cases where the integrity of an anastomosis is in doubt, exteriorisation of the divided bowel would seem sensible. There has been an evolution of surgical options for left-sided obstructing cancers ranging

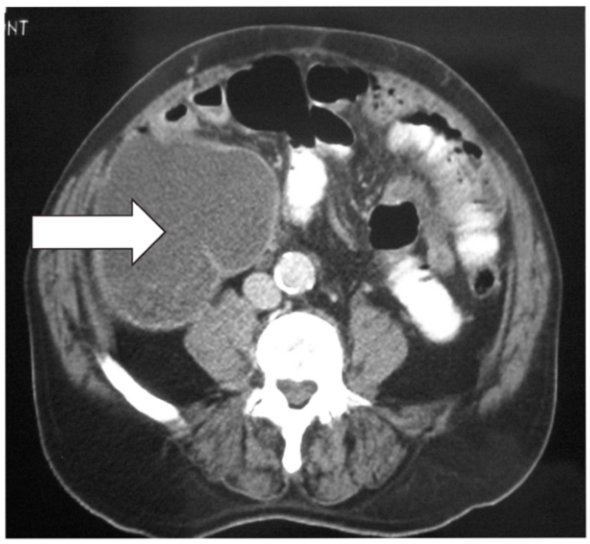

Fig. 4. CT scan demonstrating a dilated caecum (arrow) and collapsed distal colon indicating a transverse colonic obstruction. (By kind permission of Mr E Carapeti, Mr M George, Mr A Williams, Consultant Surgeons, St. Thomas Hospital, London, UK.)

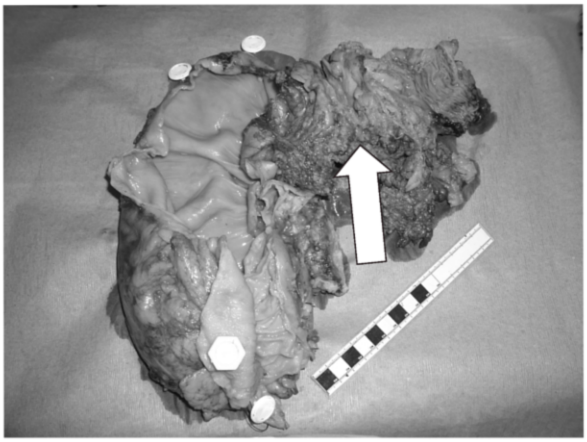

Fig. 5. Resected right Hemicolectomy specimen related to Fig. 4. Note the obstructing transverse colonic carcinoma (arrow), and proximally dilated ascending colon and caecum. (By kind permission of Mr E Carapeti, Mr M George, Mr A Williams, Consultant Surgeons, St. Thomas Hospital, London, UK.)

Fig. 6. CT scan showing a stenosing sigmoid carcinoma with contrast in the lumen of the mass (arrow). This patient had a defunctioning colostomy. (By kind permission of Mr H Wegstapel, Consultant Surgeon, Medway Maritime Hospital, Gillingham, UK.)

from staged resections to single procedures. The simplest would be the formation of a defunctioning colostomy or caecostomy as an initial step; this relieves the obstruction and allows recovery but does not deal with the primary disease (Fig. 6). It does permit a delayed resection of the tumour without the need to form a covering proximal stoma. The final stage would involve closing the defunctioning stoma. A two-stage procedure, which is resection and formation of a proximal end colostomy, as described by Hartmann, with closure of the rectal stump or with creation of a distal mucous fistula and subsequent reversal is a common alternative. The main disadvantage is that some patients may not proceed to have a Hartmann' s procedure reversed. Two options incorporate the formation of a primary colonic anastomosis as part of surgical therapy for left-side colonic obstructions. The first would involve resection of the tumour, on-table colonic irrigation with primary anastomosis [5]. On-table colonoscopy in this setting would exclude synchronous lesions such as polyps [6]. There are some advocates of manual decompression rather than irrigation of the proximal colon [7,8]. The second option involves resection of the entire colon proximal to the obstructing tumour and creation of an ileo-sigmoid or ileo-rectal anastomosis; this of course has the advantage of removing synchronous tumours. Lee et al. [9] compared the morbidity of resections in 107 right-sided lesions and 101 left-sided lesions, 75 of which had segmental resections and primary anastomosis and 26 had subtotal colectomy. There were no differences in mortality or leakage rates between patients with right-sided and left-sided lesions, which would indicate that resection with primary anastomosis for left-sided obstructing lesions should not be discounted. Omejc et al. [10] provided a useful comparison of the outcome after emergency subtotal colectomy for obstruction with elective resection for left-sided colonic lesions and showed that patients who presented with obstruction were usually older than electively treated patients and postoperative mortality was higher. A similar comparison by Zucchetti et al. [11] agreed with these findings and highlighted that patients with obstruction submitted to radical resections had a far poorer prognosis as compared with non-obstructed radically resected cancers (disease-related death of 47.6% versus 16.3% respectively).

Goyal and Schein [12] analysed current practices of the management of left-sided colonic malignancies amongst US gastrointestinal surgeons by questionnaire. In sigmoid obstruction, 96 responders (53%) selected a one-stage procedure in ' good-risk' patients, 78 preferred sigmoid resection with (n = 46) or without (n = 32) ' on-table' colonic lavage and 18 opted for a subtotal colectomy and ileo-rectal anastomosis. Most (94%) responders preferred a staged procedure in ' high-risk' patients: a Hartmann resection (n = 120) or a transverse colostomy (n = 46). This survey suggests that a half would perform a one-stage resection and anastomosis in ' good-risk' patients with left colonic obstruction though in ' poor-risk' patients most would still opt for a staged procedure.

Stents for resectable obstructed colonic malignancies

Endoluminal colorectal stents permit a less invasive alternative to the initial formation of a defunctioning

colostomy or caecostomy to relieve the obstruction and allow appropriate resuscitation to continue whilst still planning definitive surgical resection; this is coined a ' bridge to surgery' . Dohomoto (1991) [13] first described the use of a metal stent to relieve malignant rectal obstruction. Sebastian et al. [14] pooled the results of the uses of colorectal stents in malignant colonic obstruction and reported on 54 studies incorporating 1198 patients. The median technical and clinical success rates were 94% and 91% respectively and the clinical success when used as a ' bridge to surgery' was 71.7%. Khot et al. (2002) [15] conducted an earlier systematic review of the efficacy and safety of colorectal stents and included 29 case series. Of 598 cases of stent insertion, technical success was achieved in 551 (92%) and clinical success (defined by colonic decompression within 96 hours without endoscopic or surgical reintervention) was achieved in 525 (88%). 223 of 262 (85%) went on to have a successful ' bridge to surgery' . Technical failure was seen in 47 of 598 (8%) cases and was predominately related to inability to place a guide wire across the lesion (36 cases). An ideal colonic stent is one that can be inserted easily trans-rectally, can negotiate the colonic folds, be comfortably deployed, allow a sufficient channel for faecal material to pass and remain in position (Fig. 7). There are two types of metallic stent systems: expandable and self-expanding. The former need to be manually expanded, whilst in the latter, self-expanding metallic stents (SEMS), the radial force generated after deployment allows a sufficient channel for the passage of faeces. SEMS have to be of the correct diameter; if too narrow they may migrate and if too wide may cause colonic erosions leading to perforation. Recent stents made of nitinol (nickel and titanium alloy) have ' shape memory' , reverting to a predetermined configuration after deployment. This occurs after 2–5 days as radial expansile force occurs. Furthermore, the inherent flexibility of nitinol affords some colonic peristalsis. Three stents have been approved by the United States Food and Drug Administration (FDA) agency for use in malignant colonic obstruction: the Enteral Wallstent (Boston Scientific, Microvasive Corporation, Natick, Massachusetts, USA), the BARD Memotherm stent (BARD, Billerica, Massachusetts, USA) and the colonic Z-stent (Wilson–Cook Medical, Winston–Salem, North Carolina, USA). More proximal colonic lesions would favour stents such as the Enteral Wallstent because it has a longer and smaller diameter delivery system making it suitable for endoscopic placement. A combined approach by a surgical endoscopist and radiologist is usually favoured for successful stent placement. A guide-wire is first placed across the lesion by the endoscopist or the radiologist under fluoroscopic control. In the latter case, a second ' safety-wire' is passed in case the initial guide wire should become displaced during stent placement. The SEMS can then be deployed through the endoscope and correct placement checked either endoscopically or radiologically. The use of SEMS is not without risk. There may be an inability to negotiate the lesion with a guide wire and the procedure may have to be abandoned. A longer stenosing lesion can be overcome by the use of multiple stents parachuted through each other. Complications during placement include perforation of the colon and malposition, though these reduce with operator experience. Pain usually settles once the SEMS is expanded to its full diameter. Longer-term problems include migration and recurrent luminal obstruction. Khot et al.' s [14] and Sebastian et al.' s [15] reviews of the use of SEMS showed comparable complication rates: perforation (4% and 3.8%); stent migration (10% and 11.8%); and reobstruction (10% and 7.3%). The mortalities in these analyses were similar (1% and 0.58%). SEMS are not suitable for low rectal lesions as patients may experience troublesome tenesmus, furthermore rectal propulsion may cause the stents to migrate through the anal canal. Saida et al. [16] compared the long-term prognosis of SEMS as a ' bridge to surgery' with emergency resection without SEMS use and demonstrated no difference in overall survival rate at three (48% vs. 50%) and five years (40% vs. 44%), with a reduced anastomotic leak rate (3% vs. 11%).

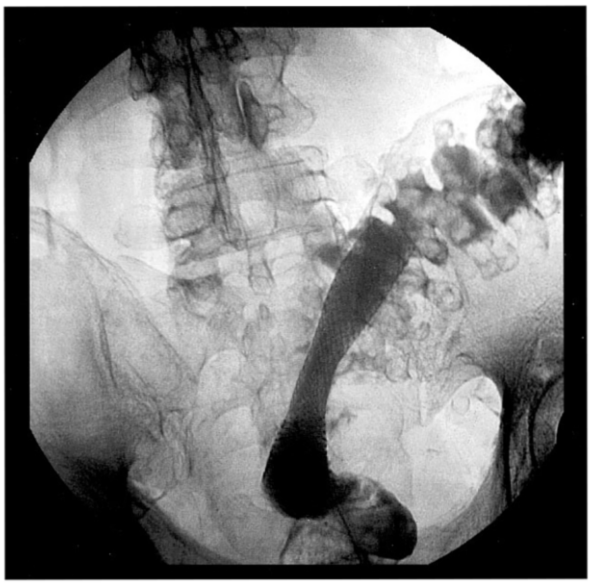

Fig. 7. Successful placement of a self-expanding colorectal stent across a sigmoid stricture.

These data would indicate that SEMS when successful could improve morbidity without adversely affecting mortality. A recent cost-effective analysis [17] comparing stents and surgery in this setting showed that colonic stents resulted in 23% fewer operative procedures per patient (1.01 vs. 1.32 operations per patient), an 83% reduction in stoma requirement (7% vs. 43%), and lower procedure-related mortality (5% vs. 11%). They also calculated that colonic stents were associated with a lower mean cost per patient ($45,709 vs. $49,941). The authors suggested that colonic stent insertion should be offered, whenever feasible, as a bridge to elective surgery in patients presenting with malignant colonic obstruction.

Palliative therapies for obstructing colorectal carcinoma

Palliative therapies encompass care that improves the physical, psychosocial and spiritual quality of life of the patient. For obstructing colonic malignancies, one would aim to resolve the symptoms and signs of obstruction and help to minimise the local complications of the tumour, which may include pain, bleeding and alteration in bowel habit. Whilst surgery should not be discounted, kinder strategies may be more appropriate. These include SEMS insertion, simple endoscopic dilatation and endoscopic laser ablation. The use of palliative radiotherapy and chemotherapy for locally invasive advanced malignancies and those with metastatic disease are outside the scope of this article.

Palliative surgery in malignant colonic obstruction

In cases of obstructing colorectal cancer, palliative surgery is often limited to the formation of a simple proximal trephine colostomy. For obstructing left colonic malignancies, sigmoid colostomies are favoured over transverse colostomies as they prolapse less. Laparoscopic techniques allow mobilisation of the bowel to form a stoma in cases of impending obstruction where a laparotomy may be too traumatic. In some cases removing the tumour mass by performing a segmental colonic resection with end-colostomy formation can be useful to minimise anticipated symptoms such as bleeding and diarrhoea. This can also be successfully performed laparoscopically [18,19].

Obstructing rectal cancers pose a specific challenge. A patent channel in obstructing rectal cancers can be created with a urological resectoscope. Hamy et al.' s [20] report on 46 patients with advanced rectal cancer who underwent this technique showed a median survival time of 14 (range 0–62) months. Pelvic exenteration for locally advanced rectal cancers can also provide a satisfactory symptom free period. Law et al. [21] analysed 23 patients who had rectal stents placed, 11 of whom had primary colorectal cancer. Seven of these were treated palliatively, and the remaining six underwent resection. Advances in preoperative chemoradiotherapy schedules have enabled satisfactory survival following resectional surgery.

Stents as palliation in malignant colonic obstruction

In this role, SEMS are particularly beneficial. Early reports by Spinelli et al. [22] showed at a mean follow up of seven months 10 (83%) of 12 patients had a patent stent lumen with no reports of discomfort. Rey et al. (1995) [23] used SEMS in 12 patients with rectal or rectosigmoid carcinomas as an alternative to laser ablation; stent placement was successful in 11 of the 12 (92%) patients. Dohmoto et al. (1997) [24] employed three varieties of stent prostheses in 19 patients with nonresectable or metastatic rectal cancer: plastic tubes (n=8), SEMS (n=6) or endocoil stents (n=5). At a median follow-up of six months, eight patients had died whereas those remaining alive had no evidence of recurrent obstruction. Turegano-Fuentes et al. (1998) [25] reported successful treatment of obstruction in seven of 11 (64%) patients with left-sided colonic obstruction and advanced disease. Lasers can be useful prior to SEMS placement. Tack et al. (1998) [26] also described the use of a Nd:YAG laser to create a channel for SEMS placement and nine of ten (90%) patients with advanced obstructing rectosigmoid carcinomas had successful stent placement, with patients remaining free of obstruction for 103±31 days.

The relief of obstruction is rapid. De Gregorio et al.' s (1998) [27] multicentre study of 24 patients treated palliatively showed successful stent placement in all patients and in 23 (96%), there was relief of obstruction within 24 hours. Similarly in Fernandez et al.' s (1999) [28] report where 38 of 41 (93%) patients had their obstruction relieved this occurred within 24–96 hours.

Though low rectal cancer is a relative contraindication to SEMS placement in the palliative setting it can provide useful. Troublesome tenesmus can be treated with non-steroidal medication. Coco et al. (2000) [29]

showed successful stent placement in three patients with recurrent rectal cancer and pelvic recurrences though patients complained of rectal tenesmus during the first 48 hours.

The use of repeat SEMS is also useful in cases of recurrent obstruction. In Paul et al.' s (1999) [30] series three (20%) of the 15 cases in whom colonic obstruction was initially relieved required further SEMS.

If further SEMS placement is not possible due to complications or stent obstruction the option of forming a proximal diverting stoma is still available. In Miyayama et al.' s (2000) [31] series where one covered and ten uncovered nitinol stents were deployed in eight patients with left sided colonic cancers reobstruction occurred in two cases; these required a subsequent stoma formation. In Ben Soussan et al.' s (2001) [32] series whilst 16 (94%) of 17 patients had successful stent placement with relief occurred in 13 (74%) within 48 hours, subsequent colostomies were necessary in five patients due to complications that included perforation, stent migration and dislocation of the stent. Law et al. (2004) [33] reported the subsequent formation of a proximal stoma necessary in seven of 52 patients in whom SEMS were used for palliation.

Covered stents may be more effective in preventing tumour ingrowth, which can lead to reobstruction. This may extend the interval where patients have to seek medical intervention. Repici et al. (2000) [34] showed that in 15 of 16 (93%) patients who had successful SEMS placement with covered stents no obstruction was seen at a median follow up of 21 weeks. Similar periods of luminal patency were described by Spinelli and Mancini (2001) [35] where in 28 patients who had successful SEMS placement, follow up at a median of seven (3 weeks to 33 months) showed no obstructive symptoms.

SEMS may also be used for treating colonic obstruction from other intra-abdominal malignancies such as ovarian and gastric carcinoma. Araki et al. (2002) [36] reported five successful cases where SEMS were used, and the Xinopoulos et al. (2002) [37] study consisted of 11 successfully treated cases, though in five cases the use of a laser was required to deal with late tumour ingrowth.

Widespread recognition of the benefits of colorectal stents has enhanced their recent clinical use in the palliative setting. Aviv et al. (2002) [38] reported successful placement of 16 stents in 13 of 15 (87%) patients, most of whom were almost obstructed, with a median survival of two months (range 0.5–12).

Recent work has focused on comparisons of SEMS against surgery for obstructing colonic lesions. Law et al. (2003) [39] compared 30 patients treated by each modality and concluded that SEMS were associated with a shorter hospital stay, less likelihood of intensive care and a lower incidence of stoma creation when compared with emergency surgery. Similarly Johnson et al. (2004) [40] evaluated 18 patients with obstructing left-sided colonic cancer treated successfully with SEMS compared with 18 historical controls treated with a palliative stoma; there were no differences in survival or in hospital mortality and the median length of palliation was 92 days for stenting and 121 days for stoma formation. Those in the stent group were frailer and the study highlights the advantage of SEMS in the elderly.

Xinopoulos et al. (2004) [41] conducted a randomised trial comparing efficacy, safety and cost of endoscopic palliative treatment with SEMS in 15 patients with stoma creation in 15 patients in the management of inoperable malignant left-sided colonic obstructions. SEMS were placed successfully in 14 (93%) though in six, tumour ingrowth was observed which was treated successfully with laser ablation. Although the cost-effectiveness analysis showed that the stoma formation was less expensive the authors suggested that the SEMS provided a better quality of life for the patient. This is paramount in the palliative care setting.

Lasers

Laser (light amplification by stimulated emission of radiation) photocoagulation of colorectal malignancies in the palliative setting is of particular benefit but has been restricted to sporadic clinical use. The neodynium:yttrium–aluminum–garnet (Nd:YAG) laser is most commonly used and can be performed under sedation as a day case procedure as it is not time-consuming (Fig. 8). Two reports indicate favourable treatment times of 40 (range 30–90) minutes [42] and 35 (range 25–90) minutes in rectal and sigmoid cancers [43].

Several interventional sessions are often required to achieve resolution of symptoms such as obstruction and bleeding. Naveau et al. (1986) [44] treated 45 patients with rectal carcinoma palliatively and showed restoration of luminal patency in 80% with a minimum of three sessions; total destruction of intraluminal tumour was possible in 40%. Bleeding may be a problem. Chia et al. (1991) [45] reported 20 cases with rectal carcinoma in which obstruction was relieved with one session, though haemostasis took on average two sessions. Mlkvy et al. (1994) [46] showed that of

Fig. 8. The GreenLight PV laser system (Nd:YAG KTP 532 laser). (By permission of Laserscope Corporation, USA.)

112 with larger tumours 84 had tumours that occupied three-quarters of the lumen. Within the group of 112 patients, an average of 3.7 sessions was required to achieve symptom improvement. Nevertheless, most patients do achieve satisfactory palliation. Of 55 patients with either disseminated or complex rectosigmoid lesions or with severe comorbidity reported by Schulze and Lyng (1994) [47], 74% experienced symptomatic relief. Sometimes laser therapy may not completely resolve symptoms but does improve them. Farouk et al. (1997) [48] conducted a study to assess the degree of symptom relief, complication rate and survival time in patients being treated palliatively in 41 consecutive patients. Thirty-three received treatment for the primary tumour and eight for local recurrence following surgery. The mean survival time was 19 (range 1–60) months and 7 (range 18–41) months respectively. For both groups the mean number of treatments was two and the interval between treatments was six weeks. Four patients decided to undergo palliative surgery and five others eventually had a loop colostomy. The authors stated that whilst laser ablation was effective in palliating symptoms, surgery might still be indicated if patients survived for longer than 24 months. Mathus-Vliegen and Tytgat (1986) [49] show relief of obstruction in 15 of 16 (94%) patients presenting with colonic obstruction, though restenosis necessitating colostomy formation occurred in three patients. Gevers et al. (2000) [50] conducted a retrospective analysis in 219 patients with rectal cancer referred for palliative laser therapy. After initial resolution of symptoms in 198 of 219 (92%) patients for obstruction treatment was repeated at intervals from two to four months and those with bleeding, tenesmus or diarrhoea were only treated if symptomatic. The total number of treatments was significantly higher if obstruction was present at presentation and if tumours were circumferential. The survival rate in the group was 44.4% at one year and 20.4% at two years.

There have been several reports advocating radiotherapy to enhance palliation with lasers [51,52]. Though this seems promising, more data are required.

Diverticular obstruction

This usually occurs in the presence of severe diverticulitis. Definitive surgical therapeutic options are similar to obstructing cancers and include resection and diversion with the possibility of reversal at a later stage or resection with primary anastomosis with on-table lavage. In the absence of intraperitoneal faecal contamination and extensive co-morbidity a single-stage procedure is associated with decreased hospital stay and has lower mortality and morbidity compared with two-stage and three stage procedures [53–55]. The introduction of dedicated daytime emergency lists with senior anaesthetists and specialist senior surgical staff allow single-stage procedures to be undertaken in an adequately resuscitated patient. SEMS may be used successfully in cases without intraperitoneal sepsis to provide a ‘ bridge to surgery’ .

Volvulus

This term describes the torsion of a segment of bowel around its mesentery leading to intermittent or complete obstruction. The sigmoid colon is commonly affected followed in order of frequency by the caecum, splenic flexure and transverse colon. On a plain abdominal radiograph a ‘ coffee bean sign’ appearance may be seen; its position provides a clue of the segment involved (Fig. 9). Conservative therapies such as radiological and endoscopic decompression are usually reserved for those unfit to undergo surgery as recurrence rates are high [56]. Endoscopic treatment does however allow the treated segment to be fixed percutaneously [57]. A trephine stoma is reserved for those too unfit for resection [58]. If the volvulus is successfully treated by non-operative means an elective resection may be carried out. Alternative

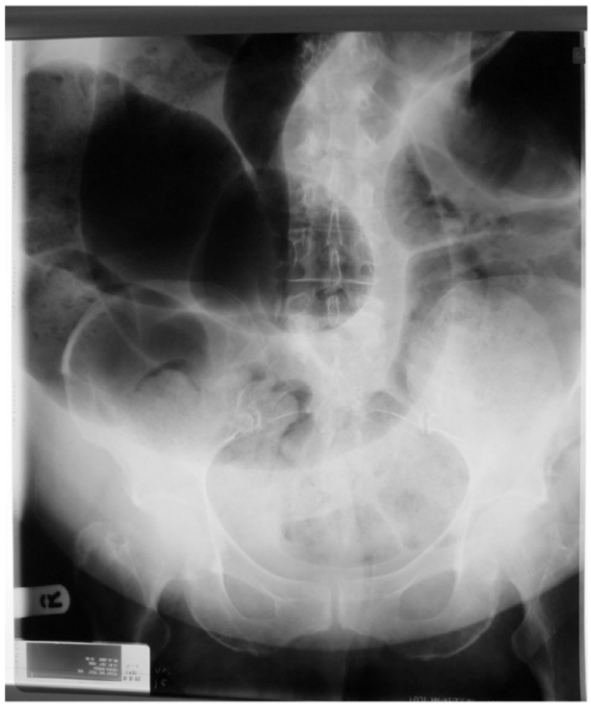

Fig. 9. X-Ray appearance of a grossly distended sigmoid colon from a volvulus (see Fig. 10). (By kind permission of Mr P Webb, Consultant Surgeon, Medway Maritime Hospital, Gillingham, UK.)

Fig. 10. Operative finding of a grossly distended sigmoid colon arising from a volvulus (see Fig. 9). (By kind permission of Mr P Webb, Consultant Surgeon, Medway Maritime Hospital, Gillingham, UK.)

approaches include extraperitonealisation of the (usually) sigmoid colon [59]. This may be performed laparoscopically [60]. Colonic volvulus resulting in a non-viable colon usually necessitates resection. In the case of a sigmoid volvulus a Hartmann' s resection, a Paul Mikulicz procedure or primary anastomosis with on-table colonic lavage are the preferred options (Fig. 10) [61–65]. Mesosigmoidoplasty is a surgical alternative that reduces the risk of further rotation by shortening the mesentery of the affected segment, though this is only possible if the colon is still viable. ' Ileosigmoid knotting' is a rare cause of sigmoid volvulus in which the ileum wraps itself around the base of the sigmoid resulting in obstruction of both the ileum and sigmoid colon. Whilst the segments may be unwrapped if there is any concern about viability resection is the safest option [66]. Non-operative decompression for caecal volvulus is usually not successful and resection is often required [67,68]. Caecopexy and caecostomy are also alternatives; the former can be undertaken laparoscopically.

Pseudo-obstruction

Acute dilatation of the colon in the absence of an identifiable obstructing lesion is termed ' pseudo-obstruction' or Ogilvie' s syndrome (Figs. 11, 12). Recent evidence suggests that it is due to colonic sympathetic overactivity and/or parasympathetic sup-

Fig. 11. X-ray appearance of a distended colon seen with colonic pseudo obstruction (see Fig. 12). (By kind permission of Mr H Wegstapel, Consultant Surgeon, Medway Maritime Hospital, Gillingham, UK.)

Fig. 12. Colonic distension in a patient with pseudo obstruction (see Fig. 11). (By kind permission of Mr H Wegstapel, Consultant Surgeon, Medway Maritime Hospital, Gillingham, UK.)

pression. Its precise aetiology is uncertain though related factors include recent surgery, trauma, severe illness or medication. Treatment is aimed at correction of possible causative factors; correction of metabolic irregularities and omission of drugs that decrease colonic motility (narcotics, anticholinergics and calcium channel antagonists) [69,70]. Whilst neostigmine can provide rapid reversal of the pseudo-obstructive episode, the role of agents such as 5-hydroxytrytamine-4 receptor antagonists and motilin receptor agonists is uncertain [71–73]. Endoscopic decompression may be effective but recurrence is common.

Long standing intestinal dilatation and dysmotility without mechanical obstruction, chronic intestinal pseudo-obstruction, can be diffuse or specific to an isolated segment of gut. It is associated with evidence of autonomic neuropathy and generalised smooth muscle dysfunction [74–76]. Colonic biopsy and manometry provide useful information in making a diagnosis. Treatment is aimed at limiting symptoms, restoring normal intestinal propulsion and maintaining adequate nutrition.

Other causes

Postoperative adhesions usually affect the small bowel though the large bowel is susceptible to involvement. The intra-peritoneal position of the transverse and sigmoid colon make these segments more prone to adhesional obstruction. Strategies are underway to investigate these occurrences [77–79]. One should also be aware of cases where adhesions have been misinterpreted on a double contrast barium enema as colonic cancers.

Inflammatory bowel conditions such as ulcerative colitis, Crohn' s disease and antibiotic associated colitis can cause colonic distension from stricture formation or toxic megacolon. If severe toxicity ensues, this may require surgical intervention.

The colon may incarcerate in a hernia and obstruction and perforation can rapidly occur. If gangrene within the obstructed segment is clinically suspected a laparotomy is necessary. There are many lesser causes of colonic obstruction: faecal impaction (particularly at a previous colonic anastomosis) [80], colo-colic intussception [81] and ischemic colitis [82]. Each of these has to be addressed on its own merits.

Conclusion

The improved management of colonic obstruction is as a result of enhanced imaging modalities, focused preoperative preparation, acceptance of minimally invasive options and evolution of surgical techniques. A multidisciplinary approach is particularly useful in providing the appropriate intervention at the correct time.

References

1 Biondo S, Pares D, Frago R, Marti-Rague J, Kreisler E, De OJ et al. Large bowel obstruction: predictive factors for postoperative mortality. *Dis Colon Rectum* 2004, **47**(11), 1889–1897.
2 Strother M, Chen M, Ott D. Bowel Obstruction: Current role of Plain Radiographic Evaluation. *The Radiologist* 2005, **9**, 1–10.
3 Beall DP, Fortman BJ, Lawler BC, Regan F. Imaging bowel obstruction: a comparison between fast magnetic resonance imaging and helical computed tomography. *Clin Radiol* 2002, **57**(8), 719–724.
4 Caiazzo P, Di PR, Pesce G, Pede A. [Obstructing colon cancer – what' s the surgical strategy?]*Ann Ital Chir* 2004, **75**(4), 455–460.
5 Villar JM, Martinez AP, Villegas MT, Muffak K, Mansilla A, Garrote D et al. Surgical options for malignant left-sided colonic obstruction. *Surg Today* 2005, **35**(4), 275–281.
6 Park UC, Chung SS, Kim KR, Seong MK, Yoon WH, Kim YJ et al. Single-stage procedure with intraoperative colonoscopy and colonic irrigation in patients with obstructing left-sided colonic cancer. *Int J Colorectal Dis* 2004, **19**(5), 487–492.
7 Lim JF, Tang CL, Seow-Choen F, Heah SM. Prospective, randomized trial comparing intraoperative colonic irrigation with manual decompression only for obstructed left-sided colorectal cancer. *Dis Colon Rectum* 2005, **48**(2), 205–209.
8 Naraynsingh V, Rampaul R, Maharaj D, Kuruvilla T, Ramcharan K, Pouchet B. Prospective study of primary anastomosis without colonic lavage for patients with an obstructed left colon. *Br J Surg* 1999, **86**(10), 1341–1343.
9 Lee YM, Law WL, Chu KW, Poon RT. Emergency surgery for obstructing colorectal cancers: a comparison between right-sided and left-sided lesions. *J Am Coll Surg* 2001, **192**(6), 719–725.
10 Omejc M, Stor Z, Jelenc F, Repse S. Outcome after emergency subtotal/total colectomy compared to elective resection in

patients with left-sided colorectal carcinoma. *Int Surg* 1998, **83**(3), 241–244.
11 Zucchetti F, Negro F, Matera D, Bolognini S, Mafucci S. Colorectal cancer: obstruction is an independent negative prognostic factor after radical resection. *Ann Ital Chir* 2002, **73**(4), 421–425.
12 Goyal A, Schein M. Current practices in left-sided colonic emergencies: a survey of US gastrointestinal surgeons. *Dig Surg* 2001, **18**(5), 399–402.
13 Dohmoto M. New Method – endoscopic implantation of rectal stent in palliative treatment of malignant stenosis. *Endoscopica Digestiva* 1991, **3**, 912–913.
14 Sebastian S, Johnston S, Geoghegan T, Torreggiani W, Buckley M. Pooled analysis of the efficacy and safety of self-expanding metal stenting in malignant colorectal obstruction. *Am J Gastroenterol* 2004, **99**(10), 2051–2057.
15 Khot UP, Lang AW, Murali K, Parker MC. Systematic review of the efficacy and safety of colorectal stents. *Br J Surg* 2002, **89**(9), 1096–1102.
16 Saida Y, Sumiyama Y, Nagao J, Uramatsu M. Long-term prognosis of preoperative ' bridge to surgery' expandable metallic stent insertion for obstructive colorectal cancer: comparison with emergency operation. *Dis Colon Rectum* 2003, **46**(10 Suppl), S44-S49.
17 Targownik LE, Spiegel BM, Sack J, Hines OJ, Dulai GS, Gralnek IM et al. Colonic stent vs. emergency surgery for management of acute left-sided malignant colonic obstruction: a decision analysis. *Gastrointest Endosc* 2004, **60**(6): 865–874.
18 Hasegawa H, Kabeshima Y, Watanabe M, Yamamoto S, Kitajima M. Randomized controlled trial of laparoscopic versus open colectomy for advanced colorectal cancer. *Surg Endosc* 2003, **17**(4), 636–640.
19 Morino M, Bertello A, Garbarini A, Rozzio G, Repici A. Malignant colonic obstruction managed by endoscopic stent decompression followed by laparoscopic resections. *Surg Endosc* 2002, **16**(10), 1483–1487.
20 Hamy A, Tuech JJ, Pessaux P, Regenet N, Ziani M, Bergamaschi R et al. Palliation of carcinoma of the rectum using the urologic resectoscope. *Surg Endosc* 2003, **17**(4), 627–631.
21 Law WL, Chu KW, Ho JW, Tung HM, Law SY, Chu KM. Self-expanding metallic stent in the treatment of colonic obstruction caused by advanced malignancies. *Dis Colon Rectum* 2000, **43**(11), 1522–1527.
22 Spinelli P, Dal FM, Mancini A. Rectal metal stents for palliation of colorectal malignant stenosis. *Bildgebung* 1993, **60** Suppl 1, 48–50.
23 Rey JF, Romanczyk T, Greff M. Metal stents for palliation of rectal carcinoma: a preliminary report on 12 patients. *Endoscopy* 1995, **27**(7), 501–504.
24 Dohmoto M, Hunerbein M, Schlag PM. Application of rectal stents for palliation of obstructing rectosigmoid cancer. *Surg Endosc* 1997, **11**(7), 758–761.
25 Turegano-Fuentes F, Echenagusia-Belda A, Simo-Muerza G, Camunez F, Munoz-Jimenez F, Del Valle HE et al. Transanal self-expanding metal stents as an alternative to palliative colostomy in selected patients with malignant obstruction of the left colon. *Br J Surg* 1998, **85**(2), 232–235.
26 Tack J, Gevers AM, Rutgeerts P. Self-expandable metallic stents in the palliation of rectosigmoidal carcinoma: a follow-up study. *Gastrointest Endosc* 1998, **48**(3), 267–271.
27 De Gregorio MA, Mainar A, Tejero E, Tobio R, Alfonso E, Pinto I et al. Acute colorectal obstruction: stent placement for palliative treatment – results of a multicenter study. *Radiology* 1998, **209**(1), 117–120.
28 Fernandez LR, Pinto I, Paul L, Tejero E, Montes C, Fernandez L et al. Self-expanding prostheses as a palliative method in treating advanced colorectal cancer. *Int Surg* 1999, **84**(2), 159–162.
29 Coco C, Cogliandolo S, Riccioni ME, Ciletti S, Marino-Consentino L, Coppola R et al. Use of a self-expanding stent in the palliation of rectal cancer recurrences. A report of three cases. *Surg Endosc* 2000, **14**(8), 708–711.
30 Paul DL, Pinto P, Fernandez LR. Palliative treatment of malignant colorectal strictures with metallic stents. *Cardiovasc Intervent Radiol* 1999, **22**, 29–36.
31 Miyayama S, Matsui O, Kifune K, Yamashiro M, Yamamoto T, Kitagawa K et al. Malignant colonic obstruction due to extrinsic tumor: palliative treatment with a self-expanding nitinol stent. *AJR Am J Roentgenol* 2000, **175**(6), 1631–1637.
32 Ben SE, Savoye G, Hochain P, Antonietti M, Herve S, Forestier F et al. [Expandable metal stents in palliative treatment of malignant colorectal stricture. A report of 17 consecutive patients]. *Gastroenterol Clin Biol* 2001, **25**(5), 463–467.
33 Law WL, Choi HK, Lee YM, Chu KW. Palliation for advanced malignant colorectal obstruction by self-expanding metallic stents: prospective evaluation of outcomes. *Dis Colon Rectum* 2004, **47**(1), 39–43.
34 Repici A, Reggio D, De AC, Barletti C, Marchesa P, Musso A et al. Covered metal stents for management of inoperable malignant colorectal strictures. *Gastrointest Endosc* 2000, **52**(6), 735–740.
35 Spinelli P, Mancini A. Use of self-expanding metal stents for palliation of rectosigmoid cancer. *Gastrointest Endosc* 2001, **53**(2), 203–206.
36 Araki Y, Sato Y, Kido K, Torigoe S, Kishimoto Y, Fukumitsu T et al. Endoluminal ultraflex stent for palliative treatment of malignant rectosigmoidal obstruction. *Kurume Med J* 2002, **49**(3), 81–85.
37 Xinopoulos D, Dimitroulopoulos D, Tsamakidis K, Apostolikas N, Paraskevas E. Treatment of malignant colonic obstructions with metal stents and laser. *Hepatogastroenterology* 2002, **49**(44), 359–362.
38 Aviv RI, Shyamalan G, Watkinson A, Tibballs J, Ogunbaye G. Radiological palliation of malignant colonic obstruction. *Clin Radiol* 2002, **57**(5), 347–351.
39 Law WL, Choi HK, Chu KW. Comparison of stenting with emergency surgery as palliative treatment for obstructing primary left-sided colorectal cancer. *Br J Surg* 2003, **90**(11), 1429–1433.
40 Johnson R, Marsh R, Corson J, Seymour K. A comparison of two methods of palliation of large bowel obstruction due to irremovable colon cancer. *Ann R Coll Surg Engl* 2004, **86**(2), 99–103.
41 Xinopoulos D, Dimitroulopoulos D, Theodosopoulos T, Tsamakidis K, Bitsakou G, Plataniotis G et al. Stenting or stoma creation for patients with inoperable malignant colonic obstructions? Results of a study and cost-effectiveness analysis. *Surg Endosc* 2004, **18**(3), 421–426.
42 Mandava N, Petrelli N, Herrera L, Nava H. Laser palliation for colorectal carcinoma. *Am J Surg* 1991, **162**(3), 212–214.
43 Mesko TW, Petrelli NJ, Rodriguez-Bigas M, Nava H. Endoscopic laser treatment for palliation of colorectal adenocarcinoma. *Surg Oncol* 1993, **2**(1), 25–30.
44 Naveau S, Roulot D, Zourabichvili O, Poitrine A, Poynard T, Chaput JC. Palliative treatment of adenocarcinoma of the rectum by Nd:YAG laser. Immediate and long-term results.

Study of factors related to the initial destruction of the tumor. *Gastroenterol Clin Biol* 1986, **10**(10), 651–655.
45 Chia YW, Ngoi SS, Goh PM. Endoscopic Nd:YAG laser in the palliative treatment of advanced low rectal carcinoma in Singapore. *Dis Colon Rectum* 1991, **34**(12), 1093–1096.
46 Mlkvy P, Vrablik V, Kralik G, Laborecky M. Endoscopic ND:YAG laser treatment of rectosigmoidal cancer. *Neoplasma* 1994, 41(5), 285–289.
47 Schulze S, Lyng KM. Palliation of rectosigmoid neoplasms with Nd:YAG laser treatment. *Dis Colon Rectum* 1994, **37**(9), 882–884.
48 Farouk R, Ratnaval CD, Monson JR, Lee PW. Staged delivery of Nd:YAG laser therapy for palliation of advanced rectal carcinoma. *Dis Colon Rectum* 1997, **40**(2), 156–160.
49 Mathus-Vliegen EM, Tytgat GN. Laser photocoagulation in the palliation of colorectal malignancies. *Cancer* 1986, **57**(11), 2212–2216.
50 Gevers AM, Macken E, Hiele M, Rutgeerts P. Endoscopic laser therapy for palliation of patients with distal colorectal carcinoma: analysis of factors influencing long-term outcome. *Gastrointest Endosc* 2000, **51**(5), 580–585.
51 Chapuis PH, Yuile P, Dent OF, Sinclair G, Low L, Aggarwal G. Combined endoscopic laser and radiotherapy palliation of advanced rectal cancer. *ANZ J Surg* 2002, **72**(2), 95–99.
52 Sargeant IR, Tobias JS, Blackman G, Thorpe S, Bown SG. Radiation enhancement of laser palliation for advanced rectal and rectosigmoid cancer: a pilot study. *Gut* 1993, **34**(7), 958–962.
53 Franklin ME, Jr., Dorman JP, Jacobs M, Plasencia G. Is laparoscopic surgery applicable to complicated colonic diverticular disease? *Surg Endosc* 1997, **11**(10), 1021–1025.
54 Schwesinger WH, Page CP, Gaskill HV, III, Steward RM, Chopra S, Strodel WE et al. Operative management of diverticular emergencies: strategies and outcomes. *Arch Surg* 2000, **135**(5), 558–562.
55 Pain J, Cahill J. Surgical options for left-sided large bowel emergencies. *Ann R Coll Surg Engl* 1991, **73**(6), 394–396.
56 Martinez AD, Yanez LJ, Souto RJ, Vazquez Millan MA, Gonzalez CB, Suarez LF et al. Indication and results of endoscopic management of sigmoid volvulus. *Rev Esp Enferm Dig* 2003, **95**(8), 544–43.
57 Daniels IR, Lamparelli MJ, Chave H, Simson JN. Recurrent sigmoid volvulus treated by percutaneous endoscopic colostomy. *Br J Surg* 2000, **87**(10), 1419.
58 Caruso DM, Kassir AA, Robles RA, Gregory MW, Tsujimura RB, Cheung P et al. Use of trephine stoma in sigmoid volvulus. *Dis Colon Rectum* 1996, **39**(11), 1222–1226.
59 Bhatnagar BN. Extraperitonealization of sigmoid for prevention of recurrence of volvulus: a follow-up study. *Am J Proctol* 1977, **28**(1), 37–44.
60 Mehendale VG, Chaudhari NC, Mulchandani MH. Laparoscopic sigmoidopexy by extraperitonealization of sigmoid colon for sigmoid volvulus: two cases. *Surg Laparosc Endosc Percutan Tech* 2003, **13**(4), 283–285.
61 Chung CC, Kwok SP, Leung KL, Kwong KH, Lau WY, Li AK. Laparoscopy-assisted sigmoid colectomy for volvulus. *Surg Laparosc Endosc* 1997, **7**(5), 423–425.
62 Dulger M, Canturk NZ, Utkan NZ, Gonullu NN. Management of sigmoid colon volvulus. *Hepatogastroenterology* 2000, **47**(35), 1280–1283.
63 Merono Carbajosa EA, Menarguez Pina FJ, Morales CM, Martin AV, Medrano HJ. Current management of colonic volvulus. Results of a treatment protocol. *Rev Esp Enferm Dig* 1998, **90**(12), 863–869.
64 Pahlman L, Enblad P, Rudberg C, Krog M. Volvulus of the colon. A review of 93 cases and current aspects of treatment. *Acta Chir Scand* 1989, **155**(1), 53–56.
65 Raveenthiran V. Restorative resection of unprepared left-colon in gangrenous vs. viable sigmoid volvulus. *Int J Colorectal Dis* 2004, **19**(3), 258–263.
66 Alver O, Oren D, Apaydin B, Yigitbasi R, Ersan Y. Internal herniation concurrent with ileosigmoid knotting or sigmoid volvulus: Presentation of 12 patients. *Surgery* 2005, **137**(3), 372–377.
67 Anderson JR, Lee D. Acute caecal volvulus. *Br J Surg* 1980, **67**(1), 39–41.
68 Hiltunen KM, Syrja H, Matikainen M. Colonic volvulus. Diagnosis and results of treatment in 82 patients. *Eur J Surg* 1992, **158**(11–12), 607–611.
69 Belliveau P. Acute colonic pseudo-obstruction. *Dis.Colon Rectum* 1998, **41**(9), 1210.
70 Laine L. Management of acute colonic pseudo-obstruction. *N Engl J Med* 1999, **341**(3), 192–193.
71 De GR, Barbara G, Stanghellini V, Tonini M, Vasina V, Cola B et al. Review article: the pharmacological treatment of acute colonic pseudo-obstruction. *Aliment Pharmacol Ther* 2001, **15**(11), 1717–1727.
72 Paran H, Silverberg D, Mayo A, Shwartz I, Neufeld D, Freund U. Treatment of acute colonic pseudo-obstruction with neostigmine. *J Am Coll Surg* 2000, **190**(3), 315–318.
73 Ponec RJ, Saunders MD, Kimmey MB. Neostigmine for the treatment of acute colonic pseudo-obstruction. *N Engl J Med* 1999, **341**(3), 137–141.
74 Hirano I, Pandolfino J. Chronic intestinal pseudo-obstruction. *Dig Dis* 2000, **18**(2), 83–92.
75 Patel R, Christensen J. Chronic intestinal pseudo-obstruction: diagnosis and treatment. *Gastroenterologist* 1995, **3**(4), 345–356.
76 Verne GN, Sninsky CA. Chronic intestinal pseudo-obstruction. *Dig Dis* 1995, **13**(3), 163–181.
77 Ellis H, Moran BJ, Thompson JN, Parker MC, Wilson MS, Menzies D et al. Adhesion-related hospital readmissions after abdominal and pelvic surgery: a retrospective cohort study. *Lancet* 1999, 353(9163), 1476–1480.
78 Parker MC, Ellis H, Moran BJ, Thompson JN, Wilson MS, Menzies D et al. Postoperative adhesions: ten-year follow-up of 12,584 patients undergoing lower abdominal surgery. *Dis Colon Rectum* 2001, **44**(6), 822–829.
79 Parker MC, Wilson MS, Menzies D, Sunderland G, Thompson JN, Clark DN et al. Colorectal surgery: the risk and burden of adhesion-related complications. *Colorectal Dis* 2004, **6**(6), 506–511.
80 Lohlun J, Margolis M, Gorecki P, Schein M. Fecal impaction causing megarectum-producing colorectal catastrophes. A report of two cases. *Dig Surg* 2000, **17**(2), 196–198.
81 Toso C, Erne M, Lenzlinger PM, Schmid JF, Buchel H, Melcher G et al. Intussusception as a cause of bowel obstruction in adults. *Swiss Med Wkly* 2005, **135**(5–6), 87–90.
82 Pietroletti R, Navarra L, Aloisio F, Leardi S, Simi M. [Intestinal obstruction caused by ischemic colitis: description of 3 surgically treated cases]. *Minerva Chir* 1995, **50**(10), 911–915.