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Colonoscopy — Indications and Contraindications

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Abstract

This chapter discusses some of the major indications and contraindications for colonoscopy. Advances in colonoscopic techniques have expanded the role of colonoscopy beyond conventional screening, surveillance, and diagnosis to various complex therapeutic and interventional utilities. Several guidelines with new information are being published and updated regularly in the field of colonoscopy and are currently used in clinical practice. However, there is still a lack of well-designed randomized clinical trials investigating the role of colonoscopy in early diagnosis and treatment of various conditions and its impact on long-term survival and disease status. Nevertheless, retrospective observational studies and a few randomized clinical trials abundantly supply data supporting the role of colonoscopy in the diagnosis and management of colonic pathologies in the absence of comparable alternatives.

Keywords: Colonoscopy, Indication, Contraindication, Screening, Surveillance, Diagnostic, Therapeutic

1. Introduction

In the 1960s, Drs. William Wolff and Hiromi Shinya developed a way to probe the full length of the colon using a tube with electronic sensors [1]. Since its inception, colonoscopy has

become a very popular method for screening of colorectal cancers and for treating a variety of conditions of the lower gastrointestinal tract. The decision to perform colonoscopy should take into account the indication and contraindication for the procedure, the risks of the procedure, and the cost. A key quality measure of colonoscopy is the indication for the procedure, because as high as 20-50% of colonoscopies are performed for inappropriate indications [2]. Performing colonoscopy for inappropriate indications not only exposes patients to procedure-related complications such as bowel perforation, bleeding, infection, and cardiovascular events, but also increases on the health-care-related cost. Therefore, several societies including the American Society of Gastrointestinal Endoscopy (ASGE) and the European Panel on the Appropriateness of Gastrointestinal Endoscopy (EPAGE), have established guidelines for appropriate use of colonoscopy. In this chapter, we aim to outline the common indications and contraindications for performing colonoscopy and detail the evidence supporting the facts.

2. Indications for colonoscopy (table 1)

2.1. Lower gastrointestinal (GI) bleeding

Lower GI bleeding may occur in the form of occult bleeding, melena, scant intermittent hematochezia, or severe hematochezia [3]. Lower GI bleeding from any cause requires colonoscopy either urgently or routinely. Patients with occult GI bleeding require colonoscopy to exclude malignant or adenomatous etiologies. Patients who are not good candidates for colonoscopy can be evaluated using CT colonography [4]. In patients presenting with melena, upper GI endoscopy is performed first to identify any upper GI causes. If the upper GI endoscopy does not reveal a source of bleeding, colonoscopy is then indicated to identify any colonic source. Intermittent scant hematochezia can be diagnosed by anoscopy with/without sigmoidoscopy for low-lying lesions in the anus, rectum, and sigmoid in patients who are younger than 40. However, colonoscopy may still be required if a definitive source cannot be identified. On the other hand, colonoscopy is the recommended procedure for patients with intermittent hematochezia who have one of the following risk factors: age >50, family history of colon cancer, or other alarming symptoms such as weight loss, anemia, and change in bowel habits [5, 6]. Overall, colonoscopy has been reported to have a higher yield than other modalities such as proctosigmoidoscopy, single-contrast barium studies, or combined flexible sigmoidoscopy and double-contrast barium enema for diagnosis of lower GI bleeding. In case of severe hematochezia, hemodynamic stability determines the diagnostic and therapeutic approach [7-9]. In hemodynamically stable patients, urgent (within 8-24 h) colonoscopy is recommended [10-13]. In critically ill patients, upper endoscopy is indicated first followed by colonoscopy after excluding the upper GI tract as the source of bleeding [14]. The therapeutic indications of colonoscopy for the treatment of lower GI bleeding are discussed separately in this chapter.

Indications for colonoscopy:
1.Lower GI bleeding
2.Screening and surveillance of colorectal polyps and cancers: a. Colon cancer b. Surveillance after polypectomy c. Colorectal cancer post-resection surveillance d. Inflammatory bowel diseases
3.Acute and chronic diarrhea
4.Therapeutic indications for colonoscopy: a. Excision and ablation of lesions b. Treatment of lower GI bleeding c. Colonic decompression d. Dilation of colonic stenosis e. Foreign body removal
5.Miscellaneous indications: a. Abnormal radiological examinations b. Isolated unexplained abdominal pain c. Chronic constipation d. Preoperative and intraoperative localization of colonic lesions

Table 1. Indications for colonoscopy

2.2. Screening and surveillance of colorectal polyps and cancers

2.2.1. Colon cancer

According to the World Health Organization report in 2012, colorectal cancer (CRC) is the third most common cancer in men (746,000 cases, 10% of the total) and the second in women (614,000 cases, 9.2% of the total) worldwide. In 2014, the American Cancer Society predicted that about 136,830 people would be diagnosed with colorectal cancer in the United States, and about 50,310 people were predicted to die of the disease. Recent studies show declining in the CRC incidence and mortality rates, which have been attributed to the awareness of the risk factors and reduced exposure to them, the effect of early detection and prevention through polypectomy, and improved treatment [15]. The recommendations for screening colonoscopies are divided based on the known risk factor profile: 1) screening in the average-risk population and 2) screening in patients with a family history of colon cancer.

In the average-risk patient, current American, European, and Asian guidelines recommend beginning CRC screening with colonoscopy at the age of 50 years and every 10 years thereafter regardless of the gender. However, the American College of Gastroenterology recommends that the screening colonoscopy begin at the age of 45 years in African Americans [16, 17]. Published evidence favoring the effectiveness of colonoscopy in reducing mortality from CRC by routine colonoscopy is insufficient because of a lack of randomized controlled trials and

the limited consensus in guidelines on the appropriateness of colonoscopy. However, a few studies have modeled and predicted the impact of screening colonoscopy on CRC incidence and mortality using various transition models in hypothetical average-risk individuals aged 50 years. These studies have found that initial screening colonoscopy and repeat colonoscopy every 10 years might reduce CRC incidence by 58% and the reduction in CRC mortality is approximately 64% [18, 19]. In the average-risk individuals, yearly fecal occult blood testing (FOBT) and flexible sigmoidoscopy (FSIG) every 3 years are also accepted methods of screening for CRC. A follow-up colonoscopy, however, is warranted to completely visualize the entire length of the colon for patients with positive FOBT results or FSIG findings of adenoma in the distal colon [20-23].

Family history of CRC is a major risk factor for CRC. It has been estimated that the first-degree relatives of CRC patients have two- to threefold increased risk of dying from CRC, and the risk is inversely associated with the age of diagnosis of the affected family member [24]. Patients with a single first-degree relative with CRC or advanced adenoma (adenoma ≥ 1 cm in size, with high-grade dysplasia, or villous elements) diagnosed at age ≥ 60 years are recommended to undergo routine CRC screening same as an average-risk individual beginning at age 50 years. On the other hand, patients with a single first-degree relative with CRC or advanced adenoma diagnosed at age < 60 years, or two first-degree relatives with CRC or advanced adenomas should receive colonoscopy every 5 years beginning at age 40, or 10 years earlier than the age at diagnosis of the youngest affected relative, whichever comes first [16]. The data supporting these recommendations emerge from the retrospective studies rather than the randomized control trials [25, 26].

Patients with a family history of hereditary nonpolyposis colorectal cancer (HNPCC), an autosomal dominant disease, are recommended to start the CRC screening at the age of 20-25 years or 10 years prior to the earliest age of HNPCC diagnosis in the patient's family member, whichever comes first. The recommended interval for colonoscopy is every 1-2 years until age 40, then annually thereafter [27-30]. This condition, in particular, has two-thirds of adenomas occurring on the right side and warrants colonoscopy for complete colonic surveillance [31]. Indications for performing colonoscopy in individuals with a history of familial adenomatous polyposis (FAP) are guideline-dependent after genetic testing returns positive. FSIG and colonoscopy have not been compared head-to-head regarding their effectiveness and reducing mortality in patients with FAP in the clinical trials and, as such, either FSIG or colonoscopy annually is recommended, starting at the age of 10-12 years [16]. A colonoscopy is deemed necessary when polyps are detected on FSIG and a decision to perform polypectomy is made.

2.2.2. Surveillance after polypectomy

Post-polypectomy surveillance constitutes 20% of the performed colonoscopies, thereby constituting a large share in the amount of health care expenditure [32, 33]. Adhering to the indications for the repeat colonoscopy for the surveillance of CRC after the first colonoscopy, therefore, is very important as earlier colonoscopy can increase the risks to the patient and add to the health care cost whereas delaying the surveillance can also increase the risks by increasing the chances of missed interval cancers. Various observational studies report a 2-5%

risk of an advanced neoplasia 5-10 years after a negative colonoscopy, a risk that is comparable to the risk of advanced colonic neoplasia in the average-risk patients undergoing their first colonoscopy [34-39]. Moreover, the risk of developing CRC 10 years after a negative colonoscopy is reported to be significantly lower (adjusted OR 0.26) [36, 40], supporting the current recommendation of repeat colonoscopy every 10 years in the average-risk general population.

Although the detection and removal of polyp(s) can offer a significant reduction in the mortality of CRC, the development of interval cancers, i.e., the cancers occurring after the initial colonoscopy with polypectomy, appears to be the highest in the first 3-5 years. In 2012, the United States Multi-Society Task Force (USMSTF) published a revision of the 2006 guidelines on post-polypectomy surveillance and divided recommendations based on the presence of polyp(s) (hyperplastic vs. adenomatous), the number and the size of adenomatous polyp(s), villous component and high-grade dysplasia in the polyp, and the presence of serrated lesions or serrated polyposis syndrome (>20 serrated polyps of any size throughout the colon) at baseline colonoscopy. In 2013, the European Society of Gastrointestinal Endoscopy (ESGE) published its post-polypectomy surveillance guidelines, stratifying risk into: low risk (1-2 adenomas <1 cm), intermediate risk (3-4 small adenomas or one >1 cm), and high risk (>5 small adenomas or >3 adenomas with at least one >1 cm) based on the first colonoscopy. According to the USMSTF guideline, it is indicated that patients with 1-2 tubular adenomas <1 cm have a repeat colonoscopy in 10 years; whereas patients with a high-risk adenoma (defined as adenoma with villous histology, high-grade dysplasia, adenoma >10 mm, or three or more adenomas) are recommended to have surveillance interval of 3 years. According to the ESGE guideline, the high-risk group should undergo surveillance at 1 year, the intermediate-risk group at 3-yearly intervals until two consecutive examinations are negative, and the low-risk group requires no surveillance colonoscopy or 5-yearly colonoscopy until one negative examination after which surveillance can be discontinued. The evidence supporting the indications in the arena of surveillance for the serrated polyp is insufficient. According to the USMSTF guideline, sessile serrated polyp(s) <1 cm with no dysplasia should be considered low risk and can be followed at a 5-year interval. However, sessile serrated polyp(s) ≥1 cm or sessile serrated polyp with dysplasia or serrated adenoma should undergo surveillance at 3 years and serrated polyposis syndrome should be surveyed annually. The ESGE recommends that patients with serrated polyps <10 mm in size without dysplasia should be classified as low risk, whereas patients with large serrated polyps (≥10 mm) or those with dysplasia as high risk and undergo surveillance accordingly. Patients with ≥5 serrated polyps proximal to the sigmoid, of which ≥2 are sized ≥10mm, or with ≥20 serrated polyps of any size are classified as serrated polyposis and should be referred for genetic testing.

2.2.3. CRC post-resection surveillance

There are no clear survival benefits for performing colonoscopy in patients who have had colon cancer resection. However, a majority of the groups and societies such as American Cancer Society (ACS), and a joint American Cancer Society/US Multi-Society Task Force on Colorectal Cancer, Cancer Care Ontario [41-44], recommend post CRC resection surveillance. An indication to perform colonoscopy in these patients will help detect metachronous CRCs and

polyps as well as anastomotic recurrences of the initial primary cancer at a stage that would allow further treatment. Currently, a follow-up colonoscopy is indicated at 1 year after the surgical removal of CRC. If no new cancer or polyp(s) is identified, a colonoscopy is repeated at 3 years and at 5 years if the findings are negative for interval development of cancer. An exception to this indication is HNPCC, which requires colonoscopic surveillance every 1-2 years regardless of the surgical resection of the cancer.

2.2.4. *Inflammatory bowel diseases and other colitis*

The indications for colonoscopy in inflammatory bowel disease (IBD), namely ulcerative colitis (UC) and Crohn's disease (CD) fall under a large spectrum. Colonoscopic diagnosis and differentiation between the UC and CD, assessment of the extent and severity of disease activity, treatment effectiveness, surveillance of malignancies, and endoscopic treatment, such as stricture dilation, are all within the scope of colonoscopy and its indications in IBD. Currently, American, European, and other international societies and guideline-defining bodies recommend endoscopic visualization of the entire colon for the initial diagnosis of IBD and other colitis [45-48]. The clinical presentation and laboratory data characterizing both diseases may overlap but endoscopic visualization of the mucosa of the rectum, colon, and terminal ileum, and the extent of the disease involvement may help differentiate the disease processes. Moreover, colonoscopy offers the opportunity to perform biopsy, which is the major advantage of colonoscopy. Unless contraindicated because of severe colitis or possible toxic megacolon, a full colonoscopy with intubation of the terminal ileum should be performed during the initial evaluation of patients with a clinical presentation suggestive of IBD. Ileoscopy is superior for the diagnosis of CD of the terminal ileum when compared with radiological methods, especially for mild lesions [49, 50]. During the colonoscopic examination, biopsy samples should be obtained both from areas affected by the disease and from unaffected areas. After initiating therapy, a smaller number of biopsy samples may be necessary to confirm the diagnosis. In postsurgical follow-up, biopsies of the neoterminal ileum are indicated when disease recurrence is suspected. In patients who have undergone ileal pouch-anal anastomosis, biopsies of the afferent limb are indicated when Crohn's disease is suspected [46]. Other forms of colitis, such as drug-induced, infectious, vascular, and radiation colitis also present in a similar pattern and require colonoscopy at baseline for the diagnosis and the assessment of severity.

Patients with IBD have an increased risk of CRC compared to those without IBD [51-55]. In fact, CRC accounts for one-sixth of ulcerative colitis-related deaths [56]. There is a lack of randomized control studies demonstrating the effectiveness of colonoscopy in improving survival in the IBD patients from CRC. However, numerous observational studies have reported that colonoscopic surveillance of CRC in IBD offers early detection of cancers and improves CRC-related survival in IBD patients [57, 58]. In a retrospective study of 6,823 patients with IBD in US tertiary referral hospitals followed-up for at least 3 years, the incidence of CRC among patients without a recent colonoscopy was 2.7% which was significantly higher than among patients with a recent colonoscopy (1.6%) [59]. Additionally, a colonoscopy within 6-36 months before diagnosis was associated with a 64% reduction in mortality rate [59].

According to most guidelines, colonoscopies are indicated for CRC screening starting at 8-10 years from initiation of IBD-related symptoms [48, 53, 60-62]. The National Institute for Health and Clinical Excellence (NICE) London 2011 guideline, however, recommends only offering colonoscopic surveillance to patients with Crohn's colitis involving more than 1 segment of the colon or left-sided or more extensive UC, but not isolated ulcerative proctitis. Most guidelines recommend yearly follow-up colonoscopy for high-risk patients (those with primary sclerosing cholangitis, extensive colitis, active endoscopic or histologic inflammation, a family history of CRC in a first-degree relative before 50 years of age, personal history of dysplasia, presence of strictures on colonoscopy, and, possibly, gender), and every 2-5 years for those without major risk factors.

2.3. Acute and chronic diarrhea

Patients presenting with acute diarrhea should undergo initial evaluation with stool studies. If blood and stool cultures are inconclusive, or if symptoms persist or worsen despite empiric therapy, then colonoscopy is indicated due to its high diagnostic yield [63]. For most patients with chronic diarrhea, patients with suspected acute diffuse *Clostridium Difficile* colitis, pregnant patients, patients with predominantly left-sided symptoms (tenesmus/urgency) and patients with multiple morbidities, a flexible sigmoidoscopy can be used for the initial evaluation. Even if patients have macroscopically normal-appearing mucosa, biopsies must be obtained to exclude microscopic diseases. If flexible sigmoidoscopy yields inconclusive results, if diarrhea persists, or if there is suspicion of inflammatory bowel disease (IBD) or cancer, then colonoscopy should be the next investigative study.

Histology is an integral component of colonoscopic evaluation of chronic diarrhea because several diseases, such as microscopic colitis, eosinophilic colitis, amyloidosis, and IBD, may appear normal on endoscopy but are abnormal on microscopy. In patients undergoing colonoscopy for chronic diarrhea, IBD or colitis is the most likely disease to be detected [64]. Microscopic colitis can be lymphocytic or collagenous and is characterized by nonbloody, watery diarrhea. On endoscopy, microscopic colitis can be missed because of patchy colonic involvement. Even if mucosa appears normal endoscopically, multiple biopsies from both sides of the colon are necessary to avoid missing microscopic colitis [65]. If there is suspicion of inflammatory diarrhea, then a biopsy of the terminal ileum is helpful in the diagnosis. However, a biopsy of the terminal ileum has the highest diagnostic yield in patients with known or suspected Crohn's disease, terminal ileal abnormalities on imaging, or endoscopic findings of ulcers, ileitis, or erosions [66].

Colonoscopy is not routinely used to evaluate acute diarrhea because it is commonly due to infectious etiology. If stool tests are negative and/or if diarrhea persists, then endoscopy is indicated. An additional important exception is the case of an immunocompromised patient. In a patient with diarrhea with HIV, organ or bone marrow transplant, or on immunosuppressive medications, a colonoscopy with biopsy is necessary to exclude CMV colitis and graft versus host disease (GVHD). In such cases, colonoscopic evaluation of diarrhea has higher sensitivity and cost-effectiveness than FSIG [67]. Patients who undergo stem cell transplant often present with diarrhea in the initial 3 months following transplantation. In these patients,

abnormal mucosa on endoscopy has not been shown to correlate with biopsy results. Therefore, biopsies of normal and abnormal-appearing mucosa are indicated, especially of the distal colon, which has the highest diagnostic yield in patients undergoing endoscopy for gastrointestinal symptoms [68]. Based on the location of highest diagnostic yield, a flexible sigmoidoscopy with distal colon biopsy is indicated in patients with diarrhea suspected of acute GVHD. However, some centers endorse combined upper GI endoscopy as well as colonoscopy in patients following hematopoietic stem cell transplantation to diagnose disease more quickly.

2.4. Therapeutic indications for colonoscopy

2.4.1. Excision and ablation of lesions

Endoscopic mucosal resection (EMR) is a method for treating early CRC. Most adenomas and intramucosal cancers can be removed by EMR. For tumors larger than 2 cm, EMR is less likely to achieve complete resection (histopathologically tumor-free lateral and vertical margins of the resected specimens) [69, 70]. Another method, known as endoscopic submucosal dissection (ESD) is also performed in several countries. The procedure is simpler than the laparoscopic colectomy but is time-consuming and carries a higher risk of perforation than EMR. ESD is indicated in lesions >2 cm, lesions that are suspected to be invasive submucosal cancer, and mucosal lesions with fibrosis or local residual early cancer after endoscopic resection. The rate of complete resection for large colorectal tumors by ESD has been reported to be 80-98.9% [71-74]. However, both procedures are operator-dependent and have limited data supporting their use.

2.4.2. Treatment of lower GI bleeding

Treatment of acute lower GI bleeding from any sources described earlier is indicated either urgently or as an elective procedure. In case of urgent colonoscopy, the colon is prepared using polyethylene glycol based solution administered orally or via nasogastric tube. Currently, metallic clip placement, thermal coagulation, and epinephrine injection are the available methods. Depending on the lesion and the severity of bleeding, colonoscopic intervention with any one of these methods is indicated as the first step in achieving hemostasis. In case of persistent diverticular bleeding, a bleeding vessel can be treated with metallic clip placement [75, 76]. Vascular ectasias can be treated with either thermal or epinephrine injection, though thermal cauterization has 87% of success rate [77]. Cases where a definite bleeding site cannot be located or cases where the visualization of the bleeding source is poor due to inadequate views due to bleeding need referral for angiographic or surgical treatment.

2.4.3. Colonic decompression

Acute colonic obstruction is a common presentation of colon cancer and, often, the presenting patient is in poor overall health making surgical intervention a suboptimal choice. Since 1990, the utility of colonoscopic interventions via either self-expanding metal stent (SEMS), placement of a decompression tube, or tumor debulking has become very popular and has been studied more frequently in recent years in various populations. Endoscopic interventions serve

as a bridge to surgery or as a palliative measure in patients who are poor surgical candidates. A majority of the studies comparing SEMS placement with surgery has reported high clinical success rates (92%), better symptomatic relief, lower complication rates (<5%), cost-effectiveness, and higher patient acceptance and shorter hospital stay with endoscopic SEMS placement [78-83]. Argon plasma coagulation (APC) and snare polypectomy have been used to treat colonic obstruction and maintain luminal patency, and are good alternatives to endoscopic SEMS in treating colonic obstruction [84-86].

Endoscopic decompression of an acute colonic pseudo-obstruction or Ogilvie syndrome is another therapeutic indication for colonoscopy. The etiology of this condition is multifactorial (post-intraabdominal surgery, sepsis, hypothyroidism, neurological disorder, spinal cord injury, etc.) in the absence of a true mechanical obstruction. Bowel ischemia and perforation are dreaded complications and management is often conservative, involving the correction of the underlying disorder. However, in cases where the initial management fails, colonoscopic decompression is indicated [87, 88].

Colonoscopy is also used for decompression of sigmoid and cecal volvulus. Volvulus is a condition in which a part of colon twists upon itself. Due to venous congestion and obstruction to blood flow, tissue viability becomes a major issue. Patients presenting with signs of perforation, peritonitis, bowel necrosis or profound hemodynamic instability need immediate surgery. However, patients with less severe sigmoid and cecal volvulus can be managed endoscopically [89, 90]. Endoscopic correction of sigmoid volvulus achieves better success rates than the correction of cecal volvulus and is associated with a lesser need for surgical intervention [91]. A study by Oren and colleagues reported that sigmoidoscopic correction of sigmoid volvulus with a rectal tube was successful in 78% of patients [92]. Nevertheless, the rate of recurrence of sigmoid volvulus is high, ultimately requiring surgical treatment [93]. Cecal volvulus has been treated endoscopically but due to the high failure rate, often requires surgical intervention for most patients. Surgeons usually combine operative detorsion of cecal volvulus with right hemicolectomy (to prevent recurrence) and either a primary anastomosis or an ileostomy with mucus fistula. In medically unstable, high-risk patients who are poor surgical candidates or have poor vascular supplies to the cecum, cecal volvulus detorsion may be achieved with a cecostomy and cecopexy, which also are associated with significant morbidity and mortality [94]. Colonic volvulus in other areas such as flexural territories are less common and the indication to perform colonoscopic interventions in these situations is not well studied.

2.4.4. *Dilation of colonic stenosis*

Colonoscopic intervention of stenotic lesions such as anastomotic strictures and strictures caused by IBD are among the common indications for performing colonoscopy. Several studies have reported high success rate with a low complications rate. However, recurrence is common. The methods commonly employed for the treatment of colonic stenosis are balloon dilation with or without steroid injection and electro-incision, all of which have been shown to have a variable amount of success [95-101].

2.4.5. Foreign body removal

The current management of the foreign bodies lying in the lower GI tract is based on the type of foreign body, the proximity to the anus, the injury to the adjacent structure, as well as the surgical and endoscopic expertise at the health care center. A foreign body in the GI tract presents after voluntary or involuntary insertion or ingestion of the foreign body. Very often, the patient tries to manipulate the object and attempts self-exploration to remove it before presenting to the hospital. Endoscopy provides an opportunity to avoid abdominal exploration. However if the radiological exam or clinical presentation indicates perforation or higher-lying object(s), colonoscopy may fail and may pose a delay in surgical management [102-106].

2.5. Miscellaneous indications

2.5.1. Abnormal radiological examination

Colonoscopy is commonly performed after an abnormal or suspicious radiological finding in the search for true pathological lesions such as cancers or ulcerative lesions. Filling defect or mucosal defect on barium enema or a luminal narrowing on barium enema or CT scan is routinely evaluated with a colonoscopy. Patients presenting with symptoms suggestive of acute diverticulitis with supportive CT scan findings also need to be evaluated with colonoscopy, but only after the acute inflammation has resolved. Air insufflation during colonoscopy in acute diverticulitis can lead to the bowel perforation and is considered a contraindication. A luminal defect or polyp(s) on CT scan or CT colonography is usually followed-up by a colonoscopy when feasible. However, controversy exists between the American College of Radiology, the American Gastroenterology Association, and American College of Gastroenterology regarding the size and number of polyps on CT colonography that meet the requirement for colonoscopy [107-109]. Patients with abnormal positron emission tomography (PET) scan showing a possible colorectal lesion should undergo colonoscopic evaluation. Nevertheless, in the light of insufficient clinical data, the indications for colonoscopy after abnormal radiological exam are based on individual presentation, availability of the endoscopist, age, and other comorbidities of the patient.

2.5.2. Isolated unexplained abdominal pain

Patients presenting with symptoms of chronic (>3 months) abdominal pain and nonspecific abdominal discomfort might require colonoscopy. In the era of thorough radiologic studies, the need for colonoscopy emerges after noninvasive diagnostic modalities fail and symptoms persist. There is no clear indication for performing colonoscopy in patients presenting with unexplained abdominal pain or discomfort. A detailed history and physical examination provide diagnostic clues but a diagnostic workup often ends up requiring colonoscopy. The diagnostic yield of colonoscopy has been previously studied in retrospective studies. For example, in a study by Neugut et al., a total of 7% of patients who presented with abdominal pain (n=113) either had carcinoma or a polyp >1 cm in size on colonoscopy [110]. It is worth mentioning that detection of the pathological process does not offer symptomatic relief in these cases. In a more recent study by Kueh and colleagues, the diagnostic yield of colonoscopy was

evaluated from 2005 to 2010 in a tertiary center in New Zealand among the patients who presented with isolated abdominal pain, which accounted for 1.2% of all colonoscopies (n=2633). The diagnostic yield of colonoscopy for a cancer, adenoma, diverticulosis, or hemorrhoid in the patients with abdominal pain was significantly lower in this cohort than the yield of colonoscopy performed for other symptoms such as rectal bleeding and/or iron deficiency anemia [111].

2.5.3. *Chronic constipation*

Chronic constipation, as defined by the Rome III criteria [112], is reported to be associated with an increased risk of colon cancer in retrospective studies from the United States [113, 114], Australia [115], and Japan [116]. In contrast, no such association was found in several other studies [117-119]. Interestingly, the yield of colon cancer in colonoscopy performed for constipation alone was lower than in colonoscopy performed for routine colorectal cancer screening [120]. Patients with chronic constipation who present with alarming symptoms such as rectal bleeding, melena, iron-deficiency anemia, unintentional weight loss, or are >50 years should be evaluated with a colonoscopy to identify the etiology of the obstruction, such as cancer, stricture, or extrinsic compression. Colonoscopy can be used to treat chronic constipation based on the etiology. In patients who have undergone prior abdominal surgery, have inflammatory bowel disease, or are prone to ischemia, colonoscopy is used to dilate fibrotic strictures that lead to constipation [121-123]. Patients suffering from chronic constipation due to neurogenic bowel or acute colonic pseudo-obstruction also benefit from a percutaneous endoscopic colostomy [124]. Importantly, chronic constipation as a procedural indication for colonoscopy is independently associated with poor colon preparation requiring a rigorous amount of laxative(s) or a longer duration of preparation [125, 126].

2.5.4. *Preoperative and intraoperative localization of colonic lesions*

Colonic lesions, depending on the size and consistency, may pose some difficulty in localization by surgeons during the surgical procedure, and this could be even more difficult for laparoscopic surgeries than for open procedures. In such cases, localization of a mass or polyp of interest is very important. Preoperative colonoscopy to localize the lesion using penetrating India ink, Spot, or indocyanine green is becoming a common practice [127, 128]. The dye migrates to the peritoneal surface and allows for accurate localization. An alternative colonoscopic method of applying clips around the area of interest has also been studied, which requires intraoperative ultrasound to precisely locate the site. Both methods have their own advantages and disadvantages, such as inflammatory reaction to the dye, micro-abscesses, broad spreading of the dye in the field in smaller lesions, migration of the metallic clips, false localization, or inadvertent injection of dye in the adjacent vital structures. A recent review reported that the accuracy of endoscopic tattooing is 70-100% and the incidence of intraoperative invisible lesions is 1.6-15% [129]. The complications reviewed were mostly related to transmural injection and the spillage rates varied from 2.4 to 13% and were asymptomatic. Intraoperative colonoscopy can also be performed to localize the site of a tumor or a polypec-

tomy site. However, intraoperative colonoscopy is an understudied field and has reported problems with insufflated air in the colon which interferes with the surgical technique.

3. Contraindications for colonoscopy (table 2)

A patient who is either unwilling to give informed consent, or has given informed consent but is uncooperative and/or unable to achieve adequate sedation for colonoscopy, should not undergo colonoscopy. Colonoscopy is also contraindicated for known or suspected colonic perforation. Medical conditions associated with a high risk of perforation such as severe toxic megacolon and fulminant colitis are considered contraindications to colonoscopy. Although not strictly contraindicated, severe IBD with deep ulceration in the rectum/distal sigmoid colon and acute diverticulitis increase the risk of colonic perforation. The risk factors for colonic perforation during colonoscopy are age > 65, low body mass index, female gender, hypoalbuminemia, inpatient status, critically ill condition, multiple morbidities, IBD, and other forms of colitis such as ischemic colitis, colonic stricture dilation, polypectomy, foreign body removal, and hemostasis such as cautery [130-132].

Patients who are or are suspected of becoming hemodynamically unstable should be medically stabilized before colonoscopy. In patients who have had a myocardial infarction, a colonoscopy performed in the first 3 weeks following the infarction can provoke an arrhythmia although the only reported complications during colonoscopy in the 30 days following an myocardial infarction are hypotension and bradycardia [133]. Adequate bowel preparation is necessary because inadequate or poor bowel preparation increases colonoscopy duration with an increase in complications as well as an increase in the number of missed adenomas and high-risk lesions [134].

Contraindications for colonoscopy:
1. Patient refusal
2. Uncooperative patients
3. Inadequate sedation
4. Known or suspected colonic perforation
5. Severe toxic megacolon and fulminant colitis
6. Clinically unstable patients
7. Recent myocardial infarction
8. Inadequate bowel preparation
9. Peritonism

Table 2. Contraindications for colonoscopy

Patients with severe abdominal pain and peritoneal signs may be at risk for possible complete obstruction or gangrenous bowel and should be evaluated by other modalities first. These patients should not undergo colonoscopy due to the risk of bowel perforation from air insufflation of a distended bowel [135]. Colonoscopic decompression of cecal volvulus, though reported, has a high failure rate. Therefore, cecal volvulus should be managed surgically [94]. Failure of endoscopic bowel detorsion, or colonic volvulus with bowel perforation, bowel infarction, or peritonitis are indications for emergent surgery [135].

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References

- [1] Wolff WI. Colonoscopy: history and development. *Am J Gastroenterol*. 1989;84(9):1017-25. PubMed PMID: 2672788.
- [2] Telford JJ. Inappropriate uses of colonoscopy. *Gastroenterol Hepatol*. 2012;8(5):342-4. PubMed PMID: 22933868; PubMed Central PMCID: PMC3424432.
- [3] Committee ASoP, Pasha SF, Shergill A, Acosta RD, Chandrasekhara V, Chathadi KV, et al. The role of endoscopy in the patient with lower GI bleeding. *Gastrointest Endosc*. 2014;79(6):875-85. doi: 10.1016/j.gie.2013.10.039. PubMed PMID: 24703084.
- [4] Committee ASoP, Early DS, Ben-Menachem T, Decker GA, Evans JA, Fanelli RD, et al. Appropriate use of GI endoscopy. *Gastrointest Endosc*. 2012;75(6):1127-31. doi: 10.1016/j.gie.2012.01.011. PubMed PMID: 22624807.
- [5] Peytremann-Bridevaux I, Arditi C, Froehlich F, O'Malley J, Fairclough P, Le Moine O, et al. Appropriateness of colonoscopy in Europe (EPAGE II). Iron-deficiency anemia and hematochezia. *Endoscopy*. 2009;41(3):227-33. doi: 10.1055/s-0028-1119644. PubMed PMID: 19280534.
- [6] Talley NJ, Jones M. Self-reported rectal bleeding in a United States community: prevalence, risk factors, and health care seeking. *Am J Gastroenterol*. 1998;93(11):2179-83. doi: 10.1111/j.1572-0241.1998.00530.x. PubMed PMID: 9820393.

- [7] Caos A, Benner KG, Manier J, McCarthy DM, Blessing LD, Katon RM, et al. Colonoscopy after Golytely preparation in acute rectal bleeding. *J Clin Gastroenterol.* 1986;8(1):46-9. PubMed PMID: 3486210.
- [8] Tedesco FJ, Waye JD, Raskin JB, Morris SJ, Greenwald RA. Colonoscopic evaluation of rectal bleeding: a study of 304 patients. *Ann Intern Med.* 1978;89(6):907-9. PubMed PMID: 309745.
- [9] Irvine EJ, O'Connor J, Frost RA, Shorvon P, Somers S, Stevenson GW, et al. Prospective comparison of double contrast barium enema plus flexible sigmoidoscopy v colonoscopy in rectal bleeding: barium enema v colonoscopy in rectal bleeding. *Gut.* 1988;29(9):1188-93. PubMed PMID: 3273756; PubMed Central PMCID: PMC1434375.
- [10] Jensen DM, Machicado GA, Jutabha R, Kovacs TO. Urgent colonoscopy for the diagnosis and treatment of severe diverticular hemorrhage. *N Eng J Med.* 2000;342(2):78-82. doi: 10.1056/NEJM200001133420202. PubMed PMID: 10631275.
- [11] Bloomfield RS, Rockey DC, Shetzline MA. Endoscopic therapy of acute diverticular hemorrhage. *Am J Gastroenterol.* 2001;96(8):2367-72. doi: 10.1111/j.1572-0241.2001.04048.x. PubMed PMID: 11513176.
- [12] Angtuaco TL, Reddy SK, Drapkin S, Harrell LE, Howden CW. The utility of urgent colonoscopy in the evaluation of acute lower gastrointestinal tract bleeding: a 2-year experience from a single center. *Am J Gastroenterol.* 2001;96(6):1782-5. doi: 10.1111/j.1572-0241.2001.03871.x. PubMed PMID: 11419829.
- [13] Whitlow CB. Endoscopic treatment for lower gastrointestinal bleeding. *Clin Colon Rect Surg.* 2010;23(1):31-6. doi: 10.1055/s-0030-1247855. PubMed PMID: 21286288; PubMed Central PMCID: PMC2850164.
- [14] Hwang JH, Fisher DA, Ben-Menachem T, Chandrasekhara V, Chathadi K, Decker GA, et al. The role of endoscopy in the management of acute non-variceal upper GI bleeding. *Gastrointest Endosc.* 2012;75(6):1132-8. doi: 10.1016/j.gie.2012.02.033. PubMed PMID: 22624808.
- [15] Espey DK, Wu XC, Swan J, Wiggins C, Jim MA, Ward E, et al. Annual report to the nation on the status of cancer, 1975-2004, featuring cancer in American Indians and Alaska Natives. *Cancer.* 2007;110(10):2119-52. doi: 10.1002/cncr.23044. PubMed PMID: 17939129.
- [16] Rex DK, Johnson DA, Anderson JC, Schoenfeld PS, Burke CA, Inadomi JM, et al. American College of Gastroenterology guidelines for colorectal cancer screening 2009 [corrected]. *Am J Gastroenterol.* 2009;104(3):739-50. doi: 10.1038/ajg.2009.104. PubMed PMID: 19240699.
- [17] Sung JJ, Ng SC, Chan FK, Chiu HM, Kim HS, Matsuda T, et al. An updated Asia Pacific Consensus Recommendations on colorectal cancer screening. *Gut.* 2015;64(1):121-32. doi: 10.1136/gutjnl-2013-306503. PubMed PMID: 24647008.

- [18] Frazier AL, Colditz GA, Fuchs CS, Kuntz KM. Cost-effectiveness of screening for colorectal cancer in the general population. *Jama*. 2000;284(15):1954-61. PubMed PMID: 11035892.
- [19] Vijan S, Hwang EW, Hofer TP, Hayward RA. Which colon cancer screening test? A comparison of costs, effectiveness, and compliance. *Am J Med*. 2001;111(8):593-601. PubMed PMID: 11755501.
- [20] Thiis-Evensen E, Hoff GS, Sauar J, Majak BM, Vatn MH. Flexible sigmoidoscopy or colonoscopy as a screening modality for colorectal adenomas in older age groups? Findings in a cohort of the normal population aged 63-72 years. *Gut*. 1999;45(6):834-9. PubMed PMID: 10562581; PubMed Central PMCID: PMC1727750.
- [21] Hewitson P, Glasziou P, Irwig L, Towler B, Watson E. Screening for colorectal cancer using the faecal occult blood test, Hemoccult. *The Cochrane Database of Systematic Reviews*. 2007(1):CD001216. doi: 10.1002/14651858.CD001216.pub2. PubMed PMID: 17253456.
- [22] Foutch PG, Mai H, Pardy K, DiSario JA, Manne RK, Kerr D. Flexible sigmoidoscopy may be ineffective for secondary prevention of colorectal cancer in asymptomatic, average-risk men. *Dig Dis Sci*. 1991;36(7):924-8. PubMed PMID: 2070706.
- [23] Lieberman DA, Smith FW. Screening for colon malignancy with colonoscopy. *Am J Gastroenterol*. 1991;86(8):946-51. PubMed PMID: 1858758.
- [24] Johns LE, Kee F, Collins BJ, Patterson CC, Houlston RS. Colorectal cancer mortality in first-degree relatives of early-onset colorectal cancer cases. *Dis Colon Rectum*. 2002;45(5):681-6. PubMed PMID: 12004220.
- [25] Johns LE, Houlston RS. A systematic review and meta-analysis of familial colorectal cancer risk. *Am J Gastroenterol*. 2001;96(10):2992-3003. doi: 10.1111/j.1572-0241.2001.04677.x. PubMed PMID: 11693338.
- [26] Butterworth AS, Higgins JP, Pharoah P. Relative and absolute risk of colorectal cancer for individuals with a family history: a meta-analysis. *Eur J Can*. 2006;42(2):216-27. doi: 10.1016/j.ejca.2005.09.023. PubMed PMID: 16338133.
- [27] McLeod RS, Canadian Task Force on Preventive Health C. Screening strategies for colorectal cancer: a systematic review of the evidence. *Canadian J Gastroenterol = J Canadien Gastroenterol*. 2001;15(10):647-60. PubMed PMID: 11694901.
- [28] Rex DK, Johnson DA, Lieberman DA, Burt RW, Sonnenberg A. Colorectal cancer prevention 2000: screening recommendations of the American College of Gastroenterology. American College of Gastroenterology. *Am J Gastroenterol*. 2000;95(4):868-77. doi: 10.1111/j.1572-0241.2000.02059.x. PubMed PMID: 10763931.
- [29] Smith RA, Cokkinides V, Eyre HJ. American Cancer Society guidelines for the early detection of cancer, 2006. *CA: A Cancer Journal for Clinicians*. 2006;56(1):11-25; quiz 49-50. PubMed PMID: 16449183.

- [30] Force USPST. Screening for colorectal cancer: recommendation and rationale. *Am Fam Physician*. 2002;66(12):2287-90. PubMed PMID: 12507168.
- [31] Lynch HT, Smyrk T, Lynch J, Fitzgibbons R, Jr., Lanspa S, McGinn T. Update on the differential diagnosis, surveillance and management of hereditary non-polyposis colorectal cancer. *Eur J Can*. 1995;31A(7-8):1039-46. PubMed PMID: 7576988.
- [32] Lieberman DA, De Garmo PL, Fleischer DE, Eisen GM, Helfand M. Patterns of endoscopy use in the United States. *Gastroenterology*. 2000;118(3):619-24. PubMed PMID: 10702214.
- [33] Ladabaum U, Song K. Projected national impact of colorectal cancer screening on clinical and economic outcomes and health services demand. *Gastroenterology*. 2005;129(4):1151-62. doi: 10.1053/j.gastro.2005.07.059. PubMed PMID: 16230069.
- [34] Lieberman DA, Weiss DG, Harford WV, Ahnen DJ, Provenzale D, Sontag SJ, et al. Five-year colon surveillance after screening colonoscopy. *Gastroenterology*. 2007;133(4):1077-85. doi: 10.1053/j.gastro.2007.07.006. PubMed PMID: 17698067.
- [35] Leung WK, Lau JY, Suen BY, Wong GL, Chow DK, Lai LH, et al. Repeat-screening colonoscopy 5 years after normal baseline-screening colonoscopy in average-risk Chinese: a prospective study. *Am J Gastroenterol*. 2009;104(8):2028-34. doi: 10.1038/ajg.2009.202. PubMed PMID: 19455125.
- [36] Brenner H, Chang-Claude J, Seiler CM, Hoffmeister M. Long-term risk of colorectal cancer after negative colonoscopy. *J Clin Oncol*: Official journal of the American Society of Clinical Oncology. 2011;29(28):3761-7. doi: 10.1200/JCO.2011.35.9307. PubMed PMID: 21876077.
- [37] Brenner H, Haug U, Arndt V, Stegmaier C, Altenhofen L, Hoffmeister M. Low risk of colorectal cancer and advanced adenomas more than 10 years after negative colonoscopy. *Gastroenterology*. 2010;138(3):870-6. doi: 10.1053/j.gastro.2009.10.054. PubMed PMID: 19909750.
- [38] Miller HL, Mukherjee R, Tian J, Nagar AB. Colonoscopy surveillance after polypectomy may be extended beyond five years. *J Clin Gastroenterol*. 2010;44(8):e162-6. doi: 10.1097/MCG.0b013e3181e5cd22. PubMed PMID: 20628313.
- [39] Chung SJ, Kim YS, Yang SY, Song JH, Kim D, Park MJ, et al. Five-year risk for advanced colorectal neoplasia after initial colonoscopy according to the baseline risk stratification: a prospective study in 2452 asymptomatic Koreans. *Gut*. 2011;60(11):1537-43. doi: 10.1136/gut.2010.232876. PubMed PMID: 21427200.
- [40] Brenner H, Chang-Claude J, Seiler CM, Rickert A, Hoffmeister M. Protection from colorectal cancer after colonoscopy: a population-based, case-control study. *Ann Internal Med*. 2011;154(1):22-30. doi: 10.7326/0003-4819-154-1-201101040-00004. PubMed PMID: 21200035.
- [41] Rex DK, Kahi CJ, Levin B, Smith RA, Bond JH, Brooks D, et al. Guidelines for colonoscopy surveillance after cancer resection: a consensus update by the American Can-

- cer Society and US Multi-Society Task Force on Colorectal Cancer. *CA: A Cancer Journal for Clinicians*. 2006;56(3):160-7; quiz 85-6. PubMed PMID: 16737948.
- [42] Meyerhardt JA, Mangu PB, Flynn PJ, Korde L, Loprinzi CL, Minsky BD, et al. Follow-up care, surveillance protocol, and secondary prevention measures for survivors of colorectal cancer: American Society of Clinical Oncology clinical practice guideline endorsement. *J Clin Oncol*: Official journal of the American Society of Clinical Oncology. 2013;31(35):4465-70. doi: 10.1200/JCO.2013.50.7442. PubMed PMID: 24220554.
- [43] Labianca R, Nordlinger B, Beretta GD, Brouquet A, Cervantes A, Group EGW. Primary colon cancer: ESMO Clinical Practice Guidelines for diagnosis, adjuvant treatment and follow-up. *Ann Oncology*: Official journal of the European Society for Medical Oncology/ESMO. 2010;21 Suppl 5:v70-7. doi: 10.1093/annonc/mdq168. PubMed PMID: 20555107.
- [44] Glimelius B, Pahlman L, Cervantes A, Group EGW. Rectal cancer: ESMO Clinical Practice Guidelines for diagnosis, treatment and follow-up. *Ann Oncol*: Official journal of the European Society for Medical Oncology/ESMO. 2010;21 Suppl 5:v82-6. doi: 10.1093/annonc/mdq170. PubMed PMID: 20555109.
- [45] Dignass A, Eliakim R, Magro F, Maaser C, Chowers Y, Geboes K, et al. Second European evidence-based consensus on the diagnosis and management of ulcerative colitis part 1: definitions and diagnosis. *J Crohn's Colitis*. 2012;6(10):965-90. doi: 10.1016/j.crohns.2012.09.003. PubMed PMID: 23040452.
- [46] Van Assche G, Dignass A, Reinisch W, van der Woude CJ, Sturm A, De Vos M, et al. The second European evidence-based Consensus on the diagnosis and management of Crohn's disease: special situations. *J Crohn's Colitis*. 2010;4(1):63-101. doi: 10.1016/j.crohns.2009.09.009. PubMed PMID: 21122490.
- [47] Mowat C, Cole A, Windsor A, Ahmad T, Arnott I, Driscoll R, et al. Guidelines for the management of inflammatory bowel disease in adults. *Gut*. 2011;60(5):571-607. doi: 10.1136/gut.2010.224154. PubMed PMID: 21464096.
- [48] Leighton JA, Shen B, Baron TH, Adler DG, Davila R, Egan JV, et al. ASGE guideline: endoscopy in the diagnosis and treatment of inflammatory bowel disease. *Gastrointest Endosc*. 2006;63(4):558-65. doi: 10.1016/j.gie.2006.02.005. PubMed PMID: 16564852.
- [49] Horsthuis K, Stokkers PC, Stoker J. Detection of inflammatory bowel disease: diagnostic performance of cross-sectional imaging modalities. *Abdom Imaging*. 2008;33(4):407-16. doi: 10.1007/s00261-007-9276-3. PubMed PMID: 17619923; PubMed Central PMCID: PMC2386533.
- [50] Marshall JK, Cawdron R, Zealley I, Riddell RH, Somers S, Irvine EJ. Prospective comparison of small bowel meal with pneumocolon versus ileo-colonoscopy for the diagnosis of ileal Crohn's disease. *Am J Gastroenterol*. 2004;99(7):1321-9. doi: 10.1111/j.1572-0241.2004.30499.x. PubMed PMID: 15233672.

- [51] Richards ME, Rickert RR, Nance FC. Crohn's disease-associated carcinoma. A poorly recognized complication of inflammatory bowel disease. *Ann Surg.* 1989;209(6): 764-73. PubMed PMID: 2543338; PubMed Central PMCID: PMC1494126.
- [52] Ekbom A, Helmick C, Zack M, Adami HO. Increased risk of large-bowel cancer in Crohn's disease with colonic involvement. *Lancet.* 1990;336(8711):357-9. PubMed PMID: 1975343.
- [53] Farraye FA, Odze RD, Eaden J, Itzkowitz SH. AGA technical review on the diagnosis and management of colorectal neoplasia in inflammatory bowel disease. *Gastroenterology.* 2010;138(2):746-74, 74 e1-4; quiz e12-3. doi: 10.1053/j.gastro.2009.12.035. PubMed PMID: 20141809.
- [54] Friedman S, Rubin PH, Bodian C, Goldstein E, Harpaz N, Present DH. Screening and surveillance colonoscopy in chronic Crohn's colitis. *Gastroenterology.* 2001;120(4): 820-6. PubMed PMID: 11231935.
- [55] Maykel JA, Hagerman G, Mellgren AF, Li SY, Alavi K, Baxter NN, et al. Crohn's colitis: the incidence of dysplasia and adenocarcinoma in surgical patients. *Dis Colon Rectum.* 2006;49(7):950-7. doi: 10.1007/s10350-006-0555-9. PubMed PMID: 16729218.
- [56] Jess T, Loftus EV, Jr., Velayos FS, Harmsen WS, Zinsmeister AR, Smyrk TC, et al. Risk of intestinal cancer in inflammatory bowel disease: a population-based study from olmsted county, Minnesota. *Gastroenterology.* 2006;130(4):1039-46. doi: 10.1053/j.gastro.2005.12.037. PubMed PMID: 16618397.
- [57] Karlen P, Kornfeld D, Brostrom O, Lofberg R, Persson PG, Ekbom A. Is colonoscopic surveillance reducing colorectal cancer mortality in ulcerative colitis? A population based case control study. *Gut.* 1998;42(5):711-4. PubMed PMID: 9659169; PubMed Central PMCID: PMC1727094.
- [58] Lutgens MW, Oldenburg B, Siersema PD, van Bodegraven AA, Dijkstra G, Hommes DW, et al. Colonoscopic surveillance improves survival after colorectal cancer diagnosis in inflammatory bowel disease. *Brit J Can.* 2009;101(10):1671-5. doi: 10.1038/sj.bjc.6605359. PubMed PMID: 19826420; PubMed Central PMCID: PMC2778537.
- [59] Ananthakrishnan AN, Cagan A, Cai T, Gainer VS, Shaw SY, Churchill S, et al. Colonoscopy is associated with a reduced risk for colon cancer and mortality in patients with inflammatory bowel diseases. *Clin Gastroenterol Hepatol: Official clinical practice journal of the American Gastroenterological Association.* 2014. doi: 10.1016/j.cgh.2014.07.018. PubMed PMID: 25041865; PubMed Central PMCID: PMC4297589.
- [60] Cairns SR, Scholefield JH, Steele RJ, Dunlop MG, Thomas HJ, Evans GD, et al. Guidelines for colorectal cancer screening and surveillance in moderate and high risk groups (update from 2002). *Gut.* 2010;59(5):666-89. doi: 10.1136/gut.2009.179804. PubMed PMID: 20427401.
- [61] Van Assche G, Dignass A, Bokemeyer B, Danese S, Gionchetti P, Moser G, et al. Second European evidence-based consensus on the diagnosis and management of ulcer-

- ative colitis part 3: special situations. *J Crohn's Colitis*. 2013;7(1):1-33. doi: 10.1016/j.crohns.2012.09.005. PubMed PMID: 23040453.
- [62] Cancer Council Australia Colonoscopy Surveillance Working Party. Clinical practice guidelines for surveillance colonoscopy – in adenoma follow-up; following curative resection of colorectal cancer; and for cancer surveillance in inflammatory bowel disease. Sydney (Australia): Cancer Council Australia; 2011 Dec. 144 p. Available from: <http://www.guideline.gov/content.aspx?id=47635>.
- [63] Lasso A, Kilander A, Stotzer PO. Diagnostic yield of colonoscopy based on symptoms. *Scand J Gastroenterol*. 2008;43(3):356-62. PubMed PMID: 18938663.
- [64] Shah RJ, Fenoglio-Preiser C, Bleau BL, Giannella RA. Usefulness of colonoscopy with biopsy in the evaluation of patients with chronic diarrhea. *Am J Gastroenterol*. 2001;96(4):1091-5. doi: 10.1111/j.1572-0241.2001.03745.x. PubMed PMID: 11316152.
- [65] Tanaka M, Mazzoleni G, Riddell RH. Distribution of collagenous colitis: utility of flexible sigmoidoscopy. *Gut*. 1992;33(1):65-70. PubMed PMID: 1740280; PubMed Central PMCID: PMC1373867.
- [66] McHugh JB, Appelman HD, McKenna BJ. The diagnostic value of endoscopic terminal ileum biopsies. *Am J Gastroenterol*. 2007;102(5):1084-9. doi: 10.1111/j.1572-0241.2007.01194.x. PubMed PMID: 17391315.
- [67] Kearney DJ, Steuerwald M, Koch J, Cello JP. A prospective study of endoscopy in HIV-associated diarrhea. *Am J Gastroenterol*. 1999;94(3):596-602. doi: 10.1111/j.1572-0241.1999.00920.x. PubMed PMID: 10086637.
- [68] Khan K, Schwarzenberg SJ, Sharp H, Jessurun J, Gulbahce HE, Defor T, et al. Diagnostic endoscopy in children after hematopoietic stem cell transplantation. *Gastrointest Endosc*. 2006;64(3):379-85; quiz 89-92. doi: 10.1016/j.gie.2005.08.040. PubMed PMID: 16923486.
- [69] Saito Y, Fukuzawa M, Matsuda T, Fukunaga S, Sakamoto T, Uraoka T, et al. Clinical outcome of endoscopic submucosal dissection versus endoscopic mucosal resection of large colorectal tumors as determined by curative resection. *Surg Endosc*. 2010;24(2):343-52. doi: 10.1007/s00464-009-0562-8. PubMed PMID: 19517168.
- [70] Tajika M, Niwa Y, Bhatia V, Kondo S, Tanaka T, Mizuno N, et al. Comparison of endoscopic submucosal dissection and endoscopic mucosal resection for large colorectal tumors. *Eur J Gastroenterol Hepatol*. 2011;23(11):1042-9. doi: 10.1097/MEG.0b013e32834aa47b. PubMed PMID: 21869682.
- [71] Isomoto H, Nishiyama H, Yamaguchi N, Fukuda E, Ishii H, Ikeda K, et al. Clinicopathological factors associated with clinical outcomes of endoscopic submucosal dissection for colorectal epithelial neoplasms. *Endoscopy*. 2009;41(8):679-83. doi: 10.1055/s-0029-1214979. PubMed PMID: 19670135.

- [72] Yoshida N, Naito Y, Sakai K, Sumida Y, Kanemasa K, Inoue K, et al. Outcome of endoscopic submucosal dissection for colorectal tumors in elderly people. *Int J Colorectal Dis.* 2010;25(4):455-61. doi: 10.1007/s00384-009-0841-9. PubMed PMID: 19921221.
- [73] Yoshida N, Wakabayashi N, Kanemasa K, Sumida Y, Hasegawa D, Inoue K, et al. Endoscopic submucosal dissection for colorectal tumors: technical difficulties and rate of perforation. *Endoscopy.* 2009;41(9):758-61. doi: 10.1055/s-0029-1215028. PubMed PMID: 19746316.
- [74] Yoshida N, Yagi N, Naito Y, Yoshikawa T. Safe procedure in endoscopic submucosal dissection for colorectal tumors focused on preventing complications. *World J Gastroenterol: WJG.* 2010;16(14):1688-95. PubMed PMID: 20379999; PubMed Central PMCID: PMC2852815.
- [75] Savides TJ, Jensen DM. Colonoscopic hemostasis for recurrent diverticular hemorrhage associated with a visible vessel: a report of three cases. *Gastrointest Endosc.* 1994;40(1):70-3. PubMed PMID: 8163141.
- [76] Binmoeller KF, Thonke F, Soehendra N. Endoscopic hemoclip treatment for gastrointestinal bleeding. *Endoscopy.* 1993;25(2):167-70. doi: 10.1055/s-2007-1010277. PubMed PMID: 8491134.
- [77] Santos JC, Jr., Aprilli F, Guimaraes AS, Rocha JJ. Angiodysplasia of the colon: endoscopic diagnosis and treatment. *Brit J Surg.* 1988;75(3):256-8. PubMed PMID: 3258173.
- [78] Sagar J. Colorectal stents for the management of malignant colonic obstructions. *The Cochrane Database of Systematic Reviews.* 2011(11):CD007378. doi: 10.1002/14651858.CD007378.pub2. PubMed PMID: 22071835.
- [79] Frago R, Ramirez E, Millan M, Kreisler E, del Valle E, Biondo S. Current management of acute malignant large bowel obstruction: a systematic review. *Am J Surg.* 2014;207(1):127-38. doi: 10.1016/j.amjsurg.2013.07.027. PubMed PMID: 24124659.
- [80] Cheung DY, Kim JY, Hong SP, Jung MK, Ye BD, Kim SG, et al. Outcome and safety of self-expandable metallic stents for malignant colon obstruction: a Korean multi-center randomized prospective study. *Surg Endosc.* 2012;26(11):3106-13. doi: 10.1007/s00464-012-2300-x. PubMed PMID: 22609981.
- [81] Varadarajulu S, Roy A, Lopes T, Drelichman ER, Kim M. Endoscopic stenting versus surgical colostomy for the management of malignant colonic obstruction: comparison of hospital costs and clinical outcomes. *Surg Endosc.* 2011;25(7):2203-9. doi: 10.1007/s00464-010-1523-y. PubMed PMID: 21293882; PubMed Central PMCID: PMC3116133.
- [82] Kavanagh DO, Nolan B, Judge C, Hyland JM, Mulcahy HE, O'Connell PR, et al. A comparative study of short- and medium-term outcomes comparing emergent surgery and stenting as a bridge to surgery in patients with acute malignant colonic ob-

- struction. *Dis Colon Rectum*. 2013;56(4):433-40. doi: 10.1097/DCR.0b013e3182760506. PubMed PMID: 23478610.
- [83] van Hooft JE, Bemelman WA, Oldenburg B, Marinelli AW, Lutke Holzik MF, Grubben MJ, et al. Colonic stenting versus emergency surgery for acute left-sided malignant colonic obstruction: a multicentre randomised trial. *Lancet Oncol*. 2011;12(4):344-52. doi: 10.1016/S1470-2045(11)70035-3. PubMed PMID: 21398178.
- [84] 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):580-5. PubMed PMID: 10805846.
- [85] Solecki R, Zajac A, Richter P, Szura M. Bifocal esophageal and rectal cancer palliatively treated with argon plasma coagulation. *Surgical Endosc*. 2004;18(2):346. doi: 10.1007/s00464-003-4232-y. PubMed PMID: 15106621.
- [86] Baumhoer D, Armbrust T, Ramadori G. Nonsurgical treatment of the primary tumor in four consecutive cases of metastasized colorectal carcinoma. *Endoscopy*. 2005;37(12):1232-6. doi: 10.1055/s-2005-870225. PubMed PMID: 16329023.
- [87] Saunders MD. Acute colonic pseudo-obstruction. *Best Pract Res Clin Gastroenterol*. 2007;21(4):671-87. doi: 10.1016/j.bpg.2007.03.001. PubMed PMID: 17643908.
- [88] Tsiroline VB, Zemlyak AY, Avery MJ, Colavita PD, Christmas AB, Heniford BT, et al. Colonoscopy is superior to neostigmine in the treatment of Ogilvie's syndrome. *Am J Surg*. 2012;204(6):849-55; discussion 55. doi: 10.1016/j.amjsurg.2012.05.006. PubMed PMID: 23021196.
- [89] Renzulli P, Maurer CA, Netzer P, Buchler MW. Preoperative colonoscopic derotation is beneficial in acute colonic volvulus. *Dig Surg*. 2002;19(3):223-9. PubMed PMID: 12119526.
- [90] Swenson BR, Kwaan MR, Burkart NE, Wang Y, Madoff RD, Rothenberger DA, et al. Colonic volvulus: presentation and management in metropolitan Minnesota, United States. *Dis Colon Rectum*. 2012;55(4):444-9. doi: 10.1097/DCR.0b013e3182404b3d. PubMed PMID: 22426269.
- [91] Halabi WJ, Jafari MD, Kang CY, Nguyen VQ, Carmichael JC, Mills S, et al. Colonic volvulus in the United States: trends, outcomes, and predictors of mortality. *Ann Surg*. 2014;259(2):293-301. doi: 10.1097/SLA.0b013e31828c88ac. PubMed PMID: 23511842.
- [92] Oren D, Atamanalp SS, Aydinli B, Yildirgan MI, Basoglu M, Polat KY, et al. An algorithm for the management of sigmoid colon volvulus and the safety of primary resection: experience with 827 cases. *Dis Colon Rectum*. 2007;50(4):489-97. doi: 10.1007/s10350-006-0821-x. PubMed PMID: 17205203.
- [93] Ballantyne GH. Review of sigmoid volvulus: history and results of treatment. *Dis Colon Rectum*. 1982;25(5):494-501. PubMed PMID: 7047106.

- [94] Madiba TE, Thomson SR. The management of cecal volvulus. *Dis Colon Rectum*. 2002;45(2):264-7. PubMed PMID: 11852342.
- [95] Hassan C, Zullo A, De Francesco V, Ierardi E, Giustini M, Pitidis A, et al. Systematic review: Endoscopic dilatation in Crohn's disease. *Alim Pharmacol Therapeut*. 2007;26(11-12):1457-64. doi: 10.1111/j.1365-2036.2007.03532.x. PubMed PMID: 17903236.
- [96] Ramboer C, Verhamme M, Dhondt E, Huys S, Van Eygen K, Vermeire L. Endoscopic treatment of stenosis in recurrent Crohn's disease with balloon dilation combined with local corticosteroid injection. *Gastrointest Endosc*. 1995;42(3):252-5. PubMed PMID: 7498692.
- [97] Lucha PA, Jr., Fticsar JE, Francis MJ. The strictured anastomosis: successful treatment by corticosteroid injections – report of three cases and review of the literature. *Dis Colon Rectum*. 2005;48(4):862-5. doi: 10.1007/s10350-004-0838-y. PubMed PMID: 15747075.
- [98] East JE, Brooker JC, Rutter MD, Saunders BP. A pilot study of intrastricture steroid versus placebo injection after balloon dilatation of Crohn's strictures. *Clin Gastroenterol Hepatol: The official clinical practice journal of the American Gastroenterological Association*. 2007;5(9):1065-9. doi: 10.1016/j.cgh.2007.04.013. PubMed PMID: 17627903.
- [99] Brooker JC, Beckett CG, Saunders BP, Benson MJ. Long-acting steroid injection after endoscopic dilation of anastomotic Crohn's strictures may improve the outcome: a retrospective case series. *Endoscopy*. 2003;35(4):333-7. doi: 10.1055/s-2003-38145. PubMed PMID: 12664391.
- [100] Brandimarte G, Tursi A, Gasbarrini G. Endoscopic treatment of benign anastomotic colorectal stenosis with electrocautery. *Endoscopy*. 2000;32(6):461-3. doi: 10.1055/s-2000-651. PubMed PMID: 10863912.
- [101] Hagiwara A, Togawa T, Yamasaki J, Shirasu M, Sakakura C, Yamagishi H. Endoscopic incision and balloon dilatation for cicatricial anastomotic strictures. *Hepato-gastroenterology*. 1999;46(26):997-9. PubMed PMID: 10370654.
- [102] Koornstra JJ, Weersma RK. Management of rectal foreign bodies: description of a new technique and clinical practice guidelines. *World journal of gastroenterology : WJG*. 2008;14(27):4403-6. PubMed PMID: 18666334; PubMed Central PMCID: PMC2731197.
- [103] Goldberg JE, Steele SR. Rectal foreign bodies. *Surg Clin N Am*. 2010;90(1):173-84, Table of Contents. doi: 10.1016/j.suc.2009.10.004. PubMed PMID: 20109641.
- [104] Singaporewalla RM, Tan DE, Tan TK. Use of endoscopic snare to extract a large rectosigmoid foreign body with review of literature. *Surgical Laparosc, Endosc Percut Tech*. 2007;17(2):145-8. doi: 10.1097/SLE.0b013e318045bf1a. PubMed PMID: 17450100.

- [105] Humes D, Lobo DN. Removal of a rectal foreign body by using a Foley catheter passed through a rigid sigmoidoscope. *Gastrointestinal Endosc.* 2005;62(4):610. PubMed PMID: 16185979.
- [106] Billi P, Bassi M, Ferrara F, Biscardi A, Villani S, Baldoni F, et al. Endoscopic removal of a large rectal foreign body using a large balloon dilator: report of a case and description of the technique. *Endoscopy.* 2010;42 Suppl 2:E238. doi: 10.1055/s-0030-1255573. PubMed PMID: 20931459.
- [107] Rex DK, Lieberman D, Acg. ACG colorectal cancer prevention action plan: update on CT-colonography. *Am Journal of Gastroenterol.* 2006;101(7):1410-3. doi: 10.1111/j.1572-0241.2006.00585.x. PubMed PMID: 16863539.
- [108] Rockey DC, Barish M, Brill JV, Cash BD, Fletcher JG, Sharma P, et al. Standards for gastroenterologists for performing and interpreting diagnostic computed tomographic colonography. *Gastroenterology.* 2007;133(3):1005-24. doi: 10.1053/j.gastro.2007.06.001. PubMed PMID: 17678924.
- [109] Zalis ME, Barish MA, Choi JR, Dachman AH, Fenlon HM, Ferrucci JT, et al. CT colonography reporting and data system: a consensus proposal. *Radiology.* 2005;236(1):3-9. doi: 10.1148/radiol.2361041926. PubMed PMID: 15987959.
- [110] Neugut AI, Garbowski GC, Wayne JD, Forde KA, Treat MR, Tsai JL, et al. Diagnostic yield of colorectal neoplasia with colonoscopy for abdominal pain, change in bowel habits, and rectal bleeding. *Am J Gastroenterol.* 1993;88(8):1179-83. PubMed PMID: 8338084.
- [111] Kueh SH, Zhou L, Walmsley RS. The diagnostic yield of colonoscopy in patients with isolated abdominal pain. *N Zea Med J.* 2013;126(1382):36-44. PubMed PMID: 24154768.
- [112] Longstreth GF, Thompson WG, Chey WD, Houghton LA, Mearin F, Spiller RC. Functional bowel disorders. *Gastroenterology.* 2006;130(5):1480-91. doi: 10.1053/j.gastro.2005.11.061. PubMed PMID: 16678561.
- [113] Roberts MC, Millikan RC, Galanko JA, Martin C, Sandler RS. Constipation, laxative use, and colon cancer in a North Carolina population. *Am J Gastroenterol.* 2003;98(4):857-64. doi: 10.1111/j.1572-0241.2003.07386.x. PubMed PMID: 12738468.
- [114] Jacobs EJ, White E. Constipation, laxative use, and colon cancer among middle-aged adults. *Epidemiology.* 1998;9(4):385-91. PubMed PMID: 9647901.
- [115] Kune GA, Kune S, Field B, Watson LF. The role of chronic constipation, diarrhea, and laxative use in the etiology of large-bowel cancer. Data from the Melbourne colorectal cancer study. *Dis Colon Rectum.* 1988;31(7):507-12. PubMed PMID: 3391059.
- [116] Watanabe T, Nakaya N, Kurashima K, Kuriyama S, Tsubono Y, Tsuji I. Constipation, laxative use and risk of colorectal cancer: The Miyagi Cohort Study. *Eur J Can.* 2004;40(14):2109-15. doi: 10.1016/j.ejca.2004.06.014. PubMed PMID: 15341986.

- [117] Dukas L, Willett WC, Colditz GA, Fuchs CS, Rosner B, Giovannucci EL. Prospective study of bowel movement, laxative use, and risk of colorectal cancer among women. *Am J Epidemiol*. 2000;151(10):958-64. PubMed PMID: 10853634.
- [118] Anderson JC, Lacy BE. Editorial: Constipation and colorectal cancer risk: a continuing conundrum. *Am J Gastroenterol*. 2014;109(10):1650-2. doi: 10.1038/ajg.2014.292. PubMed PMID: 25287089.
- [119] Power AM, Talley NJ, Ford AC. Association between constipation and colorectal cancer: systematic review and meta-analysis of observational studies. *Am J Gastroenterol*. 2013;108(6):894-903; quiz 4. doi: 10.1038/ajg.2013.52. PubMed PMID: 23481143.
- [120] Obusez EC, Lian L, Kariv R, Burke CA, Shen B. Diagnostic yield of colonoscopy for constipation as the sole indication. *Colorect Dis: The official journal of the Association of Coloproctology of Great Britain and Ireland*. 2012;14(5):585-91. doi: 10.1111/j.1463-1318.2011.02664.x. PubMed PMID: 21689337.
- [121] Virgilio C, Cosentino S, Favara C, Russo V, Russo A. Endoscopic treatment of post-operative colonic strictures using an achalasia dilator: short-term and long-term results. *Endoscopy*. 1995;27(3):219-22. doi: 10.1055/s-2007-1005674. PubMed PMID: 7664698.
- [122] Sabate JM, Villarejo J, Bouhnik Y, Allez M, Gornet JM, Vahedi K, et al. Hydrostatic balloon dilatation of Crohn's strictures. *Alim Pharmacol Therapeut*. 2003;18(4):409-13. PubMed PMID: 12940926.
- [123] Morini S, Hassan C, Lorenzetti R, Zullo A, Cerro P, Winn S, et al. Long-term outcome of endoscopic pneumatic dilatation in Crohn's disease. *Dig Liver Dis: Official journal of the Italian Society of Gastroenterology and the Italian Association for the Study of the Liver*. 2003;35(12):893-7. PubMed PMID: 14703886.
- [124] Ramage JL, Jr., Baron TH. Percutaneous endoscopic cecostomy: a case series. *Gastrointest Endosc*. 2003;57(6):752-5. doi: 10.1067/mge.2003.197. PubMed PMID: 12709715.
- [125] Ness RM, Manam R, Hoen H, Chalasani N. Predictors of inadequate bowel preparation for colonoscopy. *Am J Gastroenterol*. 2001;96(6):1797-802. doi: 10.1111/j.1572-0241.2001.03874.x. PubMed PMID: 11419832.
- [126] Van Dongen M. Enhancing bowel preparation for colonoscopy: an integrative review. *Gastroenterol Nurs: The official journal of the Society of Gastroenterology Nurses and Associates*. 2012;35(1):36-44. doi: 10.1097/SGA.0b013e3182403413. PubMed PMID: 22306728.
- [127] Committee AT, Kethu SR, Banerjee S, Desilets D, Diehl DL, Farraye FA, et al. Endoscopic tattooing. *Gastrointest Endosc*. 2010;72(4):681-5. doi: 10.1016/j.gie.2010.06.020. PubMed PMID: 20883844.
- [128] Park JW, Sohn DK, Hong CW, Han KS, Choi DH, Chang HJ, et al. The usefulness of preoperative colonoscopic tattooing using a saline test injection method with pre-

packaged sterile India ink for localization in laparoscopic colorectal surgery. *Surg Endosc.* 2008;22(2):501-5. doi: 10.1007/s00464-007-9495-2. PubMed PMID: 17704874.

- [129] Trakarnsanga A, Akaraviputh T. Endoscopic tattooing of colorectal lesions: Is it a risk-free procedure? *World J Gastrointest Endosc.* 2011;3(12):256-60. doi: 10.4253/wjge.v3.i12.256. PubMed PMID: 22195235; PubMed Central PMCID: PMC3244942.
- [130] Hamdani U, Naeem R, Haider F, Bansal P, Komar M, Diehl DL, et al. Risk factors for colonoscopic perforation: a population-based study of 80118 cases. *World J Gastroenterol: WJG.* 2013;19(23):3596-601. doi: 10.3748/wjg.v19.i23.3596. PubMed PMID: 23801860; PubMed Central PMCID: PMC3691036.
- [131] Polter DE. Risk of colon perforation during colonoscopy at Baylor University Medical Center. *Proceedings.* 2015;28(1):3-6. PubMed PMID: 25552784; PubMed Central PMCID: PMC4264696.
- [132] Rex DK, Petrini JL, Baron TH, Chak A, Cohen J, Deal SE, et al. Quality indicators for colonoscopy. *Am J Gastroenterol.* 2006;101(4):873-85. doi: 10.1111/j.1572-0241.2006.00673.x. PubMed PMID: 16635231.
- [133] Cappell MS. Safety and efficacy of colonoscopy after myocardial infarction: an analysis of 100 study patients and 100 control patients at two tertiary cardiac referral hospitals. *Gastrointest Endosc.* 2004;60(6):901-9. PubMed PMID: 15605004.
- [134] Chokshi RV, Hovis CE, Hollander T, Early DS, Wang JS. Prevalence of missed adenomas in patients with inadequate bowel preparation on screening colonoscopy. *Gastrointest Endosc.* 2012;75(6):1197-203. doi: 10.1016/j.gie.2012.01.005. PubMed PMID: 22381531.
- [135] Committee ASoP, Harrison ME, Anderson MA, Appalaneni V, Banerjee S, Ben-Menachem T, et al. The role of endoscopy in the management of patients with known and suspected colonic obstruction and pseudo-obstruction. *Gastrointest Endosc.* 2010;71(4):669-79. doi: 10.1016/j.gie.2009.11.027. PubMed PMID: 20363408.

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