Colon Diverticula and Diverticulosis

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Contents

I. Introduction 5
II. Frequency and localization of diverticula 7
III. Causes and development of diverticula 9
IV. Symptomatic diverticulosis 10
V. Diverticular disease 12
  1. Diverticulitis 12
  2. Bleeding 14
  3. Fistulae 14
  4. Perforation 15
  5. Stenosis 15
VI. Diagnosis 16
  1. Radiological examinations 16
  2. Colonoscopy 20
  3. Ultrasound and computed tomography 22
VII. Therapy 24
  1. Conservative treatment of diverticulosis 24
  2. Conservative treatment of diverticulitis 28
  3. Surgical treatment of diverticulitis 30
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I. Introduction

Diverticula can occur at any point in the gastrointestinal tract (esophagus, stomach, small bowel and colon). We distinguish between congenital or inborn diverticula and diverticula that have been acquired at some point in life. They are particularly frequent in nations with a high standard of living and constitute one of the so-called diseases of civilization.

Diverticula of the colon are, in most cases, acquired outpouchings of the mucosal layer of the bowel through gaps in the bowel wall musculature (figures 1 and 2).

Figure 1: Surgical specimen of the colon including a diverticulum.
Diverticulosis describes the presence of multiple, non-inflamed diverticula, but says nothing about their localization or the patient’s symptoms.

Diverticulitis is defined as the inflammation of one of more diverticula. The inflammatory process may be limited to the immediate vicinity of the diverticula or may extend to surrounding structures and organs.

The term diverticular disease is applied to that condition in which diverticula are symptomatic, inflamed or there are complications.
II. Frequency and localization of diverticula

The importance of diverticular disease has been recognized since the 1930’s. Since then, diverticulosis with its potential complications is considered the most common bowel disease in the Western world.

With advancing age, there is a significant increase in the frequency of diverticula (figure 3). While less than 10% of persons aged 30–40 years suffer from diverticula, this proportion rises to 20–35% in persons aged 50–60 years, increasing to over 40% in persons over 70 years of age. With advancing age, there is increase in both the number and size of diverticula. Men and women are about equally affected.

Figure 3: Frequency of colonic diverticula in relation to patients’ age.
The colon (figure 4) consists of the caecum with appendix, the ascending, transverse and descending colon, the S-shaped sigmoid colon and the rectum. The sigmoid colon is the bowel segment most frequently affected by diverticula (80–95%). The second most commonly affected segment of the colon is the descending colon, followed in frequency by the other segments. Although a large percentage of the population develops diverticula at some point in their lives, over 80% of these people remain asymptomatic.
III. Causes and development of diverticula

Although the exact causes remain unknown, it is today considered very probable that diverticulosis results primarily from segmental motility disturbances in the colon that result in localized areas of high intra-luminal pressure within the bowel. Further factors include acquired weakness of the bowel wall in the area of vascular and muscular gaps (figure 2) and changes in lifestyle and nutritional habits.

In particular, reduction in dietary intake of high-fiber foods and their substitution with food with low fiber content appears to play an important role in the development of diverticula. In regions such as South-East Asia and Africa with native diets high in dietary fiber, diverticula is only rarely reported.
IV. Symptomatic diverticulosis

Non-inflamed diverticula typically cause no symptoms by themselves; for this reason, the majority of persons affected by diverticula remain complaint free throughout their lives. Instances in which persons do experience lower abdominal pain are generally due, not to the diverticula, but to simultaneous bowel spasticity.

Patients complain of pulling or cramping abdominal pains, most commonly centered in the left lower abdominal quadrant. Patients complain of tearing or colicky abdominal pain, usually involving the left lower abdominal quadrant. This pain, secondary to a cramp-like motility disturbance of the bowel, may resolve within a few hours, but may go on for several days. Food intake may be followed by an increase in symptoms due to enhanced motility, while defecation and passage of flatus may bring improvement or even resolution of complaints. The constellation of meteorism, tenesmus, flatulence and stool irregularities points to a connection to, or simultaneous presence of, irritable bowel syndrome.

The patient’s physical examination may be completely normal. Frequently, however, a pressure sensitive colon, an abdomen distended by gas or a “palpable and pressure sensitive roll” may be noted in the left lower quadrant. Laboratory parameters are within normal limits (table 1).
<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Findings</th>
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<tr>
<td>• Tenesmus</td>
<td>• Gas-distended abdomen</td>
</tr>
<tr>
<td>• Meteorism</td>
<td>• Palpable “roll” in the lower abdomen</td>
</tr>
<tr>
<td>• Stool irregularities</td>
<td>• Pressure-sensitive colon</td>
</tr>
<tr>
<td>• Feeling of fullness</td>
<td>• No derangement of laboratory parameters</td>
</tr>
<tr>
<td>• Changing localization and intensity of complaints with symptom-free intervals</td>
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Table 1: Symptoms and findings of irritable bowel syndrome with and without diverticulosis.
V. Diverticular disease

1. Diverticulitis

The most common complication of diverticulosis is the inflammation of the diverticula (diverticulitis), which occurs in about 20% of cases. Thought to trigger this inflammation is the entrapment of stool particles (fecoliths) in the diverticula (figure 5a), the constant pressure of which can lead to the formation of tiny ulcerations within the area of the diverticula (figure 5b).

If the inflammatory process extends to the entire bowel wall and even into adjacent organs, patients may experience serious complications such as abscess formation, peritonitis and the development of fistulae to adjacent organs, including other bowel segments and even the urinary bladder and vagina. Repeated bouts of inflammation in the diverticula can lead to formation of scar tissue with increased narrowing of the bowel (stenosis). Ultimately, obstruction of the bowel may develop and require surgery.

Figure 5a: Fecolith within a diverticulum.  
Figure 5b: Pressure ulcer at the margin of a diverticulum.
The inflammation of one or more diverticula manifests itself in the form of acute, usually colicky pain centered in the left lower abdominal quadrant. In addition, patients may experience fever, irregular stools (constipation, less often diarrhea), as well as nausea, vomiting and reduced general health.

If the bladder region is affected by the inflammatory process, patients may experience difficulty in urinating or having urinary urgency. In some cases, there may actually be visible blood in the urine (table 2).

The findings of the physical examination by the physician during the phase of acute inflammation (diverticulitis) reveals a distended and pressure-sensitive abdomen. The most commonly affected bowel segment is the sigmoid colon, locating in the left lower abdomen, which can be felt as a
painful “roll”. Depending on the extent of the inflammatory process, there may also be a limited inflammation of the peritoneum (the inner lining of the abdomen) with associated guarding. Laboratory tests show a moderate to significant leukocytosis or increase in the number of white blood cells (leukocytes) and of the erythrocyte sedimentation rate (ESR).

2. Bleeding

Rectal bleeding may also be due to diverticula. Significant bleeding is usually associated with non-inflamed diverticula of the ascending colon, while smaller amounts of blood are observed with inflamed diverticula. The duration and intensity of the bleeding can be variable. Bleeding stops spontaneously without therapeutic measures in over 80% of cases. About one-quarter of these patients, however, experience recurrent bleeding.

3. Fistulae

Another complication of diverticulitis is fistulation, or the formation of fistulae, which are incomplete or complete ductal structures linking the bowel segment affected by diverticula with other bowel segments. Fistulae may also form between the bowel and adjacent organs, such as the urinary bladder and vagina. In these cases, patients may experience the escape of flatus or stool through the urethra or vagina.
4. Perforation

Sometimes, diverticulitis is associated with perforation of a diverticulum. In most cases, this is not associated with acute peritonitis (inflammation of the peritoneum) because superposed adjacent bowel loops act to seal the defect. Perforation may begin with discrete areas of abdominal pain or patients may be initially asymptomatic. The escape of intestinal contents through a perforated diverticulum is a rare event, but, when it does occur, it is associated with an acute and dramatic clinical picture. In these cases, patients may experience the severe complications of generalized peritonitis.

5. Stenosis

The inflammation of diverticula can result in narrowing of that section of the bowel. If inflammation is extensive or recurs, scar tissue may form, resulting in increased thickness of the bowel wall and narrowing of the bowel (stenosis). Because such narrowing does not resolve, the ultimate result may be complete obstruction of the bowel, which may require surgical therapy.
VI. Diagnosis

Diverticula are common coincidental findings of radiological or endoscopic (colonoscopic) examinations. Symptoms of lower abdominal pain with fever and an increase in the white blood cell count point to the possibility of acute diverticulitis, among other diagnoses. Consultation of a physician is essential. The type and extent of the work-up depends on the patient’s symptoms. This means consideration of all possible disorders and the appropriate tests to rule them in or out.

1. Radiological examinations

Radiological examination of the colon using double contrast technique has been largely discontinued in the work-up of diverticulosis. Diverticula appear as circumscribed, contrast-enhanced outpouchings of the intestinal wall (figure 6). They may continue to be visible for days after the initial examination as round or oval structures filled with contrast medium, ranging in size from a pea to a hazelnut (figure 7).

Figure 6: Radiograph showing extensive diverticulosis.
Changes in the mucosal surface, narrowing of the bowel and absent motility in an area of the bowel known to be affected by diverticula can all be signs of acute or chronic diverticulitis (figure 8).

Radiological examination by itself cannot definitively determine whether narrowing of the bowel (stenosis) in a patient with known diverticula is due to inflammation or whether it may actually be caused by a tumor. In such cases, endoscopy (colonoscopy) with biopsy (tissue sampling) must be part of further work-up. The development of

Figure 7: Radiograph obtained 72 hours after contrast medium enema. Contrast medium can still be seen in the diverticula.
fistulae (figure 9), a possible complication of diverticulitis, can also be identified radiologically. In cases of bleeding from diverticula, simple radiological imaging of the colon is not useful: Here, dye is injected into an artery, permitting visualization of the vessels (angiography). If the bleeding is of sufficient quantity, the source of bleeding can be identified as a site of contrast medium escape into the bowel lumen (figure 10).
Figure 9: Radiological visualization of an incomplete fistula (arrow) in a patient with diverticulitis.

Figure 10: Radiological visualization (angiography) of the vessels supplying the colon in a patient with diverticular bleeding. At the site of bleeding, one sees a cloud-like structure representing escape of contrast medium into the bowel lumen (arrows).
2. Colonoscopy

Diverticula are easily recognized by endoscopic methods (figure 11). As a rule, colonoscopy is not performed during the acute phase of diverticulitis because the risk of injuring the bowel during the phase of acute inflammation is too high. Sometimes, inflamed diverticula cannot be seen on endoscopy. In such cases, however, one usually finds swelling and redness of the mucosal membrane at the neck of the diverticulum as a sign of inflammation (figure 12). Intestinal polyps located in segments of the bowel affected by diverticula are also more reliably detected by endoscopy than by radiologic examinations. If the distance between the polyp and the diverticular opening is sufficiently large, polyps can usually be safely removed during colonoscopy (figure 13). A further advantage of endoscopy is the detection and localization of diverticular bleeding (figure 14a), whether this is a slight ooze from an inflamed diverticulum or massive bleeding from non-inflamed diverticula. Besides identification of a bleeding site, it may in many cases be possible to stop the bleeding by, for example, injecting medications to constrict the vessels (figure 14b).

Figure 11: Endoscopic findings of extensive diverticulosis.
Figure 12: Endoscopic findings of acute diverticulitis.

Figure 13: Endoscopic evidence of diverticula and a polyp in the same bowel segment (sigmoid colon).

Figure 14a: Endoscopic evidence of diverticular bleeding.

Figure 14b: Endoscopic procedure to stop diverticular bleeding by injection of dilute epinephrine solution.
3. Ultrasound and computed tomography

Formerly, abdominal ultrasound and computed tomography (CT) were used only for demonstration or exclusion of serious complications in patients with diverticulitis, such as abscesses or conglomerate tumors (significant inter-loop adhesions of the bowel).

With increasing experience and the introduction of high-resolution ultrasound scanners, diagnostic ultrasound can provide reliable information on the thickness of the bowel wall, the presence of asymptomatic diverticula, evidence of diverticulitis and other complications of diverticulitis (figures 15, 16a and 16b). Thus, ultrasound has taken an established place besides physical examination and laboratory tests in the initial work-up of diverticulitis.

Figure 15: Computed tomography findings of an abscess (arrows) in the lower abdomen as a consequence of a perforated diverticulum in a patient with acute diverticulitis.
In addition, both ultrasound and CT provide the option of guided puncture to confirm the diagnosis in cases in which an abscess is suspected and this can be followed by evacuation or drainage as a definitive therapeutic measure. This may avoid surgery or obviate the need for multiple surgical procedures. Ultrasound also provides a means for regular monitoring of the clinical course of diverticulitis without exposing the patient to unnecessary radiation or discomfort.

Figure 16a

Figure 16b: Ultrasound findings in a patient with acute diverticulitis: thickened bowel wall with a diverticulum in longitudinal section (figure 16a) and transverse section (figure 16b).
VII. Therapy

While patients with asymptomatic diverticulosis do not require medical or surgical therapy, those with diverticular disease can be offered conservative or surgical treatment options that differ with the patient’s symptoms and the extent of the inflammation.

1. Conservative treatment of diverticulosis

Patients with diverticulosis and functional complaints (abdominal cramps, bloating, stool irregularity, feeling of fullness) without evidence of inflammation are advised to adopt a high-fiber diet including the use of wheat bran (table 3).

Dietary fiber consists of substances that act as bulking agents because of their ability to bind water without being digested by the human body. Common types of fiber include cellulose, the hemicelluloses, pectins, lignin, indigestible polysaccharides and alginates. The physical properties of these substances are very diverse but all share the capacity to increase the stool mass, reducing pressure in the bowel and shortening the stool transit time in the bowel. Besides whole

- High-fiber diet
- Wheat bran
- Other bulking agents
- Adequate fluids
- Moist-warm compresses
- Lactulose (for constipation)
- Medications that relieve cramps

Table 3: Treatment of diverticulosis with functional complaints.
grain products, important sources of dietary fiber include vegetables, potatoes, salads, fruit, and grains (table 4).

<table>
<thead>
<tr>
<th>Fruits</th>
<th>grams of fiber per 100 grams</th>
<th>Graham crackers</th>
<th>Pasta</th>
<th>Rolls</th>
<th>Rye bread</th>
<th>Wheat bread</th>
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<table>
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<tr>
<th>Grains and Baked goods</th>
<th>grams of fiber per 100 grams</th>
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<th>Cabbage</th>
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<th>Lettuce</th>
<th>Peas</th>
<th>Potatoes</th>
<th>Sauerkraut</th>
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<th>Tomatoes</th>
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Table 4: Fiber content of some foods (from: Wissenschaftliche Tabellen Geigy, 1985).
In addition, with adequate fluid intake (1.5–2.5 liters per day), patients can take 10–25 grams of wheat bran. A comparison of fiber derived from different foods has shown that wheat bran causes the greatest increase in stool weight. The effect is most pronounced when wheat bran is coarse and not finely milled. Untreated brans also have a greater effect than do cooked brans.

Patients with a tendency to constipation require generalized measures (table 5). Good-tasting muesli preparations (table 6) are recommended. In place of white bran, the pharmaceutical industry has introduced numerous effective bulking agents such as karaya gum, Plantago ovata etc. The daily dose of an agent such as Plantago ovata seed shells is 5–15 grams per day. High-fiber diet and bulking agents may take weeks or months of regular use to produce any improvement in symptoms. Adequate fluid intake of 1.5–2.5 liters per day is essential.

The activity of the colon is also affected by the type of beverage. While coffee, mineral water and fruit juice stimulate passage of stool, black tea, cocoa, and red wine may cause or worsen constipation.
• Before breakfast, take a glass of cool water containing a level teaspoon of magnesium sulfate (or sodium bicarbonate). Gradually reduce use as constipation improves.

• For breakfast, four heaping tablespoons of oatmeal and four heaping tablespoons of wheat bran, together with one tablespoon of lactulose and cold milk. Mix well.

• For breakfast, whole grain bread, if desired with prune jam and herbal tea (peppermint, rose hips, mallow). If desired, bean coffee prepared as espresso.

• After breakfast, spend the next 5–10 minutes in the bathroom and attempt to pass stool. It is important to relax and not press excessively. Be patient if you are not successful the first few times.

• For your main meals, include much high-fiber food (salads, radishes, cucumbers, sauerkraut, oranges, apples, nuts or dried apricots and plums).

• Protein-containing foods that are recommended include sour milk, kefir and yogurt. Alcoholic beverages include dry white wines (Mosel, Franconia), if desired, with high-magnesium mineral waters.

• Physical exercise and occasional massage of the back and abdomen.

• Adequate fluid intake, especially in older persons (1½–2½ liters per day)

• 1–2 pouches of Macrogol per day.

• 1–6 tablespoons of lactulose.

• Constipation is promoted by low-fiber foods (too little fruit and salads, white bread and sweets), chocolate, red wine, strong black tea and codeine-containing pharmaceuticals (analgesics, cough remedies).

Table 5: Basic treatment of chronic constipation (alternative options).
Patients with cramping abdominal pain often get relief from moist warm compresses on the abdomen (hot-water bottle with moist towel).

Your physician may temporarily prescribe medication that will relieve the cramps. Analgesics should only be used for short periods and only after consulting your doctor.

2. Conservative treatment of diverticulitis

Non-complicated acute diverticulitis can be treated conservatively (i.e., without surgery) in the great majority of cases. For better monitoring of the patient and in order to quickly recognize complications, this treatment normally requires hospitalization. Initially, patients are placed on bed rest, absolute avoidance of any food by mouth

### Muesli recipe

- One-half cup of all-purpose muesli
- One cup of yogurt
- One teaspoon of pine seeds
- One teaspoon of ground hazelnuts
- One teaspoon of sunflower seeds
- One-half teaspoon of sesame seeds
- One-half teaspoon of oatmeal
- One teaspoon of raisins
- Two teaspoons of grated apple
- One teaspoon of honey
- Juice from one half lemon

Mix ingredients and eat for breakfast.

Table 6: Muesli recipe for the treatment of constipation.
and replacement of fluid through an intravenous catheter (table 7).

- Fasting
- Parenteral nutrition
- Antibiotics
- Analgesics
- Spasmolytics (cramp-relieving medications)

Table 7: Treatment of non-complicated acute diverticulitis.

In addition, spasmolytic medication or analgesics may be temporarily required. In general, patients also undergo 7–10 days of antibiotic therapy.

The majority of patients become free of complaints after only a few days of this therapy. Regular laboratory and ultrasound monitoring together with physical examinations are necessary in order to promptly recognize complications (bleeding, abscess formation, perforation, fistulation etc.). In mild cases, diet may be advanced rapidly with tea and crackers or by use of a liquid diet that is completely absorbed in the upper small bowel. As the inflammation subsides and patients’ complaints resolve, a high-fiber diet including bulking agents can be started. Mild bleeding in cases of acute diverticulitis normally resolves spontaneously without need for surgery. About one-half of all patients experience recurrent inflammatory episodes, with some of these patients ultimately requiring surgery.

If diverticulitis recurs frequently, especially in elderly persons or in patients with other serious disease, long-term antibiotic treatment may represent an alternative to surgery. Studies have
shown that the addition of anti-inflammatory medications may also reduce the rate of inflammatory episodes.

3. Surgical treatment of diverticulitis

Diverticulosis in patients with primarily asymptomatic disease is never an indication for surgical therapy except in rare cases of massive hemorrhage that cannot be controlled with conservative measures. Perforations, abscess formation and intestinal obstruction as complications of diverticulitis represent emergent indications for surgery. Also considered absolute indications for surgery are fistulae and cases in which carcinoma of the colon cannot be definitively excluded from the differential diagnosis.

Inadequate response to antibiotic therapy in cases of acute inflammation, repeated episodes of diverticulitis, and bleeding, as well as problems with urination, may also be considered indications for a surgical approach (table 8).

A rule of thumb is that surgical removal of the affected bowel segment should occur if a patient experiences two episodes of diverticulitis within one year or three episodes within three years. Some centers even recommend surgery after the first episode. In any case, the decision for surgery must weigh all individual factors. The success of an operation is dependent to a great extent on selection of the optimum time. This requires use of clinical and imaging methods for determining of the most appropriate time for surgery when the risk to the patient is lowest.
At the same time, care is taken to spare patients the burden of multiple operations, which used to be common in such cases.

In some instances of emergency surgery it will be necessary to create an artificial outlet for the bowel. In most cases, however, the normal continuity of the bowel can be re-established by means of a second operation within a few weeks.

Abscesses that form in the abdominal cavity can today often be reduced or drained by means of a puncture needle inserted through the skin under ultrasound or computed tomographic guidance. These methods continue to reduce the number of operations. Larger abscesses, however, must generally be treated surgically.

**Emergent indications for surgery**
- Perforated diverticula with peritonitis and/or abscess formation
- Bowel obstruction
- Fistulae
- Suspected colon cancer

**Potential indications for surgery**
- Persistent complaints despite therapy
- Repeated episodes of inflammation
- Repeated bleeding
- Persistent problems with urination

**Table 8:** Emergent and potential indications for surgical treatment of diverticulitis.
Mucofalk® Orange. Active ingredient: Isphagula husk, ground (Plantago ovata seed shells). **Composition:** 5 g of granules (1 sachet or 1 level measuring spoon) contains: active ingredient: 3.25 g of Isphagula husk, ground. Other ingredients: sucrose (saccharose), citric acid, dextrin, sodium alginate, sodium citrate 2 H2O, orange flavouring, sodium chloride, saccharin sodium. **Indications:** chronic constipation, diseases in which easier bowel movements with soft stools are desirable, e.g. anal fissures, haemorrhoids, following surgery in the rectum area. As supportive treatment in diarrhoea of various causes and in irritable bowel syndrome. **Contraindications:** hypersensitivity to Isphagula or any of the excipients, excessively hard stools, abdominal complaints and pain, nausea and vomiting until the causes have been medically established, following any sudden change in bowel habits lasting longer than 2 weeks, after taking a laxative if no defaecation has occurred, undiagnosed rectal haemorrhage, dysphagia or nausea, stenosis of the oesophagus, cardia or gastrointestinal tract, threatened or actual ileus or megacolon syndrome, disturbance of water and electrolyte balance, disorders accompanied by limited fluid intake, poorly controlled diabetes mellitus. Not to be administered to children under 12 years of age. **Side effects:** increased flatulence and a feeling of fullness in the first few days of treatment, which subside on continued treatment. Hypersensitivity reactions (anaphylaxis-like reactions may occur). One case of bronchospasm has been described. In these cases, the patient should stop taking the medicine and consult a doctor. Contains sodium compounds. **Interactions:** See patient information leaflet. **Dosage instructions:** adults and adolescents from over 12 years: 1 level measuring spoon or the contents of one sachet stirred into plenty of fluid 2-6 times daily. Date of information: 04/2006