The informed patient

Colorectal cancer

Colon carcinoma
Rectal carcinoma

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Introduction: What you need to know

1.1 What are the colon and rectum? Where are they located?

The large bowel, or colon, and the rectum are located at the end of the digestive tract. The colon is about 1.5 meters long and forms a frame around the abdomen. The digested food passes out of the small bowel into the ascending colon. From here, it is transported into the transverse colon. After passing through this bowel segment, it moves into the descending colon, which stretches along the left side of the abdomen and extends downwards. In the lower abdomen, the colon forms an S-shaped curve which gives this segment the name “sigmoid” or “sigmoid colon” (figure 1).
This S-shaped segment is the final part of the colon. The remaining 16 cm of the bowel is known as the rectum, and is connected via the anal canal to the anus. The rectum is divided into three segments: the upper, middle and lower thirds. This division into thirds is of clinical relevance because treatment of tumors differs according to the third of the rectum in which they are located (figure 2).

1 Upper third of the rectum
2 Middle third of the rectum
3 Lower third of the rectum
4 Anal canal
5 Anus
6 Sphincter
1.2 What is the importance of blood vessels and lymphatic vessels in colorectal cancer?

Arteries supply the bowel with blood. Veins carry the blood through the liver and back to the heart. The superior mesenteric artery originates directly from the aorta (the central artery which passes down from the heart through the abdomen) and after splitting into two main branches, supplies the ascending colon and the transverse colon with blood. The descending colon and sigmoid are supplied from the inferior mesenteric artery. This artery also has a branch which supplies the upper part of the rectum. The middle and lower thirds of the rectum are supplied by branches of the internal pelvic artery. Lymph vessels are responsible for the drainage of fluid (lymph) and small amounts of protein from the tissues. The lymph vessels of the colon and rectum run parallel to the blood vessels and branch into the regional lymph nodes. Removal of lymph nodes is an important part of surgery for colorectal cancer as lymph node metastases are a decisive factor for the patient’s prognosis.

1.3 What is the structure of the bowel wall?

The structure of the bowel wall follows a uniform plan. From inside to out, the layers of the bowel wall are as follows:

1st layer: **Mucosa.** Once a tumor spreads beyond the mucosal membrane, this is known as colorectal cancer.

2nd layer: **Submucosa.** This layer contains the blood vessels, lymph vessels and nerve fibers. If a tumor reaches this layer, there is contact between tumor cells and blood and lymph vessels, making it possible for tumor cells to spread to other organs or lymph nodes.

3rd layer: **Muscularis.** This layer contains muscle tissues arranged along the longitudinal and transverse axes of the bowel. This allows the bowel to contract and propel the bowel contents forwards.
4th layer: **Adventitia (Serosa)**. This consists of thin connective tissues. In some bowel segments, the outermost layer is formed directly from the peritoneum (inner layer of the abdominal wall).

A knowledge of the fine structure of the intestinal wall is important for understanding the depth of tumor growth. The deeper a tumor grows, i.e. the more layers it invades, the poorer the patient’s prognosis. There is also an increased probability that tumor cells can gain access to the lymph system or blood vessels and form colonies (metastases) in distant tissues.

### 1.4 How does digestion work?

In the digestive process, food is broken down with the aid of enzymes as it passes through the digestive tract. The resulting nutrient components can then be absorbed by the body. In humans, digestion largely takes place in the mouth, stomach, duodenum and the rest of the small bowel, but nutrients are absorbed almost exclusively in the duodenum and small bowel. About 80% of the water contained in the porridge-like mass of digested food (chyme) is absorbed in the small bowel. The chyme is further thickened in the colon, where 19% of the remaining water is absorbed. The colon is inhabited by microorganisms which make up the so-called intestinal flora. These microorganisms break down certain vegetable substances by fermentation, making them easier to process. Substances which are not broken down by digestive enzymes in the small bowel and are not subject to fermentation by microorganisms in the colon are excreted unchanged through the rectum. No digestion takes place in the rectum. The colon and the rectum are not digestive organs which are necessary for life. If they are no longer present, the remaining bowel can assume most of their functions. Patients can therefore expect a good quality of life after bowel surgery.
1.5 How does an adenoma develop into carcinoma?

Colorectal cancers are among the best-researched malignancies. Most colorectal tumors develop from initially benign bowel polyps. The degeneration of benign bowel polyps (adenomas) which ultimately progress to malignant colorectal cancer (carcinoma) is known as the adenoma-carcinoma sequence (figure 3) and is a process which may extend over a number of years. Causes of this degeneration include successive changes (mutations) to genes in the cells of the mucosal membrane of the bowel wall. These lead to a loss of the natural mechanisms which curb the uncontrolled growth of these cells, allowing them to spread as cancer cells.

In the course of time, certain cells inside the adenoma experience further gene mutations. These cells turn into malignant cancer cells (carcinoma). They begin to ignore the normal boundaries between tissues and spread into neighboring structures. This is known as “invasive tumor growth”. These cancer cells gradually invade the entire bowel wall, eventually escaping from their cell mass. Carried by the blood or lymphatic fluid, they are transported to other parts of the body and form daughter tumors. These colonies are known as metastases.

It is estimated that colorectal cancer can develop from an intestinal polyp within five to ten years. The risk of cancer increases with age. Most patients with colorectal cancer are over 50. Gene mutations may also be hereditary, i.e. they have been inherited from the patient’s parents. In such cases, damage progress is much more rapid and patients may develop cancer at a much younger age. Special attention is needed in cases of hereditary or familial risk.
Normal colon mucosa (healthy bowel epithelium). The violet line marks the muscle layer of the mucous membrane, the so-called muscularis mucosae.

Local mucosal overgrowth (adenoma at an early stage).

Mucosal polyp (late-stage adenoma), still benign but exhibiting low-grade to high-grade cell changes.

Colorectal cancer (invasive carcinoma; the muscularis mucosae has been invaded by tumor cell masses).

Fig. 3 Adenoma-carcinoma sequence
1.6 How is colorectal cancer studied?

Besides activities directly related to the treatment of patients, academic hospitals are also involved in other important research and teaching tasks. They conduct clinical and basic research into the long-term improvement of treatment, care and follow-up monitoring of all patients with colorectal cancer.

Clinical studies

Clinical research involves testing certain medications or treatment methods under controlled conditions in the clinic. Care of the patient always has top priority here. Despite the great progress made in colorectal cancer treatment, there are still countless unanswered questions which can only be reliably investigated in the context of clinical studies. Participation in these studies is always strictly voluntary. An advantage of taking part in a study is that the patient has the opportunity of being treated with the latest, most promising drugs or therapeutic methods. Study participation also contributes to a better understanding of cancer and its treatment, which will in turn benefit future patients.

Basic research

Although colorectal cancers are among the best studied types of cancer, there are still many unanswered questions concerning their origin, growth and metastasis. A number of research groups throughout the world have set themselves the task of promoting an even better understanding of the origin of these tumors, their growth patterns, interaction with surrounding tissues and invasion of other organs. It is hoped that in the long run this research will contribute to better methods of early detection and treatment. The unraveling of the human genome could mean that one day the medical profession may be in a position to prevent the development of tumors.
2.1 What is cancer?
2.2 What is colorectal cancer and how frequent is it?
2.3 Risk factors for the development of colorectal cancer
2.4 What are the signs of cancer?
2.5 How can colorectal cancer be detected early (preventive screening)?
2.6 What methods are available for prevention and early detection?
2.7 What examinations will I undergo with colorectal cancer?
Colorectal cancer

2.1 What is cancer?

“Cancer” is the term used to designate a malignant growth of cells arising from the degeneration of the body’s own cells. Characteristic of cancer cells is their altered cell structure (cell atypia), their capacity to invade neighboring tissues or organs (invasivity) and to seed distant organs, giving rise to daughter tumors (metastases). Cancer can start in any part of the human body. There are three main types of cancer, depending on their origin:

1. **Carcinomas** originate in the covering layer (epithelium) of the skin, mucosal membrane or glands. They are the most frequent type of cancer in humans. Colorectal cancers belong to this group.
2. **Sarcomas**, develop in the connective, supporting or neural tissues.
3. Non-solid, diffuse types of cancer such as **leukemias** and **lymphomas** develop in blood-forming organs such as the bone marrow and spleen as well as in the lymphatic tissues.

2.2 What is colorectal cancer and how frequent is it?

As the name implies, colorectal cancer develops in the colon (colon carcinoma) or rectum (rectal carcinoma). Cancers of the small bowel and the anal region (anal carcinoma) are rarer. Colorectal carcinomas are among the most frequent malignant diseases in western industrial countries. Colorectal cancer is the third most common cancer in both men and women in the United States. Every year, about 147,000 persons develop colorectal cancer, with about 50,000 deaths. Colorectal cancer can attack anyone. Colorectal cancer incidence rates have been decreasing for most of the past two decades. Reasons are increases in screening that allow the detection and removal of colorectal polyps before they progress to
cancer. Colorectal cancer can develop in any segment of the colon and rectum, but the most commonly affected locations are the lower 40 cm of the colon and the rectum (about 60% of cases).

2.3 Risk factors for the development of colorectal cancer

Although the reasons for the development of colorectal cancer are not fully understood, scientists have identified certain risk factors which increase the personal risk of developing colorectal carcinoma.

An increased risk of colorectal cancer is associated with

- Unfavorable habits such as a diet high in meat and fat and low in fiber, smoking, alcohol consumption, overweight, and inadequate exercise
- Inflammatory bowel diseases (ulcerative colitis, Crohn’s disease)
- Certain bowel polyps (adenomas)
- Family history of colorectal cancer or bowel polyps (adenomas)
- The presence of certain other types of cancer, such as cancer of the breast, ovary or uterus

2.4 What are the signs of cancer?

Colorectal cancer does not develop and grow overnight. It takes months and years for this to happen. This is why no or only very few signs of the disease (symptoms) are evident. Intestinal bleeding and obstruction of intestinal passage are key symptoms which affect patients as the disease progresses.
The following symptoms can occur with colorectal cancer:

- Changed stool habits, alternation of constipation and diarrhea, “pencil stool”, or frequent urges to defecate without passage of stool
- Blood in or on the stool
- Repeated, cramping abdominal pains
- Loud bowel sounds, persistent bloating, foul-smelling stool
- Palpable masses in the abdomen or near the lymph nodes
- General symptoms such as reduced energy and weight loss

These symptoms do not confirm colorectal cancer. They may also be found in a variety of other diseases. This makes it all the more urgent to obtain careful clarification of these complaints.

2.5 How can colorectal cancer be detected early (preventive screening)?

As with other forms of cancer, the general rule with colorectal cancer is that the chances of cure are better the earlier the disease is detected and treated. With early diagnosis, colorectal cancer can be almost completely prevented or cured.

Early diagnosis depends on the patient participating in the early recognition programs which are available. This is particularly crucial because of the absence of symptoms or their non-specific nature at disease onset. Screening programs include fecal occult blood test, digital rectal exam and colonoscopy. Members from families with a history of colorectal cancer should have colonoscopy earlier than members from families without increased risk for colorectal cancer.
With early diagnosis, colorectal cancer has a good prognosis and can be cured.

2.6 What methods are available for prevention and early detection?

Digital rectal examination

In this procedure, the physician examines the rectum by introducing a finger through the anus. At the same time, the sphincter muscle can be evaluated, as well as the prostate gland in men. Any unclear or suspicious findings in the rectum need to be clarified by means of a colonoscopy.

Test for occult blood in the stool (hemoccult test)

This test involves laboratory testing of three consecutive stool samples for presence of blood which is invisible to the naked eye (occult blood). Presence of blood in the stool does not necessarily mean that a person has colorectal cancer. Other causes such as hemorrhoids, bowel polyps or intestinal inflammation are in fact more common, but the source of the blood must be identified by means of colonoscopy.

Colonoscopy

Colonoscopy is the best method for detecting colorectal cancer. Colonoscopy is the only method by which tissue samples can be obtained to be examined for signs of cancer (figure 4). In addition to this, bowel polyps, which are potential precursors to cancer, can be identified and removed during the same procedure. This is the first step on the way to effective cancer prevention.
2.7 What examinations will I undergo with colorectal cancer?

If symptoms or abnormal findings at screening examinations arouse suspicion of colorectal cancer, there are a variety of diagnostic procedures available. The aim of these procedures is to determine whether a patient does in fact have cancer (tumor detection) and, if so, to determine how advanced the cancer is (tumor stage).

**Procedures to confirm diagnosis of colorectal cancer:**

- Colonoscopy (examination of the entire colon using a flexible instrument)
- Sigmoidoscopy (examination of the lower colon and rectum using a flexible instrument)
- Rectoscopy (examination of the rectum using an inflexible instrument up to 15 – 20 cm)
Colonoscopy

Colonoscopy is the single most informative method of examining the colon. It is the method of choice in the diagnosis of colorectal cancer. It consists of introducing a flexible instrument (endoscope) through the anus, which allows illumination and examination of the entire colon (colonoscopy). For optimum visualization of the interior of the bowel, the colon must first be adequately cleansed by drinking a special irrigation solution or using a laxative. Colonoscopy is the sole means of confirming colorectal cancer by obtaining a specimen of tissue. In addition to this, bowel polyps, which are a precursor to cancer, can not only be detected but also removed during the procedure.

Besides confirming the diagnosis, colonoscopy demonstrates the exact location as well as other characteristics of the colorectal cancer (figure 5).

Sigmoidoscopy and rectoscopy

This smaller version of colonoscopy comprises endoscopic examination of the sigmoid colon (lower section of the colon = sigmoidoscopy) or the rectum (rectoscopy). This procedure can be used prior to performing a full colonoscopy since about 60% of all colorectal tumors are located in the lower segment of the colon or in the rectum and a shorter cleansing process is employed for this bowel segment.

Colonoscopic images of intestinal polyps (A, B) and colon cancer (C)
Fig. 5
Endoultrasound of the rectum

By introducing an ultrasound transducer through the anus, it is possible to examine the rectum using ultrasound. Unlike rectoscopy, which visualizes the spread of rectal cancer in the interior of the bowel, endoultrasound can reveal the spread of the tumor outwards through the single bowel wall layers, surrounding tissue and neighboring lymph nodes (figure 6). It is also possible to visualize the position of the tumor in relation to the sphincter muscle. This is a key examination for rectal cancer as it provides the information needed to decide whether radiation treatment ought to be performed prior to surgery. Combined with a test of sphincter muscle function, this examination also helps to decide whether it will be possible to preserve the sphincter or whether it is preferable to create an artificial bowel outlet (ostomy).

Fig. 6
Endosonographic image of rectal carcinoma
Virtual colonoscopy

Computed tomography (CT colonography) and magnetic resonance imaging (MRI colonography) are techniques which generate images of slices of the body. Using special computer programs, the data can be further processed to produce a three-dimensional image of the interior of the bowel (figure 7). The advantage of this non-invasive examination technique is that it does not require insertion of an endoscope, as the bowel is not examined directly but depicted “virtually”. As with a “real” colonoscopy, the bowel still has to be cleansed beforehand to allow adequate visualization of the bowel wall. Disadvantages of the technique are a reduced ability to distinguish between inflammation and small polyps, the exposure to radiation, and its limited application in patients with metal implants, heart pacemakers or claustrophobia. A further clear disadvantage of the technique is that it is not possible to remove suspicious lesions or obtain tissue samples for further study. For these reasons, conventional colonoscopy remains the method of choice in the diagnosis of colorectal cancer.

Radiologic examination of the bowel (barium enema)

Barium enema is a method by which the bowel is imaged radiologically after being filled with a contrast medium (such as barium) applied through the anus (figure 8). This examination is greatly inferior to colonoscopy and is rarely used today.

Ultrasound

Ultrasound is the simplest method for examining internal organs such as the liver, kidneys or spleen. It is completely safe and painless. In order to lessen the effects of over-lying intestinal gas and thereby enhance examination quality, patients are asked to abstain from eating and drinking for several hours before the examination. Patients with colorectal cancer are given diagnostic ultrasound of the abdomen in order to determine whether the cancer has spread to other organs (metastases). The chief focus of the examination is on the condition of the liver.
Fig. 7
Virtual colonoscopy with 3D reconstruction (A, B): The arrow marks an area of narrowing of the bowel (stenosis) caused by colon cancer.
Computed tomography (CT)

Computed tomography (CT) is a special radiologic method which allows the human body to be visualized in slices. In patients with colorectal cancer, a CT scan of the abdomen and pelvis can reveal not only the bowel tumor but also potentially enlarged lymph nodes and metastases in other organs. For enhanced definition of the gastrointestinal tract, the patient drinks a contrast medium about one hour prior to the examination. Immediately before the CT scan, the colon is filled with a contrast medium applied through the anus. During the examination, a contrast medium is injected directly into a vein to improve visualization of the blood vessels and abdominal organs. Besides visualizing the tumor itself, this method is particularly suitable for detecting spread of the cancer to other organs.
Fig. 9
Magnetic resonance imaging (MRI) of the pelvis showing cancer of the rectum: Arrows indicate the tumor. (A): transverse slice; (B): sagittal slice
**Magnetic resonance imaging (MRI)**

Like CT, magnetic resonance imaging (MRI) provides imaging of the body in slices. A key difference, however, is that MRI uses alternating magnetic fields instead of radiation. Besides detecting lymph node enlargement and metastases in other organs, MRI produces extremely precise images of the anatomy and the extent of the tumor in the pelvis. This is especially important with rectal cancer. As mentioned above with regard to endoultrasound, the location of the tumor and its relation to the sphincter muscle is of decisive importance when planning surgical intervention *(figure 9)*. Use of MRI is limited in patients with heart pacemakers and metal implants and those suffering from claustrophobia. Besides its advantages in imaging the pelvis, MRI is also very useful for detecting changes in the liver.

**Positron emission tomography (PET)**

Since cancer cells grow faster and therefore require more energy and sugar than healthy cells, these characteristics can be used to detect tumors and metastases. In positron emission tomography (PET) a radioactively labeled sugar is injected which is taken up by rapidly growing, metabolically active cells (especially cancer cells), thereby making them visible on a special diagnostic display. Unlike other imaging methods such as CT or MRI, PET does not produce an anatomic depiction of the body, but detects the metabolism and vitality of (cancer) cells. PET is not tumor-specific and is not used routinely for clarification of colorectal cancer.
Imaging of rectal carcinoma with positron emission tomography (PET) (A), computed tomography (CT) (B), and combined PET-CT (C), arrows indicate the tumor.

Fig. 10
Imaging of 2 liver metastases with positron emission tomography (PET) (A), computed tomography (CT) (B), and combined PET/CT (C), arrows indicate the metastases.
At present, this method is only employed for special tasks such as searching for metastases, detecting possible disease recurrence as part of follow-up monitoring of patients with colorectal cancer or assessing response to chemotherapy or radiotherapy (figures 10, 11).

**Chest X-ray**

In patients with colorectal cancer, this standard radiologic examination is used for a general evaluation of the heart and lung and also to detect any metastases in the lung. In case of suspicious findings, a CT examination of the chest is performed.

**Blood tests**

General blood tests assess the functions of individual organs such as the kidneys or the liver. In patients with cancer, the levels of so-called “tumor markers” can also be determined.

“Tumor markers” are substances which are produced in greater quantities by tumor cells but are otherwise unspecific and are also present in healthy persons. This means that a negative or normal tumor marker level does not completely exclude cancer. Nor does an elevated tumor marker level in itself confirm cancer.

A more habitual use of tumor markers is after surgical tumor removal for follow-up monitoring of patients whose levels were previously elevated. During follow-up monitoring, a new increase in a tumor marker may indicate disease recurrence. The most significant marker for colorectal cancer is CEA (carcinoembryonic antigen).
Staging methods (quantifying the extent of the cancer):

- Ultrasound examination of the rectum (endoultrasound)
- Ultrasound examination of the abdomen
- Chest X-ray
- Computed tomography of the chest, abdomen and pelvis (CT)
- Magnetic resonance imaging of the pelvis (MRI)
- Blood tests, including tumor markers (CEA)

Apart from examinations to determine the extent of the cancer, preparation for surgery always includes the evaluation of a patient’s surgical risk. The physician’s main objective is to ensure patients will tolerate the planned operation well.

Assessment of surgical risk:

- Blood tests
- Chest X-ray
- Pulmonary (lung) function tests
- Cardiological examination (electrocardiogram = ECG, stress test, echocardiogram, heart catheterization)
- Vascular studies
- Kidney and liver function tests
- Initial examination by the anesthesiologist

Your physician will inform you of the nature and purpose of the tests required in your particular case.
3.1 Treatment principles
3.2 What is necessary in preparing for surgery?
3.3 Open (classical) or laparoscopic (minimally invasive) surgery?
3.4 What surgical methods are available?
3.5 What treatment remains after surgery?

How is colorectal cancer treated?
How is colorectal cancer treated?

3.1 Treatment principles

Surgery aimed at complete removal of the tumor is the only method which offers a chance of curing cancer of the colon and rectum. Consequently, surgical removal of the tumor is the key component of the therapeutic concept.

“Cure” of any cancer is not complete until the spread of tumor cells to other organs such as the liver or lung has been excluded. This is why the extent and spread of the tumor is always determined prior to surgery. Before surgery can be performed it is necessary to determine whether the tumor is limited to the bowel or is generalized (i.e. has spread throughout the body). Even in the case of generalized disease, curative treatment is still possible under certain circumstances.

In cancer of the colon, surgery is generally performed as soon as the diagnosis has been made, the extent of the disease determined and the operability (risk estimate for the planned surgery) confirmed. Cure necessitates the complete removal of the tumor. Following surgery, the surgical specimen (tissue removed during the surgery) is examined by the pathologist, who will determine the extent of the primary tumor and the presence of lymph node metastases. The results of these examinations will determine whether additional, prophylactic chemotherapy is advisable.

In patients with rectal carcinoma, clarification procedures following diagnosis include not only determination of the extent of the tumor and the patient’s operability, but also the local spread of the tumor and its size. Depending on the findings, it is current practice to remove smaller tumors immediately. Larger tumors are pre-treated prior to surgical removal. At present, there are two options for pre-treatment. The first includes...
radiation of the rectal tumor using relatively high individual radiation doses for a period of one week. The second consists of a combination of low-dose radiation and a generally well-tolerated chemotherapy for five weeks. As large studies have shown, the goal of pre-treatment is to reduce the risk of local recurrence (i.e. the probability that the tumor will recur after surgery). Whether pre-treatment is advisable, and which treatment concept should be followed, are matters which should be discussed with the physician prior to surgery. Radiation after surgery has been shown to have poorer outcomes than radiation before surgery. The advisability of an additional, prophylactic course of chemotherapy following surgery depends on various criteria and should be determined on the basis of the histological findings.

As can be seen, therapy of colon and rectal cancers involves a number of different specialists all working together to ensure the patient receives the best possible care.

3.2 What is necessary in preparing for surgery?

Removal of a segment of bowel is a surgical procedure requiring careful preparation of the patient in order to avoid any complications. Besides general measures to improve heart and lung function, such as abstaining from smoking, breathing exercises using an incentive spirometer and climbing stairs, the bowel has to be emptied in preparation for surgery. This is done at the latest on the day before the planned surgery by drinking a special solution.
3.3 Open (classic) or laparoscopic (minimally invasive) surgery?

There are two different surgical methods available for treatment of cancer of the colon and rectum today. The so-called “classic” method involves opening the abdomen by an incision. Apart from this there is also the “key-hole” technique (laparoscopic surgery), whereby special instruments and camera optics operate inside the abdomen via minute incisions. The classic, open method gives the surgeon the best overall view of the abdomen, which contributes to reliable removal of the tumor. The ability to examine other tissue changes during surgery enhances safety and enables complete removal of the tumor, thus sparing important body structures.

Fig. 12
Surgical suite equipped for minimally invasive surgery
(C1 = surgeon, C2 = assistant, E = gastroenterologist, Op Sr = surgical nurse, A = anesthesiologist)
Use of the “key-hole” technique has increased over the past years and has the advantage that the abdominal incision is much smaller (figure 12). This technique is considered to be easier on the tissues and on the patient, but it is not appropriate for every patient. The camera optics give an excellent overview of the abdomen (figure 13). Patients generally recover somewhat faster with the key-hole technique than with conventional open surgery and usually experience somewhat lower levels of pain.

On the other hand, laparoscopic surgery usually takes longer and is much more expensive. Not every patient and tumor is suitable for laparoscopic surgery. Complete removal of the tumor has priority over cosmetic results.

The method best suited to a particular patient and tumor must be decided on together with the surgeon. Major studies of colon and rectal cancers have shown similar results for both surgical methods.
3.4 What surgical methods are available?

Curative surgery consists of removal of the bowel segment containing the tumor along with the corresponding lymph drainage region. This should be done as a package, or “en bloc resection”, not in parts. Removal of the lymph drainage vessels is essential because they may include lymph nodes containing cancer cells. These are of vital importance in assessing the patient’s further prognosis.

In recent years, substantial improvements have been made with regard to general preparation for surgery, cleansing of the bowel prior to surgery, use of antibiotics in the operating theater and optimization of anesthetic techniques. Advances include a wider range of methods to control pain, improved ways of preventing blood clots, earlier mobilization and swifter resumption of oral intake after surgery. As a result of these improvements, complication rates in good clinics are very low.

Depending on the site of the tumor as revealed by colonoscopy, the following standard operations are performed by open (“classic”) or laparoscopic (“key-hole”, minimally invasive) surgery:

**Colon carcinoma**

1. **Right hemicolectomy**
   (removal of the ascending colon)

If the tumor is located in the right arm of the colon (the ascending colon), the surgical procedure is known as a right hemicolectomy, meaning removal of the right arm of the colon (figure 14). Bowel continuity is re-established by attaching the small bowel to the transverse or descending colon. This means that besides the small bowel, the left-sided colon (descending colon) and rectum still remain. After a period of adaptation, patients can be expected to produce formed stool again.
2. **Left hemicolecotomy**  
*(removal of the descending colon)*

If the tumor is located in the descending colon, a left hemicolecotomy is performed *(figure 15)*. After removing the diseased bowel segment, the ascending or transverse colon is attached to the rectum. The remaining bowel consists of the small bowel, the right (ascending) colon and the rectum.

3. **Sigmoid resection**  
*(removal of the connecting segment between the colon and rectum)*

If the tumor is located in the sigmoid colon, which connects the descending colon and the rectum, patients undergo sigmoid resection *(figure 16)*.
Bowel continuity is re-established by connecting the descending colon to the rectum. The remaining bowel is sufficient for good stool quality.

**Rectal carcinoma**

The choice of surgical procedure in patients with rectal carcinoma depends to a large extent on the location of the tumor. Prior to the operation it must be determined whether it will be possible to preserve the sphincter muscle and thereby maintain continence. This decision is based on the proximity of the tumor to the sphincter and the pelvic floor. If there is not an adequate margin of healthy tissue between the tumor and these structures, the rectum must be removed completely, which means
that a lifelong ostomy is required. Even with an ostomy, however, patients can and do achieve an excellent quality of life. Despite this fact – and depending on the location of the tumor – the goal is always to preserve the sphincter muscle.

4. Anterior rectum resection (removal of the rectum with preservation of the sphincter)

Anterior or deep anterior rectum resection involves removal of the sigmoid colon together with the part of the rectum affected by the tumor (figure 17). With this procedure, sufficient healthy rectum remains to maintain sphincter muscle function. Once the tumor has been
removed, the descending colon is attached to the rectum. An important part of tumor removal is that there is sufficient removal of the circular fatty tissue which surrounds the rectum and contains the lymph drainage vessels. This important technique is known as partial or total mesorectal excision. The operative technique involves a surgical approach which follows the anatomic layers and is comparable in some respects to peeling an onion. This technique spares the nerves in the minor pelvis which are necessary for normal bladder control and sexual functioning.

There are several surgical procedures for creating a “pouch” as a replacement for the lost reservoir function of the rectum (figure 18). The surgeon will discuss the different options with the patient. The objective in recreating a reservoir is to make it possible to have formed and portioned stools. Depending on how close to the sphincter muscle the remaining bowel is attached, and depending on whether the patient has undergone radiation prior to surgery, it may be advisable to create a temporary ostomy (artificial bowel outlet) from the small bowel. Bowel anastomoses (sites at which the bowel is sutured) tend to heal more slowly in the vicinity of the sphincter muscle and in patients who have undergone prior radiation. Because the new anastomosis needs to be protected, it is common in such cases to place a temporary ostomy, which is reduced after two to three months. The ostomy allows temporary passage of stool through an artificially created opening in the abdominal wall, thus avoiding passage through the new bowel connection. The surgeon will inform the patient of the advisability of an ostomy in his individual case.
5. Complete removal of the rectum and sphincter muscle (abdominoperineal rectum extirpation = Miles’ operation)

Abdominoperineal rectum extirpation, also known as Miles’ Operation, involves the complete removal of the sigmoid colon, rectum and sphincter apparatus along with the anus (figure 19). This procedure is virtually the same as the anterior rectum resection described above except that the bowel cannot be connected because no residual healthy rectum remains beneath the tumor due to its proximity to the sphincter. For this reason complete removal of the tumor requires total excision of the sphincter apparatus, including parts of the pelvic floor and the sphincter muscle.
After complete removal of the tumor, the defect in the pelvic floor is closed. The descending colon is then attached to an ostomy created in the left lower abdomen. An artificial bowel outlet is something the patient has never been confronted with before. At first, life with an ostomy may seem unimaginable to him. Experience gathered from numerous patients and major studies, however, shows that patients routinely achieve an excellent quality of life in spite of having an ostomy. Complete removal of the tumor has the highest priority for the prognosis of cure, and there should be no compromises. Patients confronted with complete removal of the rectum receive counseling from their physician, other healthcare providers and an ostomy therapist. After surgery, they are given detailed instructions on caring for their ostomy and how to carry on with their normal everyday activities. This includes sports and recreational activities, including swimming, as well as the intimate relationship with spouse or partner.
Minimally invasive operations

In principle, all the above-described operations can be performed on a minimally invasive (laparoscopic) basis. The advantages and disadvantages have already been discussed in chapter 3.3. In addition to the above procedures, the following minimally invasive techniques are performed:

6. Wedge or segmental resection

This operation is usually performed laparoscopically, i.e. using the “key-hole” technique. It involves a very limited bowel resection, usually in the form of a wedge
or a small segment (*figure 20*). The operation can be carried out on any section of the colon. This method is used for the removal of broad-based polyps (benign changes of the bowel mucosa) which cannot be removed completely at colonoscopy. Surgery is performed under endoscopic guidance to ensure removal of only the diseased bowel segment along with an adequate safe margin. This method is generally only performed at specialized centers.

Fig. 20

(A) Laparoscopically assisted endoscopic resection
(B) Endoscopically assisted laparoscopic wedge resection
(C) Endoscopically assisted laparoscopic transcolic resection
(D) Endoscopically assisted laparoscopic segmental resection,
Center for Minimally Invasive Technology, Klinikum rechts der Isar,
Prof. Dr. H. Feußner
7. Full wall resection through the anus
(transanal endoscopic microsurgery = TEM)

In cases of benign or early malignant changes in the rectum, patients are given the option of transanal endoscopic mucosectomy (full wall resection). This is a less radical alternative to anterior rectum resection or abdominoperineal rectum extirpation (figure 21).

![Image of transanal excision of broad-based polyps or early carcinoma of the rectum](image)

Fig. 21
Transanal excision of broad-based polyps or early carcinoma of the rectum

This surgical technique does not require an abdominal incision as the entire operation is performed via the anus. Using specially developed instruments, the surgeon excises the benign or malignant lesion in the form of a block which includes adequate safety margins, and subsequently sutures the defect in the rectum (figure 22). An advantage of this method is the patient’s rapid recovery after surgery. A disadvantage is the lack of information about potentially affected lymph nodes. For this reason, this method should only be used in the case of patients...
with very early malignant changes in the rectum where the probability of lymph node metastases is very slight. If the rectal tumor has already grown larger, patients have to undergo a more radical procedure involving an abdominal incision and removal of the tumor along with lymph drainage pathways, as described above. Transanal surgery should only be performed by specially trained surgeons.

3.5 What treatment remains after surgery?

With most planned procedures, post-surgical treatment follows the so-called “fast-track” principle. This is based on the idea that “low stress means quick recovery”.

After the operation, patients only remain in the surgical intensive care unit (ICU) for a short period of time and may even be transferred straight back to an ordinary ward. The tube used by the anesthesiologist for artificial respiration during the operation is removed before the patient leaves the operating theater. Tubes for draining wound secretion from the abdomen (drainages) are no longer in routine use today, and if they are needed they are removed after a short time. The nasogastric tube is also removed in the operating theater. The urinary catheter, which drains urine from the bladder, does not cause any pain and is usually removed within a few days of surgery.

From the first day after operation, patients are usually allowed to have tea and soup. Their fluid balance is regulated by infusions. In order to control pain after surgery, each patient receives an individually designed pain control therapy. If necessary this can include an epidural catheter which carries anesthetic medication directly to the vicinity of the spinal cord. Of prime importance is each patient’s active participation in the recovery process.
Patients should be out of bed, sitting in a chair and walking as much as possible. They will be fitted for compression hose and, if necessary, receive heparin injections to help prevent development of thrombosis or embolisms (blood clots). Skin sutures can usually be removed after ten days.

TEM (transanal endoscopic microsurgery):
Modified equipment for endoscopic removal of adenomas or early carcinomas of the rectum.
4

Risks and complications of an operation

4.1 What complications can occur with surgery of the bowel?
4.2 What are the lasting consequences?
Risks and complications of an operation

4.1 What complications can occur with surgery of the bowel?

Every operation, even a routine procedure, has its risks and dangers. This does not just apply to the procedure itself. Complications may also be caused by concomitant disorders of the heart and lungs and metabolic disorders. Before a patient undergoes surgery, all potential risk factors must be assessed and minimized by taking appropriate preventive measures. This helps make the operation a success and shortens the period of hospitalization. A key aspect of pre-surgical preparation is to inform the patient of the exact nature of the preparations, the surgery itself and the postsurgical follow-up treatment. It is important for the patient to understand the significance of each component of his treatment, so that he is motivated to play a full and active role.

Thanks to the advances in modern surgery, anesthesia and intensive care, even the most extensive operations cause less stress to the organism and are associated with fewer risks and complications than was the case just a few years ago. After the operation, the patient should be almost free of pain. Bowel activity resumes very quickly and it is not long before the patient is up and about again. Nevertheless, major abdominal surgery may be followed by problems which can interfere with the patient’s general wellbeing, affect his health and prolong his stay in hospital. Serious complications following bowel surgery include:

**Bleeding**

Hemostasis (control of hemorrhage) is monitored with the greatest care during an operation. The highest risk of post-surgical bleeding is in the first 24 hours after surgery. Tiny blood vessels in the wound surface which
did not bleed at the end of the operation may start to bleed afterwards. Bleeding from larger vessels is extremely rare. Patients are carefully monitored for rapid detection of any bleeding. The risk of clinically significant post-surgical bleeding is low, at about 1% of cases.

Anastomotic insufficiency (leaking bowel connections)
A particular complication is suture leakage at the site of the two freshly connected bowel ends (anastomosis). This typically occurs around the seventh post-operative day. This is most commonly caused by areas of poorly perfused tissue (poor blood circulation) around the anastomosis, resulting in tissue loss and failure of the seal. There is an increased risk of leakage in rectal surgery involving anastomoses in the proximity of the sphincter muscle and in cases of pre-surgical radiation.

The rate of anastomotic insufficiency in patients operated on for colon cancer is under 2 – 3%, whereas this is 10 – 15% in patients with rectal tumor operations. Warning signs include a period of increasing abdominal pain and fever.

Wound infections
Every bowel operation is associated with a risk of contaminating the abdominal wall with bowel bacteria. During surgery, special preventive measures such as hygiene regulations and administration of antibiotics are employed to minimize this risk. Despite this, wound infections occur in up to 5% of cases. Although these usually turn out to be harmless, they may prolong the period of hospitalization.

Paralysis of the bowel
Bowel surgery is generally followed by post-operative paralysis of the bowel. The goal is to keep this period as short as possible. In an effort to get bowel activity
going again, patients are given liquids from the first day after surgery and a temporary course of medication to stimulate the bowel. They are also ambulated (encouraged to get out of bed and start walking) as soon as possible. Patients should normally be passing stool or gas within two to three days after surgery.

Pain

Each patient responds to the stress and tissue damage associated with an operation with a different level of pain. Improved pain control means earlier ambulation. This in turn reduces the risk of thrombosis of the leg veins associated with long periods of lying in bed. Physiotherapy, which is important for recovery, can also begin earlier.

Adequate pain medication aids respiratory exercises and helps prevent pneumonia. For these reasons, patients are automatically given regular pain medication after surgery as well as medication on demand to relieve bouts of residual pain.
4.2 What are the lasting consequences?

Digestive problems are among the most common consequences of bowel surgery. They depend on the extent of the bowel segment which has been removed. In most cases, however, there is no major change in stool quality once the post-surgical adaptation period is over.

Removal of bowel segments may be followed by porridge-like stool or diarrhea. Depending on the length of colon removed, there may be restriction of the body’s ability to thicken the digested food, which means that more water remains in the bowel and is excreted in the stool. The body adapts itself to this situation, however, and stool quality improves in the course of time. Diarrhea becomes less severe, and persistent diarrhea can be treated with medication to slow down the intestinal passage of food or thicken the stool.

If the rectum is removed, patients may initially experience increased stool urgency and varying degrees of incontinence (inability to control the passage of gas or stool). If this occurs or persists, the problem can often be rectified by appropriate training.

In some cases, major bowel surgery may be followed by a temporary or permanent artificial bowel outlet (ostomy). This is rarely necessary in surgery of the colon and rectum, however.

In addition to continence problems, surgery involving the rectum may lead to functional disturbances of the bladder. Men sometimes experience sexual problems such as erectile dysfunction. This is a result of irritation of, or damage to, nerves located in the immediate vicinity of the surgical field. These complaints are often only temporary. Thanks to newly developed surgical techniques, persisting problems are rare.
What information does pathological examination of the surgical specimen reveal?

Microscopic view of colon cancer
Above: EvG-stain (Elastica-van-Gieson; connective tissue stains red) of an invasive, poorly differentiated adenocarcinoma with surrounding inflammation and connective tissue growth
Below: PAS-stain (Periodic-acid-Schiff; mucus stains red) of a moderately differentiated tubular adenocarcinoma
What information does pathological examination of the surgical specimen reveal?

After surgery, the work of the pathologist begins. Pathologists are physicians who have been trained in microscopic evaluation of surgical specimens. The specimen is cut into several thin slices which are processed according to a special method using stains (dyes) and

Fig. 23 (A, B)
Fig. 23 (C, D)
Microscopic view of colon cancer
Above: Detail of above image
from margin of an invasive adenocarcinoma
Below: Transition of healthy colon mucosa (left)
to invasive adenocarcinoma (right)

examined for evidence of tumor cells (figure 23, A – D). Besides the tumor itself, the pathologist examines all the lymph nodes which have been removed. On the
basis of these specimens, he is able to make a reliable assessment of the tumor stage. Besides the size of the tumor, other key factors are the depth to which the malignancy has spread and its degree of differentiation. The lymph nodes in the surgical specimen (tissue removed at surgery) are counted, as well as the number of them which have been invaded by malignant cells. Evidence that the margins of the resected tissue are free of tumor is of vital importance. Processing a surgical specimen generally takes about three working days. A pathologist is always at hand during surgery to help determine whether the margins show any evidence of tumor by performing a “frozen section procedure”.

Examination of the surgical specimen yields the following important information:

1. Tumor position and size
2. Tumor classification (TNM stage)

The patient’s hospital discharge sheet should contain the tumor classification, which characterizes the patient’s colorectal cancer. This is specified in terms of the TNM stage according to the internationally recognized criteria established by the UICC (International Union Against Cancer).

The TNM classification characterizes the overall extent of the individual patient’s malignant disease and is crucial for planning his further therapy.

The TNM stage covers the following points:

- **T** = Tumor: The T-stage quantifies the depth of penetration and the extent of the tumor in the individual bowel wall layers. The T-stage ranges from T1 to T4.
- **N** = Node (lymph node): The N-stage quantifies the degree to which regional lymph nodes have been affected by metastases. The presence of lymph node metastases is always associated with a worse
prognosis for the patient. If lymph nodes are affected, patients are usually advised to undergo subsequent chemotherapy. The N-stage ranges from N0 to N2.

- **M = Metastases:** The M-stage quantifies the degree to which distant metastases are found in other organs. The M-stage ranges from M0 to M1.

### 3. UICC tumor stage

Based on the tumor findings and the resulting T, N and M classification, it is possible to establish a tumor stage for each patient according to UICC criteria. Current guidelines establish four stages from I to IV *(figure 24).*

<table>
<thead>
<tr>
<th>Stage</th>
<th>T-stage</th>
<th>N-stage</th>
<th>M-stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>T1 or T2</td>
<td>N0</td>
<td>M0</td>
</tr>
<tr>
<td>II</td>
<td>T3 or T4</td>
<td>N0</td>
<td>M0</td>
</tr>
<tr>
<td>III</td>
<td>T1 – T4</td>
<td>N1 or N2</td>
<td>M0 (lymph node metastases present)</td>
</tr>
<tr>
<td>IV</td>
<td>T1 – T4</td>
<td>N0 – N2</td>
<td>M1 (distant metastases present)</td>
</tr>
</tbody>
</table>

### 3.1 Grading

Grading quantifies the tumor’s degree of differentiation. Current criteria distinguish between a grade of G1 for well differentiated colorectal cancer, G2 for cancer which is moderately differentiated, and G3 for poorly differentiated cancer. Differentiation describes the extent to which the tumor tissue still resembles the tissue from which it has originated. G1 tumors grow less aggressively than G3 tumors.
Fig. 24
The 4 tumor stages of colon cancer

4. The R classification

The R classification describes the patient’s residual tumor status, i.e. whether there is still any tumor left in the body. It specifies any metastases remaining in the body and whether the margins of the surgical specimen were free of malignant tissue. The larger the tumor-free distance, the better the patient’s prognosis. The R classification is as follows:

- R0 = No tumor visible to the naked eye or microscopically.
- R1 = Microscopic evidence of residual tumor.
- R2 = Residual tumor visible to the naked eye (macroscopically).
How high are the rates of cure?
How high are the rates of cure?

The chances of cure and the patient’s overall prognosis depend first and foremost on whether it was possible to remove the primary tumor completely, along with its associated lymph nodes. If tumors are recognized at an early stage and promptly removed, the chances of cure are very good. About 50% of all patients with colorectal cancer can be cured nowadays. The prognosis is worse if the cancer has already spread to other organs such as the liver or lungs at the time of first diagnosis. In advanced tumor stages, the extent to which these other organs are affected determines how the patient will be treated.

Besides the established methods, therapy in such cases may include a more individualized therapeutic concept which should be developed in cooperation with a team of cancer experts. Many large clinics hold special tumor conferences to discuss these complex cases.

A patient’s prognosis can be estimated based on the tumor stage, but this may not be an exact estimate, as there are many other factors which play a role. Each patient is an individual case. The outcome can be positively affected by the patient’s mental attitude and whether or not help is available to cope with the fears associated with the disease.
What is the follow-up for colorectal cancer?

7.1 General recommendations
7.2 What does tumor monitoring entail?
What is the follow-up for colorectal cancer?

7.1 General recommendations

Patients with UICC stage II or III cancers of the colon or rectum whose age and general health do not exclude them from therapy for recurrent or metastatic disease, should have follow-up monitoring. Tumor follow-up monitoring is coordinated by the patient’s primary care physician or tumor clinic with the participation and constant feedback of the specialists involved, including the surgeon, gastroenterologist, oncologist, radio-oncologist, radiologist etc. A key component is complete colonoscopy before surgery or as soon as possible afterwards (preferably within the first three months).

After surgery to remove a tumor, the patient is advised on whether tumor follow-up monitoring is required and if so, how frequently this should take place. The primary goal of follow-up monitoring is early detection of disease recurrence or the appearance of daughter tumors (metastases) and prompt initiation of treatment. Even if the disease does recur or metastases appear, the options for treatment are generally quite good. The first two years after surgery are the most important ones, as this is the time during which the risk of developing recurrent disease is at its greatest.

The risk of disease recurrence declines with the passing of years. This means that the intervals between follow-up examinations can be extended. As a rule, tumor follow up is concluded after five years.
7.2 What does tumor monitoring entail?

1. The standard follow-up monitoring protocol includes an interview with the physician, a physical examination, laboratory tests (including the tumor marker CEA), ultrasound examination of the abdominal organs and a chest X-ray. Patients with colon cancer should be monitored every six months for the first three years and once a year in the fourth and fifth year. Patients with rectal cancer should be monitored every three months during the first year.

2. A further important component of the monitoring program is colonoscopy. Current recommendations for colon cancer include colonoscopy after the first, second, third and fifth year.

3. Proctoscopy (endoscopic examination of the rectum) is recommended for patients with rectal cancer every three months during the first year and every six months during the second and third years. Annual proctoscopies are generally considered sufficient in the fourth and fifth year.

4. The routine use of computed tomography (CT) as part of tumor follow-up monitoring remains controversial at present. There are no established recommendations. A post-operative CT scan of the abdomen and pelvis can be performed about six months after surgery to establish baseline status.
Will I need additional therapy after surgery?

8.1 When is chemotherapy recommended?
8.2 What does chemotherapy entail?
8.3 What are the side effects?
8.4 When is radiotherapy recommended?
Will I need additional therapy after surgery?

8.1 When is chemotherapy recommended?

**Adjuvant chemotherapy**

Chemotherapy is generally recommended when pathological examination of the surgical specimen reveals lymph nodes to which the tumor has spread. Despite complete removal of the tumor, there is still the possibility in such cases that not all viable cancer cells were removed during surgery. The tumor may have already spread to distant sites in the body. There is an approximately 50% chance that tumor cells are hidden elsewhere in the body and cannot yet be detected with available methods. Major international studies have shown that preventive, or “adjuvant” chemotherapy significantly lowers the risk of recurrence in such patients. This is why physicians offer these patients the option of chemotherapy.

Why “preventive”? Although the tumor has been completely removed, therapy recommendations are based on the probability that there may still be tumor cells hidden somewhere in the body. The physicians’ focus is still on complete cure of the malignant disease (curative intention). There are also other special situations in which adjuvant or preventive chemotherapy may be recommended, such as rupture of the tumor during removal, spread to other organs or removal of fewer than 12 lymph nodes. If any of these conditions apply, the physician will discuss the advantages and disadvantages of chemotherapy with the patient and they will reach an agreement together.

**Neoadjuvant chemotherapy**

As a rule, patients with locally advanced rectal tumors in the middle and lower thirds of the rectum undergo “neoadjuvant” therapy prior to surgery. This consists of a combination of chemotherapy and radiation of the tumor (radiochemotherapy). The objective of this is to
reduce the probability of tumor recurrence after successful surgery. The efficacy of this approach has been confirmed in international studies. For locally advanced rectal tumors, there is also a form of neoadjuvant therapy consisting of radiation alone, without chemotherapy, prior to surgery. The best approach in individual cases will be recommended by the physician.

**Palliative chemotherapy**

“Palliative” chemotherapy is used in cases in which daughter tumors (metastases) have already developed in distant organs such as the liver or lung. The goal of chemotherapy in such cases is to improve the quality of life and prolong life. Generally speaking, it is no longer possible to cure these cases, but it is not completely out of the question. In certain cases, metastases may respond so well to chemotherapy that they can be surgically removed. This is possible in the case of liver and lung metastases, for example.

**8.2 What does chemotherapy entail?**

The underlying principle of chemotherapy is the destruction of rapidly reproducing cells. The drugs used for chemotherapy are called cytostatic agents. When applied into the blood stream, they are distributed throughout the body (systemic therapy) and attack cancer cells as well as healthy tissues with a high rate of cell division. This causes various side effects, which will be discussed below. Chemotherapy is administered by a specially trained team consisting of a physician (oncologist) and nursing staff.

A wide variety of cytostatic agents are available today, such as 5-fluorouracil (5-FU), folinic acid or leucovorin, UFT (tegafur/uracil), oxaliplatin, irinotecan, capecitabin, cetuximab, bevacizumab and panitumumab. The choice of medication depends on the stage of the disease, any other illnesses present and the patient’s general health. Although cytostatic agents are normally combined
in regimens such as the FOLFOX regimen, they may sometimes be used alone (monotherapy). Chemotherapy can generally be administered on an outpatient basis unless certain health issues require inpatient treatment. In most cases, cytostatic agents are applied intravenously (through a vein). The placement of a venous catheter beneath the collarbone (clavicle) is usually more advantageous and comfortable for the patient and is even obligatory in patients receiving cytostatic regimens containing 5-FU. Only capecitabin is taken in tablet form. Adjuvant chemotherapy is usually given for a period of six months. In metastatic disease, response to treatment is the primary factor which determines the length of therapy. Depending on disease progress, various regimens can be employed, including those with antibodies such as cetuximab or bevacizumab in addition to the classic cytostatic agents. Antibodies are proteins which recognize certain surface structures of cancer cells which are important for tumor growth. They can inhibit growth signals in the cancer cells or interfere with the blood supply of the tumor. To date, antibodies have not been shown to be of any benefit in “adjuvant” therapy. Finally, under certain circumstances it is possible to supplement treatment of liver metastases using local methods such as chemoembolization, cryotherapy or radiofrequency ablation.

8.3 What are the side effects?

As mentioned above, chemotherapeutic agents attack not only cancer cells but also affect the cell division of healthy tissues. This can cause various side effects which sometimes, but not always, occur in patients receiving these treatments. Bone marrow, which produces white and red blood cells as well as blood platelets, is very sensitive to these agents. This can result in patients developing infections, anemia or bleeding during therapy. Regular monitoring of the blood count can help identify problems early on. Espe-
cially important are the white blood cells (leukocytes), which protect against infections. Therapy may need to be interrupted due to a low white blood cell count and is resumed when the blood count returns to acceptable levels.

Further side effects are nausea and vomiting. Prophylactic use of antiemetic agents (drugs to prevent nausea) administered by infusion prior to each chemotherapy is effective in preventing nausea and vomiting. Patients may also experience loss of appetite, changes in their sense of taste, and diarrhea. Side effects resolve once therapy is completed. One side effect many patients find disturbing is hair loss. Complete hair loss is not usually expected with the cytostatic combinations routinely used for colorectal cancer, and hair will grow back in again on completion of therapy. The above-described antibodies are generally well tolerated. As they are proteins, allergic reactions may occur. Cetuximab sometimes causes acne-like skin eruptions, while bevacizumab is associated with bleeding, thrombosis and hypertension (high blood pressure).

8.4 When is radiotherapy recommended?

Tumor cells can also be targeted by means of radiotherapy. The radiation used for this purpose is comparable with that used for radiologic examinations (X-rays) but contains much more energy. As with chemotherapy, radiation treatments are administered by a specially trained team led by a specialist for radiotherapy (radio-oncologist). Radiotherapy kills a significantly greater number of cancer cells compared with chemotherapy, but its effects are only local. Unlike chemotherapy, radiation is not suitable for attacking distant tumor cells (micrometastases). The two methods can be combined as radiochemotherapy. In this case, chemotherapy supports the local effects of radiotherapy. Radiation or radiochemotherapy is often used in patients with rectal tumors either prior to the planned operation (neoadjuvant therapy) or following surgery (adjuvant
therapy). With colon carcinoma, radiotherapy is only used in exceptional cases.

Prior to radiotherapy, several preliminary examinations are required in order to determine the individual tissue volume to be irradiated, establish the boundaries of the radiation and calculate the radiation dose in detail. The radiation treatment only takes a few minutes and is administered on five days a week, usually for a period of five to six weeks. There are treatment protocols which are shorter than this and use higher single radiation doses. In most cases, radiotherapy is performed on an outpatient basis. The most common side effects are irritation of the bowel and bladder (increased frequency of bowel movements and urination, bowel and bladder urgency, diarrhea) and skin irritation (redness, dryness). Should these side effects occur, they normally resolve within days or weeks of completed radiotherapy. Late reactions such as skin discoloration and hardening of the subcutaneous fatty tissue may occur.

Radiotherapy can also be useful in the treatment of daughter tumors (metastases) of colon or rectum tumors. A two-week course of radiotherapy, for example, can bring about a rapid reduction of symptoms in painful tumor metastases to the bone, with long-term stabilization of the bone in the irradiated area. In the case of metastases in the liver, lung, brain or soft tissue, high-precision (stereotactic) radiotherapy consisting of just a few high radiation doses can result in long-term control (size reduction or inhibition of further growth) of these metastases. This very well tolerated method is used in particular where there are only a few metastases (one to three) in an organ.
Dietary recommendations after bowel surgery

9.1 General recommendations
9.2 Diet recommendations with a small bowel ostomy
9.3 Characteristics of the Mediterranean diet
Dietary recommendations after bowel surgery

9.1 General recommendations

Bowel surgery for treatment of colorectal cancer involves removal of a segment of the bowel. This can result in changes in stool habits. Stool may be harder or softer than it was before surgery. The severity of the symptoms is influenced by the length of the bowel segment which was removed and the bowel site at which the resection was performed. Careful diet planning can influence stool consistency, reduce bloating and improve the patient’s general feeling of wellbeing, but no special diet recommendations are necessary. General restrictions or elimination of certain foods are not applicable.

Dietary recommendations for patients after bowel operations are similar to those of a normal, healthy diet. In order to help identify any individual intolerances, it is a good idea to keep a diary of foods and digestive problems.

Basis of nutritional therapy: “Light general diet”
The “light general diet” is an aid for patients in avoiding foods and beverages commonly known to cause intolerances. These include legumes, mushrooms, cabbage, raw onions, garlic, leeks, fried foods, whole grain breads with unmilled seeds, freshly baked bread, hard boiled eggs, acidic foods, grilled or smoked foods, highly spiced foods, foods and beverages which are too hot or too cold, carbonated beverages and unripe fruits.

Fresh fruit (apart from bananas), lettuce, raw vegetables, tomatoes, cauliflower, peas and green beans may not be well tolerated in the period following operation.

Tables 1 and 2 provide an overview of the effects of foods on stool consistency and formation of intestinal gases.
<table>
<thead>
<tr>
<th>Constipating effects (desired):</th>
<th>Laxative effects (not desired):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bananas, grated apples (with peel), raisins, blueberries (dried), baby food: apples with blueberries or apples with banana</td>
<td>Raw vegetables, cabbage, onions, legumes, beans, spinach, sauerkraut juice</td>
</tr>
<tr>
<td>White bread, graham bread, spelt bread, plain biscuits, rusks</td>
<td>Whole grain products</td>
</tr>
<tr>
<td>Polished rice, pasta, oats, semolina</td>
<td>Salads</td>
</tr>
<tr>
<td>Strong black or green tea</td>
<td>Alcoholic beverages, beer, caffeinated beverages, undiluted juices</td>
</tr>
<tr>
<td>Cooked carrots and potatoes</td>
<td>Hot spices</td>
</tr>
<tr>
<td>(Bitter) chocolate, cocoa powder, cocoa with water</td>
<td>Fried foods, very fatty foods</td>
</tr>
<tr>
<td>Dry cheese (hard cheese)</td>
<td>Nicotine</td>
</tr>
<tr>
<td>Coconut flakes, fruit gums</td>
<td>Nicotine</td>
</tr>
</tbody>
</table>

*Tab. 1  Effects of foods on stool consistency*
Reduces bloating (desired):
Cranberries (4 – 6 tablespoons per day),
blueberries (blueberry juice),
Cranberries (4 – 6 tablespoons per day),
blueberries (blueberry juice),
Caraway seed, caraway seed oil,
caraway seed tea, black caraway seed,
fennel, parsley
Fennel tea, anise tea
Yogurt

Increases bloating (not desired):
Legumes, cabbage, bell peppers, onions, garlic, mushrooms
Fresh fruit, pears, rhubarb
Fresh bread, pumpernickel
Carbonated beverages, sparkling wines, beer, fermenting new wine, caffeinated beverages
Eggs, egg products, mayonnaise

Tab. 2
Effects of foods on the formation of intestinal gases

In cases where bowel surgery requires placement of an artificial bowel outlet (ostomy) connected to the small bowel (ileostomy or jejunostomy), the function of the colon is missing. This means there is no longer adequate absorption of water, sodium and other electrolytes. Patients have thin, porridge-like stools and increased frequency of bowel movements. There is also the danger of the body dehydrating, since the small bowel excretes more liquid through the ostomy.
9.2 Diet recommendations with a small bowel ostomy

It is important for patients with small bowel ostomies to remember that each intake of food or beverage produces ostomy output. Eating and drinking slowly and chewing carefully can be most helpful in this respect.

Please note:

1. Drink plenty of fluids. Daily fluid requirements are about 2.5 – 3 liters. Suitable beverages include black tea, herbal teas (not peppermint or fruit teas), salty meat or vegetable broths, still mineral water. Urine output should amount to at least 1 liter per day.

2. Low fiber foods. Foods with a constipating effect are preferable (see table 1).

3. Foods which irritate the ostomy may lead to skin irritations. Such foods include hot spices, fruit acids, tomatoes and pickled vegetables.

Long-term preventive nutrition can be oriented to the principles of the Mediterranean diet. Mediterranean cuisine not only prevents coronary heart disease but also prevents overweight and certain forms of cancer.
9.3 Characteristics of the Mediterranean diet

- Daily intake of plenty of fruit, vegetables and salads
- Emphasis on vegetable fats, such as rapeseed, olive oil or soy oil, as well as nuts in small quantities
- Low-fat dairy products in moderation
- Fish, poultry and eggs about 3 times per week
- Red meat and sausage only a few times per month
- Frequent consumption of fish (about 2 – 3 servings per week)
- Moderate alcohol intake (1 glass at mealtimes)
- Emphasis on regional foods and fresh foods in season

The principles of the Mediterranean diet can easily be applied to the cuisine of other countries. Mediterranean customs also include a healthy lifestyle. Take time with your meals and enjoy them in an atmosphere of peace and quiet. Get plenty of physical exercise, especially in the fresh air.
How will I live with an ostomy?

10.1 General recommendations
10.2 One-part ostomy system
10.3 Two-part ostomy system
10.4 Tips and tricks
10.5 Dietary recommendations for ostomy patients
10.6 Ostomy and its psychological aspects
How will I live with an ostomy?

Modern bowel surgery tries to avoid placement of an artificial bowel outlet (ostomy) whenever possible. In certain cases, a temporary or lifelong ostomy may be necessary for safety reasons.

10.1 General recommendations

Ostomy comes from the Greek word *stoma*, meaning “mouth” or “opening”. In the medical sense, an ostomy is a surgically created opening in the abdominal wall, e.g. for the passage of stool. The term previously used, *anus praeter*, means an artificial bowel outlet, and does not give any further information on the position of the ostomy. The word *ostomy* is normally used in compound words to reflect the anatomic position of the outlet, e.g. *enterostomy* (outlet from the small bowel) or *colostomy* (outlet from the colon). More precise definitions are also possible, such as *ileostomy* (outlet from the ileum, the final segment of the small bowel), *descendostomy* (outlet from the descending colon) or *sigmoidostomy* (outlet from the sigmoid colon).

A further distinction is made between a temporarily placed artificial outlet and one which must remain in place for the rest of a patient’s life. A temporary ostomy is created for the purpose of protecting a segment of bowel following surgery. The stool is temporarily diverted through the ostomy and collected in a pouch. Once healing of the lower bowel segment is complete, the ostomy is relocated during a second operation and the continuity of the bowel system is re-established. A lifelong ostomy is necessary in cases where a malignant or inflammatory process has affected the rectum and/ or sphincter muscle to such an extent that re-connection of the bowel with normal passage of stool through the anus is no longer possible.
A distinction is also made between single-arm and double-arm artificial bowel outlets, depending on whether the bowel segment emptying at this point is proximal (above the ostomy in the normal course of the bowel) or proximal and distal (above and below the ostomy). Temporary ostomies are generally double-armed, while lifelong, or permanent, ostomies are single-armed.

Today a variety of modern appliance systems are available for use with artificial bowel outlets and there are specially trained personnel (ostomy therapists) to provide ostomy patients with comprehensive support and services at home. The object of these improvements is to help every ostomy patient achieve an optimum quality of life. Once the initial adaption phase is over, this usually means a return to career, resumption of sports and recreational activities, and satisfying intimate relationships.

### 10.2 One-part ostomy system

The plate for protecting the skin and the ostomy pouch are joined together. This provides the ostomy patient with a good, flexible, tight adaptation to the skin, permitting maximum freedom of motion and protecting the skin from leakage. The appliance should be changed every day (figures 25, 26).

**Fig. 25**  
One-part postoperative ostomy system

**Fig. 26**  
Various one-part ostomy systems
10.3 Two-part ostomy system

These systems consist of a skin-protection plate and integrated flange ring, to which a removable pouch is attached, which can be changed every day (figure 27). The plate is changed every two to four days, the frequency depending on the type of ostomy and the consistency of the excreted stool.

Choosing an ostomy appliance system depends on a variety of factors, including skin condition, anatomic location, shape and size of the ostomy site, patient’s clothing preferences and any physical limitations such as vision problems, arthritis in the hands or fingers etc. The ostomy therapist and the nursing staff will assist you in selecting the best system for your particular needs. All systems are waterproof, which makes it possible for you to shower, bathe and swim. Because intestinal gases also pass through the ostomy, an integrated filter prevents inflation of the ostomy pouch. Immediately after the operation, the nursing staff will
use transparent pouches in order to assess the ostomy and the excreted stool and monitor for leakage. On discharge from hospital, you can switch to skin-colored pouches. Becoming familiar with your ostomy and its care are subjects you will learn during your hospital stay.

On your return home, care and support can be provided by a home-care agency. The agency you choose should continue to provide you with support and services. Specialized trained personnel will not only provide the materials you require but also train you in their use and answer your questions.

10.4 Tips and tricks

- An ostomy means changes in toilet habits. Allow yourself peace and quiet to perform these tasks.
- Change your pouch before breakfast as there is little or no active digestion at this time.
- Change your appliance regularly. This prevents skin complications.
- Artificial sweetener tablets reduce stool odor. Place at least four tablets in the pouch after each emptying.
- Change your appliance before leaving the house (change the pouch with one-part system; empty the pouch with two-part system).
- Whenever you take a shower or bathe, cover the filter with the adhesive tabs provided. Moisture interferes with the filter function.
- Patients who take part in sports may benefit from sport-oriented appliances supplied by the same manufacturers such as minipouches and ostomy caps (figure 28). Avoid sports which put undue stress on the abdominal wall, such as rowing, wrestling, martial arts etc.
• When playing soccer or other ball games, protect your ostomy by using a plastic prolapse cap. These are available from the same source as your other supplies.
• For male swimmers there are Bermuda-type shorts with a net-pouch to contain the ostomy pouch. Special ostomy bathing suits for women are not yet available.
• Avoid heavy lifting (maximum 10 kg) in order to prevent ostomy prolapse or hernia. If heavy lifting is unavoidable, you should use a specially made bandage with a gap for the ostomy pouch.
• When driving, a stoma protection plate prevents irritation of the ostomy. Ostomy patients are not exempt from the requirement to wear seatbelts.
• When traveling, take adequate ostomy supplies with you in your hand luggage.
• Your first-aid travel kit should always contain medication against diarrhea and constipation.
• Patients with a permanent ostomy can apply for handicapped status. This affords extra protection against losing your job and allows you additional holidays.
A variety of books on ostomy give useful information on general ostomy questions, recreation, sports, spa cures, diet etc.

Patients with permanent ostomies may benefit from bowel irrigation every morning to help empty the bowel. Assurance of continence for 24 – 48 hours improves your quality of life by minimizing your care needs and giving you greater independence in your daily life.

10.5 Dietary recommendations for ostomy patients

An artificial bowel outlet does not require any special diet. Following the operation, you can return to your normal eating habits, although you should watch out for any changes in food intolerances. An easily digested, balanced diet which is rich in vitamins and low in fat is generally recommended. Choose fresh, lightly processed foods rather than pickled and smoked items.

Gas-producing vegetables, mushrooms and legumes should be avoided. Cranberries reduce gas production and inhibit stool odor. Dietary fiber stimulates bowel activity, binds toxins and supports the intestinal flora (bacteria). Finely milled whole-grain products such as graham bread are generally well tolerated. Foods high in tannins, pectins and potassium are recommended in order to reduce loss of water and electrolytes. Tannins slow down bowel peristalsis, while pectins bind water. Loss of sodium can be adequately replaced by foods salted in the normal way. Drinking 2.5 – 3 liters of water a day can also have a positive influence on stool regulation, but you should also let yourself be guided by your natural sense of thirst. Your daily urine output should be at least one liter.

It is advisable to eat slowly and chew well. A non-irritating diet is better tolerated and does not irritate
the gastric and bowel mucosa. Very sweet, fried, roasted or spicy foods should be avoided initially. Other tips can be found in chapter 9.2.

Living with an ostomy does not mean renouncing the pleasures of life!

10.6 Ostomy and its psychological aspects

Each person reacts differently to changes in his body image and has his own individual way of coping with them. Ostomies are “hidden” body image changes. A person’s sense of wellbeing depends on his attitude toward the ostomy. Acceptance of the ostomy makes it easier to cope with the demands of everyday life. Changing the appliance regularly helps you develop a routine which makes you feel secure and reduces anxiety. When your self-confidence and comfort increase, your quality of life also improves.

Take as much time as you need to adapt to your new situation. Talk about your feelings and thoughts with your partner, your family and other people you trust. Support and good advice can also be obtained from self-help groups.
Colorectal cancer and quality of life – What does psychooncology offer?
Colorectal cancer and quality of life – What does psychooncology offer?

Quality of life is a term which is used a lot and often misunderstood. In this particular context it means your personal experience with cancer and your feelings and problems as far as the psychological, physical and social aspects of life are concerned. Research has shown that there are no general factors which improve or worsen our quality of life. Persons may suffer from the same disease and have the same prognosis objectively speaking, but be completely different in their reactions to the disease. Some cancer patients actually have a better quality of life than the average person. Confronted with their illness, they make up their minds what is really important to them and start living life with greater awareness than they did before. It all depends how each individual patient adapts to the stressors inherent to the disease and to its treatment.

Situations of stress may occur during different phases of the disease and may be related to a variety of factors such as cancer in general, the specific diagnosis of colorectal cancer, the prescribed treatment and the potential consequences. Many of these stressors may be temporary, while others persist and may require psychological treatment.

Many patients are anxious and worried while they are in hospital because they are afraid of the surgery or the outcome. These concerns are normal and understandable but they can often be relieved by a frank talk with your physician. It is important to ask as much as you want and can take in. Do not hide your cares and anxiety. It is helpful to play as active a role as possible in working out your plan of care and to have confidence in your physician.
After being discharged from the hospital or rehabilitation center, it is advisable to return to normal life as quickly as possible. This is not always easy, and there are sure to be new challenges. These include social issues such as work, pension or disabled status and your relationships with family, friends and acquaintances. There is also the fundamental question of whether you want to make a basic lifestyle change or go on living the same way as you did before.

Research shows that the greatest fear of all cancer patients is that the disease might come back again or spread (“progression anxiety”). This concern is natural and justified, but if these fears gain the upper hand it may be helpful to face up to them and try to analyze them in detail. Some good solutions may present themselves as a result of this. It can also help to just talk things over, take your mind off things for a while or give yourself a special treat.

Research on patients with colorectal cancers has concentrated on the question of whether quality of life is affected more in those with or without artificial bowel outlets. As mentioned above, there is no generally valid answer. Patients of both groups may experience bowel problems, digestive complaints, social uncertainties and sexual problems. It has proved beneficial to include the patient’s partner in discussions from an early stage and encourage frank communication. In some cases the partner is more stressed than the patient. Patients with ostomies require comprehensive and competent ostomy counseling to help them with their queries.

Increased recognition of the importance of psychological handling of the disease has led to a variety of support options becoming available today.
12.1 General remarks
12.2 Hereditary colorectal malignancies
12.3 Do my family and I have an increased risk of colorectal cancer?
Do my family members have an increased risk of colorectal cancer?

12.1 General remarks

Relatives of patients with colorectal cancer or bowel polyps have a statistically higher risk of developing colorectal cancer themselves. Family members should be aware of this increased risk early on and make sure they get adequate colorectal cancer screening.

There is a difference between hereditary colorectal malignancies and the increased incidence of malignant disease of the colon or rectum in a particular family. In about 25% of patients with colon cancer, there is increased family incidence of the disease. About 5% of patients with colon cancer have hereditary forms. These known kinds of hereditary malignancies include Hereditary Non-Polyposis Colorectal Cancer (HNPCC = hereditary cancer without multiple bowel polyps) or Lynch Syndrome and Hereditary Polyposis Syndrome (occurrence of multiple bowel polyps). The latter includes familial adenomatous polyposis (FAP) as well as other, rarer syndromes.

12.2 Hereditary colorectal malignancies

If several persons in one family develop colorectal carcinoma or other tumors, the likelihood of hereditary cancer should be considered. The development of multiple tumors in a patient, or the occurrence of a solitary tumor at a young age, may also point towards hereditary colorectal cancer. Genetic studies are able to identify high-risk persons who would benefit from a careful early-detection monitoring program and exclude other high-risk persons with no genetic predisposition for tumor, as these do not have a higher tumor risk than the general population.
Mutations of various genes have been associated with particular hereditary cancers. If hereditary cancer is suspected in a family, genetic counseling should be recommended. After taking a careful case history including analysis of the family tree and documentation of any cancers in the family, it is now possible to conduct targeted molecular-genetic studies.

12.3 Do my family and I have an increased risk of colorectal cancer?

By answering the following questions, you can determine whether there is an increased risk of colorectal cancer in your family. It is important to find out who in your family has or had colorectal cancer or colon polyps and at what age these occurred.

**Question 1:**
_Did a direct relative (parents, siblings, children) develop colorectal cancer before the age of 50 years?_

**Question 2:**
_Has a direct relative (parents, siblings, children) been diagnosed with a colon polyp (adenoma) before the age of 40 years?_

**Question 3:**
_Does your family have more than three cases of colorectal cancer, stomach cancer, uterine cancer, ovarian cancer or cancer of the renal pelvis or ureter?_

**Screening recommendations**

If you have answered all the above questions with “no”, there is no increased risk of colorectal cancer in your family. It is sufficient for all family members to begin routine cancer screening at the age of 50.
The health insurance will pay for annual stool occult blood tests from the age of 50 and for a colonoscopy from the age of 55.

If you have answered one or more of the above questions with “yes”, there may be a form of hereditary colorectal cancer in your family. All direct relatives (parents, siblings, children) of the person who has developed colorectal cancer have a significantly greater risk of developing cancer and should be sure to consult their physician, gastroenterologist or geneticist for advice on the preventive measures they should take.