Chapter 1

Diagnostics in Colorectal Surgery

Murat Ferhat Ferhatoglu and Abdulcabbar Kartal

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.74027

Abstract

The rapid development in radiological examinations has opened a new chapter in colorectal surgery. Unlike classical books, in this section we preferred to use more modern and everyday practical methods such as endoscopy or magnetic resonance imaging or endorectal ultrasonography, rather than sparing less used examinations such as X-rays and barium graphs.

Keywords: colorectal cancer, diagnostic tests, endoscopy, endoultrasonography

1. Endoscopy

1.1. Rectosigmoidoscopy

A rectosigmoidoscopy is an examination of the rectum and pelvic colon with a sigmoidoscope. In this procedure an endoscopic vision equipment is introduced for visualization of the anus, rectum and sigmoid colon. No special preparation is required, except "fleet-enema" applications. It is helpful in the research of hemorrhoidal disease, as well as in the diagnosis of diseases of the rectum and the first portions of the large bowel, for example, Crohn's disease, ulcerative rectocolitis, diverticula, polyps and colorectal cancer.

1.2. Colonoscopy

Colonoscopy is an examination of lower part of the alimentary tract. Colonoscopy is a safe procedure that gives information other tests may not be able to give. Often, people have colonoscopy as a screening test to check for polyps or cancer in the colon or rectum [1].

Indications: Colonoscopy can be performed for both diagnostic and therapeutic indications. Diagnostic indications include screening and surveillance for colon cancer, evaluating signs and symptoms suggestive of possible colonic or distal small bowel disease, assessing a response to treatment in patients with known colonic disease, and evaluating abnormalities found on imaging studies. Therapeutic indications include stricture dilation, stent placement and foreign body removal [2].

Contraindications: Colonoscopy is contraindicated in the following situations.

- When the risks of the colonoscopy outweigh the expected benefits.
- Consent cannot be obtained for a non-urgent procedure.
- A perforation is known or suspected.
- Documented acute diverticulitis.
- Fulminant colitis.

It is important that the expected benefits of colonoscopy be carefully weighed against the risks, particularly in older adults and patients with comorbid illnesses because these patients are at increased risk for serious complications from colonoscopy. A suspected poor preparation is a relative contraindication to colonoscopy.

Important considerations: A high-quality examination requires careful investigation of colonic mucosa. High-quality examination requires appropriate tissue acquisition and endoscopic removal of all polyps less than 2 cm. Removal of polyps larger than 2 cm may require special endoscopic skills.

1.3. Patient preparation

Diet: Patients need to consume a low-residue diet or clear liquids for at least 1 day prior to elective colonoscopy. Liquids that are red can be mistaken for blood in the colon or can obscure mucosal details and should be avoided [3, 4].

Medications: Most medications may be continued up to the time of colonoscopy and are taken with a small sip of water the day of the colonoscopy. Some medications may need to be adjusted prior to colonoscopy, such as medications for diabetes, due to decreased oral intake prior to the procedure. Oral iron should be stopped at least 5 days before the colonoscopy since it makes the residual feces black, viscous, and difficult to purge. Management decisions about antithrombotic agents should be made following discussion with the patient and the clinician prescribing the medications. Aspirin and nonsteroidal anti-inflammatory drugs in standard doses may be continued safely in patients having colonoscopy [5].

Bowel preparation: An adequate bowel preparation is critical for colonoscopy because it permits visualization of the entire colonic mucosa and increases the safety of therapeutic maneuvers. Poor preparation leads to increased procedure time, risk of complications, and

probability of missing lesions. It is important to consider the patient's comorbid illnesses and the timing of the preparation when choosing an appropriate preparation or combination of preparations [6].

Sedation assessment: Options for sedation include no sedation, moderate procedural sedation, or deep sedation. Deciding upon the appropriate approach requires an assessment of the patient's sedation needs and risks prior to the colonoscopy. This includes a complete history of factors that might make sedation more difficult such as prior difficulties with sedation, chronic narcotic or benzodiazepine use, diminished mental capacity, and agitation or severe anxiety [7].

Informed consent: Informed consent includes full disclosure with a clear and complete explanation of all portions of the procedure. Discussion of the possible risks of colonoscopy, including frequent and less frequent but severe complications, must occur and be tailored to the specific patient and procedure. Incidences of possible complications should be mentioned. Written documentation of the consent process is mandatory [8].

Equipment: Routine colonoscopy is performed using a high-definition white-light colonoscope. Both adult and pediatric colonoscopes are available. Adult colonoscopes have a diameter of approximately 13 mm, whereas pediatric colonoscopes have a diameter of approximately 11 mm. An ultra-slim colonoscope with a diameter of 9.5 mm may be particularly helpful in patients with tight turns [9]. Various accessories are available that can be passed through the accessory channel of a colonoscope. These include biopsy forceps, brushes, snares, baskets, nets, injection needles, hemostatic clips, and argon plasma coagulation probes (**Figure 1**).

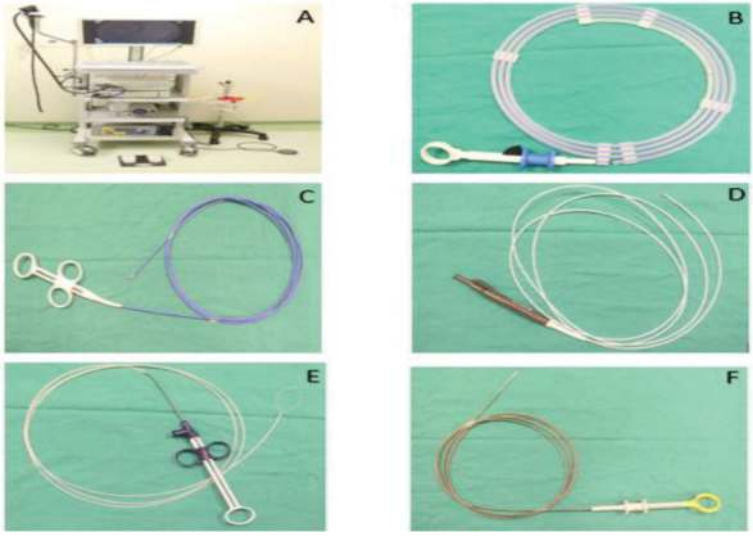

Figure 1. Basic materials used in colonoscopy. A: colonoscope, B: endoscopic clip shooter, C: biopsy forceps, D: endoscopic sclerotherapy needle, E: polypectomy snare, F: foreign body forceps.

Tissue sampling: Visible lesions identified during colonoscopy should be sampled or removed for pathology [10]. Tissue sampling includes biopsies, brushings, and polypectomy. Specimens obtained can be sent for histology, cytology, microbiology, or virology, depending upon the clinical situation.

Polypectomy: Most polyps less than 2 cm in size can be removed endoscopically, as well as many larger polyps. Small polyps may be completely removed using biopsy forceps, while larger polyps require snare resection, with or without electrocautery. Advanced endoscopic mucosal resection and endoscopic submucosal dissection techniques are used for large polyps (greater than 2 cm). Nearly all pedunculated polyps without invasive cancer can be removed endoscopically. If polyps are too numerous for removal, representative samples should be obtained (**Figure 2**).

Photodocumentation and reporting: All colonoscopic procedures should include a complete report detailing the extent of the colon examined, quality of the preparation, and all normal and abnormal findings encountered [11]. Photodocumentation greatly enhances the record and should be included when possible.

1.4. Virtual colonoscopy

Computed tomographic colonography gives a computer-simulated endoluminal vision of air-filled distended colon. This technique uses both spiral or helical CT scan images acquired as an uninterrupted volume of data and employs sophisticated post-processing software to generate images that allow the operator to evaluate a cleansed colon in any chosen direction [12].

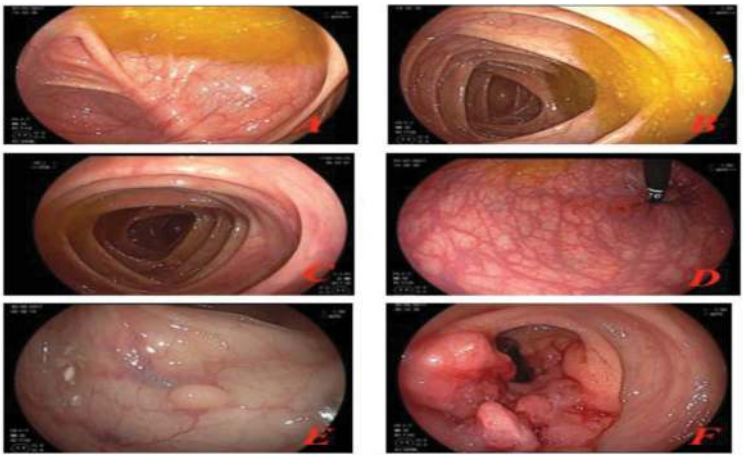

Figure 2. Normal and pathologic images on colonoscopy. A: normal view of caecum, B: normal view of ascending colon, C: normal view of transvers colon, D: reverse image of the rectum, E: sessile polyp of the rectosigmoid junction, F: tumor image at the sigmoid colon.

Indications: Potential indications for virtual colonoscopy include the following:

- Screening for colorectal cancer: virtual colonography is an method for colorectal cancer screening in asymptomatic patients over the age of 50 years. There is consensus that CT colonography should not be used for screening in patients at increased risk for colorectal cancer (e.g., history of adenomas, inflammatory bowel disease, familial colorectal cancer syndrome).
- Evaluation for synchronous colorectal cancer: in patients with a colorectal cancer in whom a complete colonoscopy cannot be performed due to the inability to pass the colonoscope beyond an obstructing tumor, a CT colonography can rule out a proximal synchronous colorectal cancer (**Figure 3**).
- Evaluation of patients with signs or symptoms suggestive of colorectal cancer: while colonoscopy is the preferred initial diagnostic test in patients with signs or symptoms of a colorectal cancer as it permits biopsy of the lesion, a CT colonography may be performed in patients with an incomplete or failed colonoscopy or in whom a colonoscopy is contraindicated [13, 14].
- Evaluation of with signs or symptoms suggestive of divertiküler disease.

Contraindications: The following situations are relative contraindications for CT colonography:

- Active colonic inflammation
- Symptomatic colon-containing abdominal wall hernia
- Recent acute diverticulitis
- Recent colorectal surgery
- Recent deep endoscopic biopsy/polypectomy/mucosectomy
- Known or suspected colonic perforation
- Symptomatic or high-grade bowel obstruction

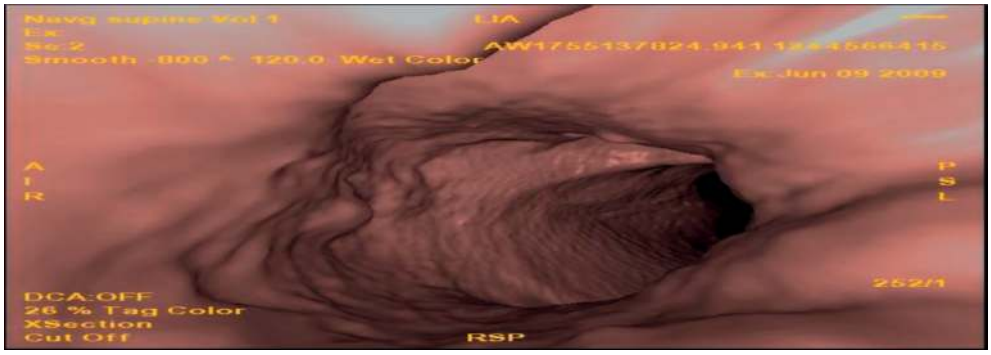

Figure 3. In the image of three-dimensional endoluminal CT colonography, a 9 mm diameter polyp.

Patient preparation: Patient preparation consists of dietary restriction with a low-residue diet and clear liquids for 24 h or more and bowel preparation with a laxative. Patient preparation is critical for computed tomographic (CT) colonography as stool can obscure underlying polyps or mass lesions, and in some cases, can simulate polyps. Several regimens (e.g., polyethylene glycol, phospho soda, magnesium citrate) have been used. It is important to consider the patient's comorbid illnesses when choosing an appropriate preparation or combination of preparations.

Even with the use of cathartic colon preparations, retained fluid in the lumen may obscure or mimic small polyps. Residual material is therefore tagged with oral administration of water-soluble contrast alone (typically with several meals prior to the examination) or in combination with a low-volume barium contrast agent. The contrast-enhanced residual material can then be differentiated from the surrounding colonic mucosa. While bowel preparation is required at the present time, CT colonography without a cathartic bowel preparation is also being evaluated [15].

1.5. Procedure

Technique and data acquisition: Following placement of a thin and flexible rectal catheter, the colon is distended with air or carbon dioxide throughout its length. Carbon dioxide has an improved patient tolerance as compared with air due to more rapid post-procedure absorption. Distension is also facilitated by use of smooth muscle relaxants, such as glucagon or hyoscine, which reduce peristalsis. Colonic distension is evaluated on the computed tomographic (CT) table immediately prior to image acquisition by reviewing the planar CT scout image in order to ensure technical adequacy of the resultant acquisition.

Following this, an uninterrupted volume of data is then acquired through the abdomen in several seconds during a single breath-hold. Because of the presence of stool, fluid, or bowel spasm, data are often acquired in both the supine and prone positions in order to redistribute fluid and colonic gas, thereby facilitating polyp detection. Scanning parameters are designed to cover a large volume of data with thin slices in order to optimize subsequent image reformation.

Intravenous injection of iodinated contrast medium is reserved for patients with known colorectal cancer in order to improve staging, in patients with symptoms of colorectal cancer, or in whom the extracolonic organs need to be further evaluated.

Image processing and reconstruction: Once image data are acquired, post-processing is performed on a computer using a variety of commercially available software packages [16]. The data are then used to render multiplanar reformatted images (in coronal, sagittal, and axial planes), mucosal relief profiles, or hybrid surface-shaded or volume-rendered endoluminal perspectives (picture).

1.6. Capsule endoscopy

Capsule endoscopy is a noninvasive diagnostic method and designed for imaging of the small intestine, which is hard to visualize. Images of esophagus, stomach, and proximal colon can

also be obtained. Images have a 1:8 amplification and resolution is higher than conventional endoscopes. This better images allow visualization of individual villi. Capsule endoscopy gives the concept of physiological endoscopy since the capsule moves in a passive state, does not inflate the bowel, and get images of the mucosa in the collapsed state. Capsule endoscopy is usually used for the diagnosis of small intestine disorders.

1.6.1. Small bowel capsule endoscopy

Indications: Primary indication is suspected intestinal bleeding, Crohn's disease and intestinal tumors. Capsule endoscopy can be used to diagnose small bowel injury due to the use of nonsteroidal anti-inflammatory drugs (NSAIDs), to evaluate abdominal pain of unclear etiology, to investigate for polyps in patients with familial polyposis syndromes and small bowel malignancies in patients with Lynch syndrome, and celiac disease [17–19].

Contraindications: The contraindication of the procedure are listed below:

Dementia, gastroparesis, an esophageal stricture or swallowing disorders, those patients who are inoperable or refuse surgery, partial or intermittent small bowel obstruction, patients who have defibrillators or pacemakers and pregnant women [20, 21].

Procedure: The video capsule (PillCam SB, EndoCapsule, and MiRo capsule) is swallowed with water after 12 h fasting. Following ingestion of the video capsule, clear liquids can be taken after 3 h, and foods can be taken 5 h later. Capsules are disposable and are excreted with defecation. The sensor arrays are removed 8–12 h after ingestion, and the recorded images are downloaded and being processed on Workstation computers. The recorders obtain about 50,000 images in duration of 8–24 h. Review of the video, selection of images, and production of a report may take 30–90 min [22–24].

1.6.2. Colon capsule endoscopy

A colon capsule for the screening of colorectal cancer has been approved by the US Food and Drug Administration and by the European Medicines Agency. Guidelines suggest that colon capsule endoscopy is a suitable and good alternative to colonoscopy for colorectal cancer in average-risk patients. However, it is not recommend for patients at increased risk for colon cancer or for patients with alarm symptoms [25].

Like conventional colonoscopy, a bowel preparation should be given to patients. The evening prior to the examination, patients should take about 3 L of polyethylene glycol. The morning of the procedure, the patient drinks another liter of polyethylene glycol between 6:00 and 7:00 am, and then the capsule is ingested at 8:00 am. Additional drugs (phospho soda and bisacodyl) can be given during the procedure for increasing transit of the capsule [25].

The colon capsule can be used to screen for colon cancer and polyps. Unfortunately, colonic capsule endoscopy cannot allow for biopsy polyp removal. Colonoscopy is required for lesions detected during the colon capsule endoscopy, subsequently for further evaluation and/or treatment.

2. Magnetic resonance imaging

Magnetic resonance imaging (MRI) is one of the most important methods for local staging of patients with rectal cancer. There are three different modalities of MRI as body coil MRI, endorectal coil MRI and pelvic phased-array coil MRI. Body coil MRI is not superior to CT scan in staging and it is insufficient in local staging.

ERC-MRI is used to provide images of the rectum and the area surrounding the rectum with a probe inserted into the rectum through the anal canal. ERC-MRI is an important method for staging of the anal canal and rectal cancers and diagnosis of anorectal fistulas and abscesses. ERC-MRI can make T-staging with an accuracy of 70–90% particularly for T1–T2 and early T3 tumors [26]. Despite this, likelihood of success in evaluation of T3 and T4 tumors decreases due to narrow field of view and implementation difficulty of ERC-MRI. Additionally, endorectal coil MRI cannot visualize the mesorectal fascia and it is an important disadvantage. Likelihood of success is less in conditions where the patient is noncompliant and not tolerating anal coil insertion, in tumors with a longitudinal length of more than 5 cm, tumors invading ¾ of the lumen, tumors located above the level of 10 cm from the anal verge [27].

More detailed images were obtained by using pelvic phased-array coil MRI (PP-MRI) which was developed recently and providing high-resolution images. Thus, local staging of rectal tumor resulted in a higher accuracy rate. Obtaining a wide angled image is its superiority to endorectal coil MRI.

Distension of rectal lumen and rectal wall with use of preoperative intrarectal contrast material such as water or gel, air insufflation, premedication with spasmolytic agents improve the quality of both of ERC-MRI and PP-MRI [28].

T-staging: The accuracy rate of staging performed with PP-MRI is markedly higher compared to CT. Excellent imaging of layers of the rectal wall, mesorectum and mesorectal fascia particularly in middle and upper rectal cancers improved description of T3 tumors.

It is very important to be able to determine the distance between the mesorectal fascia and tumor in detail as mm for local recurrence. This distance shows compliance reaching 95% with pathological measurement performed in specimen removed by using PP-MRI and total mesorectal excision. This feature enabled us to make preoperative substaging of T3 tumors [29]. In T3 tumors, if tumor invasion into the mesorectum is <5 mm then tumor is classified as T3a and if it is >5 mm then tumor is classified as T3b. While less number of lymph node involvement was observed in T3a tumors, lymph node involvement was seen in a more aggressive manner in T3b tumors. PP-MRI fell behind endoanal ultrasonography to show the relationship between the tumor and the anal sphincter muscles particularly in patients requiring intersphincteric resection.

Besides, endoanal ultrasonography is more successful than PP-MRI in discrimination between T1 tumor and T2 tumor in lower rectal cancers compared to PP-MRI.

N-staging: Regardless of T stage, N positivity shows locally advanced tumor and there is also a higher risk of local recurrence. These patients are candidates for neoadjuvant hormone

therapy. Distinguishing tumor and involved lymph node from reactive lymph node is important. PP-MRI has a success rate reaching 85% in evaluation of lymph node.

3. Contraindications for MRI

Absolute	Relative
1. Presence of pacemaker	1. Pregnancy
2. Cochlear implant	2. Claustrophobia
3. Metallic implant/object in the eyeball	3. Metallic implant/object in the soft tissue
4. If communication cannot be established with patient	4. Prosthetic heart valve
	5. Dental implant
	6. Intrauterine device
	7. Monitored patient
	8. Permanent makeup and tattoo

4. Endorectal ultrasonography

ERUS is being increasingly commonly used as a method in preoperative staging of rectal cancer. It is an ultrasonic method enabling simultaneous investigation of rectal wall layers and perirectal tissues in a 360° axis with a probe inserted into the rectum. A probe within a balloon inflated with water and inserted into the rectum detect the sound waves echoes of its own level by continuously rotating 360°. Axial length of tumor, its extension into rectal wall layers (T) and lymph nodes in perirectal tissues (N) are detected by moving the probe forward and backward through the anal canal and rectum (**Figure 4**). The structures of anal sphincters are established at the level of anal canal. The relationship between the tumor and anal sphincter is determined. However, inability to visualize the mesorectal fascia is the most important disadvantage. Therefore, it causes errors in staging of advanced T3 and T4 tumors. Besides, the lymph nodes far from the rectum may not be determined. Additionally, since higher staging can be made an erroneously, care should be exercised during interpretation of locally advanced cancer or desmoplastic tumors [30].

The other negative aspects of ERUS are as followings: inability to use in obstructive tumors, decline in diagnostic accuracy of T-staging in patients undergoing preoperative radiotherapy due to increased echogenicity of the rectal wall [31].

Lymph node staging by ERUS is problematic. It is difficult to determine whether lymph node is metastatic or not. Sensitivity and specificity of ERUS in determining lymph node are approximately 55 and 78%; respectively [33].

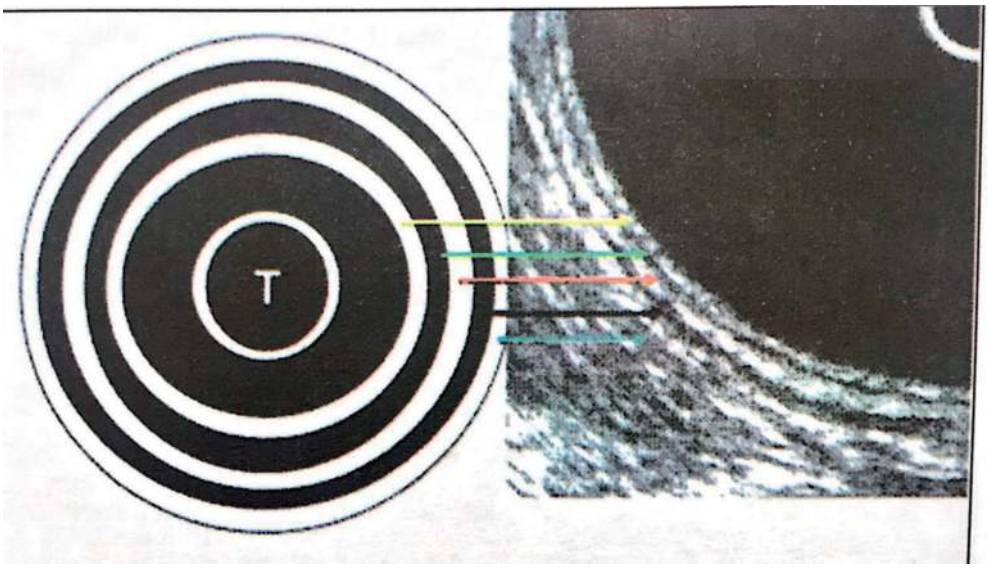

Figure 4. Rectal layers. Yellow arrow: mucosal surface, green arrow: mucosa, red arrow: submucosa, black arrow: proper muscle layer, blue arrow: perirectal fatty tissue.

The accuracy rate of ERUS in determining perirectal lymph node is about 70 and 75%. If sonographic appearance of lymph node is round in shape and its size is greater than 1 cm, it is suggestive of a malignancy. Malignant lymph nodes are hypoechoic and hypervascular. Lymph nodes with a diameter of greater than 0.5 cm are 50–70% malignant, the probability of malignancy is less than 20% if its diameter is less than 4 mm [32].

When ERUS, MRI and CT are compared for staging of rectal cancer, a marked superiority of ERUS and MRI is observed in T and N-staging compared to CT. While the accuracy rates of CT, ERUS and endorectal coil MRI in T-staging were reported to be 73, 87 and 84%, respectively; the accuracy rates of CT, ERUS and endorectal coil MRI in N-staging were reported to be 66, 74 and 82%, respectively [33].

Also localization and size of tumor affect the accuracy rates of methods. While the results with ERUS are better in tumors located within the 1/3 lower part of the rectum, PP-MRI provides a higher rate of accuracy in the middle and upper rectum. While ERUS is better in T1 and T2, a more detailed evaluation can be performed with PP-MRI in T3 and T4. Currently, since importance of the distance of the tumor to the mesorectal fascia became evident, the value of PP-MRI in local staging increased. Because, ERUS cannot visualize the mesorectal fascia. This is an important part of evaluation which will be performed before decision-making process for neoadjuvant chemotherapy. Performing PP-MRI in the preoperative assessment of rectal tumors should be considered mandatory. However, there is a risk for higher staging (due to desmoplastic reaction). This might cause initiation of unnecessary neoadjuvant chemotherapy in some patients. ERUS is superior in assessment of anal sphincter involvement.

In conclusion, when these two stagings are performed together the accuracy rate in local staging increases, in other words these two methods are complementary. Reporting higher or lower stage T is in question for both methods. This can be observed much more in PP-MRI for discrimination of T2/T3 and in ERUS for discrimination of T3/T4. In recent years, tumor extension can be determined well with development of three-dimensional ERUS.

Author details

Murat Ferhat Ferhatoglu* and Abdulcabbar Kartal

*Address all correspondence to: ferhat.ferhatoglu@okan.edu.tr

Department of General Surgery, Faculty of Medicine, Okan University, Istanbul, Turkey

References

[1] Bjorkman DJ, Popp JW Jr. Measuring the quality of endoscopy. Gastrointestinal Endoscopy. 2006;**63**:1

[2] Rex DK, Schoenfeld PS, Cohen J, et al. Quality indicators for colonoscopy. Gastrointestinal Endoscopy. 2015;**81**:31

[3] Faigel DO, Eisen GM, Baron TH, Dominitz JA, Goldstein JL, Hirota WK, et al. Preparation of patients for GI endoscopy. Gastrointestinal Endoscopy. 2003;**57**:446-450

[4] Park DI, Park SH, Lee SK, Baek YH, Han DS, Eun CS, et al. Efficacy of prepackaged, low residual test meals with 4L polyethylene glycol versus a clear liquid diet with 4L polyethylene glycol bowel preparation: A randomized trial. Journal of Gastroenterology and Hepatology. 2009;**24**:988-991

[5] ASGE Standards of Practice Committee, Anderson MA, Ben-Menachem T, Gan SI, Appalaneni V, Banerjee S, Cash BD, et al. Management of antithrombotic agents for endoscopic procedures. Gastrointestinal Endoscopy. 2009;**70**:1060-1070

[6] Chokshi RV, Hovis CE, Hollander T, Early DS, Wang JS. Prevalence of missed adenomas in patients with inadequate bowel preparation on screening colonoscopy. Gastrointestinal Endoscopy. 2012;**75**:1197-1203

[7] Standards of Practice Committee of the American Society for Gastrointestinal Endoscopy, Lichtenstein DR, Jagannath S, Baron TH, Anderson MA, Banerjee S, Dominitz JA, et al. Sedation and anesthesia in GI endoscopy. Gastrointestinal Endoscopy. 2008;**68**:815-826

[8] Standards of Practice Committee, Zuckerman MJ, Shen B, Harrison ME, Baron TH, Adler DG, Davila RE, et al. Informed consent for GI endoscopy. Gastrointestinal Endoscopy. 2007;**66**:213-218

[9] Shumaker DA, Zaman A, Katon RM. A randomized controlled trial in a training institution comparing a pediatric variable stiffness colonoscope, a pediatric colonoscope, and an adult colonoscope. Gastrointestinal Endoscopy. 2002;**55**:172-179

[10] Faigel DO, Eisen GM, Baron TH, Dominitz JA, Goldstein JL, Hirota WK, et al. Tissue sampling and analysis. Gastrointestinal Endoscopy. 2003;**57**:811-816

[11] Williams JE, Faigel DO. Colonoscopy reports and current state of performance measures. Gastrointestinal Endoscopy Clinics of North America. 2010;**20**:685-697

[12] Levine MS, Yee J. History, evolution, and current status of radiologic imaging tests for colorectal cancer screening. Radiology. 2014;**273**:160-180

[13] Levin B, Lieberman DA, McFarland B, Andrews KS, Brooks D, et al. Screening and surveillance for the early detection of colorectal cancer and adenomatous polyps, 2008: A joint guideline from the American Cancer Society, the US Multi-Society Task Force on Colorectal Cancer, and the American College of Radiology. Gastroenterology. 2008;**134**: 1570-1595

[14] U.S. Preventive Services Task Force. Screening for colorectal cancer: U.S. Preventive Services Task Force recommendation statement. Annals of Internal Medicine. 2008;**149**: 627-637

[15] Kim B, Park SH, Hong GS, Lee JH, Lee JS, Kim HJ, et al. Iohexol versus diatrizoate for fecal/fluid tagging during CT colonography performed with cathartic preparation: Comparison of examination quality. European Radiology. 2015;**25**:1561-1569

[16] Summers RM, Yao J, Pickhardt PJ, Franaszek M, Bitter I, Brickman D, et al. Computed tomographic virtual colonoscopy computer-aided polyp detection in a screening population. Gastroenterology. 2005;**129**:1832-1844

[17] Petroniene R, Dubcenco E, Baker JP, Ottaway CA, Tang SJ, Zanati SA, et al. Given capsule endoscopy in celiac disease: Evaluation of diagnostic accuracy and interobserver agreement. The American Journal of Gastroenterology. 2005;**100**:685-694

[18] Cobrin GM, Pittman RH, Lewis BS. Increased diagnostic yield of small bowel tumors with capsule endoscopy. Cancer. 2006;**107**:22-27

[19] Gastineau S, Viala J, Caldari D, Mas E, Darviot E, Le CC, et al. Contribution of capsule endoscopy to Peutz-Jeghers syndrome management in children. Digestive and Liver Disease. 2012;**44**:839-843

[20] Bandorski D, Höltgen R, Stunder D, Keuchel M. Capsule endoscopy in patients with cardiac pacemakers, implantable cardioverter defibrillators and left heart assist devices. Annals of Gastroenterology. 2014;**27**:3-8

[21] Stanich PP, Kleinman B, Betkerur K, Mehta Oza N, Porter K, Meyer MM. Video capsule endoscopy is successful and effective in outpatients with implantable cardiac devices. Digestive Endoscopy. 2014;**26**:726-730

[22] de Franchis R, Avgerinos A, Barkin J, Cave D, Filoche B, ICCE. ICCE consensus for bowel preparation and prokinetics. Endoscopy. 2005 Oct;**37**(10):1040-1045

[23] Marshall CA, Cave DR. Preparation for video capsule endoscopy: A clear choice? Gastrointestinal Endoscopy. 2017;**85**:194-195

[24] Holden JP, Dureja P, Pfau PR, Schwartz DC, Reichelderfer M, Judd RH, et al. Endoscopic placement of the small-bowel video capsule by using a capsule endoscope delivery device. Gastrointestinal Endoscopy. 2007;**65**:842-847

[25] Spada C, Hassan C, Galmiche JP, Neuhaus H, Dumonceau JM, Adler S, Epstein O, et al. European Society of Gastrointestinal Endoscopy. Colon capsule endoscopy: European Society of Gastrointestinal Endoscopy (ESGE) Guideline. Endoscopy. 2012;**44**:527-536

[26] Matsuoka H, Nakamura A, Masaki T, et al. Comparison between endorectal coil and pelvic phased array coil MRI in patients with anorectal tumor. American Journal of Surgery. 2003;**185**:328-332

[27] Drew PJ, Farouk R, Turnbull LW, et al. Preoperative magnetic resonance staging of rectal cancer with an endorectal coil and dynamic gadolinium enhancement. The British Journal of Surgery. 1999;**86**:250-254

[28] Iafrate F, Laghi A, Paolantonia P, et al. Preoperative staging of rectal cancer with MR ımaging: Correlation with surgical and histopathologic findings. Radiographics. 2006;**26**: 701-714

[29] Brown G, Radcliffe AG, Newcombe RG, et al. Preoperative assessment of prognostic factors in rectal cancer using high-resolution magnetic resonance imaging. The British Journal of Surgery. 2003;**90**:355-364

[30] Karantanas AH, Yarmenitis S, Papanikolaou N, Gourtsoyiannis N. Preoperative imaging, staging of rectal cancer. Digestive Diseases. 2007;**25**:20-32

[31] Beynon J, Mortensen NJ, Foy DM, et al. Preoperative assessment of local invasion in rectal cancer: Digital examination, endoluminal sonography or computed tomography? The British Journal of Surgery. 1986;**73**:1015-1017

[32] Bipat S, Glas AS, Slors FJ, et al. Rectal cancer: Local staging and assessment of lymph node involvement with endoluminal US, CT, and MR imaging a metaanalysis. Radiology. 2004;**232**:773-783

[33] Merkel S, Mansmann U, Siassi M, et al. The prognostic inhomogeneity in pT3 rectal carcinomas. International Journal of Colorectal Disease. 2001;**16**:298-304