I

INTRODUCTION

ENDOSCOPY AND ENDOSCOPIC INTERVENTION

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Over the past several decades, flexible endoscopy has shifted the management of numerous gastrointestinal diseases from the surgeon to the endoscopist. What had started as a diagnostic discipline has now become one of advanced therapeutic potential. The concept of performing endoscopic surgery has become a reality with the advancement of endoluminal therapies for neoplasia, gastroesophageal reflux, and obesity. In addition, with the significant investigation into Natural Orifice Translumenal Endoscopic Surgery and the development of advanced endoscopic tools, the ability to perform intraperitoneal therapies without abdominal scars continues to become more possible.. This chapter will address the indications and techniques for upper and lower flexible endoscopy as well as the recent advances in imaging and interventional endoscopy.

THE FLEXIBLE ENDOSCOPE

Imaging

The flexible endoscope was initially developed in 1957 as an imaging device dependent on the delivery of light and transmission of the image along multiple bundles of chemically treated glass fibers. The fiberoptic bundle is 2–3 mm wide and is composed of 20,000–40,000 individual fine glass fibers, each approximately 10 micrometers in diameter. [1] The image undergoes a series of internal reflections within each fiber, which are coated with low optical density glass to prevent escape of light, as it is transmitted up the bundle. Due to formation of the fibers and surrounding material, a characteristic meshed image is seen in fiberoptic endoscopes, which inherently results in a lower resolution than that seen with rigid lens systems. In addition, if the fibers become cracked, the image is not generated at this site of the bundle and multiple black spots are seen.

When utilizing a fiberoptic endoscope, the endoscopist view the image through the eyepiece at the instrument head, or alternatively, a video camera can be affixed to the eyepiece to transmit the image to a video monitor. The progression from fiberoptic scopes to the videoendoscopes we use today, has allowed for advancements in our ability to perform more involved therapies, educate physicians and endoscopic assistants, and obtain static and dynamic recorded data images for improved clinical management.

The majority of endoscopes in use today are videoscopic, although in many parts of the world, fiberoptic systems are still the standard. In these videoscopic systems, the visualized image is created from reflections onto a charge coupled device (CCD), which is a chip mounted at the end of the endoscope rather than via the fiberoptic bundles.. The CCD chip has thousands of pixels (light-sensitive points) which directly increases image resolution. (2)

Imaging Advances

There have been many recent advances in endoscopic imaging techniques. The purpose of most of these techniques is early detection of dysplasia, which might elude standard endoscopic visualization. Clinical use of new imaging is limited principally to specialized centers, but future widespread application of an imaging method for early dysplasia detection is a certainty.

CHROMOENDOSCOPY

The aim of chromoendoscopy is to detect subtle mucosal abnormalities. Commonly used agents include Lugol's solution, methylene blue, indigo carmine, and Congo red. A 2%-3% solution of potassium iodide (Lugol's solution) reacts with glycogen in keratinized squamous epithelium. Normal squamous epithelium stains a deep brown, but inflammation, dysplasia, and carcinoma do not stain because of a lack of glycogen. Lugol's solution has been shown to be effective in detecting Barrett's esophagus as well as screening for squamous cell carcinoma of the esophagus. (3)

FIGURE 3-1 Standard white light versus NBI imaging of the distal esophagus in patients with Barrretts esophagus. Differentiation of the squamous and columnar mucosa is easily seen in the NBI image.

FIGURE 3-2 Standard white light versus NBI imaging of the distal esophagus in patients with Barrretts esophagus. Differentiation of the squamous and columnar mucosa is easily seen in the NBI image.

MAGNIFICATION ENDOSCOPY

In magnification endoscopy, a cap with a magnifying lens is fitted to the tip of an endoscope. The mucosa in contact with the lens is magnified without impairing the maneuverability of the scope. Degrees of magnification range from 1.5x to 115x and can be changed on the scope by turning a dial at the hand controls. The technique of magnification endoscopy is frequently used in conjunction with chromoendoscopy. Chromoendoscopy is used for broad surveillance of the mucosa followed by focused examination of suspicious lesions in magnification mode. This combined examination has been reported in case series to enhance detection of Barrett's esophagus, chronic gastritis, Helicobacter pylori infection, gastric dysplasia, and early gastric cancer. [4,5,6]

CONFOCAL FLUORESCENCE MICROENDOSCOPY

Standard endoscopy uses white light to visualize a large surface area with relatively low resolution. In contrast, confocal endoscopy aims to visualize the mucosa and submucosa with subcellular resolution, a technique deemed optical biopsy. The process of confocal magnification reduces out-of-focus light from above and below the focal plane at a magnification of 1000x. The system is designed to measure tissue fluorescence, therefore an exogenous fluorophore (a molecule which causes another molecule to be fluorescent) is usually administered. Varying depths of tissue are examined by altering the focal plane, and images from different depths are stacked together to create an optical slice of tissue, thus the term optical biopsy. (4)

NARROW BAND IMAGING

Most endoscopes now have the ability to switch from standard to narrow band imaging (NBI) with the push of a button. In narrow band endoscopy filtered light is used to preferentially enhance the mucosal surface, especially the network of superficial capillaries. Narrow band imaging is often combined with magnification endoscopy. Both adenomas and carcinomas have a rich network of underlying capillaries and enhance on narrow band imaging, thereby appearing dark brown against a blue green mucosal background. (5) The use of white light as well as NBI has enable endoscopists to provide an immediate assessment of small colonic lesions without histopathologic evaluation. (7) Gastric mucosal abnormalities are also differentiated by NBI with and without magnification endoscopy. (8) NBI can also differentiate squamous from nonsquamous epithelium to help identify Barrett's esophagus. (Fig. 3-1 and 3-2)

AUTOFLUORESCENCE

Autoflurescence endoscopy has been shown in pilot studies to improve the detection of dysplasia in Barrett's esophagus and chronic ulcerative colitis. Autofluorescence endoscopy relies on several principles: tissue architecture changes such as mucosal thickening dampen submucosal autofluorescence; neovascularization alters the light emitting and scattering properties of surrounding tissue; the biochemical microenvironment, such as high oxidation-reduction activity, alters autofluorescence; and different tissue types have unique distribution of fluorophores. (4,9)

OPTICAL COHERENCE TOMOGRAPHY

Endoscopic optical coherence tomography is an emerging technology analogous to endoscopic ultrasound. OCT utilizes a probe passed via the endoscope, although it does not require tissue contact. The technique uses reflection of near-infrared light to produce real-time two-dimensional cross sectional images of the gastrointestinal tract. These true anatomic images correspond to the histologic layers (mucosa, submucosa, muscularis propria). The images obtained have a resolution 10-fold greater than endoscopic ultrasound. (Fig 3-3) Preliminary studies have looked at the utility of OCT in the evaluation of Barrett's esophagus. (10) Endoscopic optical coherence tomography is not yet in widespread use.

LIGHT SCATTERING SPECTROSCOPY

Light scattering spectroscopy mathematically analyzes the intensity and wavelength of reflected light to estimate the size and degree of crowding of surface epithelial nuclei. The technique relies on absorption and scattering of white light. Light scattering spectroscopy has shown limited efficacy in detecting Barrett's esophagus and early colonic dysplasia. The technique relies on graphing mathematical computations rather than an optical biopsy as is done in other emerging imaging techniques. Light scattering spectroscopy might be used in combination with optical biopsy for detection of early dysplasia. (4)

Image Documentation

Many gastrointestinal diseases require surveillance evaluation, and the progression or regression of identified disease state is vital to appropriate patient care. Video endoscopes produce digital signals that can be recorded on a variety of media, including film, hardcopy printout, disk, or a secure data file. During the procedure, it is imperative to visually document important findings and their location for comparison with previous or follow-up studies This practice also allows other members of the health care team to understand and interpret the findings and plan for appropriate treatment. Additional documentation on anatomic diagrams will also facilitate interpretation. Pertinent negative findings should also be documented.

Endoscope Anatomy

Flexible endoscopes are being created in a wide variety of lengths and diameters, with an assortment of channel num-

FIGURE 3-3 OCT image of the esophagus. Reprinted with permission from Wang and Sampliner, Updated guideline 2008 for the diagnosis, surveillance and therapy for Barrett's esophagus. Am J Gastroenterol 2008;103:788-797.

FIGURE 3-4 The variable stiffness control is seen at the base of the head piece of the colonoscope.

bers and sizes, adjunct imaging modalities, and intrinsic and extrinsic scope mechanics for reducing scope looping and providing improved scope advancement. A basic understanding of the scope anatomy is vital to the performance of safe and effective flexible endosocpy.

Uniformally, the knobs for controlling manipulation of the scope tip are located on the right side of the headpiece, with an internal larger knob for upward and downward deflection and an external smaller knob which manipulates the tip to the left and right. Locks accompany each knob to hold the deflection in position when needed. The ability for greater degree of deflection of the endoscope occurs with upward rather than downward manipulations. There is no variability in deflection provided by the right-left knob. In addition to manipulation of the deflecting knobs, significant scope rotation can be achieved by torquing the endoscope, altering the endoscopist's stance, or by rotating the headpiece while inserting or withdrawing the shaft of the endoscope.

- There are two buttons on the front of the scope headpiece responsible for tip cleaning, air insufflation, and suction.
- The suction channel also functions as the biopsy channel so that any endoscopic tools placed into the biopsy channel will limit the ability to suction fluids through the endoscope.
- A small button on the front of the handpiece above the suction button allows for freezing of the image and digital recording by pressing the image capture button on the back of the handpiece.
- The endoscope is held in the left hand regardless of the individual physician's hand dominance. The internal up and downward deflection knob is controlled by the left thumb while the air, water and suction by the left index and middle fingers.
- The smaller left-right knob then is usually manipulated by the right hand.

One of the challenges in modern endoscopy, especially colonoscopy, is the formation of undesired loops in the shaft of a flexible scope. Loop formation impedes expeditious and safe passage to the cecum by transmitting the force of insertion to the colon wall or mesentery rather than to forward progression. Two technical advances aim to prevent loop formation: variable stiffness endoscopes and shape-locking overtubes.

VARIABLE STIFFNESS ENDOSCOPES

Conventional colonoscopes have a static level of column strength throughout the length of the insertion tube. The column strength determines the amount of buckling of the instrument that occurs during insertion and the level of elasticity that remains during reduction of loops. Variable stiffness endoscopes permit alteration of the column strength through an adjustable tensioning coil. (fig 3-4) The data from studies comparing variable stiffness colonoscopes to conventional scopes are inconclusive. Some studies reports faster cecal intubation using variable stiffness endoscopes with less need for adjunct maneuvers, while other similar studies report no significant differences. (11,12)

SHAPE LOCKING DEVICE

The ShapeLock Endoscopic Guide (ShapeLock, USGI Medical, San Clemente, CA) consists of a reusable skeleton of multiple titanium links, a disposable inner plastic lining, an atraumatic foam tip, and a disposable smooth external skin. A squeeze handle at the base of the device converts it from a flexible mode to a rigid mode. The shape locking device is made in 40 cm and 60 cm lengths with an inner diameter of 20 mm. A small clinical study has been reported using the shape locking device. No device-related complications were noted, but the optimal strategy for employing the device was uncertain. (13)

New Scope Technology

While the construction of standard endoscopes has remained largely unchanged over many decades, novel scope designs are being developed to either simplify colonoscopic examinations or enhance mucosal visualization. Other than double balloon enteroscopy, these technologies are chiefly limited to small clinical trials, but their application could gain momentum in the coming years.

SELF-PROPELLED COLONOSCOPES

In an effort to simplify the process of colonoscopic screening, self-propelled endoscopes are in development. The Aer-O-Scope (GI View, Ltd, Ramat Gan, Israel) is a user-independent, self-propelled, self-navigating colonoscope. The device consists of a disposable rectal introducer, supply cable, and a scope embedded within a scanning balloon. The device contains no working channel for therapeutic interventions, therefore it is intended for screening purposes only. A small pilot study examined the proof of concept of the Aer-O-Scope. There were no device-related complications. (4)

Another self-propelled colonoscope, the ColonoSight (Stryker Corp, Kalamazoo, MI) employs air-assisted propulsion in a disposable system. A pneumatic mechanism generates the pressure to create the forward force while an operator directs the scope using handles. The system uses light emitting diode optics, rather than video or fiber optics, and has disposable working channels. A pilot study for ColonoSight reported intubation of the cecum in 88% of cases at a mean time of 12 minutes without any device-related complications. (4)

Endoscopic Education

Recent mandates from the American Board of Surgery now require surgical residents to graduate with an increased number of flexible endoscopy cases (50 colonoscopies, 35 EGDs). To provide this experience and to improve the overall endoscopic education of surgery residents, a cohesive curriculum is needed. (14) An iteration of such a curriculum might include periodic simulation training for first-year residents, formal endoscopy rotations for junior residents, and intra-operative and advanced endoscopy for senior and chief residents. (15)

Efforts to improve endoscopic training have led to the development of computer simulators for teaching endoscopic skills. Currently, simulators are available for training in flexible sigmoidoscopy, gastroscopy, ERCP, endoscopic ultrasound (EUS), and colonoscopy. (16)

PATIENT ASSESSMENT, SEDATION AND MONITORING

Patient Assessment

Although both upper and lower endoscopy can be performed unsedated, the majority of patients undergoing endoscopic procedures receive agents to provide conscious sedation. Pre-procedural patient risk assessment, intra-procedural cardiopulmonary monitoring, and post-procedural recovery are vital to the performance of safe and effective endoscopic interventions. Pre-procedural evaluation for ASA risk classification and Malampati score have become standard guidelines for most endoscopy units. (19) Elderly patients or those with preexisting cardiopulmonary conditions are at increased risk for these complications, as are those undergoing more extensive endoscopic interventions. Patients with diseases associated with the oropharynx or trachea, and those with morbid obesity, sleep apnea, or neuromuscular degenerative diseases require extra vigilance during endoscopic procedures. (20)

Monitoring

Monitoring should be performed before, during, and after the procedure by a dedicated endoscopy assistant. Signs that are routinely monitored include the patient's level of consciousness, degree of pain, vital signs, and respiratory status. (21)

1. Supplemental nasal oxygen is required to decrease the frequency of desaturation during endoscopic procedures.
2. The patient's oxygenation status and cardiac electrical activity are also monitored by equipment throughout the procedure.
3. It must be understood that pulsoximetry levels can rule out hypoxia, hypoventilation and resultant hypercarbia can still go undetected.
4. At this time, measurement of end tidal CO2 monitoring however, is just beginning to be utilized at the time of endoscopic interventions.

In addition, external suction for clearing oropharyngeal secretions must be immediately available and within reach of the endoscopic assistant.

Sedation

The combination of narcotics (analgesia) and benzodizepines (sedation and amnesia) are commonly used to provide sedation during endoscopic procedures. (22) Although propofol has a more rapid onset and shorter half-life, it's routine use during endoscopic procedures has been widely reserved for those performed in an operating room with an anesthesiologist. (23) Reversal agents (antagonists) for both class of drugs are now available and should be immediately ready for delivery in patients who show signs of over-sedation. Titration of medications delivered in small increments allows for the safe performance of sedated endoscopy, especially in older patients with slower circulatory distribution.

Cardiopulmonary issues are the most commonly reported complications with endoscopic procedures. These complications include aspiration, oversedation, hypotension, hypoventilation, arrhythmia, bradycardia (vasovagal), and airway obstruction. Many of the latter are associated with use of intravenous moderate (formerly "conscious") sedation, defined as decreased consciousness associated with preservation of protective reflexes.

UPPER GASTROINTESTINAL ENDOSCOPY

Indications

The indications for upper gastrointestinal endoscopy (EGD) can be divided between those for diagnosis and those to provide for potential therapy. Diagnostic EGD is used for the evaluation or surveillance of patients who present with "alarm symptoms" (Table 3-1) as do those with abnormal or inconclusive radiographic studies. Follow-up evaluations for ulcers or surveillance for patients with Barrett's esophagus are also indications. Therapeutic upper endoscopic interventions include the management of bleeding, removal or ablation of pre-malignant or malignant lesions, management of upper gastrointestinal obstructions, leaks or fistulae, and the creation of enteral access for supplemental feeding or decompression.

Contraindications

The contraindications to EGD are related to the patient's associated co-morbidities , underlying gastrointestinal disorders, or patient's inability to tolerate conscious sedation. Recent myocardial infarction, pneumonia, and recent foregut surgical procedure are relative contraindications for EGD, and the risks and benefits need to be weighed on an independent basis for each patient to determine appropriateness. A recent surgical anastomosis is most likely safe at any time during the post-operative period to be evaluated endoscopically, remembering that tissue strength will be weakest on postoperative days five to seven.

Coagulopathy secondary to thrombocytopenia, liver failure, renal failure, or exogenous use of anticoagulants and platelet inhibiting agents is a relative contraindication for a diagnostic EGD, but an absolute contraindication for a therapeutic intervention. Patient non-cooperation or inability for a patient to be safely sedated due to high cardiopulmonary risk, are also contraindications to EGD. Respiratory depression secondary to medications as well as inability to maintain an airway can occur in these high risk patients. Pre-assessment with ASA classification and Malampatti scores will help predict this high risk group. Patients with suspected perforation or caustic ingestion injury should not undergo EGD unless there are plans to provide palliative therapy such as endoscopic closure or stent placement. .

PATIENT PREPARATION

Upper gastrointestinal endoscopy requires very little preparation other than fasting of solid food for 6-8 hours and liquids for 2-4 hours. Removable dentures and dental implants must be taken out to avoid dislodgement and aspiration during the procedure. The role of lavage in patients with bleeding is debatable, and if large volume lavage is to be used, care must be taken to avoid aspiration including the judicious use of endotracheal intubation. If intervention is anticipated, a recent coagulation profile and platelet count should be within safe ranges. The use of topical pharyngeal anesthetic spray is necessary in unsedated procedures in order to suppress the gag reflex, and is used based on physician preference for sedated cases.

The use of prophylactic antibiotics is rarely indicated for EGD, except in the scenario of esophageal sclerotherapy, dilation, and percutaneous endoscopic gastrostomy (PEG) tube placement. Discussion with the cardiologist as to the role of antibiotics is recommended for patients with prosthetic heart valves, previous endocarditis, systemic pulmonary shunts, or recent vascular prostheses.

Basic Endoscopic Techniques-EGD

The forward-viewing endoscope is preferred for routine diagnostic endoscopy. It should be noted that the medial duodenal wall, at the site of the ampulla, is preferentially seen with a side viewing endoscope. More recently, the use of small diameter 5mm transnasal endoscopes has allowed for the safe performance of unsedated endoscopy.

TABLE 3-1: INDICATIONS FOR ENDOSCOPIC ULTRASOUND

1. Abdominal complaints not responsive to appropriate empiric therapy
2. weight loss
3. early satiety
4. Odynophagia
5. Dysphagia
6. Persistent nausea and vomiting
7. Hematemesis/melena
8. Foreign body impaction
9. Iron deficiency or unexplained chronic anemia

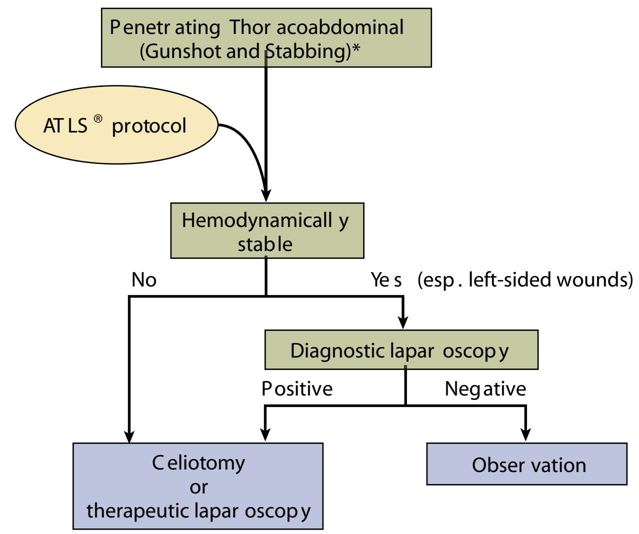

FIGURE 3-5 Retroflex view in the stomach, here revealing a large Type III paraesophageal hernia. Reprinted with permission from Wang and Sampliner, Updated guideline 2008 for the diagnosis, surveillance and therapy for Barrett's esophagus. Am J Gastroenterol 2008;103:788-797.

After appropriate pre-procedural patient assessment and informed consent, the patient is routinely placed in a left side down lateral decubitus position. Patients undergoing PEG procedure or other therapies requiring access to the abdominal wall are left supine. Prior to delivery of sedation, a baseline set of vitals is taken and it is confirmed that the equipment is in proper working order and potentially necessary endoscopic tools are readily available. Following the slow delivery of medications, titrating the doses as needed based on the individual patient needs, the distal several centimeters of the endoscope are lubricated avoiding the actual tip of the endoscope as this will obscure the image and even with irrigation, will make visualization difficult.

Intubation of the esophagus is best accomplished under direct vision by advancing the endoscope over the tongue, past the uvula and epiglottis, and then posterior to the arytenoid cartilages. This maneuver will impact the endoscope tip at the cricopharyngeal sphincter and allow entry into the cervical esophagus with gentle forward pressure once the patient swallows. Blind insertion with the endoscopists hand in the patient's pharynx is not recommended as this is more dangerous for both the patient and the endoscopist.

Once in the cervical esophagus, the instrument is advanced under direct vision taking care to survey the mucosa both during insertion and withdrawal. The distance to the squamo-columnar junction, the "Z-line", where the white squamous esophageal mucosa meets the red columnar gastric epithelium is recorded in the procedure report. The site of the diaphragmatic crura (hiatus) should also be recorded and is seen as impression into the esophageal or gastric lumen. This point can be accentuated by asking the patient to sniff while the area is visualized. The endoscope is then advanced into the gastric lumen under direct visualization. Unlike colonoscopy where there is a requirement for significant torquing or twisting of the scope, due to fixation of the esophagus in the mediastinum, EGD manuipulations can be more directly achieved with deflection of the wheels and movement of the handpiece ("dancing with the scope").

After aspirating any gastric contents, the four gastric walls are surveyed using combinations of tip deflection and shaft rotation, insertion, or withdrawal. During upper endoscopy, the endoscope will naturally follow the greater curvature as it advances toward the antrum and this is called the "long position. This affords an end-on view of the pylorus, which is approached directly. Passage through the pylorus can usually be facilitated by gentle pressure and air insufflation. Entry into the duodenal bulb is recognized by the typical granular, pale mucosa without the folds of the valvulae conivente. Finally, the second portion of the duodenum is entered with the associated folds, by deflecting the tip up and to the right. In addition, rotating the handpiece to the right will help facilitate this maneuver. Withdrawal of the endoscope at this point while keeping the tip deflected leads to paradoxical advancement of the endoscope down the duodenum. Withdrawl of the endoscope places the shaft along the lesser curvature of the stomach and allows for this paradoxical forward advancement of the tip. This is referred to the "short position". All areas should be carefully surveyed again as the endoscope is withdrawn.

The final component of a diagnostic EGD is evaluation of the cardia, fundus, and incisura along the lesser curvature. With a forward-viewing endoscope, these sites are visualized by a retroflxion maneuver with full upward tip deflection. (Fig 3-5, Fig 3-6)

Techniques of Endoscopic Tissue Sampling

Sampling of tissue is most frequently obtained by passage of a spiked forceps via the endoscope's biopsy channel. Multiple biopsies should usually be obtained. For ulcers, one should biopsy the edge of the lesion in at least four quadrants. Standard biopsy techniques are quite superficial, however, if deeper biopsies are desired, these can be obtained by using either a jumbo forceps, or the practice of repetitive biopsies at the same site, which will lead to a deeper sampling.

Surveillance in diseases such as ulcerative colitis and barrett's esophagus require a standardized sampling technique. Ulcerative colitis protocols recommend biopsies every 10cm throughout the entire colon, and barrett's sampling per the Seattle protocol requires at minimum 4-quadrant biopsies every 1 cm using a jumbo forceps. The goal of these sampling techniques is to identify the presence of dysplastic tissue necessitating further intervention.

Tissue and lesions can also be sampled by the use of brush cytology. In this technique, a sleeved brush is passed through the biopsy channel of the scope and rubbed forcefully over the desired site. The brush head is extended, stirred in a fixative solution to be spun down for cell evaluation, and then tran-

TABLE 3-3: ETIOLOGIC FACTORS ASSOCIATED WITH PATHOGENESIS OF ESOPHAGEAL CANCER

Factor	Squamous cell cancer	Adenocarcinoma
Smoking	+++	+
Alcohol consumption	+++	-
Hot beverages	+	-
N-nitroso compounds, e.g pickled vegetables	+	-
Chewing betel nut	+	-
Maté drinking	+	-
Deficiencies of green vegetables, fruits and vitamins	+	-
Low socioeconomic class	+	-
Fungal toxin or virus	+	-
History of radiation to mediastinum	+	+
Lye corrosive stricture	+	-
History of aerodigestive malignancy	+++	-
Plummer-Vinson syndrome	+	-
Achalasia	+	-
Obesity	-	++
Gastroesophageal reflux	-	+++
Barrett's esophagus	-	++++

sected and dropped into fixative for direct cytologic analysis. The sensitivity and specificity of this technique are dependent on direct approximation to the diseased mucosa, and should not replace a directed biopsy if attainable.

Therapeutic Endoscopic Interventions

MANAGEMENT OF BLEEDING

Endoscopy plays a critical role in evaluation and treatment of UGI bleeding. The degree of rapidity of UGI bleeding varies from severe with gross hematemesis to mild, presenting as either heme-positive stools or iron deficiency anemia. The timing for EGD should be based on each individual clinical scenario, understanding that endoscopy is both a diagnostic and a therapeutic tool. In all patients, hemodynamic stabilization and correction of any sources for ongoing coagulopathy are a priority.

Endoscopic hemostatic therapies can be divided into thermal and nonthermal categories. In addition, these hemostatic options can be further delineated based on specific ideal applications. There are associated risks with each of these techniques which must be understood to allow for appropriate tool selection. It is also possible to treat bleeding with combined modalities such as coagulation and injection, or clipping and injection. When comparing individual therapeutic techniques, there is very little difference between them in terms of providing successful hemostasis. In fact, there are numerous studies to demonstrate the superiority of combined over single hemostatic therapy. Given the relatively high success rates of controlling upper GI bleeding by endoscopic modalities, it is appropriate to pursue endoscopic means whenever available before seeking surgical or interventional radiology options. (24)

THERMAL TECHNIQUES

Thermal therapies control hemorrhage by inducing tissue coagulation, collagen contraction, and vessel shrinkage. Thermal energy is delivered via a contact or a non-contact device. Thermal therapies are successful in 80–95% of cases, with a rebleed rate of 10–20%. These techniques are easy to use and safe, with a perforation rate of 0.5%, although this is dependent on the site of the gastrointestinal tract, with the cecum more likely to result in perforation than a thicker organ such as the stomach. (25)

CONTACT THERMAL TECHNIQUES

Contact or coaptive techniques involve the use of probes passed via the biopsy channel which allow for pressure tamponade of the bleeding point with simultaneous application of thermal energy for coagulation. The firmer one applies the device to the tissue, the greater the depth of energy penetration. In addition, the tamponade not only improves visualization, but also reduces the "heat sink" effect of active bleeding, and thereby improves the efficiency of the coagulation process. Multipolar (bipolar) cautery (Fig 3-7) and heater probe devices are used most commonly, although monopolar

TABLE 3-4: DYSPLASIA GRADE AND SURVEILLANCE INTERVAL

Dysplasia	Documentation	Follow-up
None	Two EGD*s with biopsy within 1 year	Endoscopy every 3 years
Low Grade	• Highest grade on repeat EGD with biopsies within 6 months • Expert pathologist confirmation	1 year interval until no dysplasia x 2
High Grade	• Mucosal irregularity • Repeat EGD with biopsies to rule out invasive cancer within 3 months • Expert pathologist confirmation	Endoscopic resection Continue 3 month surveillance or intervention based on results and patient

* EGD: esophagogastroduodenoscopy
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cautery via a biopsy forceps or snare may also be employed, albeit with a potentially higher risk of injury. The heat generated, which can reach several thousand degrees, is sufficient to cause full-thickness tissue damage, so care is required when using this modality.

Both cautery and heater probe units allow pulse irrigation to be performed for visualization and clot clearance via foot pedal control. Variables important in achieving hemostasis include probe size, force of application, power setting, and duration of energy delivery. (25,26) Vessels of up to 2 mm in diameter appear to be able to be well controlled by these techniques although the overall surface area treated by these devices is limited by the size of the probes.

NON-CONTACT THERMAL TECHNIQUES

Argon plasma coagulation (APC) is a technique in which thermal energy is applied to tissue via ionized argon gas. This technique has the disadvantage of not allowing a tamponade effect, but conversely is not prone to adherence of the probe to the hemostatic coagulum. The gas has an effect of clearing luminal liquid from the point of application; however, due to the high pressure of gas delivery, one must be careful to avoid overdistention of the lumen by using frequent suctioning during APC usage. It is more widely utilized in most centers than laser, and in limited studies appears to have similar efficacy to contact probes. (26)

TABLE 3-5: STAGE GROUPINGS FOR SQUAMOUS CELL CARCINOMA

Stage	T	N	M	G	Location
0	In-situ (HGD)	0	0	1	Any
IA	1	0	0	1	Any
IB	1 2-3	0 0	0 0	1 2-3	Any Lower
IIA	2-3 2-3	0 0	0 0	1 2-3	Upper, middle Lower
IIB	2-3 1-2	0 1	0 0	2-3 Any	Upper, middle Any
IIIA	1-2 3 4a	2 1 0	0 0 0	Any Any Any	Any Any Any
IIIB	3	2	0	Any	Any
IIIC	4a 4b Any	1-2 Any N3	0 0 0	Any Any Any	Any Any Any
IV	Any	Any	1	Any	Any

TABLE 3-6: INDICATIONS FOR ENDOSCOPIC ULTRASOUND

Pancreatic
1. Fine-needle aspiration and cytology of cystic or solid lesions
2. Drainage of fluid collections
3. Lymph node sampling (to determine resectability)
4. Assess portal venous system
5. Intraductal ultrasound
6. Ampullary mass

Hepatobillary
1. Detect stones (in conjunction with or in lieu of ERCP)
2. Intraductal ultrasound
3. Periportal lymph node sampling
4. Biopsy of liver mass

Mediastinal
1. Aortopulmonary window lymph node sampling (in lieu of mediastinoscopy)
2. Bronchial and carinal tissue sampling/cytology
3. Lung cancer staging

Esophageal
1. Esophageal cancer staging
2. Follow-up of hiatal hernia repair and antireflux surgery (under investigation)

Gastric
1. Gastric cancer staging
2. Evaluation of submucosal masses

Retroperitoneal
1. Lymph node cytology
2. Celiac axis nerve blocks
3. Retroperitoneal biopsies
4. Renal/Adrenal biopsies

Colerectal
1. Anorectal cancer staging
2. Anorectal lymph node evaluation
3. Anal sphincter evaluation
4. Perirectal abscess detection and management

Source: Adapted, with permission from, Masferrer et al: History of the respiratory care profession. In: Respiratory Care. Philadelphia: Lippincott, 1991:12.

APC is particularly well-suited for settings where large mucosal areas require treatment such as gastric antral vascular ectasia (GAVE) (Fig 3-8), or where the risk of deeper thermal injury leading to perforation is of heightened concern, for example, cecal angiodysplasia.

NON-THERMAL TECHNIQUES

Injection Sclerotherapy. Injection therapy is performed by passage of a catheter system through the biopsy channel of the endoscope. There is an internal 5-mm needle which can be advanced and withdrawn as needed.

TABLE 3-7: MECHANICAL VENTILATION

Table Cross Head	
	Table Straddle Head
Year of Introduction	Brand
1948	Bennett TV-2P
1950	Engstrom 150
1954	Drager Poliomat
1954	Thompson Portable Respirator
1955	Morch "Piston"
1955	Bird Mark 7
1955	Emerson High-Frequency Ve Pulse
1989	PPG (Drager)IRISA
1989	Bird VIP
1989	Infrasonics Adult Star
1991	Siemens Servo 300
1993	Bear 1000

Source: Adapted, with permission from, Masferrer et al: History of the respiratory care profession. In: Respiratory Care. Philadelphia: Lippincott, 1991:12.

1. Supplemental nasal oxygen is required to decrease the frequency of desaturation.
2. The patient's oxygenation status and cardiac electrical activity are also monitored by equipment.
3. It must be understood that pulsoximetry levels can rule out hypoxia.
4. At this time, measurement of end tidal CO2 monitoring.
5. Supplemental nasal oxygen is required to decrease the frequency of desaturation.
6. The patient's oxygenation status and cardiac electrical activity are also monitored.
7. It must be understood that pulsoximetry levels can rule out hypoxi.
8. At this time, measurement of end tidal CO2 monitoring however, is just beginning to be utilized at the time of endoscopic interventions.
9. Supplemental nasal oxygen is required to decrease the frequency of desaturation during endoscopic procedures.
10. The patient's oxygenation status and cardiac electrical activity are also monitored by equipment throughout the procedure.

The sclerosant is injected submucosally. Injection therapy at three or four sites surrounding a bleeding site prior to contact thermal techniques may prove more effective, as the created eschar is occasionally removed inadvertently affixed to the treating probe. If tamponade is provided first with injection therapy, bleeding following initial thermal therapies can be reduced. The amount injected varies with different agents, and it must be remembered that systemic absorption will occur. Dilute 1:10,000 epinephrine solution is the most commonly used agent, and should be limited to less than 10cc total volume.

For esophageal varices, injections are begun just above the gastroesophageal junction. Sclerosants can be injected either directly into the varix or along side it, intravariceal or paravariceal. Variceal banding with endoscopic band ligators, although associated with a slightly higher rate of rebleeding, has predominantly supplanted injection sclerotherapy due to lower complication rates. In the absence of active bleeding or stigmata of bleeding, prophylactic endoscopic variceal eradication should not be performed because of the high risks of complications associated with the procedures. In patients with severe variceal bleeding or recurrent bleeding following endoscopic therapies, other options such as transjugular intrahepatic portosystemic shunt (TIPS) or surgical portosystemic shunting should be considered (see Chapter 47)

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41B

PERSPECTIVE ON RECTAL CANCER

Mark Welton

INTRODUCTION

Drs. Goldberg and Bleday have admirably summarized the current literature regarding the diagnosis, evaluation and treatment of rectal cancer. In broad strokes, I agree with what they say and wish primarily to highlight a few important issues.

ANATOMIC LANDMARKS

In the description of the anatomy the authors emphasize their preference for the anorectal ring as the anatomic landmark when evaluating the level of the tumor. Yet in other sections of the chapter the anal verge and the dentate line are mentioned as the distal landmark rather than the anorectal ring. This is consistent with the confusion that exists in colorectal and general surgery and confounds and confuses recommendations made for approaching rectal tumors. I personally prefer the dentate line because it is a clear tissue transition not effected by patient body habitus. Consider for example a lesion at 5 cm from the anal verge. Heavyset patients may have a longer distance from the anal verge to the dentate line (4cm), leaving the lesion quite close to the dentate line (1 cm above). In contrast the distance from anal verge to the dentate may be very short in thin patients (1 cm) and the lesion may actually reside relatively high in the rectum (4 cm above the dentate line). This variability holds true for the other landmark mentioned, the anorectal ring. The muscular funnel that comprises the anal sphincters may be long in young muscular patients and shorter in others. These variations lead to unclear recommendations at to how to approach lesions at various heights. The literature would benefit from a standardization of landmarks so that authors, and clinicians attempting to follow the recommendations in articles, could compare outcomes across studies.

PREOPERATIVE ASSESSMENT

I agree with the authors' recommendation for a CT scan of the chest, abdomen and pelvis in the preoperative evaluation of patients with rectal cancer and would add that a preoperative PET scan adds value when used selectively to assess abnormalities identified on CT scans. This approach is preferred to the routine use of PET scans as it is more cost effective. It is better than a follow up CT in 3 months after surgery in that it allows for earlier identification and treatment of metastatic and may obviate the need for surgical intervention.

TNM STAGING

The 7th edition of the AJCC TNM staging system published in 2010 developed new classifications of stage II and III tumors following the recommendations of the Hindgut Taskforce [Edge SB, Byrd DR, Compton CC, Fritz AG, Green FL, Trotti A. AJCC staging manual 7th ed New York: Springer 2010][Gunderson LL, Jessup JM, Sargent DJ, Green FL et al. Revised TN categorization for colon cancer based on national survival outcomes data. J Clin Oncol. 2009; 28:264-71.]. As noted by the authors the tumors are evaluated with regards to depth of tumor invasion (T), nodal involvment (N) and distant metastases (M). Stage 0 tumors are T0 or Tis, N0 and M0. Stage I is T1 or T2, N0, M0. Stage II is T3 or T4, N0, M0. Stage III is Any T stage, N1 or N2, M0. Stage IV is Any T stage, Any N stage, and M1. Stage II and stage III can be subdivided and these subdivisions were modified in the 7th edition based on SEER and NCDB data. Traditionally stage II was divided into IIA and IIB, T3, N0, M0 and T4,N0,M0, respectively. Stage III was separated into three stages IIIA (T1 or T2, N1, M1) IIIB (T3 or T4, N1, M0) and IIIC (Any T, N2, M0). T4bN0 is associated with poorer survival and is now classified as IIC (previously IIB). In contrast the following three tumors appear to have somewhat better survivals upgrading their classifications to IIIB, T1 or T2, N2a, T1 or T2, N2b and T3, N2a. Finally,T4b, N1a and T4b, NIb are IIIC (previously IIIB). These re-classifications are important for prognostication and treatment planning.

PERI-OPERATIVE MANAGEMENT

Peri-operative management is an arena in which data appears to drive practice less rigorously than in other realms in surgery despite the push to practice evidence-based, outcomes driven, medicine. A case in point is the issue of bowel preparation. The authors note despite the lack of evidence supporting oral mechanical bowel preparation and evidence from Cochrane reviews and a meta-analysis from Pineda et al that oral mechanical bowel preparation may be harmful, it is still their preference to mechanically bowel prep their patients prior to surgery [Mechanical bowel preparation for elective colorectal surgery. Guenaga KK, Matos D, Wille-Jørgensen P. Cochrane Database Syst Rev. 2009 Jan 21;(1):CD001544] [Mechanical bowel preparation in intestinal surgery: a meta-analysis and review of the literature. Pineda CE, Shelton AA, Hernandez-Boussard T, Morton JM, Welton ML. J Gastrointest Surg. 2008 Nov;12(11):2037-44. Epub 2008 Jul 12.]. They are not alone in this practice. 99% of colorectal surgeons surveyed in 2003 did the same [Zmora O, Wexner SD, Hajjar L, et al. Trends in preparation for colorectal surgery: survey of members of the American Society of Colon and Rectal Surgeons. Am Surg. 2003;69:150-4.]. Unfortunately, this survey predates the larger discussion and simply reinforces the need to educate the practicing physicians. We abandoned routine oral mechanical bowel preparation at our institution over 3 years ago because there is no data to support its routine use. We have continued oral mechanical bowel preparation when intraoperative colonoscopy is planned for tumor localization or clearing of the proximal bowel. Oral mechanical bowel preparation is associated with increased anastomotic leaks and wound complications in many series. This may result from dehydration, increased intraoperative fluid requirements (secondary to the dehydration), decreased core temperature (secondary to rehydration) and over resuscitation leading to edematous bowel. We have not noted any negative impact on bowel handling on either open or laparoscopic cases as suggested by the authors. Many other centers have abandoned routine oral mechanical bowel preparation based on the literature for all cases and simply perform one or two preoperative enemas to clear the distal bowel of feces to allow passage of a stapler. Others have eliminated bowel preparation for all right sided lesions. The issue is far from settled as highlighted by a debate at the SSAT in 2009 when the presentation to eliminate oral mechanical bowel preparation won the debate unanimously and yet not one individual out of 250 attending agreed to change their practice based on the data. A large multi-center North American trial is still desired.

Wound infections rates are impacted by factors other than oral mechanical bowel preparation. The Surgical Care Improvement Project (SCIP) has outlined recommendations that have been adopted by the Centers of Medicare and Medicaid Services (CMS) and the Centers for Disease Control as performance measures. These recommendations emphasize appropriate timing of antibiotic delivery, within 60 minutes of incision, discontinuation of antibiotics within 24 hours (although there is no data to support more than one preoperative dose with appropriate intraoperative redosing as needed [Dipiro JT, Cheung RP, Bowden TA Jr, Mansberger JA. Single dose antibtiotic prohphylaxis of surgical wound infections. Am J Surg 152(5); 1986, 552-559]), appropriate hair removal, maintenance of normothermia and "early" removal or urinary catheters [Song F, Glenny A. Antimicrobial prophylaxis in colorectal surgery: a systematic review of randomized controlled trials. Br J Surg. 1998;85:1232-41][Bratzler DW et al. Antimicrobial prophylaxis for surgery: an advisory statement from the National Surgical Infection Prevention Project. Clin Infect Dis. 2004;38:1706-15.][Nelson RL, Glenny AM, Song F. Antimicrobial prophylaxis for colorectal surgery. Cochrane Database Syst Rev 2009;1:CD001181][Bratzler DW, Hunt DR. The surgical infection prevention and surgical care improvement projects: National initiative to improve outcomes for patients having surgery. Clin Infect Dis. 2006;43:322-30.][Fry DE. Surgical site infections and the surgical care improvement project (SCIP): evolution of national quality measures. Surg Infect. 2008; 9:579-84.]. In teaching hospitals the discontinuation of antibiotics proved to be a challenge. Therefore we moved to a single dose of Ertapenum when appropriate as it provides 24-hour coverage obviating the need for any post-operative "prophylaxis". The timing of urinary catheter removal has not been well studied in the colorectal population and colorectal pelvic cases are explicitly exempted from the urinary catheter removal performance measure.

LOCAL EXCISION

The authors provide an excellent discussion of the controversies surrounding local excision of rectal cancers as would be expected given Dr. Bleday's leading role in defining patient populations appropriately treated in this fashion. Articles by You, Ptok, Garcia-Aguilar, Varma, Paty all highlight the potential risks and benefits of transanal excision[You YN, Baxter NN, Steward A, et al. Is the increasing rate of local excision for stage I rectal cancer in the United States justified? A nationwide cohort study from the National Cancer Database. Ann Surg. 2007;245(7):726-33.][Ptok H, Marusch F, Meyer F et al. Oncological outcome of local vs radical resection of low risk pT1 cancer Arch Surg. 2007;142(7):649-56.] [Garcia-Aguilar J, Mellgre A, Sirivongs P, et al. Local excision of rectal cancer without adjuvant therapy. Ann Surg 2000;231(3):345-51.][Paty PH, Nash GM, Baron P, et al. Long-term results of local excision for rectal cancer. Ann Surg. 2002;236(4):522-30][Varma MG, Rogers SJ, Schrock TR, Welton ML. Local excision of rectal carcinoma. Arch Surg:134(8);1999, 863-7.]. It appears T1 lesions within 5 cm of the dentate line with favorable histology and clear margins seem appropriately treated in this fashion. Whether T2 lesions may be treated in this fashion if they meet the above criteria and are treated with either preoperative combined modality therapy (chemotherapy plus radiation therapy) or postoperative therapy remains unclear. The potential for decreased for operative morbidity and mortality with local excision is clear. Recently the presumed functional benefit and associated improved quality of life associated with transanal excision was questioned when local excision was compared to low anterior resection.

It is clear appropriate patient selection and adherence to preoperative selection criteria is critical and ultimately this is an individual decision made after lengthy informed discussions with the patient and the patient's family. Unfortunately the current selection criteria are still lacking an ability to predict who will fail locally or with distant disease and we await biologic markers. However, even with improved markers questions will remain regarding treatment of primary rectal tumors by local excision in attempts to preserve gastrointestinal continuity. For instance, in a patient with markers that predict a high likelihood of early metastatisis, does the method of removing the primary rectal tumor impact development of systemic disease and overall survival? Is local excision and early chemotherapy to treat microscopic disease preferable to a large operation because of the potential for immunosuppression associated with a more invasive procedure?

As with any other operative approach, surgical technique (and most likely surgeon volume and possibly hospital volume) plays a role. This is clear in TME and it seems reasonable to assume it would be true for local excision approaches, whether TEM or transanal excision. This issue is at the heart of the dilemma in that surgeons often feel their personal experience is not equal to that published in large series where technique and selection maybe harder to define.

The authors give a nice description of transcoccygeal surgery. I have not had the opportunity to use this approach feeling the morbidity of a transsacral colocutaneous fistula outweighs the potential benefits. Selected patients with significant comorbidities increasing operative risk might be candidates for this approach. My practice has been to proceed with an LAR or APR instead of the transcoccygeal approach.

QUALITY OF LIFE

Quality of life is a much-understudied subject in the treatment of rectal cancer. We are just starting to accumulate data to help us answer how best to treat these patients with a focus on long-term QOL issues. QOL impacts our decisions to perform lateral lymph node dissections, provide pelvic radiation therapy, create a colonic "J" pouch, and pursue palliative procedures. The experience in North America with lateral pelvic node dissection, as highlighted by the authors, suggests the complications associated with the procedure outweigh potential benefits. However a true comparison of TME plus lateral pelvic node dissection versus TME plus pelvic irradiation in the treatment of patients with rectal cancer with a focus on local failure, overall survival and QOL is lacking.

Pelvic radiation for the treatment is standard of care for T3 or T4 lesions and Any T with nodal disease. However, there is clearly room to define the functional impact of radiation therapy on the function of the residual rectum. Many patients suffer frequent bowel movements after resection of the rectum with clustering of their movements (low anterior resection syndrome). Radiation therapy negatively impacts the reservoir function of the rectum leaving some to question the routine use of radiation after a well-performed TME.

Colonic "J" pouches favorably impact the frequency of bowel movements in the first year [ref]. The pouch does not appear to be associated with significant long-term benefit and many patients have difficulty evacuating the pouches leaving some to question the advisability of creating a pouch for short-term benefit. One note of caution, the authors state they select either sigmoid or descending colon to create the pouch. In western cultures the surgeon needs to be sure the sigmoid is healthy and not involved with diverticular disease that would limit distensibility of the pouch.

Palliation of the primary rectal lesion in a patient with established distant disease is a challenging problem that is best approached with a multispecialty team, often a tumor board. We have chosen to be aggressive in our treatment of metastatic disease in the well-selected patient believing the metastatic disease presents the biggest challenge to overall survival. In a patient with an asymptomatic primary, we have offered chemotherapy to treat the metastatic disease looking for a tumor response. In those patients where a response is seen, we may proceed with chemoradiation therapy of the primary if indicated by imaging studies. If the metastatic disease does not progress during this time interval we may then proceed with resection of the primary with simultaneous resection of the metastatic disease, especially if we are able to achieve these goals laparoscopically with the assistance of an experienced laparoscopic liver surgeon. We may also proceed with resection of the primary alone or metastatic disease in staged procedures. We are ever vigilant with regards to the primary tumor and local invasion of surrounding structures believing the pain associated with local invasion a significant issue that we control poorly. If the primary appears to be encroaching on the sidewalls, we offer resection for palliation.

We have been aggressive, as have the authors, with locally advanced primary or recurrent disease believing posterior exenteration, pelvic exenteration and exenteration including sacrectomy, to be the best methods to control the tumor and associated symptoms in those with locally advanced disease.

Finally, whenever possible we have preferred stenting of the primary rectal tumor in the patient with advanced metastatic disease to fecal diversion as it avoids a stoma and the morbidity of surgery with associated time loss due to hospitalization and recovery.

TECHNIQUE

The description of TME is excellent and the importance of this technique cannot be understated. Pathologic assessment of the specimen and evaluation of the adequacy of mesorectal excision has been shown to predict 5-year survival[Nagtegaal ID, van de Velde CJ, van der Worp E, Kapiteijn E, Quirke