MEDICAL PROGRESS

ENDOSCOPY OF THE UPPER GASTROINTESTINAL TRACT

JACQUES VAN DAM, M.D., PH.D., AND WILLIAM R. BRUGGE, M.D.

The rapid development of high-technology procedures has come at a time when the ability of the U.S. health care system to provide expensive services to all patients is increasingly constrained. The inverse relation between expanding medical achievement and contracting resources for health care delivery has stimulated an evaluation of the appropriate use of endoscopic procedures. Serious concern about the effects of a reduction in health care costs on the quality of patient care has led to critical analysis of endoscopic practice. There appears, however, to be little consensus on the appropriate uses of endoscopic procedures. In prospective trials involving primary care physicians and more than 8000 patient visits, both underuse and overuse of upper gastrointestinal endoscopy were reported. The estimated rates of underuse and overuse of endoscopy were approximately the same — 5 percent — which suggests that the criteria by which patients are selected for endoscopic procedures can be improved.

One way to improve the safety and reduce the cost of endoscopy is to perform procedures without sedation. The ability to provide sedation and analgesia safely and effectively and to ensure the clinical stability and comfort of the patient have long been important components of the endoscopic procedure. However, because a substantial proportion of procedure-related complications are due to sedation and analgesia, the performance of endoscopy without sedation would appear to be a worthwhile goal. Endoscopy without sedation would also reduce costs substantially by eliminating the need for sedatives, hemodynamic monitoring during the procedure, time in the recovery room, some of the nursing staff, a day off from work by the patient, and an escort to accompany the patient home from the procedure. Current interest in endoscopy without sedation has been stimulated by the development of ultrathin endoscopes. Whereas standard diagnostic gastroscopes are 9 mm in diameter and endoscopes used to perform therapeutic procedures in the upper gastrointestinal tract are typically 11 mm in diameter (and contain a wide-caliber accessory channel), newer ultrathin endoscopes have an outer diameter of 5.3 mm (for fiberoptic endoscopes) or 5.9 mm (for video endoscopes). Such instruments can be inserted either transorally or transnasally with reasonable ease. Although not yet in widespread use, ultrathin endoscopes may permit endoscopy to be performed without sedation, thereby reducing the direct and indirect costs of the procedure.

DIAGNOSIS AND TREATMENT OF NONVARICEAL BLEEDING OF THE UPPER GASTROINTESTINAL TRACT

Hemorrhage of the upper gastrointestinal tract is a common reason for emergency medical care and hospitalization. Despite the widespread use of histamine H₂-receptor antagonists and proton-pump inhibitors, bleeding from a peptic ulcer (Fig. 1) remains the most common cause of upper gastrointestinal bleeding, accounting for approximately 50 percent of cases of severe upper gastrointestinal hemorrhage. Other common causes of upper gastrointestinal bleeding are esophageal or gastric varices, Mallory–Weiss tears, and vascular malformations. Endoscopy is the preferred investigative procedure for upper gastrointestinal bleeding because of its accuracy, low rate of complications, and potential for therapeutic intervention. Rates of hemostasis that resulted from a first endoscopic procedure exceeded 94 percent in most large studies in which standardized techniques were used for thermocoagulation of bleeding lesions. Methods of achieving hemostasis include multipolar electrocoagulation, injection therapy, endoscopic laser therapy, hemoclipping, and ligation. Endoscopic ligation was first used for the treatment of bleeding esophageal varices in 1988, but its technical simplicity as compared with other endoscopic methods of achieving hemostasis has led to its use in treating a variety of upper gastrointestinal lesions, including Dieulafoy’s lesions, duodenal ulcers, gastric angiodysplasia, and Mallory–Weiss tears.

Endoscopic therapy that is performed within 24 hours after admission is associated with reductions in the length of hospital stay and in the risk of recurrent bleeding. After bleeding from ulcers is controlled...
trolled endoscopically, the rate of recurrent bleeding is 15 to 20 percent. Endoscopic retreatment was compared with surgery in a prospective trial involving 3473 adults with bleeding peptic ulcers who had been admitted to a single medical center. The success rate of an initial endoscopic procedure to achieve hemostasis in patients with severe upper gastrointestinal bleeding was high; the rate of rebleeding was only 8.7 percent. Ninety-two patients in whom hemostasis was achieved with an initial procedure but who later had recurrent bleeding were randomly assigned to undergo either a second endoscopic procedure (48 patients) or surgery (44 patients). As compared with the patients randomly assigned to surgery, the patients with recurrent bleeding who were treated with a second endoscopic procedure had a reduced need for surgery without a concomitant increase in the risk of death and had a lower rate of complications. The authors concluded that in the minority of patients in whom hemostasis was not achieved by an initial endoscopy, at least one more attempt at endoscopic therapy was preferable to surgery.

At the other end of the spectrum, some patients can be assigned to outpatient treatment of acute upper gastrointestinal hemorrhage on the basis of the early identification of favorable clinical and endoscopic characteristics. In prospective analyses, hemodynamically stable patients in whom endoscopy did not show features suggestive of a high risk of rebleeding — such as arterial bleeding, an ulcer greater than 2 cm in diameter, an adherent clot, a visible vessel, esophageal varices, or portal hypertensive gastropathy — were safely discharged from acute care after medical treatment was begun. This strategy has the potential to reduce costs considerably in the treatment of upper gastrointestinal bleeding.

**DIAGNOSIS AND TREATMENT OF VARICEAL BLEEDING OF THE UPPER GASTROINTESTINAL TRACT**

Variceal hemorrhage is the most serious complication of portal hypertension and occurs in one third of patients with esophageal varices. The 30 to 50 percent mortality rate that is associated with variceal bleeding has challenged endoscopists to design improved methods of treating active hemorrhage. Upper gastrointestinal endoscopy, performed by an experienced endoscopist, should be the initial diagnostic test after the patient’s condition has stabilized. Endoscopic therapy consists of variceal band ligation or injection sclerotherapy.

Until recently, injection sclerotherapy was considered the endoscopic treatment of choice for controlling active variceal hemorrhage. Sclerotherapy is successful in controlling active bleeding in more than 90 percent of patients and has been shown to reduce the frequency and severity of recurrent bleeding. Sclerotherapy is performed by injecting a sclerosant (e.g., ethanolamine olate, sodium tetradeoxy sulfate, polidocanol, morrhuate sodium, mecrylate, or ethanol) into the varix to produce thrombosis or injecting it adjacent to the varix to induce submucosal fibrosis. Complications of sclerotherapy include fever, chest pain, bacteremia, esophageal ulceration, bleeding, stricture formation, dysphagia, and perforation. In patients in whom endoscopic therapy of bleeding esophageal or gastric varices fails, good immediate, short-term control of bleeding may be achieved by transjugular intrahepatic portosystemic shunting.

Endoscopic band ligation of varices is now considered to be the treatment of choice for patients with bleeding esophageal varices. The technique of endoscopic ligation is similar to that used to treat internal hemorrhoids, in which bands are used to ligate the base of the hemorrhoid or varix. Results of several randomized, controlled trials in which endoscopic variceal ligation was compared with sclerotherapy suggest that variceal band ligation controls active bleeding in 80 to 90 percent of patients; it also requires fewer treatment sessions and results in fewer complications than sclerotherapy. A meta-analysis has confirmed the superiority of endoscopic ligation over sclerotherapy with regard to rebleeding, local complications, time to variceal obliteration, and even short-term survival. In addition, variceal band ligation may be more effective than medical therapy that involves the use of the beta-adrenergic antagonist propranolol for the primary prevention of bleeding in patients with large esophageal varices.

**ENDOSCOPY OF THE SMALL INTESTINE**

After a careful history taking has eliminated common causes of gastrointestinal blood loss and the results of upper endoscopy and colonoscopy are found to be negative, an examination of the small

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**Figure 1.** Endoscopic Image of a Gastric Ulcer with a Visible Vessel.
The small intestine is usually performed. The small intestine can be evaluated by endoscopy in three ways: push enteroscopy, operative endoscopy, or sonde (passive) enteroscopy.

In push enteroscopy, the tip of a long endoscope (a colonoscope, pediatric colonoscope, or specially designed enteroscope) is passed beyond the ligament of Treitz. The push-enteroscopic technique does not permit visualization of the distal portions of the small intestine. In a study of 55 patients with occult gastrointestinal bleeding, push enteroscopy led to the detection of the site of bleeding in 35 patients (64 percent), and surprisingly, 21 of the 35 patients (60 percent) had lesions located proximal to the ligament of Treitz. In asymptomatic patients with iron deficiency who have had a negative result on colonoscopy, the most efficient and cost-effective approach to evaluate the patient further was recently found to be enteroscopy. The use of an enteroscope rather than a gastroscopy in this group of patients increased the proportion in whom diagnoses were made from 41 percent to 67 percent and did so at a lower cost. In general, the farther the enteroscope is advanced into the small intestine, the more likely it is that a diagnosis will be made. Figure 2 shows a small-bowel arteriovenous malformation detected by enteroscopy.

Once identified, potential sources of bleeding can be treated by an endoscopic method. Treatment is typically accomplished with either a neodymium:yttrium–aluminum–garnet (Nd:YAG) laser or a bipolar electrocautery unit with a modified, extra-long probe. Among 29 patients with occult gastrointestinal bleeding who underwent push enteroscopy after negative results were obtained on upper gastrointestinal endoscopy and colonoscopy (or in whom bleeding persisted despite treatment of potential sources of gastrointestinal bleeding detected on endoscopy), the most common finding was angiodysplasia (13 patients, or 45 percent), which was treated with electrocautery. Twenty of the 29 patients had received transfusions (at a mean of 8 units per patient) in the year preceding the enteroscopy. In the year after enteroscopy, their transfusion requirements decreased substantially, and 4 of 13 treated patients (31 percent) required no additional blood transfusions. Thus, the outcome in some patients with gastrointestinal bleeding of initially obscure origin was improved after push enteroscopy.

In hospitals in which push enteroscopy is not available, the next-best method for evaluating bleeding from the small intestine is surgical endoscopy, during which a surgeon advances the endoscope manually through the surgically exposed intestine. Unlike either push or sonde enteroscopy, intraoperative endoscopy permits visualization of the entire length of small-bowel mucosa in the majority of cases. Intraoperative endoscopy may be performed with a standard gastroscope, colonoscope (pediatric, if available), or enteroscope.

The third method of small-bowel endoscopy is sonde enteroscopy, during which the tip of a small-caliber enteroscope is allowed to move along the small intestine passively. The instrument is extremely flexible, with a length that varies from 270 to 400 cm. The instrument is inserted through the nose or the mouth, depending on the diameter of the endoscope and the preference of the endoscopist. Unlike push enteroscopy, the sonde method allows visualization of the distal portions of the small intestine but offers little or no therapeutic capability. Inspection of the mucosa of the small intestine is performed on withdrawal of the enteroscope. Because most sonde enteroscopes do not permit (or have limited) deflection of the tip, and because reinsertion is not an option, the enteroscope must be withdrawn slowly and the bowel must be kept insufflated throughout the procedure.

**DIAGNOSIS AND TREATMENT OF NONMALIGNANT DISEASES OF THE UPPER GASTROINTESTINAL TRACT**

Subepithelial Lesions

Subepithelial or extraluminal lesions are sometimes detected incidentally during contrast radiography or upper gastrointestinal endoscopy. Endoscopy permits visualization of the mucosal aspect of the lesion but does not allow evaluation of the depth or overall size of the lesion. In addition, with endoscopy one often cannot distinguish lesions in or involving the submucosa from lesions involving the other layers of the wall of the gastrointestinal tract or ad-
adjacent, extrinsic (extraluminal) lesions. Endoscopic biopsies can be used for diagnosis only rarely, because they sample the mucosa but not the deeper layers of the gastrointestinal tract wall.

The prevalence of subepithelial lesions is difficult to assess, because most are asymptomatic and are found incidentally during an evaluation for other reasons. The most common lesions of the upper gastrointestinal tract that present as subepithelial masses are leiomyomas, which are found in the esophagus in up to 5 percent of autopsy specimens and in the stomach in 50 percent of patients older than 50 years of age. Other abnormalities that present as subepithelial lesions are lipomas, duplication cysts, carcinoid tumors, varices, and extrinsic compression by a normal adjacent organ. In the past, surgical exploration was the standard method used for diagnosing (and treating) subepithelial lesions, but endoscopic ultrasonography has recently emerged as a new endoscopic method of determining the nature of subepithelial lesions in the upper gastrointestinal tract.

Endoscopic ultrasonography is perhaps the most noteworthy advance in endoscopic technology in the past 20 years. It combines the diagnostic imaging capability of ultrasonography with the access afforded by endoscopy. The composite instrumentation permits the placement of a piezoelectric transducer directly adjacent to the target tissue, thereby obviating the need to transmit sound waves through mediums that attenuate sound, such as air in the lungs, gas in the bowel, or bone, as is often the case with standard transcutaneous ultrasonography. This technique makes possible high-resolution, close-proximity imaging of the gastrointestinal tract, elucidation of the mural histology of the gastrointestinal tract (the mucosa, submucosa, muscularis propria, and adventitia or serosa), and imaging of adjacent, extraluminal, or retroperitoneal structures that cannot be visualized as clearly by more conventional imaging methods.

Endoscopic ultrasonography is an essential adjunct to endoscopy for the diagnosis of subepithelial lesions. Scanning at 20 MHz with the use of endoscopic ultrasound probes that can be passed through the accessory channel of a standard endoscope provides high-resolution images and has been used to evaluate patients with benign subepithelial lesions and large gastric folds. Scanning with ultrasound of lower frequencies (5.0 MHz and 7.5 MHz) permits the visualization of organs and lesions extrinsic to the gastrointestinal tract wall. The size and location of subepithelial tumors can be clearly elucidated (Fig. 3). In the majority of cases, the clinical care of patients is changed as a result of the information obtained by endoscopic ultrasonography.

**Barrett’s Esophagus**

Barrett’s esophagus is characterized by a metaplastic change of any length in the esophageal epithelium;
it is recognizable during endoscopy and can be confirmed histologically as intestinal metaplasia.\textsuperscript{44} There is considerable controversy regarding its precise definition, however.\textsuperscript{45} It is a consequence of long-standing acid reflux, which is found in 8 to 20 percent of patients who undergo upper gastrointestinal endoscopy for symptoms of gastroesophageal reflux disease.\textsuperscript{46} Barrett’s esophagus is a precursor of adenocarcinoma of the esophagus, the incidence of which has been increasing over the past 20 years.\textsuperscript{47,48}

Recent practice guidelines offered by the American College of Gastroenterology suggest that patients with long-standing symptoms of gastroesophageal reflux, particularly patients older than 50 years of age, should undergo upper gastrointestinal endoscopy to determine whether Barrett’s esophagus is present.\textsuperscript{44} A recent population-based, case–control study found a strong causal relation between gastroesophageal reflux and esophageal adenocarcinoma.\textsuperscript{49} The care of patients with Barrett’s esophagus should include upper gastrointestinal endoscopy and mucosal biopsies performed at time intervals determined by the presence and grade of dysplasia.\textsuperscript{44,50} Once Barrett’s esophagus has been detected, the patient’s condition should be monitored even if the symptoms of gastroesophageal reflux are controlled by medications that suppress gastric acid.\textsuperscript{51,52}

The restoration of normal squamous epithelium in patients with Barrett’s esophagus has been a goal of treatment that, until recently, has been unattainable. The long-term suppression of acid, with or without surgical fundoplication, does not reverse Barrett’s esophagus.\textsuperscript{53,54} The application of new endoscopic therapies aimed at the destruction of the metaplastic columnar epithelium in the esophagus, followed by squamous rec epithelialization of the esophageal surface during intensive suppression of acid by therapy with proton-pump inhibitors, has been found to reverse Barrett’s esophagus (Fig. 4). Endoscopic thermal methods that have been shown to have at least limited success in this regard include electrocoagulation,\textsuperscript{55} argon plasma coagulation,\textsuperscript{56,57} laser therapy,\textsuperscript{58} a combination of laser therapy and antireflux surgery,\textsuperscript{59} and photodynamic therapy.\textsuperscript{60-62} The thermal ablation of metaplastic esophageal mucosa may be complicated by the formation of an esophageal stricture, which results in dysphagia. Of potentially greater concern is that a substantial number of patients treated with endoscopic thermal ablation have subsequently been found to harbor foci of persistent columnar epithelium beneath the rec epithelialized squamous epithelium. The important question of whether the risk of transformation to adenocarcinoma is eliminated by endoscopic thermal ablation remains unanswered.\textsuperscript{63-65}

As yet, there are no reliably effective endoscopic, medical, or surgical therapies for patients with Barrett’s esophagus, and thus no definitive recommendations can be made regarding optimal treatment.

\section*{Achalasia}

One of the most fascinating therapeutic innovations in the treatment of patients with achalasia has been the intrasphincteric injection of botulinum toxin during endoscopy.\textsuperscript{66} Since the initial report, the relatively short duration of the therapeutic response has been recognized.\textsuperscript{67-70} Approximately 40 to 50 per-
cent of the patients treated with an intrasphincteric injection of botulinum toxin require retreatment within 12 months because of recurrent symptoms. When it is evaluated for a period of up to two years, retreatment with botulinum toxin is as effective as a single pneumatic dilation. However, in selected patients with serious underlying medical disorders who would not be able to tolerate a dilation-induced esophageal perforation or the complications of surgical esophagomyotomy, a series of injections of botulinum toxin may be preferable.

**DIAGNOSIS AND STAGING OF MALIGNANT DISEASE**

**Esophagus**

Over the past decade, there have been striking advances in endoscopy with regard to diagnosis, staging, and treatment of esophageal cancer. The diagnosis of esophageal cancer is generally made by endoscopy in combination with biopsy or by barium-contrast radiography followed by endoscopy and biopsy. Early-stage carcinomas of the esophagus are asymptomatic, are usually detected incidentally during endoscopy performed for other indications, and are the most curable form of the disease. Because of their small size, such tumors may not be detected on contrast radiography. Large esophageal carcinomas typically present with dysphagia, are rarely curable, and represent the majority of cases diagnosed in the United States.

Therapy for patients with esophageal cancer is based on the anatomical extent of the disease as assessed with the TNM (tumor–node–metastasis) classification system. Initial staging examinations should include computed tomographic scanning of the chest and abdomen. If there is no evidence of metastatic disease, further staging (assessment of the T and N classification) is performed through endoscopic ultrasonography.

Endoscopic ultrasonography has become essential in the evaluation of esophageal cancer. It has been shown to more accurately in determining the stage of esophageal tumors than is computed tomography; to guide the selection of treatment for patients with esophageal cancer; to guide fine-needle aspiration for the cytologic determination of malignant lymph-node involvement (N classification); and to help detect recurrent esophageal cancer even in the absence of endoscopically detectable disease (i.e., in biopsy-negative disease). Endoscopic ultrasonography is well established in clinical practice, and its accuracy in tumor staging (T and N) is unsurpassed.

**Stomach**

The digestive tract is the most commonly involved extranodal site of non-Hodgkin’s lymphoma. Lymphomatous involvement of the stomach may be present as either primary gastric B-cell lymphoma of the mucosa-associated lymphoid tissue (MALT) type or nodal non-Hodgkin’s lymphoma; the two forms may be differentiated by endoscopic and clinicopathological features. Endoscopic ultrasonography is the method of choice for determining the stage of gastric lymphoma and may be predictive of the response to medical therapy. Endoscopic ultrasonography is also the single best method to monitor the response (or lack of response) to medical treatment.

Gastric cancer is associated with a five-year survival rate of approximately 15 percent and is one of the most common solid tumors in the world. Early-stage gastric cancer is typically asymptomatic, and most patients with gastric cancer have advanced disease at diagnosis. Although a number of precursors of gastric cancer have been identified, including gastric surgery, pernicious anemia, gastric adenoma, atrophic gastritis, intestinal metaplasia, and *Helicobacter pylori* gastritis, no properly randomized trials have been undertaken to demonstrate the value of endoscopic monitoring of these conditions. Upper gastrointestinal endoscopy is considered the method of choice for diagnosing gastric cancer, although the sensitivity is only 81 percent. The role of computed tomography in determining the stage of gastric cancer is controversial because of its poor sensitivity in detecting perigastric spread and peritoneal dissemination. Endoscopic ultrasonography is now well established as the most sensitive and specific preoperative method to determine the depth of penetration of gastric tumors (T stage) and to assess the local or regional spread of the disease.

**TREATMENT OF MALIGNANT DISEASE IN THE UPPER GASTROINTESTINAL TRACT**

**Esophagus**

At the time of diagnosis, 50 to 60 percent of esophageal tumors are surgically unresectable. The overall prognosis, even after resection with curative intent, is poor, with a long-term survival rate of less than 10 percent. Therefore, palliative care is critical in treating patients with esophageal cancer and cancers that metastasize to the esophagus. There are a variety of endoscopic methods currently in use for palliation of malignant dysphagia associated with esophageal cancer. Endoscopic placement of a guide wire can facilitate fluoroscopically monitored bougienage with polyvinyl dilators. Alternatively, dilation of a malignant esophageal stricture can be accomplished with a pneumatic dilator (an expandable balloon). Both methods achieve adequate but often only temporary relief and are not without risk. Endoscopically directed thermal therapies that reduce the size of the tumor include monopolar and bipolar electrocautery and laser therapy (e.g., with a Nd:YAG or potassium titanyl phosphate laser) (Fig. 5).

The newest form of endoscopic thermal therapy is argon plasma coagulation. Argon plasma coagulation...
is an electrosurgical technique in which electrical energy is transferred to the tissue by means of ionized, electrically conductive argon gas. The equipment is less expensive to purchase and operate than standard laser equipment. Argon plasma coagulation also has additional advantages over standard laser therapy, including its capacity to perform therapy tangentially (it does not have to be aimed directly at the lesion) and its enhanced control over the extent to which tissue is treated. Such advantages have made argon plasma coagulation attractive for the treatment of early-stage esophageal cancers as well as Barrett’s esophagus and dysplasia.57

Photodynamic therapy is a nonthermal endoscopic and laser-associated palliative technique approved by the Food and Drug Administration for the treatment of patients with esophageal cancer or lung cancer. Patients referred for photodynamic therapy must be carefully selected because of the risk of skin photosensitivity (and subsequent skin damage), and treated patients must temporarily avoid direct exposure to sunlight. After a specified interval following the administration of a photosensitizer (a pharmaceutical agent that is retained selectively by neoplastic tissue and activated by laser light), patients undergo endoscopy, at which time light from a laser is directed onto the tumor containing the photosensitizer. Once activated by laser light, the photosensitizer undergoes a chemical reaction in which cytotoxic oxygen radicals are formed. Tissue destruction is thus limited to the tumor.

The results of a multicenter comparative trial suggest that photodynamic therapy provides palliation equivalent to that of Nd:YAG laser therapy and may be easier to perform.97 Because of its limited depth of effect, photodynamic therapy is currently approved only for palliation of malignant dysphagia. However, preliminary studies suggest that photodynamic therapy may be effective as a primary treatment for patients with small esophageal carcinomas who are poor candidates for surgery.98 Current research involving photosensitizers with more favorable safety profiles (e.g., a shorter duration of skin photosensitivity) has shown promising results.81,99

Endoprostheses that are placed with an endoscope can relieve dysphagia and close tracheoesophageal fistulas. Such fistulas occur in 5 to 15 percent of patients with esophageal cancer or metastatic mediastinal disease.100 Such patients are usually unable to swallow any food or liquids without risking aspiration or food impaction; pneumonia, pyopneumothorax, and progressive pulmonary sepsis often develop. Attempts to close or divert tracheoesophageal fistulas surgically have resulted in unacceptably high mortality rates. Traditional rigid (plastic) esophageal stents can be placed across fistulas but require extensive dilation of the tumor before placement to allow passage of the large-diameter stents. This dilation resulted in rates of perforation of approximately 14 percent as well as aspiration pneumonia and migration of the stent in an additional 29 percent in a large prospective trial.101

Recently, a new type of stent has been developed that is associated with substantially reduced rates of complications.102–105 These self-expanding metallic stents can be compressed into a narrow device that allows placement with minimal or no prior esophageal dilation. After insertion into the esophagus, the delivery device is released and the stent expands rapidly to create an open lumen through which food can pass. Self-expanding metallic stents can be used to palliate intrinsic or extrinsic malignant obstruc-
tion of the esophagus (Fig. 6). Self-expanding metallic stents designed with a plastic polymer membrane or silicone covering can also seal fistulas effectively.

Prospective randomized trials, including one in which plastic stents were compared with self-expanding metallic stents, have shown that self-expanding metallic stents are associated with a significantly lower rate of immediate complications and a reduced length of hospital stay. A comparative trial that involved patients without tracheoesophageal fistulas suggests that endoscopic laser therapy has a lower rate of complications than either plastic stents or self-expanding metallic stents in the palliation of malignant dysphagia. Thus, the recommended endoscopic approach for palliating malignant dysphagia includes laser therapy (e.g., with a Nd:YAG laser or photodynamic therapy) or the insertion of self-expanding metallic stents.

**Stomach**

The complete removal of a tumor in a patient with gastric carcinoma offers the only chance for cure. Endoscopic mucosal resection is a new method for the endoscopic removal of benign gastric lesions and early-stage (superficial) gastric carcinomas. Similar to the technique used to ligate esophageal varices, endoscopic mucosal resection has been widely used throughout Japan to treat patients with early-stage gastric cancer and is becoming increasingly available in the United States. In this procedure, hypertonic saline is injected locally into the submucosa adjacent to the tumor to separate the lesion from the muscularis propria. The raised lesion is then aspirated into a ligating device and resected with the use of high-frequency electrocautery, either with or without band ligation of the lesion. Endoscopic mucosal resection is suitable for the treatment of benign gastric tumors and early-stage gastric carcinomas smaller than 2 cm in diameter.

In the future, the treatment of patients with gastric cancer may include the endoscopic injection of chemotherapeutic agents. The successful response to the injection of cisplatin with epinephrine into tumors of the head and neck has stimulated the endoscopic application of such therapies in patients with gastric cancer. Direct endoscopic or endoscopic ultrasound-guided injection of new tumor-specific treatments may improve the success of treatment of a variety of gastrointestinal tumors.

Historically, gastric-outlet obstruction due to gastric or pancreatic cancer has been treated with surgical bypass. Because patients with gastric-outlet obstruction present late in the course of their disease, they are often only marginally suitable for even limited surgical intervention. In addition, patients who have previously undergone gastric bypass operations may present with recurrent obstruction due to progression of malignant disease. Just as expandable metallic endoprostheses are now commonly used for the treatment of malignant esophageal obstruction, recent experience with similarly designed endoprostheses suggests that in the near future, expandable metallic stents may provide an endoscopic (and therefore minimally invasive) alternative to surgical intervention in the small intestine.

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