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David C. Borgstrom
Editors

Advanced Surgical Techniques for Rural Surgeons

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Foreword

Advanced Surgical Techniques for Rural Surgeons is a textbook that is vitally needed for the twenty-first century rural surgeon. In the previous century, the surgical world transmuted from essentially untrained surgeons to the golden age of general surgery when surgeons taught by Halsted, Wagenstein, Moyer, and others who populated the landscape with scientifically trained surgeons. From those classic traditions sprang the post-World War II explosion of surgeons who concentrated on specific problems now approachable by the coinciding explosion in technology. The result was the specialist surgeon increasingly dominated the field of surgery while the general surgeon became ill defined and more obscure. Despite these changes, in the rural parts of the USA and in the world in general, a need for the broad-based, well-trained "omni-surgeon" remains. *Advanced Surgical Techniques for Rural Surgeons* is an effort to address that need, to reinvigorate the specialty of rural general surgery, and to support rural surgeons in their practices. *Advanced Surgical Techniques for Rural Surgeons* will quickly become a valuable reference for rural surgeons who, not only must maintain their operative skills, but who must also keep pace with a rapidly changing environment. Today's surgeons are challenged by advancing technologies at a much greater pace than in the past. *Advanced Surgical Techniques for Rural Surgeons* will form the basis to meet those demands.

Urban and rural surgeons offer identical general surgical procedures, such as cholecystectomy, hernia repair, bowel resection, and breast operations. However, rural surgeons are often required to perform additional types of procedures such as gynecologic, urologic, ENT, and orthopedic operations, Cesarean sections, and endoscopies, all of which are performed only by subspecialists in urban areas. Because many surgeons usually select and perform only the operations that have been taught to them, there is a rising gap between training and the operations *required* for a specific, rural population.

Subspecialty surgeons may not be available in rural settings, but rural residents prefer to receive surgical services in their local environments. It is estimated that more than 60 million people live in rural areas in North America. These citizens are confronted by many obstacles, such as the long travel distances and geographic isolation. Rural patients, much like inner-city urban populations, can have limited financial resources. These patients tend to be older, sicker, and are often underfunded for health care. Surgeons who practice in rural locations must address these issues. A rural surgeon must be capable of performing many operative procedures with high skill and quality despite low volumes. All of this practice must occur while the surgeon is truly integrated into the community.

Fewer surgeons are choosing to practice in rural locations, which already have low surgeon to population ratios. The exposure to rural practice is variable and in most instances severely limited. Although providing surgery residents with a dedicated and significant experience in a rural setting increases the likelihood that a resident will decide to practice in a rural area, years will pass before training is modified by rural fellowships and rural residencies produce another generation of "omni-surgeons." In the interim, for those surgeons who are recently trained and who select rural surgical practices, *Advanced Surgical Techniques for Rural Surgeons* will be a valuable reference. The skilled rural surgeon of the future will not supplant subspecialty care, but complement it by offering and performing uncomplicated, routine specialty procedures in order to allow subspecialists to truly specialized and advanced cases. Rural citizens will also

be served by obtaining high quality care at home. These benefits have been validated. An unsuccessful experiment in Ireland demonstrated the futility of having all subspecialty work, regardless of complexity, sent to referral centers. The effort was made in the name of improved quality. All breast cases were mandatorily referred to specialty centers. As a consequence of this mandate, these centers became inundated with benign breast disease, and delays in the treatment of complicated breast diseases, including malignancies, resulted. Benign disease could have been easily treated on a local level, and the more advanced pathologies would have been more efficiently managed at the referral centers. *Advanced Surgical Techniques for Rural Surgeons* will give rural surgeons the techniques in order to provide the best practices for routine procedures, which are only offered by subspecialists in urban centers.

Advanced Surgical Techniques for Rural Surgeons is a textbook written by rural surgeons who clearly understand the demands of rural practice. The challenges and potential limitations of rural practice are considered by the authors. Chapters cover gastrointestinal surgery, abdominal wall procedures, surgical oncology, head and neck operations, thoracic surgery, vascular surgery, trauma, obstetrics and gynecology, urology, orthopedics, and pediatric surgery. Each chapter is comprehensively written to include indications for any procedure and the preoperative preparation that is required. Operative strategies and techniques are detailed. Potential pitfalls are clearly pointed out. Postoperative care is described; common complications and the potential need for rehabilitation are discussed. Every chapter concludes by addressing transfer needs for patients who may require specialized care. Selected readings are included for rural surgeons who want additional documentation and information on every subject.

Besides possessing common sense, commitment, compassion, and communication skills, rural surgeons must demonstrate superior competence. Competency must cover practice elements not routinely part of today's surgical training. *Advanced Surgical Techniques for Rural Surgeons* addresses the requirements that come from all the aspects of a rural surgical practice. A broadly trained general surgeon, practicing general surgery in a rural setting, has a varied, interesting, and stimulating career. This textbook will be an integral part of that career.

Tyler G. Hughes
Philip R. Caropreso

Preface

Surgeons in rural practice encounter a wider range of conditions requiring surgical intervention compared to their urban counterparts. The majority of the cases they perform include endoscopic procedures, cholecystectomy, hernia repair, appendectomy, and colon resection. Due to limited availability of surgical subspecialists, rural surgeons are also called upon to address various issues that would otherwise be referred to urologists, plastic surgeons, surgical oncologists, etc. This expanded scope of practice may also include the care of pediatric and obstetric patients. Our aim was to provide rural surgeons with a resource that corresponded to their expanded scope of practice.

Much discussion and deliberation went into choosing which topics to include. There were numerous conversations with surgeons in rural practice and with surgical subspecialists. The list of chapters was revised repeatedly. The topics that we ultimately choose consisted of urgent surgical issues requiring immediate intervention and elective subspecialty procedures that were unlikely to be included in other general surgery references. We also included topics addressing recent updates in relatively common procedures such as polypectomy and central line insertion. Although central venous catheter insertion is a relatively basic procedure, we thought that the insight of a surgeon who has such vast experience with this procedure would be of value. Most surgeons in rural practice were trained long before ultrasound was used as a routine adjunct to central venous catheter insertion.

The authors were chosen based on their expertise in a given specialty. Most authors have either direct experience working in rural areas or experience caring for patients transferred to regional centers from outlying rural areas. We are extremely grateful to the authors for the many thoughtful discussions about what topics are appropriate for this book. We appreciate their efforts to share information that is most supportive to surgeons who will likely encounter many of these procedures only rarely.

We worked under the assumption that our audience would have a solid foundation of knowledge regarding surgical principles in general. We choose the format of a narrative atlas to provide surgeons an accessible guide to various procedures. Each chapter discusses the indications for a particular procedure. The overall operative strategy is summarized, and a step-by-step description of the procedure is accompanied by exquisite illustrations. Common complications and postoperative care are also explained. Unique to this book is a discussion about prudent limitations of care and when to transfer a patient to a specialist.

The determination of appropriateness of surgical intervention should be based on the surgeon's comfort with the procedure and the resources of the local hospital. Surgical emergencies such as massive gastrointestinal hemorrhage, testicular torsion, and obstetric emergencies require urgent intervention even if subsequent transfer is planned. In some cases transfer may be warranted, but not possible due to weather or transportation limitations. Another consideration regarding transfer to a regional center is the additional burden on the patient and the patient's family in terms of travel costs and time away from work.

We would like to acknowledge the editors at Springer who supported our vision for this book. We are grateful to our working editor, Joni Fraser, who endured countless revisions to the table of contents and cheerfully kept us and the authors on track. Finally, we are thrilled with the numerous, outstanding illustrations created by the Springer Art Department.

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Part I

Gastrointestinal

Endoscopic Control of Upper GI Bleeding

1

Michael D. Sarap

Indications

Upper gastrointestinal bleeding (UGIB) is a common potentially life-threatening emergency. This condition results in over 300,000 hospital admissions annually in the USA. The incidence of UGIB is approximately 80–100 cases per 100,000 population with mortality rates historically reported from 7.5 to 10 %. Recent studies have documented a decrease in inpatient UGIB mortality rates from 4.6 % in 1989 to 2.13 % in 2009. During the same period the percentage of combined endoscopic procedures, diagnostic and therapeutic, rose from 69 to 85 %. The rise in therapeutic procedures was 2–27 % in the same time period. The nearly 50 % drop in death rates may likely be a result of the wider use of diagnostic and therapeutic inpatient endoscopies and improved specific medical treatment of UGIB.

The most common etiologies for UGIB include peptic ulcer disease (20–50 %), gastric or duodenal erosions (8–15 %), esophagitis (5–15 %), varices (5–20 %), Mallory–Weiss tears (8–15 %), vascular malformations (5 %), and neoplasm (3 %). The remaining causes of UGIB involve other more uncommon conditions including anastomotic ulcers, polyps, submucosal lesions, hemobilia, foreign bodies, and postprocedural bleeding.

Comorbid illnesses, rather than actual bleeding, are the major cause of death in patients with UGIB. One or more comorbid illnesses are noted in 98 % of deaths from UGIB with 72 % listing the comorbid illness as the cause of the death. The increase in percutaneous coronary interventions (PCI) in recent years, utilizing the use of multiple combinations of anticoagulants, significantly increases the risk of major GI bleeding in this patient population. Major GI bleeding rates after PCI have been reported from 0.2 to 2.3 %. Dual therapy with aspirin and clopidogrel results in a fourfold increase in the risk of major bleeding. The inability to quickly reverse the effects of some of these medications and the cardiac risks of withdrawing the medications complicates the treatment of these patients with UGIB.

Preoperative Preparation

Patients with acute UGIB require prompt evaluation and resuscitation prior to any endoscopic procedures. Patients with suspected acute bleeding should be evaluated in the Emergency Department or Intensive Care Unit. As with any acutely ill patient, a thorough patient history and physical exam should be completed. Important information relating to UGIB includes a history of liver disease, alcoholism, malignancies, prior bleeding episodes and use of anticoagulants and NSAIDS. Evaluation of adequacy of the airway and potential hypovolemia is critical. Venous access via two large bore peripheral IVs should be established in hemodynamically unstable patients. Consideration for urinary catheter placement and endotracheal intubation early in the resuscitation of hypotensive patients is advisable. Blood should be drawn for hemoglobin and hematocrit, platelet count, coagulation profiles and blood typing and cross matching. Patient vital signs including blood pressure, pulse, urine output, oxygen saturation, and orthostatic changes must be closely monitored.

Resuscitation for the hypotensive patient is begun with crystalloid fluids to maintain adequate blood pressure but patients with ongoing blood loss may need blood products including packed red blood cells, platelets, fresh frozen plasma, and coagulation factors. The availability of six units of PRBCs, FFP, and platelets within 1 h of patient arrival with a significant UGIB is no less crucial than in the treatment of a major trauma patient. Reversal of anticoagulants should be considered if feasible. In addition to the usual initial assessment of possible hemodynamic instability, airway compromise, coagulopathy, and other organ dysfunction, the rural surgeon must quickly evaluate each surgical emergency

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in respect to available resources. Acute variceal hemorrhage and aorto-enteric fistula are examples of UGIB conditions that can quickly deplete the entire resources of a small hospital ancillary staff and blood bank. In these instances, it is much more efficient and efficacious to consider an early transfer to a tertiary center than to try and definitively treat the patient in the rural facility with limited resources. Emergency measures can be instituted to begin resuscitation and stabilization while transfer arrangements are being made. Familiarity and open communication between rural surgeons and their tertiary colleagues facilitates a more seamless and effective transfer between facilities and improved patient outcomes.

Certain factors help predict the need for immediate endoscopic evaluation. These include a history of cirrhosis or malignancy, hematemesis, and signs of hypovolemia (hypotension, tachycardia, shock, and hemoglobin less than 8 g/dL). Placement of a nasogastric tube is sometimes considered in patients with UGIB to assess for active hemorrhage or in patients presenting with significant bleeding from the rectum and an unclear etiology. The absence of blood in a gastric aspirate however, does not exclude an active UGIB. The presence of bile without blood in the NG tube however significantly decreases the chance of a bleeding source within reach of the UGI endoscope. The use of proton pump inhibitor (PPI) therapy is recommended for patients suspected of presenting with acute UGIB. Intravenous PPI given before endoscopic procedures significantly reduces rates of high-risk stigmata identified on endoscopy and reduces the need for endoscopic therapeutic maneuvers. The routine use of prokinetic agents (intravenous erythromycin and metoclopramide) in UGIB is not recommended but their use may result in a higher diagnostic yield at endoscopy in patients with fresh blood in the stomach.

Operative Strategy

Esophago-gastro-duodenoscopy (EGD) is the main diagnostic and therapeutic procedure for UGIB. The endoscopist can locate the source of the bleeding in the majority of cases and perform therapeutic maneuvers to control active hemorrhage. Preparation prior to initiating the procedure is crucial. The ability to perform the procedure in the Emergency Department or ICU by the use of a mobile endoscopy unit is very beneficial in cases of unstable or critically ill patients. A fully stocked endoscopy cart and dedicated endoscopy staff familiar with all equipment, devices, and medications that might be utilized for therapeutic procedures is mandatory. In an emergency situation, laminated index cards attached to the endoscopy cart can be very helpful in prompting the endoscopy staff on the appropriate settings for coagulation devices and instructions for mixing saline/epi or other injections. Surgeons working in rural areas need to be very knowledgeable in therapeutic endoscopic maneuvers and constantly strive to advance these skills.

Treatment of Specific Causes of UGIB

Peptic Ulcer Disease and Stigmata of Hemorrhage

Peptic ulcer disease is the most common cause of UGIB. Predisposing factors include acid, *H. pylori* infection, NSAID use, and anticoagulation therapy. Clinical trials have documented the effectiveness of injection, ablative, and mechanical therapies depending on the specific appearance and location of the lesion.

Endoscopic features of the bleeding source are important prognostic indicators of recent or potential hemorrhage. Multiple classification systems, including the Forrest system (Fig. 1.1), attempt to identify and stratify the stigmata of recent hemorrhage (SRH) to help determine which lesions have a high risk of rebleeding if not actively treated. Critical SRH requiring mandatory treatment include lesions with active bleeding (Aa, Ab) or a nonbleeding lesion with a visible vessel (Ba), defined as an elevation within an ulcer base that is pigmented. Less concerning SRH include an adherent clot on an ulcer (Bb) or a pigmented flat spot on an ulcer base (Bc). Simple clean-based ulcers (C) with no oozing, no adherent clot, no visible vessel, and no pigmented spots lack SRH. With medical therapy alone, major SRH have a greater than 50 % risk of continued bleeding or rebleeding with low SRH lesions having a much lower risk of these complications.

Controversy exists regarding how aggressive the endoscopist should be in attempting to dislodge an adherent clot from a nonbleeding ulcer.

Esophageal Varices Associated with Portal Hypertension (Fig. 1.2)

Early endoscopy with confirmation of a variceal source of bleeding and therapeutic banding of bleeding varices should be carried out in those institutions with skilled endoscopic support. Smaller institutions with limited resources should consider early transfer to a tertiary center with advanced endoscopic and radiologic support, unlimited resources, and capabilities for emergent portal-systemic shunting (TIPS). Specific measures can be utilized to better stabilize the patient whether the patient is treated locally or while arrangements are being made for transfer to a tertiary center.

Specific measures include:

- Intravenous fluid resuscitation.
- Early endotracheal intubation to prevent aspiration and respiratory compromise.
- Blood component therapy to correct anemia and coagulopathy.

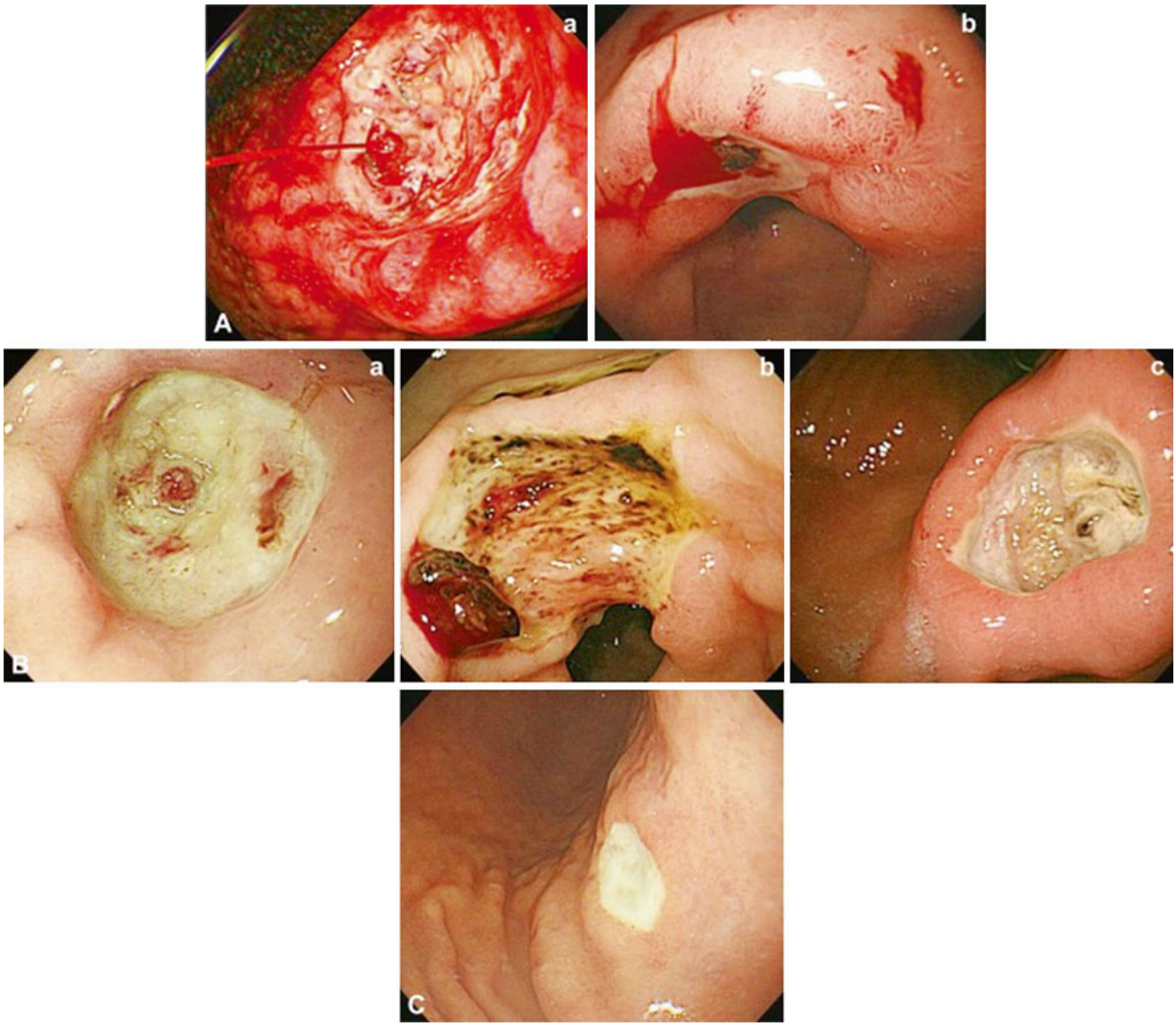

Fig. 1.1 Forrest classification can be summarized as grade: (**Aa**) Arterial hemorrhage ("spurting"). (**Ab**) Diffuse hemorrhage ("oozing"). (**Ba**) Non-bleeding visible vessel. (**Bb**) Adherent clot. (**Bc**) Flat pigmented spot. (**C**) Ulcer without recent stigmata of bleeding ("clean base"). From Seung Young Kim, Jong Jin Hyun, Sung Woo Jung, and Sang Woo Lee, Management of Non-Variceal Upper Gastrointestinal Bleeding, Clin Endosc. 2012 September; 45(3): 220–223

- Octreotide infusion (50 μg bolus then 50 μg/h infusion) to increase splanchnic vascular resistance and decrease bleeding. Octreotide has been shown to be equally as effective as vasopressin in reducing or stopping variceal bleeding and avoids the cardiac and mesenteric vascular complications of vasopressin.
- Mechanical compression of bleeding varices with a Sengstaken–Blakemore tube or one of its variants.

Mallory–Weiss Tears (Fig. 1.3)

Mallory–Weiss tears are lacerations in the region of the esophago-gastric junction that account for 5–15 % of cases of UGIB. Vomiting is the usual cause for the tear. Bleeding is self-limited in 80–90 % of cases with a very low incidence of rebleeding. Supportive therapy is usually all that is indicated although if necessary, endoscopic therapy with electrotherapy, heater probes, clipping, and injections are all effective (Fig. 1.4).

Dieulafoy's Lesion

This lesion was first described in 1896. It consists of an abnormally large submucosal artery protruding through a minute mucosal defect. Dieulafoy's lesion can cause significant bleeding and are often difficult to diagnose especially if there is not active bleeding present during endoscopy. The lesions occur twice as often in men than in women and

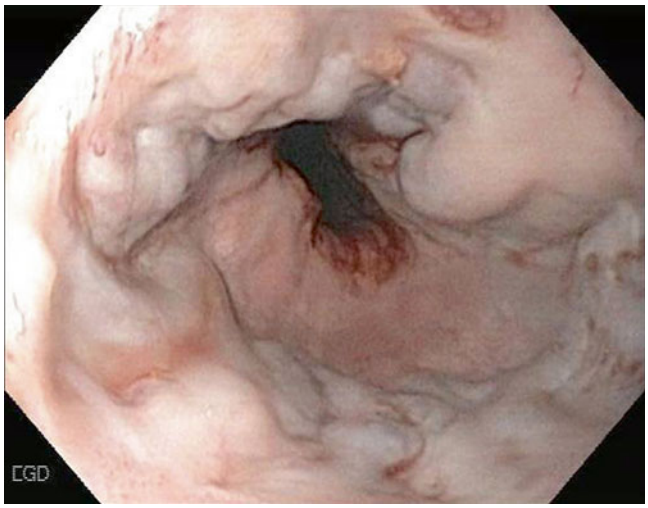

Fig. 1.2 Esophageal varices

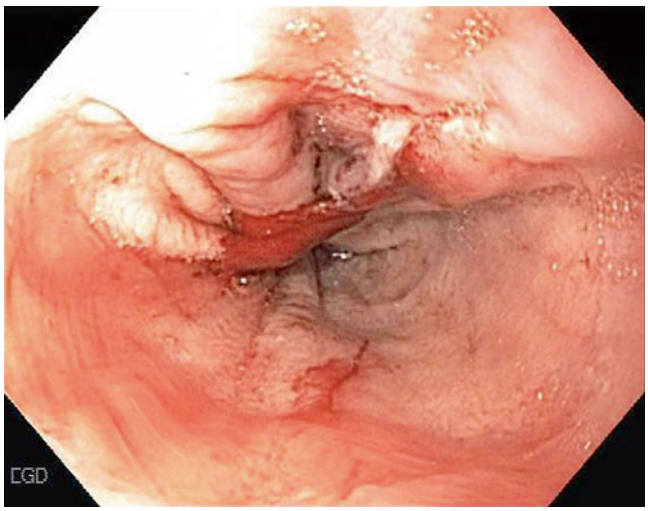

Fig. 1.3 Mallory–Weiss tear at GE junction

usually in patients with multiple comorbidities. The lesions are found in the upper part of the stomach in 75 % of cases usually on the lesser curve within 6 cm of the GE junction. Combination endoscopic therapy (injection/clipping or injection/coagulation) is exceedingly effective in arresting the hemorrhage and preventing rebleeding when the lesion is identified and treated (Fig. 1.5).

Congestive Gastropathy

This is a condition related to portal hypertension that causes chronic blood loss in cirrhotic patients. It mimics gastritis on endoscopy and microscopically reveals dilated submucosal veins and vascular ectasia in the muscle layer. The primary therapy is reduction of portal venous pressure and not endoscopic therapy.

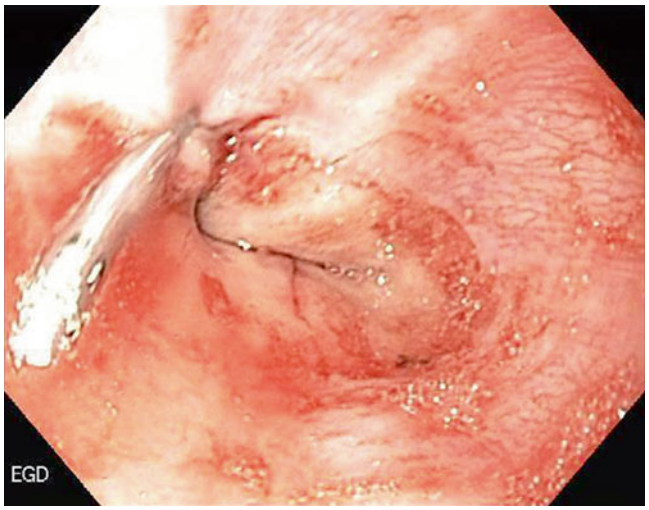

Fig. 1.4 Mallory–Weiss tear treated with injection and clipping

Vascular Conditions

Angiodysplasia accounts for 5–7 % of UGIB. It can be associated with advanced age, chronic renal failure, hereditary hemorrhagic telangiectasia, and prior radiation therapy. Individual lesions can be treated with mechanical clipping or ablation techniques but patients with multiple diffuse lesions are problematic from an endoscopic approach.

Gastric antral vascular ectasia (GAVES) or "watermelon stomach" is an uncommon vascular malformation of unknown etiology. The lesion presents endoscopically as wide stripes of erythematous friable mucosa in the gastric antrum resembling a watermelon rind (Fig. 1.6). Argon plasma coagulation (APC) and radiofrequency ablation have been described to treat this condition.

Aorto-Enteric Fistula

Fistulae between the aorta and bowel can occur after Dacron graft replacement of the aorta. Atherosclerotic plaque or mycotic aneurysm can less commonly result in a fistula. The lesion involves the third or fourth portion of the duodenum and in many cases the graft can be visualized protruding through the back wall of the duodenum (Fig. 1.7). A CT scan with IV contrast can also make the diagnosis. Patients have an initial "herald bleed" which can abate on its own to be followed by a massive exsanguinating event hours, days, or weeks later. Endoscopy can make the diagnosis but there is no role for endoscopic therapy for this life-threatening condition. Even with immediate transfer and surgical therapy there is a very significant rate of morbidity and mortality with this condition.

Neoplasms

Malignant lesions of the upper GI tract are uncommon causes of UGIB and usually self-limited. Endoscopy plays a limited role in therapy.

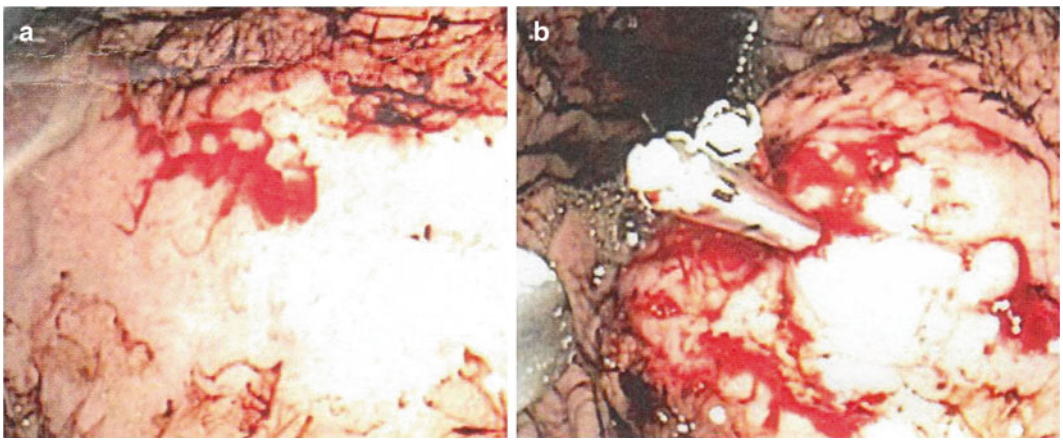

Fig. 1.5 Bleeding Dieulafoy's lesion (**a**) with injection/clip application (**b**)

Fig. 1.6 Gastric antral vascular ectasia (GAVES)

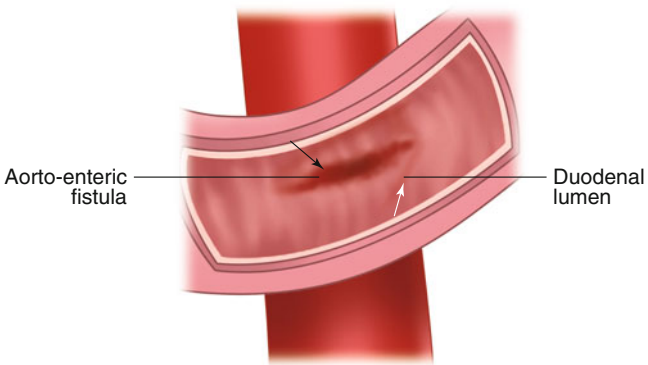

Fig. 1.7 Aorto-enteric fistula, endoscopic view. *White arrow*—duodenal lumen; *black arrow*—aorto-enteric fistula

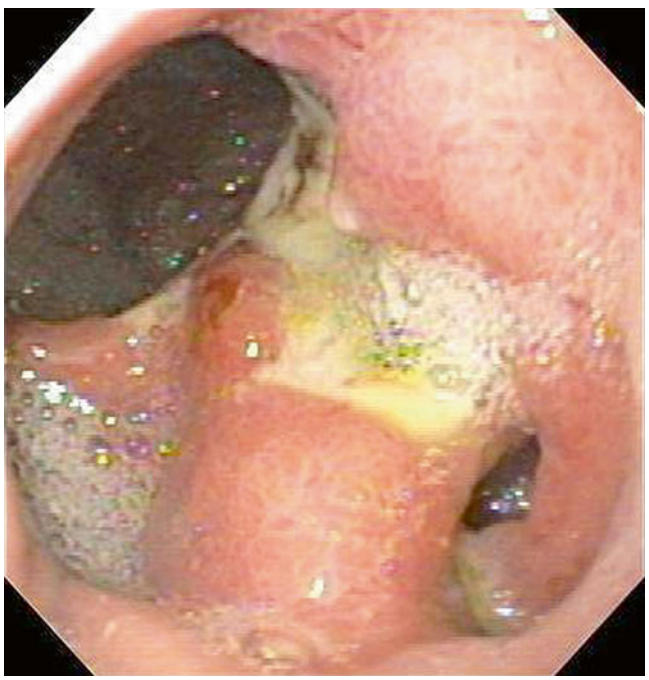

Fig. 1.8 Anastomotic ulcer

Anastomotic Ulcers (Fig. 1.8)

Anastomotic ulcers, also termed marginal or stomal ulcers, occur in 0.6–16 % of bariatric patients treated with laparoscopic rou-en-y gastric bypass. Nonsurgical approaches are successful in healing the lesions in 68–88 % of the cases. Up to 1/3 of patients may ultimately need surgical revision and even in these re-operated cases up to 10 % may have a recurrence. Bleeding lesions are treated in the same fashion as peptic ulcers.

Operative Technique

A plethora of injections, devices, and tools are available to the endoscopist treating patients with UGIB. The availability of certain therapies in smaller institutions may be limited by

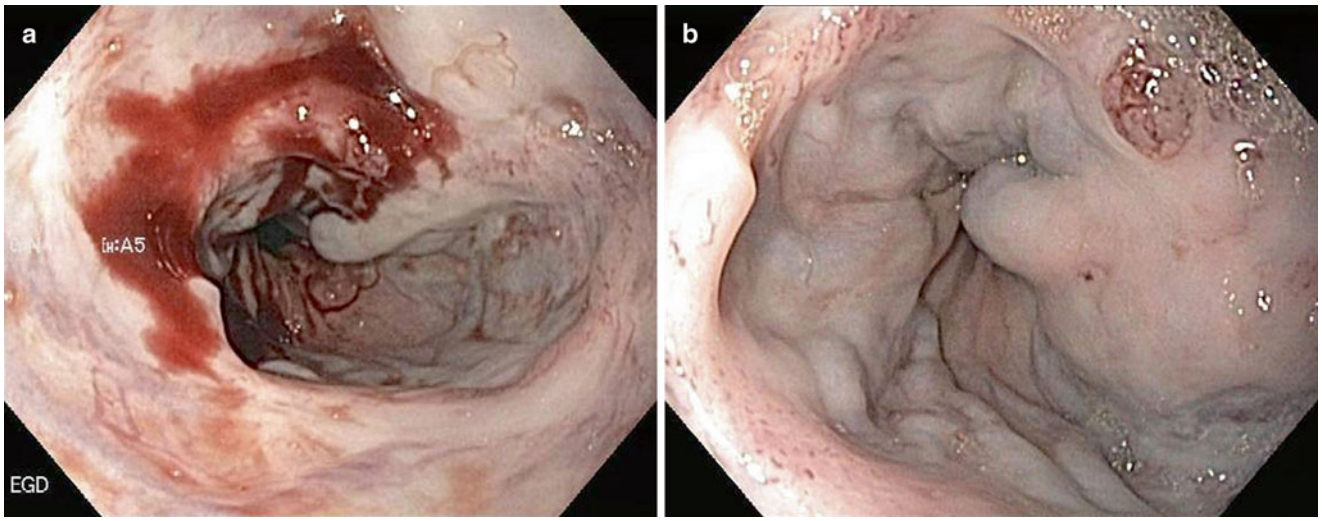

Fig. 1.9 (**a**) Bleeding esophageal varix; (**b**) esophageal varix after saline/epi injection

financial constraints but most cases of UGIB can be treated with many different single and combination modalities. Each endoscopist must become comfortable and familiar with the available devices in their individual institution. Obviously, the rural surgical endoscopist must be knowledgeable and confident in their ability to perform standard open surgical therapy to control hemorrhage when endoscopic therapy fails to stabilize the patient. The timing, surgical approach, and resources required should be considered even as the initial endoscopy is being carried out.

A partial list of available modalities includes:

- Injection therapy:
  - Normal or concentrated saline injection
  - Epinephrine (adrenaline)
  - Sclerosants (ethanol, ethanolamine, polidocanal)
  - Thrombin
  - Fibrin
  - Cyanoacrylate glues
- Cautery devices:
  - Heat probes
  - Neodymium-yttrium aluminum garnet lasers (YAG)
  - Argon plasma coagulation (APC)
  - Electrocautery probes (BICAP, GOLD Probe)
  - Radiofrequency ablation devices
- Mechanical therapy:
  - Endoscopic clips
  - Endoscopic Band Ligation devices
- Future modalities undergoing clinical testing
  - Endoscopic nanopowder spray
  - Endoscopic suture methods

Therapeutic Endoscopic Techniques

Injection Therapy

Saline With/Without Epinephrine

Injections with concentrated saline solutions containing diluted epinephrine are widely utilized because of its ease of use and beneficial effects. A standard retractable 25-gauge sclerotherapy needle is used to inject a solution of 1:10,000 epinephrine and saline into and around the bleeding point. Injection of 1.0 mL aliquots into the submucosal space promotes hemostasis by local tamponade, by promoting vasospasm and causing thrombosis (Fig. 1.9). Rebleeding occurs in 15–20 % of lesions treated by injection alone. Application of a second hemostatic technique (ablative or mechanical), in addition to injection, can provide a more permanent hemostasis. Limiting the volume of epinephrine solution to 12 mL or less reduces potential toxic cardiac effects including angina, tachycardia, arrhythmias, and hypertension. To further decrease the cardiac risks in at-risk patients, concentrated saline without epinephrine can also be effective.

The technique of using concentrated saline alone for sclerotherapy involves mixing together 17.4 mL of Sterile Water and 2.6 mL of 23.4 % NaCl (4 mEq/mL). This makes 20 mL of 3 % saline for injection. Sclerotherapy with saline and epinephrine is accomplished by adding 2.5 mL of Epinephrine 1:10,000 to each 20 mL syringe of 3 % saline.

Sclerosants

Sclerosants are substances that cause local tissue inflammation and edema which compresses and tamponades the bleeding lesion and promotes clotting. Resultant necrosis and fibrosis occurs which can cause ulcers, strictures, and perforation. Examples of these agents include sodium tetradecyl sulfate, polidocanol, ethanolamine, and absolute alcohol.

Thrombin, fibrin glue, and cyanoacrylate glue have all been described for use in UGIB but are less effective, less practical, or more expensive than other injection therapies.

Ablative Therapy

Devices that deliver intense energy to the bleeding lesion to promote hemostasis are termed ablative therapies. The energy causes coagulation of tissue proteins that results in edema, vasoconstriction, thrombocoagulation, and tissue

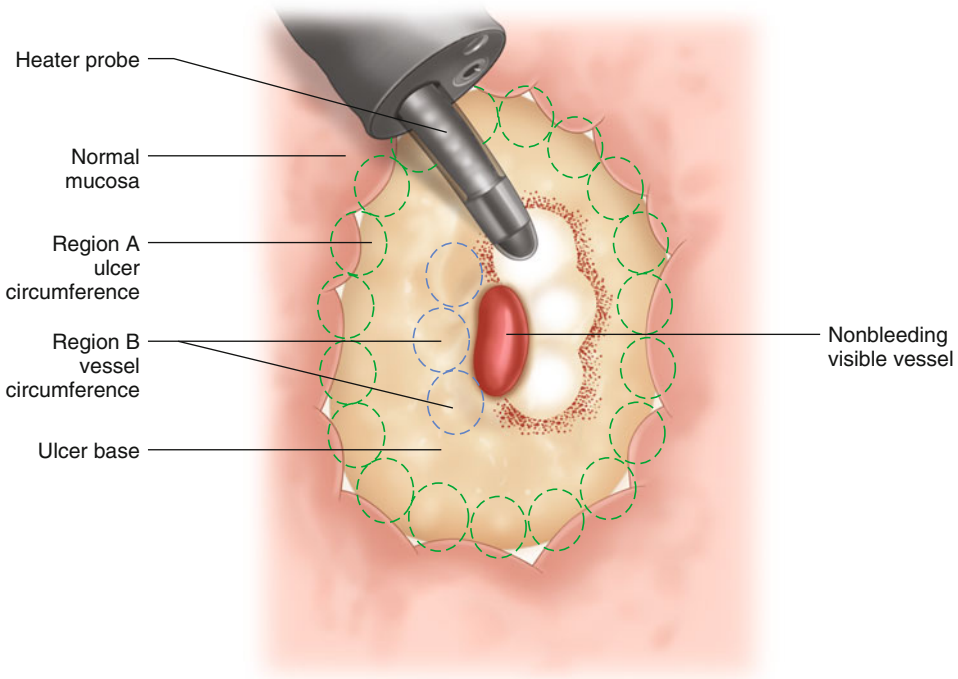

Fig. 1.10 Rimming technique for contact ablative therapy

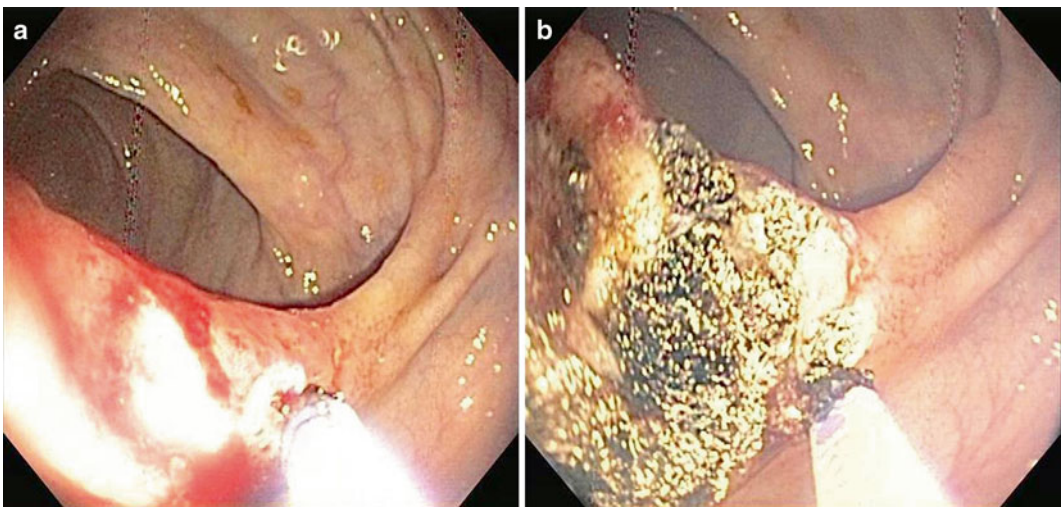

Fig. 1.11 Bleeding lesion (**a**) treated with argon plasma coagulation (**b**)

destruction. Thermocoagulation (Heater Probe) uses heat, electrocoagulation (BICAP, Gold Probe) uses electricity, radiofrequency uses high frequency alternating current, and APC uses excited electrons to achieve the desired beneficial results. Electrocoagulation, thermocoagulation, and radiofrequency ablation require the probe or catheter to contact the tissue for delivery of the energy. Compression of an exposed vessel by the probe reduces blood flow in the vessel making the energy more efficient. A rimming technique is used to treat the area immediately around a visible or bleeding vessel before applying the device to the actual bleeding site (Fig. 1.10). The end result is to fuse or weld the two sides of the vessel together for hemostasis. Water irrigation during probe removal helps prevent pulling tissue away from the site which may cause rebleeding.

APC is a noncontact technique for UGIB. Monopolar electrocoagulation is used to ionize argon gas into a plasma that coagulates tissue (Fig. 1.11). Various sizes of catheters are available as well as a choice of devices that deliver the plasma beam from the tip or the side of the catheter. The thick-walled stomach is well suited to use of the APC where there is much less risk of perforation (<0.5 %) than other

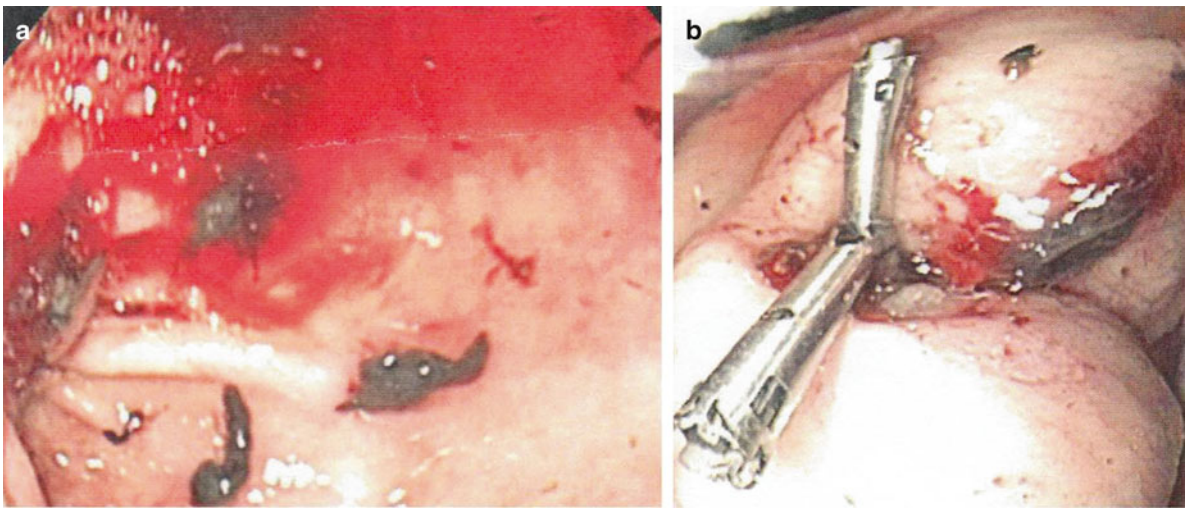

Fig. 1.12 Bleeding gastric ulcer (**a**) with clip application (**b**)

areas of the GI tract, particularly the cecum. A benefit of the APC is that the gas displaces fresh blood from the bleeding site aiding in visualization during application of the energy. Argon gas accumulates in the lumen of the bowel during the treatment and needs to be periodically suctioned to prevent distention or perforation of the GI tract. The normal settings for the APC application for esophagus, stomach, and small intestine are 60–80 W of power with single shot duration of 1–3 s. A secondary benefit of the availability of APC technology in a rural facility is its use to control liver bed bleeding during laparoscopic cholecystectomy and to treat splenic capsular injuries.

The Nd:YAG laser deeply penetrates and injures tissue and therefore has a perforation rate of approximately 3 %. Studies show a lower rate of hemostasis than other ablative therapies and it has high initial and ongoing maintenance costs.

Radiofrequency ablation has been utilized for ablative procedures in the fields of cardiology, invasive radiology, venous surgery, pain management, and for Barrett's esophagitis. The device has been used to treat large bleeding areas such as occur in GAVES and other vascular malformations in the GI tract.

Mechanical Therapy

This class of therapy mechanically compresses the bleeding point to achieve hemostasis (Fig. 1.12).

Hemoclips presently are the most commonly used mechanical therapy. Accurate placement can sometimes be challenging but they are very effective in controlling bleeding in the right circumstance. Fibrosis and acute inflammation can be problematic in approximating and compressing the tissue. Three brands of endoscopic hemostatic clips are currently available, each having different capabilities in terms of size, rotation, and reversibility.

Endoscopic band ligation (EBL) is a technique usually reserved for esophageal varices. They can be utilized for primary hemostasis in acutely bleeding varices, ones deemed to have bled recently and for prophylaxis in high-risk nonbleeding varices. The bands are preloaded onto a delivery device at the end of the endoscope. The varices are suctioned into the cap of the device and the band is fired onto the varix. Successful deployment results in the treated varix having a dusky pedunculated appearance with the band visualized at the neck (Fig. 1.13). EBL has been described for use in peptic ulcers, Mallory–Weiss tears, and Dieulafoy's lesions.

Combination Therapy

Significant improvement in rebleeding rates can be achieved by combining epinephrine injection with ablative or mechanical therapies. The specific combination varies with the endoscopist, the specific bleeding lesion and the available resources.

Insertion of Sengstaken–Blakemore Tube

A Sengstaken–Blakemore tube is a device inserted through the nose or mouth for management of UGIB secondary to esophageal or gastric varices in patients with portal hypertension. Use of the tube was originally described in 1950 and the device can be used as adjunctive therapy in cases of massive bleeding to stabilize patients until resuscitation, endoscopic therapy, or transfers are carried out. The device consists of a flexible plastic tube containing several channels and two inflatable balloons (Fig. 1.14a). More modern versions, termed Minnesota tubes, have channels for suction at the gastric tip and in the upper esophagus section. The two inflatable balloons are used to compress areas of varices in the proximal stomach and distal esophagus. Due to the high risk of aspiration in these patients, endotracheal intubation is usually indicated before placement of the S–B tube.

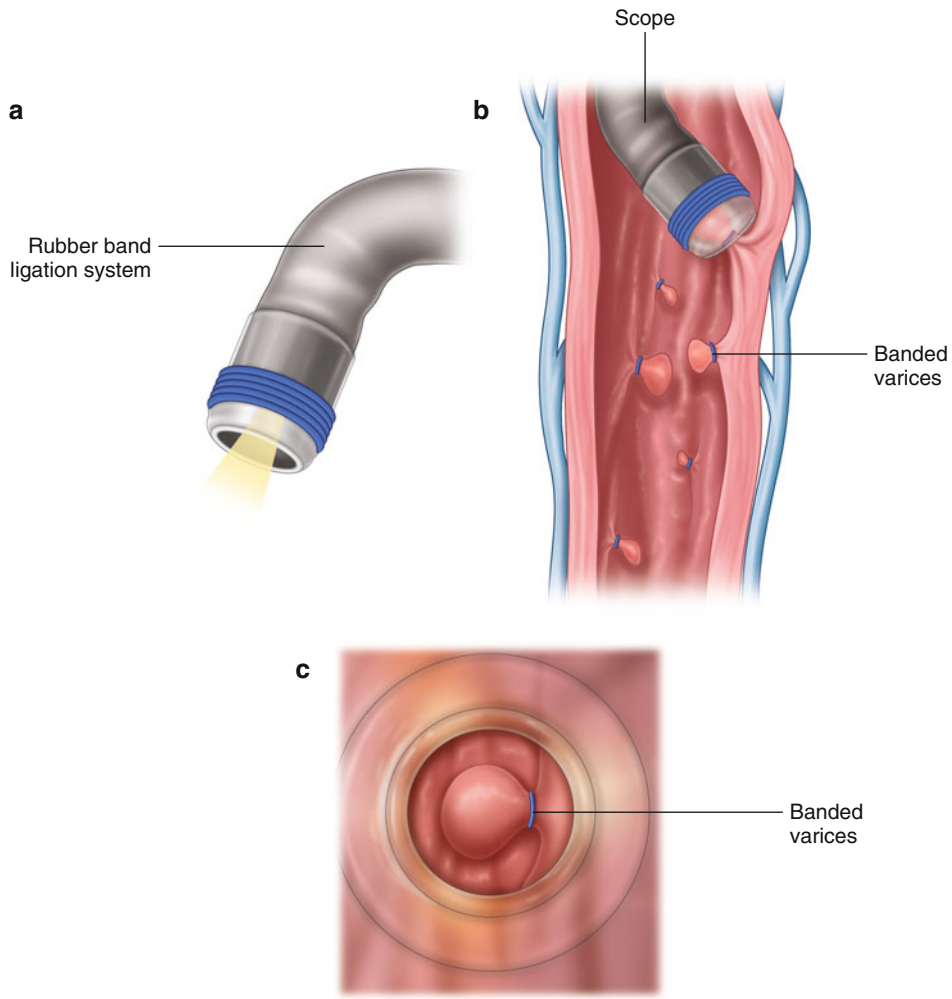

Fig. 1.13 Endoscopic band ligation of esophageal varices

The tube is usually inserted via the mouth and into the stomach (Fig. 1.14b). Confirmation of position on CXR or fluoroscopy will prevent inflation of the gastric balloon in the esophagus, which can cause perforation and death. The gastric balloon is inflated using 50 mL increments of air up to 250–300 mL for S–B tubes (450–500 mL for Minnesota tubes). Manometry can be used to measure the pressure in the gastric balloon with specific volumes of air before insertion. If the pressure during insertion is >15 mmHg more than the pre-insertion pressure at the same pre-insertion volume then the gastric balloon may be in the esophagus and needs to be re-positioned. Using a pulley system and a 500 cm^3 bag of IV fluid, traction is placed on the tube to cause compression of the gastric fundus. If bleeding continues, the esophagus balloon can also be inflated to 40 mmHg. Deflation of the balloons should be attempted every 6–12 h to prevent necrosis and then re-inflated if there is continued bleeding.

Potential Pitfalls

Complications of endoscopic therapy for UGIB include the inability to arrest the hemorrhage, rebleeding after treatment, and perforation. Multiple studies document rates for successful control of bleeding, rebleeding and perforation for each type of bleeding lesion and the different therapies utilized in their treatment (Table 1.1).

Rural facilities with smaller caseloads and limited financial resources must make sound decisions regarding technology acquisition for the treatment of patients with UGIB. Cost, efficacy, and adaptability for multiple uses (endoscopic and surgical) are important considerations. Table 1.2 lists the approximate relative costs of the various modalities used to control UGIB. Each individual facility and vendor will obviously have varying pricing depending on purchasing groups, agreements, and contracts.

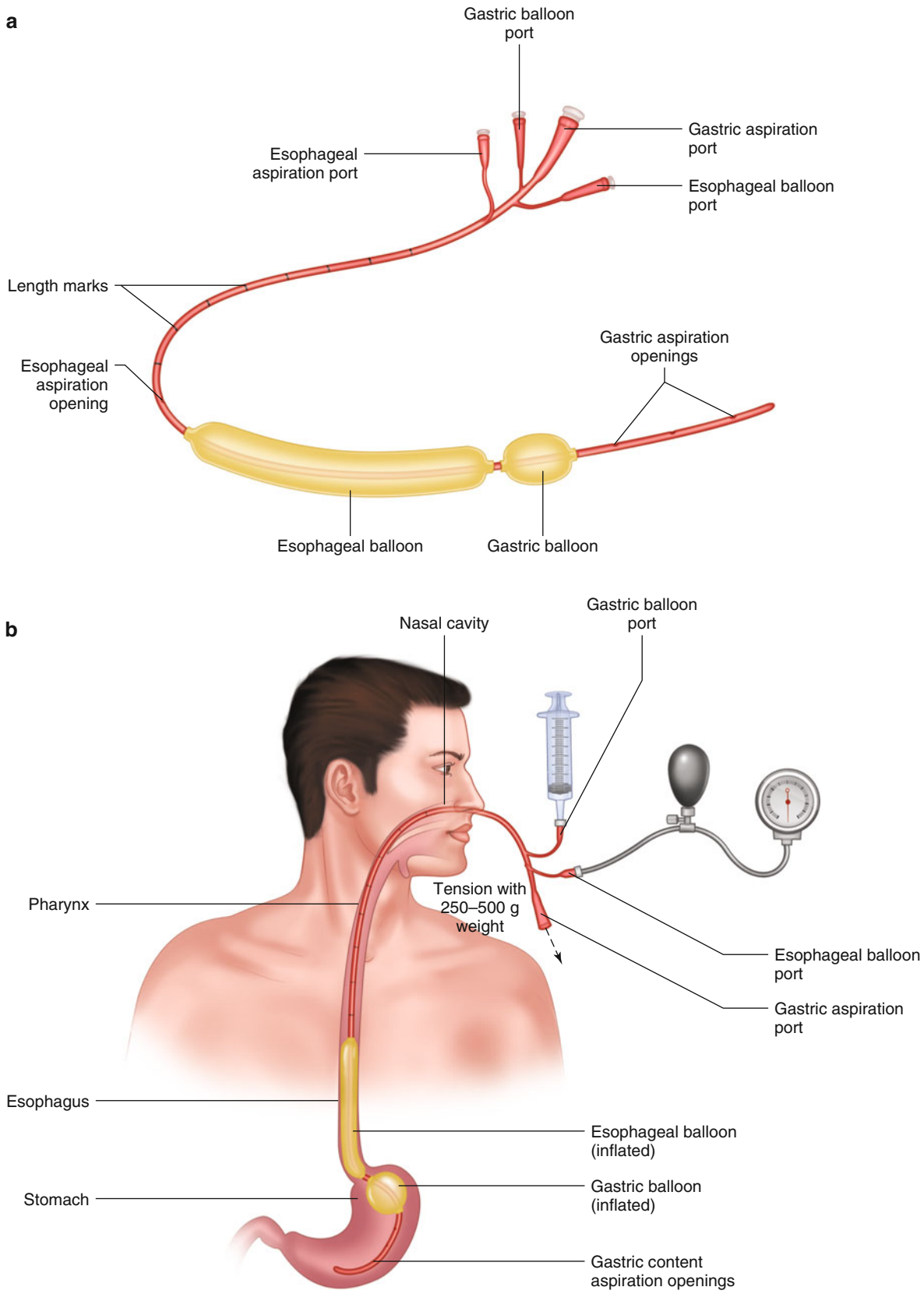

Fig. 1.14 (**a**) Sengstaken–Blakemore tube; (**b**) proper insertion of S–B tube