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## Introduction

Upper gastrointestinal bleeding (UGIB) is defined as bleeding in the gastrointestinal tract originating between the mouth and the ligament of Treitz. Nonvariceal UGIB is responsible for over 300,000 hospitalizations per year in the USA and is the primary reason for urgent endoscopy. The mortality rate for UGI bleeding is significant, although in recent years, it has been declining with the use of effective medical and endoscopic therapies [1]. Gastroenterologists will typically manage UGIB cases from presentation through evaluation, treatment, and follow-up care on a routine basis on inpatient services. The technical approach to the endoscopic treatment of UGIB is a set of skills that must be learned for treating bleeding effectively in clinical practice. There are multiple guidelines that detail the recommended approach to the management of patients with UGIB [2–7]. In this chapter, the evaluation and management of patients with suspected or established nonvariceal UGIB are discussed, with a focus on the various endoscopic techniques and tools.

### Electronic supplementary material

Supplementary material is available in the online version of this chapter at [10.1007/978-3-319-49041-0\\_2](https://doi.org/10.1007/978-3-319-49041-0_2). Videos can also be accessed at [https://link.springer.com/chapter/10.1007/978-3-319-49041-0\\_2](https://link.springer.com/chapter/10.1007/978-3-319-49041-0_2).

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## Initial Management

Initial therapy for patients with acute UGIB includes resuscitation with immediate placement of at least two large-bore ( $\geq 18$ -gauge) peripheral intravenous catheters [8, 9]. Establishment of large-bore vascular access is critical for the delivery of appropriate volumes and types of fluid, or in some cases, blood product, for resuscitation and hemodynamic stabilization of the patient. By comparison, an 18-gauge intravenous catheter allows for a maximum fluid flow rate of 105 mL/min, whereas a 20-gauge intravenous catheter allows for a maximum fluid flow rate of 60 mL/min. In patients with compromised ability to protect their airway, altered mental status, or ongoing and severe hematemesis, elective endotracheal intubation should be considered. Intubation is recommended in cases of active vomiting or significant hematemesis because of the increased risk of clinically significant aspiration during endoscopy.

A restrictive strategy to the administration of blood transfusions has been shown to benefit most patients with acute UGIB [10]. This includes refraining from packed red blood cell transfusions when the hemoglobin is  $\geq 7$  g per deciliter in cases of acute UGIB without ongoing active bleeding or active coronary disease. Prior management strategies included initial nasogastric tube placement and lavage to evaluate for an upper GI source of bleeding. However, the use of nasogastric tubes is no longer recommended because of their low negative predictive value, as well as a lack of benefit in patient outcomes in clinical studies [3, 11].

## Medical Therapies

Many medications have been used as part of the management of patients with acute UGIB. These include antacids, histamine-2-receptor antagonists, proton pump inhibitors

(PPIs), and octreotide. Antacids and histamine-2-receptor antagonists can increase intragastric pH but have been superseded by PPIs.

The use of PPIs in the initial management of patients with suspected UGIB is now widely adopted as part of the treatment of acute UGIB since a landmark study in 1997 showed improved outcomes with the use of PPI versus placebo [12]. PPI use allows patients to achieve a gastric pH of  $>6.0$  and decreases rates of further ulcer bleeding, allowing for more rapid patient stabilization and facilitation of other medical and endoscopic therapies [13]. Early PPI use also aides in initial ulcer healing [14]. A recent meta-analysis has shown that twice-daily IV PPI bolus is noninferior to an IV PPI bolus dose followed by a continuous infusion [15]. Thus, either a PPI twice-daily bolus or IV infusion may be given to patients with acute UGIB. There is also data that suggest that oral PPI therapy is similarly effective to IV PPI therapy in the setting of bleeding [16]. In patients on IV PPI therapy, once the bleeding has been stabilized or stopped, patients may be safely transitioned to an oral PPI. In patients receiving endoscopic therapy for high-risk lesions, the switch to an oral PPI typically occurs after 72 h without the evidence of rebleeding.

Many patients with UGIB will present while on therapeutic antithrombotic agents. It has been shown that therapeutic endoscopy is effective and can be safely performed in patients with an INR of  $\leq 2.5$  [17]. Vitamin K or fresh frozen plasma can be administered as part of resuscitation prior to endoscopy in cases of ongoing active bleeding. When patients present on other antithrombotic agents including aspirin, thienopyridines, or novel oral anticoagulants, the endoscopist must consider the indication for therapy and consequences, including potential for adverse events if the antithrombotic agent is stopped in the setting of UGIB. In the setting of acute bleeding, these agents are typically withheld, but should be restarted after the bleeding is controlled if the indication is secondary prevention [18, 19]. It has been recommended that aspirin and warfarin are restarted within one to three days or four to seven days, respectively, following control or bleeding [3]. Decisions on antithrombotic management should be carried out in collaboration with the prescribing physicians, considering the risks of bleeding if these medications are continued and the risks of thrombotic events if these medications are withheld.

## Risk Stratification

Risk stratification in acute UGIB can be accomplished by the use of validated risk scores. These can be used to separate low-risk patients (who can often be discharged after endoscopy) from high-risk patients who will benefit from more

resources, including intensive care unit (ICU) level of care and urgent endoscopy [2, 3]. Several UGIB risk stratification scores exist including the Rockall score, the Glasgow-Blatchford score, (GBS), and the AIMS65 score [20–22].

The GBS and AIMS65 scores use only the clinical information available at the time of initial presentation to the emergency department. The AIMS65 score includes five factors: serum albumin  $<3.0$  g/dL, INR  $>1.5$ , altered mental status, systolic blood pressure  $<90$  mm Hg, and age  $\geq 65$  years. In the AIM65 score, each factor is assigned a score of 1 and high-risk patients have an AIMS score  $>1$ . Patients with a GBS score of 0–2 and an AIMS65 score of 0 can be considered for outpatient management, while patients with a GBS  $>10$  or an AIMS65  $>2$  should be considered for ICU management and an urgent endoscopy following adequate volume resuscitation [23, 24].

## Endoscopic Management

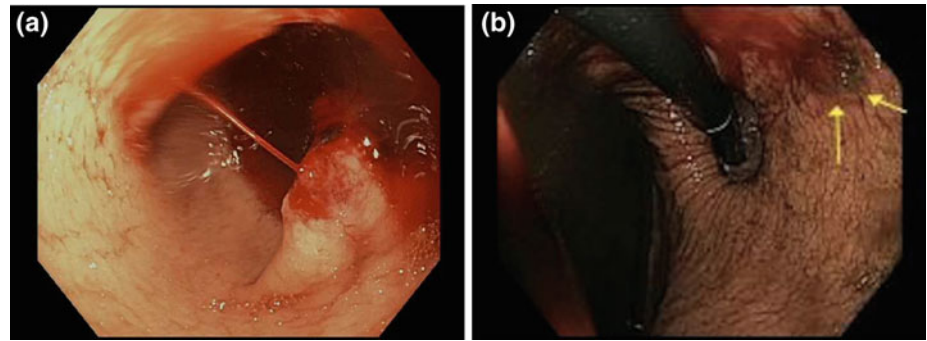
In the management of UGIB, in addition to the stabilization of the patient, volume resuscitation, medical therapy, and endoscopy should be performed. Endoscopic therapy can often completely stop active bleeding and prevent rebleeding. Upper endoscopy is more than 90% sensitive in identification of a bleeding site, with sensitivity inversely related to the time elapsed between patient presentation and the timing of the endoscopic procedure. After hemodynamic resuscitation and stabilization, multiple guidelines recommend that all patients with acute UGIB should undergo upper endoscopy within 24 h of the patient's initial presentation. Urgent endoscopy (less than 12 h after presentation) has not been shown to be superior to early endoscopy (within 24 h of presentation). However, urgent endoscopy may be beneficial for patients with suspected ongoing active bleeding or for patients with high-risk prognostic scores following hemodynamic stabilization. All lesions should be photographed prior to and after endoscopic intervention to provide proper documentation of the initial lesion and its response to endoscopic treatment.

The goals of endoscopy are to identify and treat lesions that are actively bleeding or contain high-risk stigmata of recent bleeding (Table 2.1). High-risk stigmata of recent hemorrhage (SRH) include actively bleeding lesions (spurting or oozing) (Fig. 2.1), nonbleeding visible blood vessels within an ulcer, and adherent blood clots covering a lesion (Fig. 2.2). These stigmata are important to recognize because they are the lesions with the greatest risk of having a rebleeding event. High-risk SRH should generally be treated when identified by endoscopy. The management of adherent clots is most controversial as the bleeding risk depends on the bleeding stigmata underneath the clot. A commonly

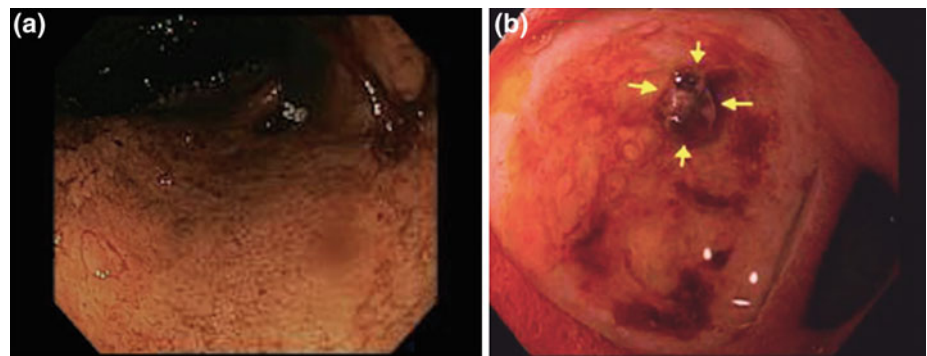
**Table 2.1** Stigmata of recent hemorrhage in descending order from highest risk to lowest risk for further bleeding

	Further bleeding (average) (%)	Prevalence (%)
Spurting bleeding	80	9
Nonbleeding visible vessel	44	10
Adherent clot	20	12
Active oozing	10	6
Flat pigmented spot	10	8
Clean-based ulcer	5	55

**Fig. 2.1** **a** Actively spurting bleeding. **b** Active oozing blood from an ulcer



**Fig. 2.2** **a** Adherent clot on gastric ulcer. **b** Duodenal ulcer with a visible vessel surrounded by arrows



employed endoscopic technique to evaluate lesions underneath visible clots is to inject dilute epinephrine at the base of the clot and then to cold guillotine the clot off the lesion using a snare without using shearing force. The underlying area is then vigorously irrigated. If a bleeding or a nonbleeding visible vessel is uncovered, further endoscopic therapy is indicated [25].

## Measures to Improve Visibility

### Direct Irrigation

Irrigation during endoscopy is important not only to identify the bleeding site, but also to prepare the target tissue for intervention. Irrigation of suspected bleeding lesions is done with water or saline directed onto the lesion until adequate visualization is achieved. Most current endoscopes include ports and accessories to deliver a forward-directed water jet

through the tip of the endoscope, allowing for easy and copious directed delivery of irrigating fluid. When significant air bubbles are present, addition of simethicone to the irrigating fluid in the water bottle can aid in visualization. Irrigation of an ulcer should not be deferred out of fear for provoking bleeding. Irrigation can help to identify the precise location of the SRH and can provide the operator information needed to determine which endoscopic tool or approach is optimal.

If a large volume of blood or clot is present, a standard endoscope may not provide enough suction capacity to clear the area. In these cases, a large channel or dual-channel therapeutic endoscope can be used to facilitate more effective suctioning of fluid and/or clots. A large capacity external suction device can also be attached to the biopsy port of an endoscope for patients with large amounts of intraluminal contents requiring aspiration bypassing the suction inside of the endoscope housing connected to the endoscope processor and allowing for more effective suctioning.

## Pharmacologic Methods

Several pharmacologic agents have been used in UGIB to help clear the stomach contents in an effort to facilitate improved visualization during endoscopy. Intravenous erythromycin used prior to endoscopy can help with gastric visualization. Erythromycin is a motilin-like prokinetic agent, promoting gastric contractions and subsequent gastric emptying. Erythromycin at 250 mg bolus or 3 mg/kg infusion administered over 30 min (intravenously) is effective clinically and should be administered 30–120 min prior to the anticipated endoscopy. Metoclopramide 10 mg IV has also been used as a prokinetic agent to promote clearance of gastric debris and blood from the stomach prior to endoscopy, although there is less available data concerning its efficacy. These prokinetic agents improve gastric visualization and potentially reduce the need for repeat endoscopy [26].

## Endoscopic Therapeutic Methods

Once a source of bleeding has been identified, there are many instruments and techniques in the endoscopist's armamentarium to provide treatment and to prevent rebleeding (Table 2.2). Rebleeding is a major source of morbidity and mortality. Endoscopic techniques for bleeding control include injection therapies, contact and noncontact thermal devices, mechanical devices such as endoscopic clips and band ligation, radiofrequency ablation, and the use of a combination of techniques. Other novel tools include hemostatic sprays, but these are not currently approved by the FDA.

**Table 2.2** Commonly used modalities for endoscopic therapy

<i>Injection therapy</i>
– Epinephrine (1:10,000)
– Sclerosant agents (alcohol, ethanolamine, and polidocanol)
– Tissue adhesives (cyanoacrylate glue and thrombin/fibrin)
<i>Thermal therapy</i>
– Contact: heater probe, bipolar probe, and monopolar probe
– Noncontact: APC
<i>Mechanical therapy</i>
– Hemoclips
– Over-the-scope clips
– Endoscopic band ligation
<i>Combination therapy</i>
– Injection + thermal therapy
– Injection + mechanical therapy

## Injection Therapies

Injection therapy is primarily performed with dilute epinephrine, although saline alone may be used if epinephrine is not available [27]. Injection therapies induce hemostasis by producing a tamponade effect on the area and epinephrine causes vasoconstriction reducing local blood flow, although this effect is less than the primary fluid tamponade. Epinephrine is generally diluted to 1:10,000. This may be done by adding 1 mL of 1:1000 epinephrine into a syringe containing 9 mL of saline. The concentration can be further reduced in patients with serious cardiac comorbidities to 1:100,000, especially when used near the gastroesophageal junction where its use may cause more systemic cardiac effects. Patients with contraindications to epinephrine can receive saline alone as the injectate. Saline alone can be used as an injectant to produce tamponade if epinephrine is not available.

The general technique of injection is to introduce a standard endoscopic injection catheter through the working channel of the endoscope until the tip is visible. Then, the injection needle is advanced and locked in position. Different injection needles with different diameters allow for variability in the amount of force needed to introduce the needle into the submucosa. It is recommended to inject into multiple locations surrounding the bleeding lesion with a four-quadrant technique, although some lesions with active bleeding may achieve hemostasis after only one injection. If the needle is not inserted deep enough to reach the submucosal space, injected fluid will leak into the lumen when the syringe is depressed. If this happens, one can readjust the needle by pulling the injection catheter out of the mucosa and then reinserting at the same or a different location in an effort to reach the submucosa with the needle tip. Of note, some pressure is required to introduce the injection needle tip into the submucosa. Alternatively, the injection can be started with the tip of the needle in the lumen and the probe advanced during injection to find the submucosal space.

Injection can be used to help control bleeding of various etiologies, including from vessels within ulcers, vascular malformations, and Dieulafoy's lesions, as well as when a discrete lesion is not visualized due to active bleeding. In the stomach, 8–10 mL total injection can be used in multiple injections of about 2 mL each, although there is no absolute number or volume of injections. Higher doses are more likely to cause cardiovascular side effects, and this should be kept in mind, especially when epinephrine is used near the gastroesophageal junction.

Soon following the injection, the area around the lesion will develop pallor and the hemostatic effects are seen when any active bleeding slows or stops. Use of injection monotherapy is not recommended because it is less effective



than other monotherapies or combination therapies and is less durable as it is associated with higher rates of rebleeding. Rather, injection therapy is often used as a prelude to a second treatment (thermal or mechanical therapy) once bleeding has abated and visualization has been improved.

Injection therapy can be used to treat a myriad of bleeding lesions because of the short-lived effect of vasoconstriction and temporary cessation of bleeding. In situations where there is overwhelming bleeding obscuring visualization despite irrigation, injection of epinephrine can help slow bleeding and ultimately identify and thus allow treatment of the source. Injection therapy is most helpful to slow or stop bleeding; thermal and/or mechanical therapy can subsequently be applied to achieve complete and durable hemostasis.

Other injection agents include sclerosants (although these are usually used in the treatment of bleeding varices if band ligation has failed or is not available). These agents can be used for nonvariceal bleeding sources as well. Sclerosants include ethanol, polidocanol, and ethanolamine. These agents induce local inflammation and fibrosis of a bleeding vessel. Other agents that can be injected include cyanoacrylate and fibrin glues. Cyanoacrylate glue is a liquid material that transforms (polymerizes) into a solid after injection. This can be particularly useful in bleeding gastric varices, whereby the glue becomes an artificial thrombus in the varix reducing blood flow by occluding the vessel. Fibrin glue has also been used endoscopically as a form of injection therapy. Fibrinogen and factor XIII are mixed with thrombin and calcium. In this manner, the clotting cascade is activated and clotting is promoted. Cyanoacrylate and fibrin glue may be of limited availability.

## Thermal Therapies

Contact thermal therapies used for the control of UGIB include heater and bipolar probes, as well as monopolar therapies [27]. The technique for the use of heater and bipolar therapies involves controlling bleeding by simultaneously compressing and cauterizing a bleeding vessel, known as coaptive coagulation. Heater and bipolar therapies do not require a grounding pad applied to the patient as the electrical circuit is completed within the device itself. Once in widespread use, heater probes rarely are utilized in current practice and bipolar electrocautery devices are now commonly employed to treat GI bleeding. Heater probes are quite effective and, if available, are still an excellent choice for treating upper GI bleeds.

While the bipolar probe can be used multi-directionally, with either a perpendicular or tangential approach, a heater probe can be used perpendicularly only. The larger 10 French probes can deliver thermal energy over a larger area

than the smaller 7 French probes and are felt to be more effective, although the 10 French probes require a therapeutic endoscope with a large channel size.

The technique of applying endoscopic cautery using either a bipolar or heater probe is similar for both devices. First, the probe is advanced out of the tip of the endoscope and into the lumen for a short distance, so that the tip is visualized endoscopically (Video 2.1). If the probe is too far out of the scope, it can be difficult to control and the operator will lose mechanical advantage. The endoscope should be positioned as close to the lesion as possible for the control of therapy to maximize visualization and efficiency of endoscopic maneuvers. The probe should make direct contact with the bleeding vessel and be held in place with direct pressure to ensure continued contact. Moderate-to-firm pressure is usually used in the stomach due to its relatively thick wall, and mild-to-moderate pressure is typically used in the rest of the gastrointestinal tract, such as in the small bowel or esophagus where the walls are thinner. One suggested technique uses four to six pulses of energy for approximately 10 s each, although many variations exist. No gold standard on the number and duration of therapy exists as these depend on the specifics of the lesion being treated and on its location. The endpoint for therapy is the cessation of bleeding and visible cauterization of the target lesion, which often appears flattened following successful therapy application.

Energy levels recommended are 10–15 W in the duodenum and 15–20 W in the stomach. After each round of therapy, the target lesion can be inspected for ongoing bleeding, adverse events, and the need for additional therapy. If the probe is stuck to the vessel, removal of the probe can sometimes trigger rebleeding. Some devices allow water irrigation directly through the probe to minimize the risk of the probe adhering to the coagulum and can be irrigated after each application of cautery.

Monopolar therapy can also treat bleeding vessels and has been extensively used to treat endoscopically induced bleeding, such as bleeding occurring during endoscopic submucosal dissection (ESD). However, there is much less clinical data available on the use of monopolar cautery for the control of acute UGIB. One monopolar probe is a rotatable probe with flat jaws (Coagrasper, Olympus Corporation, Center Valley, PA), used to capture and compress tissue while delivering thermal energy. The technique involved with this device is different from the coaptive coagulation technique used for the heater and bipolar probes. By using monopolar forceps, the bleeding lesion is grasped and “tent-ed” toward the scope. Cautery is used at higher power settings, such as 50 W, for shorter durations of 1–2 s [28]. Monopolar cautery requires the use of a grounding pad, similar to that used for polypectomy. This pad should not be placed over any implanted metal, such as a joint replacement.

Argon plasma coagulation (APC) is a noncontact, superficial method of thermal therapy that induces destruction of bleeding lesions or aberrant vessels and vascular malformations. APC uses argon gas that is electrically conducted creating a high-energy plasma. It is unlike heater, bipolar, or monopolar probe therapies, as it does not touch or compress the tissue targeted for therapy. APC uses monopolar energy, and a grounding pad must be placed on the patient prior to use. The probes for APC are available in a variety of configurations, including with those tips that are end-firing and circumferential. Cautery will seek the closest mucosal surface to the probe, regardless of probe type. APC has, in general, a lesser degree of tissue penetration than other hemostatic methods.

APC technique involves passing the probe carefully through the endoscope as the probe can easily kink and advancing the probe close to the target tissue. The probe needs to be only a few millimeters away from the target but should *not* make contact with the mucosa. Contact of the probe may cause dissection of charged argon gas through the wall and result in perforation. Pulses of argon gas and ionization charge are controlled by a foot pedal. The lesion may be “sprayed” or “painted” with the goal being adequate treatment of the tissue, with a white charring of the superficial layer of the mucosa (Fig. 2.3).

APC can be used in the treatment of bleeding from vascular malformations, radiation-induced rectal bleeding, or gastric antral vascular ectasia (GAVE). In a lesion that

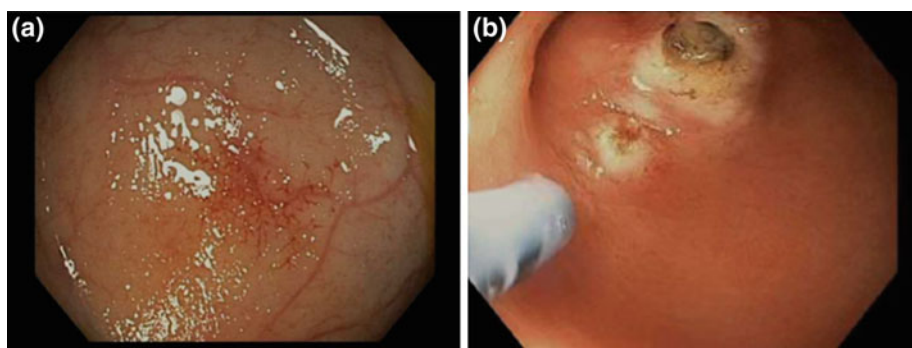
spreads, such as GAVE, APC is effective in treating a large involved area. The tissue is sprayed as the APC probe or endoscope is moved along a lesion and large amount of mucosa can therefore be quickly treated. Repeated treatments are often required for cases of GAVE, with typically three to four treatment sessions required depending on the extent of GAVE. The tip of the APC probe will collect charred material if there is contact with the tissue. The probe should then be removed from the endoscope removing the charred material with gauze, following which the probe may be reintroduced through the endoscope for resuming treatment.

During treatment with APC, there will be a buildup of visible gas in the lumen. This buildup of gas is expected, and the argon gas should be intermittently suctioned completely during the course of therapy, requiring removal of the probe unless a double-channel therapeutic scope is used. APC may also be used to treat upper GI tumor bleeding (Video 2.1), although there is a risk of rebleeding and little available data on its effectiveness (Fig. 2.4).

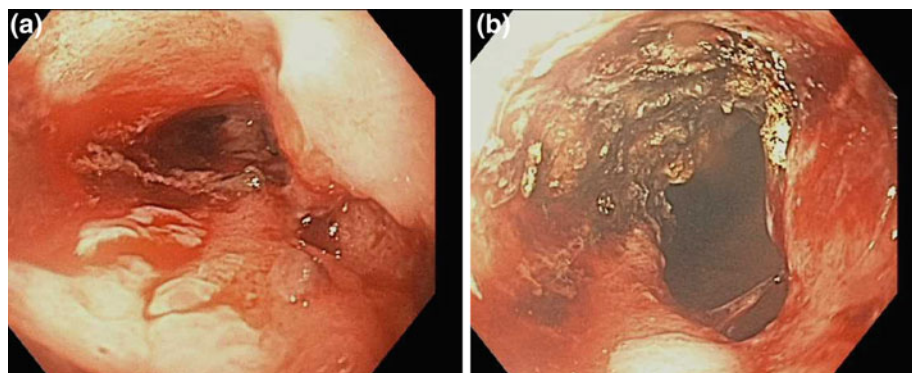
## Radiofrequency Ablation

Radiofrequency ablation (RFA) is another treatment modality that delivers superficial cautery and can be used in the treatment of GAVE and vascular malformations. There are several types of probes available, including a rotatable

**Fig. 2.3** **a** Arteriovenous malformation with classic spider appearance. **b** Tissue destruction (AVM) after APC therapy. Charring of the tissue is seen



**Fig. 2.4** **a** Bleeding esophageal tumor. **b** Bleeding esophageal tumor after the treatment with APC therapy



RFA probe that can be deployed through the scope, as well as a 60 or 90° probe that attaches externally to the scope tip. The probe needs to make direct and solid contact with the target area in order to provide effective cautery. The through-the-scope probe can be rotated in order to accomplish adequate positioning and tissue contact. Using a pedal connected to the generator, RFA is delivered with a set energy and time pulse. Each area of the lesion should be treated with two successive pulses, with a typical energy per pulse of 12 J/cm<sup>2</sup>.

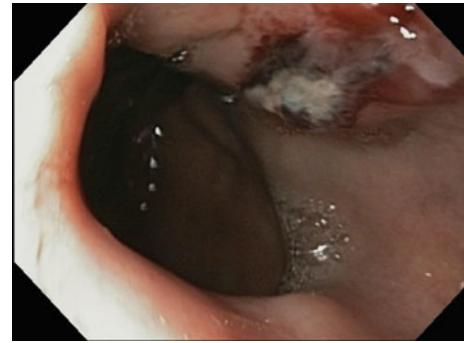
### Mechanical Hemostasis Using Clips

Endoscopic through-the-scope clips are commonly used to treat bleeding lesions [29, 30]. They can be used on actively bleeding lesions as well as on lesions with stigmata of recent bleeding, such as visible vessels within ulcers, vascular malformations, and Dieulafoy's lesions (Fig. 2.5). Most available clips can be rotated, opened, and closed repeatedly as needed prior to the deployment. Ideal lesions for clips include those that are accessible, vessels less than 2 mm in diameter and ulcers that are pliable (not firm or indurated). Difficult locations for clip application include high on the lesser curvature of the stomach and the posterior wall of the duodenum. Clips can also be applied successfully for closure of Mallory–Weiss tears (Fig. 2.6).

The technique of through-the-scope clip application starts with the passage of the clip catheter. The clip should be closed and then passed through the working channel of the endoscope. Once visible endoscopically, the clip can be opened and rotated to the desired position by the assistant working with the endoscopist. Clip rotation is beneficial for ideal hemoclip placement, especially in challenging locations. The goal of the therapy is to target the lesion with the clip as well as any feeding vessel. If targeting a visible vessel in an ulcer base, the clip should ideally span across the vessel. The delivery catheter is then extended such that the clip is engaged with the targeted tissue. As with thermal



**Fig. 2.5** Duodenal ulcer shown in Fig. 2.2b after hemoclip placement



**Fig. 2.6** Mallory–Weiss tear with oozing

therapies, the scope should be as close to the target lesion as possible for best mechanical advantage in order to effectively deploy the hemoclip. Suction helps enable the hemoclip to sit flush against the target tissue. If the endoscopist is satisfied with the position, the clip can be closed. If the clip placement or position is not appropriate, it can be opened again and its position can be changed. Once in the desired position, the clip can then be deployed, thereby separating it from the catheter (Video 2.1). After firing and deployment, it is sometimes necessary to gently move the delivery catheter slightly forward and backward to fully separate the delivery system from the clip.

When a target lesion is on a wall that is difficult to approach and not amenable to perpendicular clip placement, clips can still be used. In these situations, the clip is extended only slightly out of the endoscope. The alignment of the clip should be made to be flushed with the mucosa. The clip can then be manipulated to rest onto the lesion tangentially (as if it is being laid flat). Then, the clip can be closed and deployed. Multiple clips can be placed in one area, and once the visible vessel has been clipped, placing a clip on each side of the vessel may ablate the blood flow from a feeding vessel. In some situations, it may be difficult to place a hemoclip directly on a vessel. When this occurs, clips should be placed on each side of the lesion to ligate the feeding vessel.

Clips typically stay in place for several weeks following which they slough off, although they may remain in place much longer, especially if attached to underlying muscularis propria. Patients receiving clips must be made aware that some clips may not be MRI compatible and a plain radiograph can confirm whether they are present. Most current clips are approved by the FDA as conditionally MRI compatible, safe up to a 3 T magnet MRI. Clips can also be utilized in combination with injection therapy. The use of clips may follow injection with dilute epinephrine, especially if the target lesion is initially difficult to visualize due to active bleeding or when treating large arteries, such as Dieulafoy's lesions, the left gastric artery, or the gastroduodenal artery. Injection therapy can be used after the



application of clips when there is residual oozing following successful placement of the clips.

### Over-the-Scope Clips

A recent addition to mechanical hemostasis is the over-the-scope clip (OTSC). These are larger clips, more similar to a clamp, that is fitted to the end of the endoscope. These OTSCs can be used to treat larger lesions, such as large vessels within bleeding ulcers (i.e., Dieulafoy's lesions, the left gastric artery, or the gastroduodenal artery), or to treat cases of recurrent or refractory bleeding (Fig. 2.7) [31]. The OTSC is attached to the end of the scope similar to a banding device. There is a release thread that is pulled through the scope, similar to a banding device, and attached to a wheel that is in turn attached to the channel port of the endoscope. The target lesion is drawn using full suction into a cap at the end of the endoscope, and the wheel is turned deploying the over-the-scope clip. These clips are large enough that they may cover an entire bleeding ulcer. When placing these clips, they should be applied directly over the lesion in a straight-on approach.

### Band Ligation

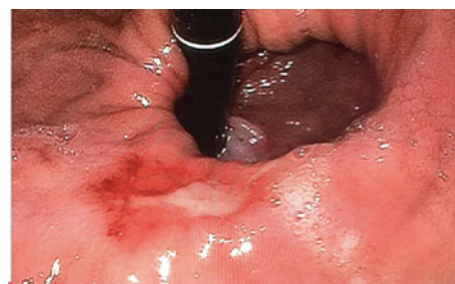
Endoscopic band ligation is a technique most often used in the treatment of esophageal or gastroesophageal varices. However, band ligation has also been used to treat Dieulafoy's (Fig. 2.8) and Cameron (Fig. 2.9) lesions.

### Spray Therapies

Several new topical hemostatic powders have become available as endoscopic treatment modalities for UGIB [32]; however, these are not currently FDA approved. TC-325 is an inorganic powder that sprayed onto a bleeding site. The

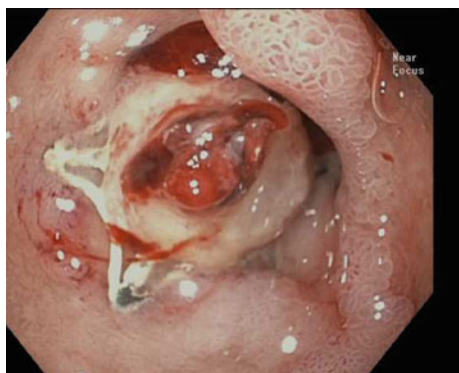


**Fig. 2.8** Dieulafoy's lesion



**Fig. 2.9** Cameron lesion

endoscopic technique is to advance the spray catheter through the scope, which is placed near the targeted bleeding lesion. The endoscopist then presses a trigger releasing CO<sub>2</sub> and applying TC-325 under pressure to the bleeding site. The compound adheres to the lesion causing a mechanical tamponade, activating platelets and coagulation factors, as well as desiccating the tissue. TC-325 has been shown to be useful in the treatment of bleeding ulcers, Dieulafoy's lesions, malignancy, and post-sphincterotomy bleeding [33, 34]. However, the lesion must be actively bleeding at the time of therapy in order for the therapy to be effective. In addition, lesions with a significant risk of further bleeding should be treated with an additional modality, such as hemoclips, to decrease rebleeding risk.



**Fig. 2.7** Over-the-scope clip applied to a duodenal ulcer

### Adjuncts to Therapy

#### Cap

Clear caps attached to the tip of the endoscope can be used to help manage difficult locations of UGIB treatment [35]. Caps can aid in visualization by allowing for compression of tissue with the cap, such that SRH can be seen behind folds or in difficult intestinal turns. The use of the cap can thus bring a lesion into better view and facilitating endoscopic therapy. The cap can also be used to help remove large blood clots, which is facilitated by suction into the rimmed cap [36].



## Doppler Probe

A Doppler probe can be passed through the endoscope's working channel and used to interrogate a bleeding lesion. The probe should be placed in contact with the target lesion with mild pressure and is used in the low or medium depth settings with an auditory signal. The lesion can be interrogated starting at the vessel or center and extending radially in four-quadrants to fully assess the lesion. The Doppler probe can be used before therapy to determine whether there is blood flow in the case of indeterminate lesions (Video 2.1). Following therapy of a bleeding lesion, the Doppler probe can also confirm cessation of blood flow or determine whether there is residual blood flow. It has been shown that lesions with cessation of blood flow following treatment are much less likely to rebleed than those with continued blood flow. It appears that Doppler criteria are better at predicting successful endoscopic treatment than traditional visual criteria, such as flattening of the treated vessel following cautery. Doppler probes have not disseminated widely into clinical use at this time, although this could change going forward.

## Recurrent Bleeding

Recurrent bleeding occurs in 10–20% of patients who undergo endoscopic therapy for UGIB. Patients with rebleeding after initial control represent a subset of patients with more severe bleeding associated with a higher mortality. A repeat endoscopy with another attempt at endoscopic therapy should typically be performed in patients with recurrent UGIB [37]. Select patients with severe bleeding, such as with ongoing hemodynamic compromise or bleeding from large arteries or in difficult endoscopic locations, may directly proceed with interventional radiology/angiography or surgery. However, the majority of patients with rebleeding deserve another endoscopic attempt due to the efficacy of endoscopic therapy and reduced complication rate compared to other interventions.

At the time of an endoscopy for rebleeding, the choice of endoscopic therapy depends on the exact findings. The same therapy as initially given can be applied a second time, or a different therapy can be applied. If a thermal therapy was initially used, hemoclips may be preferable so that the tissue is not further damaged, to decrease the risk of perforation. If hemoclips were initially used, additional hemoclips can be applied or the patient may be treated with thermal therapy without concern for conducting electric current if the metallic clip is inadvertently contacted. An OTSC can also be deployed to control recurrent upper GI bleeding.

## Conclusions

Acute upper GI bleeding remains a major source of morbidity and mortality. It is also responsible for a large number of hospitalizations and significant healthcare expenditure in the USA. While the majority of patients with acute upper GI bleeding will spontaneously stop bleeding, patients with ongoing or severe bleeding or high-risk stigmata of recent hemorrhage require endoscopic therapy. There are a multitude of tools that can be used to endoscopically identify, treat, and prevent bleeding. It is important for endoscopists to be familiar with all available resources in order to optimally manage patients with acute upper GI bleeding.

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Upper Endoscopy for GI Fellows

Adler, D.G. (Ed.)

2017, XIII, 182 p. 141 illus., 120 illus. in color.,

Hardcover

ISBN: 978-3-319-49039-7