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Accessories Used for Hemostasis in Gastrointestinal Bleeding

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Abstract

Endoscopic hemostatic devices improve the outcome of patients bleeding from the gastrointestinal tract. They range from well-known thermal devices (multipolar and heater probes), which are efficient, safe and relatively low in cost, to novel redesigned mechanical devices such as endoscopic hemoclips that have also been widely adopted. In general, there are two basic principles of hemostasis: thermal (contact and non-contact) and non-thermal (injection and mechanical methods). Thermal hemostasis can be achieved by either contact thermal modalities: heater probe coagulation, monopolar coagulation, bipolar coagulation, or non-contact thermal modalities: argon plasma coagulation and laser photocoagulation. Their efficacies are probably more affected by personal preferences and expertise rather than minor differences between the modalities. Non-thermal modalities include injection needles, band ligators, endoclips and loops. We gathered data from various sources to describe the most commonly used hemostatic devices in everyday practice.

In general, there are two basic principles of hemostasis: thermal (contact and non-contact) and non-thermal (injection and mechanical methods) [1] (table 1; fig. 1–5).

Thermal Hemostasis

Thermal hemostasis can be achieved by either contact thermal modalities: heater probe coagulation, monopolar coagulation, bipolar coagulation, or non-contact thermal modalities such as argon plasma coagulation (APC) and laser photocoagulation. Their efficacies are probably more affected by personal preferences and expertise rather than minor differences between the modalities.

Contact Thermal Modalities

The heater probe and bipolar electrocoagulation are the most commonly used devices for contact coagulation of bleeding and non-bleeding visible vessels. Thermal hemostasis is achieved

Table 1. Methods used for hemostasis

Thermal therapy	Electrocoagulation Monopolar Multipolar/bipolar Heater probe Argon plasma coagulation Laser photocoagulation
Injection therapy	Ethanol Epinephrine Sclerosants Ethanolamine Polidocanol Thrombin
Mechanical	Endoscopic clips Detachable snare (endoloop) Endoscopic band ligation

with relatively low energy outputs and thermal heating of the tissue. All thermal devices generate heat either directly (heater probe) or by passage of electrical current through tissue (multipolar probes).

The *heater probe* consists of a Teflon-coated hollow aluminum cylinder with an inner heating coil. In addition, the heater probe has an irrigation port with flushing capabilities. The Teflon coating of the probe prevents tissue adherence to the probe tip. The mechanism of tissue coagulation is direct heat transfer. Heat application causes edema, coagulation of tissue proteins and contraction of vessels. A foot pedal controls coagulation by delivering a preselected quantity of energy in joules to the diode in the probe tip, generating coagulating heat at the tip of the catheter. The combination of pressure to co-apt the vessel walls and heat to coagulate the tissue results in effective hemostasis. During therapy, the distal tip of the heater probe is applied directly to the bleeding site. Initially, 4 or 5 pulses of 10–15 J/pulse are given. If bleeding persists, the procedure is repeated. Finally, several additional pulses can be applied, surrounding the bleeding site, to address the feeding vessel. The depth of coagulation using the heater probe is similar to that in bipolar coagulation.

Monopolar electrocoagulation requires the placement of a neutral electrode on the patient's body and the electrical current flows from the probe through the patient's body. Coagulation depth is greater than in bipolar electrocoagulation.

Repeated application of these devices can result in the build-up of coagulum at the tip, which can impede conductivity and necessitates removal of the probe and cleaning the tip.

In *bipolar electrocoagulation* an electrical current passes through the tissue between the two electrodes on the probe tip (fig. 2). In contrast to monopolar electrocoagulation, the circuit is completed locally; therefore it does not pass through the patient's body and grounding is not required. As the targeted tissue desiccates, loss of conductivity occurs. A port at the tip delivers water for irrigation, which improves overall visualization. A foot pedal controls coagulation and irrigation. Both the thermal and co-aptive components can be applied tangentially or enface to the targeted lesion. A major problem is that the probe may stick to the tissue, and removal of the probe can tear off tissue and induce bleeding. It should be kept in mind that the right colon

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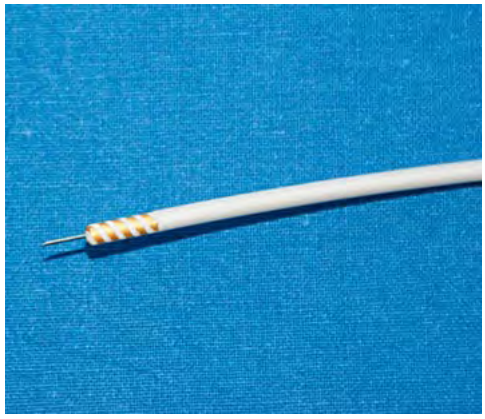

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Fig. 1. Endoscopic band ligation is the preferred method to treat esophageal varices. However, banding can be used to treat other bleeding lesions such as hemorrhoids, Mallory-Weiss lesions and Dieulafoy's ulcer.

Fig. 2. The Gold probe is a classic thermal hemostatic method which uses bipolar electrocoagulation. Monopolar electrocoagulation is rarely used to treat bleeding lesions. The classic monopolar instrument used by endoscopists is the 'hot biopsy'. Bipolar and monopolar electrocoagulation differs from the more popular heater probe by the use of electrical current.

wall is thinner and that colonic perforation after treatment of angiodysplasia can be seen in up to 2.5% of patients in whom bipolar coagulation is performed [2]. Therefore, forceful co-aptation in this region should be avoided.

Non-Contact Thermal Modalities

Argon plasma coagulation (APC) is a non-contact electrocoagulation modality that utilizes high-frequency monopolar alternating current conducted to target tissues through ionized argon gas (argon plasma; fig. 3). Electrons flow through a channel of electrically activated, ionized argon gas from the probe electrode to the targeted tissue causing a thermal effect at the interface. The APC probe consists of a flexible Teflon tube with a tungsten electrode contained in a ceramic nozzle at its distal end. Coagulation depth depends on generator power setting, flow rate of the argon gas, duration of application and the distance of the probe tip to the target tissue which ranges from 0.8 to 3.0 mm [3] (fig. 3b). The depth of penetration is automatically limited by desiccation of the tissue. As the tissue surface loses its electrical conductivity because of desiccation, the plasma stream shifts to the adjacent non-desiccated (conductive) tissue (fig. 3c). The APC unit includes a high-frequency electrosurgical generator, automatically regulated argon gas supply unit, gas flow meter, flexible delivery catheter, grounding pad, and foot switch to activate both gas and energy (Erbe Elektromedizin GmbH, Tübingen, Germany). APC probes are available in a variety of diameters and lengths (table 2). The available probes direct plasma parallel or perpendicular to the axis of the catheter.

APC is frequently used to treat chronic, actively bleeding lesions of the gastrointestinal (GI) tract. It is especially useful when coagulation needs to be carried out over a large surface while limiting penetration depth. It provides effective, even surface coagulation with uniform hemostasis and devitalization. Major advantages are that it is non-contact procedure and enables better dosage of

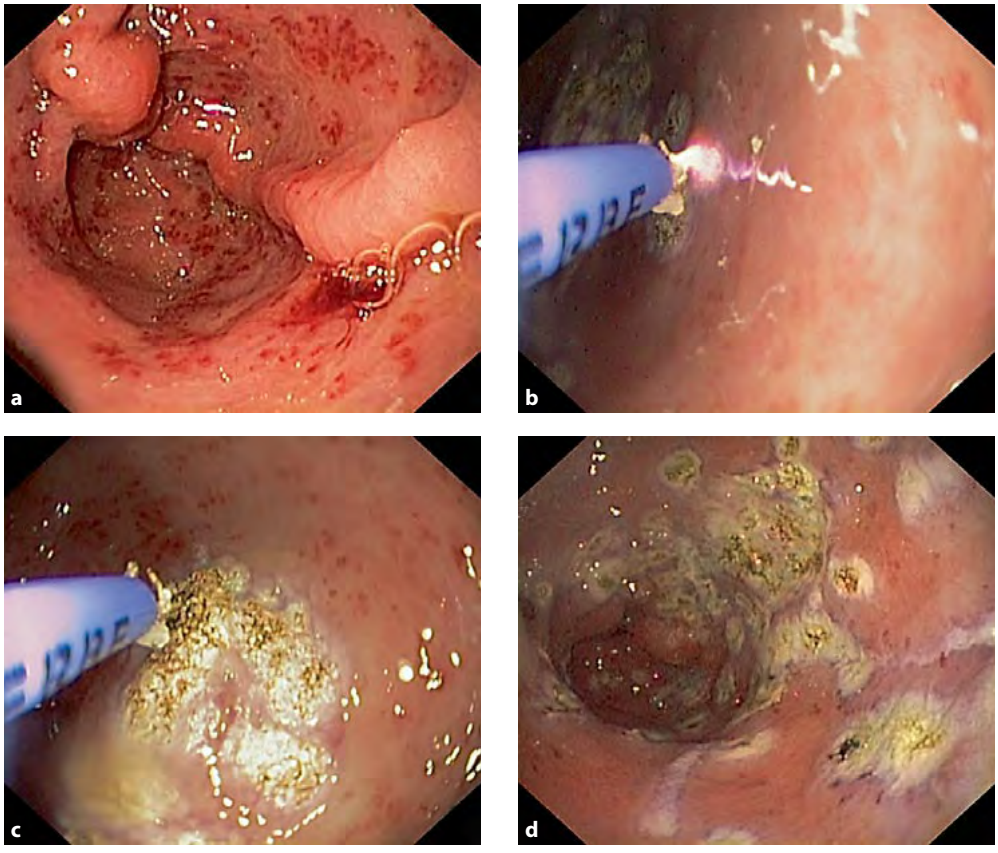


Fig. 3. **a** Classic endoscopic appearance of watermelon stomach or GAVE (gastric antral vascular ectasias). This condition is often missed or referred to as 'hemorrhagic gastritis'. Close inspection with standard or high definition endoscopes clearly show the submucosal vascular malformations. **b** Application of argon plasma coagulation with the Erbe device. Note that the tip of the probe should be placed about 1–2 mm above the mucosal surface. This allows the creation of a spark once electrical current is applied to the argon gas. **c** Note the fulguration of the tissue resulting from APC. The objective is to 'paint' an adequate area of mucosa. **d** End result of an APCsession. Some experts start the patient on proton pump inhibitors to accelerate the mucosal healing and prevent gastric hemorrhage. Photos with the courtesy of Klaus Mönkemüller, MD, PhD (Germany).

penetration which leads to safer application and limited risk of perforation with few complication. Nonetheless, APC carries the risk of perforation, especially in the thin-walled cecum. Although validated data regarding the rates of perforation are lacking, it is estimated that it is below 1% [4–6].

We typically use APC for ablation of solitary or multiple vascular ectasias and telangiectasias seen as a clinical spectrum of angiodysplasias, watermelon stomach (fig. 3a) and post-irradiation injury of the colon. We use APC settings of different power ranging from 50 to 60 W for the rectum, 40–50 W in the left colon, and 20–30 W for the small bowel, right colon and cecum, with a 0.8–1.5 l/min of argon flow. Care must be taken with lesions located in the small bowel and cecum as the risk of perforation is higher! However, the power can be adjusted to between 0 and 155 W, and gas flow from 0.5 to 7 l/min [3]. The operated distance between the probe and the targeted tissues depends on the power setting. At low power settings the probe must

Table 2. Flexible argon plasma coagulation (APC) probes

APC probe	Product no.	Beam forms	Flexibility	Dimension mm	Length cm	Cleaning in washer disinfector	Sterilization in autoclave	Packaging unit
1500	20132-183	A	flexible	1.5	150	max 95°C	max 138°C	1 piece
1000	20132-178	A	flexible	2.3	100	max 95°C	max 138°C	1 piece
2200	20132-177	A	flexible	2.3	220	max 95°C	max 138°C	1 piece
2200	20132-180	SW	flexible	2.3	220	max 95°C	max 138°C	1 piece
2200	20132-181	SC	flexible	2.3	220	max 95°C	max 138°C	1 piece
3000	20132-179	A	flexible	2.3	300	max 95°C	max 138°C	1 piece
2200	20132-182	A	flexible	3.2	220	max 95°C	max 138°C	1 piece
1500	20132-155	A	flexible	1.5	150	disposable	disposable	10 pieces
3000	20132-212 for DBE	A	flexible	1.5	300	disposable	disposable	10 pieces
2200	20132-156	A	flexible	2.3	220	disposable	disposable	10 pieces
2200	20132-167	SC	flexible	2.3	220	disposable	disposable	10 pieces
2200	20132-186	C	flexible	2.3	220	disposable	disposable	10 pieces
3000	20132-166	A	flexible	2.3	300	disposable	disposable	10 pieces
2200	20132-157	A	flexible	3.2	220	disposable	disposable	10 pieces

A = Axial beam; C = circumferential beam; DBE = double balloon enteroscopy; SC = side fire conical beam; SW = side fire wide beam.

be held closer to the tissue and vice versa. In general, the distance between the probe and tissue can range from 2 to 8 mm. The surface of the targeted tissue must be clear of blood and surface fluids to prevent the development of a coagulated film which leaves the tissue surface beneath inadequately treated.

Hemostasis using a laser is achieved by transmission of photoenergy to the target tissue. This method is rarely used today.

Non-Thermal Modalities

Injection Therapy

Injection Needles ('Sclerotherapy Needles')

Injection needles are used to deliver the injection solution to the intestinal wall. They are designed with outer sheath of plastic, Teflon or stainless steel, and an inner core needle. The needles are available in lengths of 200–240 cm for standard gastroscopes and colonoscopes, and 320–350 cm for the intestinoscopes. Most of the injection needles are marketed as single-use devices, but

ones with a full-metal sheath can be sterilized in autoclave. Other features of injection needles include the ability to predetermine the length of the needle nose and the locking mechanism to prevent retracting [7]. The metal sheath enables needle extension with an endoscope in a looped or retroflexed position as it is kink resistant. Some needles are combined with bipolar cautery to allow injection and cauterization with the same instrument [7].

Injection Solutions

Diluted epinephrine is most often used for injection therapy. It is inexpensive and easy to learn. It is used to slow or stop bleeding by tamponade and vasoconstriction. As in treatment of a bleeding ulcer, a 1:10,000 solution is injected in 0.5-ml aliquots around but not into the bleeding lesion until hemostasis is achieved. The total injected volume of diluted epinephrine should be as low as possible (as the absorption has systemic effects) but up to 35–45 ml may be administrated to achieve hemostasis [8, 9]. Standard injection therapy of epinephrine with saline often offers transient relative hemostasis with its effects disappearing rapidly. Therefore, injection therapy can be used in combination with any thermal or mechanical modalities depending on the circumstances. Some experts prefer to first inject and then treat with contact or non-contact thermal hemostatic devices [8–10]. The bleb created with the injection may provide a safe cushion for the application of thermal energy. Other injection solutions for hemostasis include sclerosants such as absolute alcohol; fatty acid derivates (5% ethanolamine oleate and 5% sodium morrhuate; synthetic agents (1 and 3% sodium tetradecyl sulfate, 0.5–3% polidocanol); tissue adhesives (N-butyl-2-cyanoacrylate; Hystoacryl®); fibrin glue (fibrinogen + thrombin) or thrombin alone, and saline and hypertonic (50%) dextrose solutions [11–13]. The use of injection solutions other than diluted epinephrine (1:10,000–1:20,000) is declining but should still be considered applicable as they are well documented to be effective in achieving hemostasis. For the sclerosing agents, attention should be paid as they can cause transmural necrosis and carry the risk of perforation at the injection site.

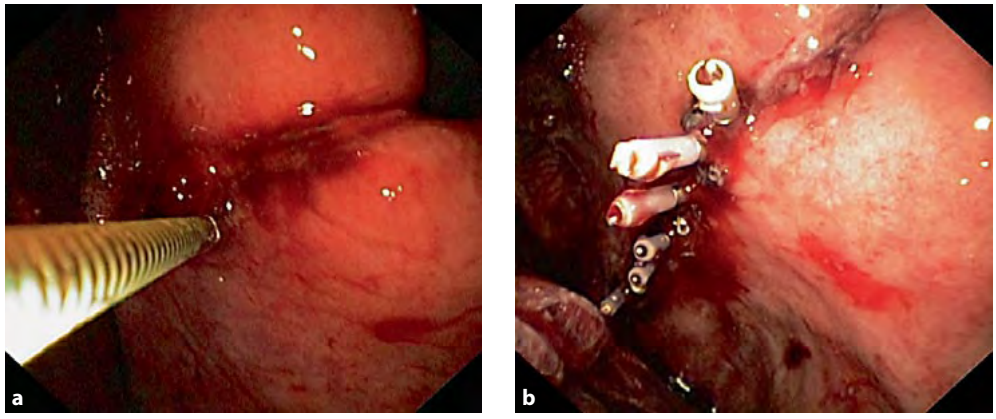
Because Hystoacryl® can result in arterial embolism, most experts rarely use it, and for this reason it is not available in many countries. However, Histoacryl® is a useful method to treat bleeding gastric varices, a condition for which there are not many other endoscopic options.

Fibrin glue, although simple to use, is relatively more expensive. Its efficacy is comparable to other hemostatic injection solutions.

Endoclips

Endoclips provide mechanical hemostasis without injuring the surrounding tissue and are ideal for hemostasis when a bleeding vessel or small mucosal bleeding defect is visible, such as a bleeding peptic ulcer, post-polypectomy or diverticular bleeding [14–19] (fig. 5a–c). Clips are available in multiple sizes and some can be rotated or reopened while being deployed through the endoscope [20].

Four companies produce disposable hemoclips. (1) Olympus Corp. produces the QuickClip2, which is a rotatable clip device. These devices are produced in two sizes, 8 and 12 mm in width when opened, and 165–230 cm in length, allowing deployment through a colonoscope. (2) Boston Scientific Inc. produces the Resolution Clip which cannot be rotated but can be reopened after closure if repositioning is required. The Resolution Clip has an opening width of 11 mm and is available in lengths of 165 and 235 cm. (3) Wilson-Cook produces the TriClip, a 3-pronged endoclip. The TriClip opens to a width of 12 mm and is 205 cm long. Preliminary experience has not detected obvious advantages of this configuration. (4) Inscope (a division of Ethicon Endosurgery



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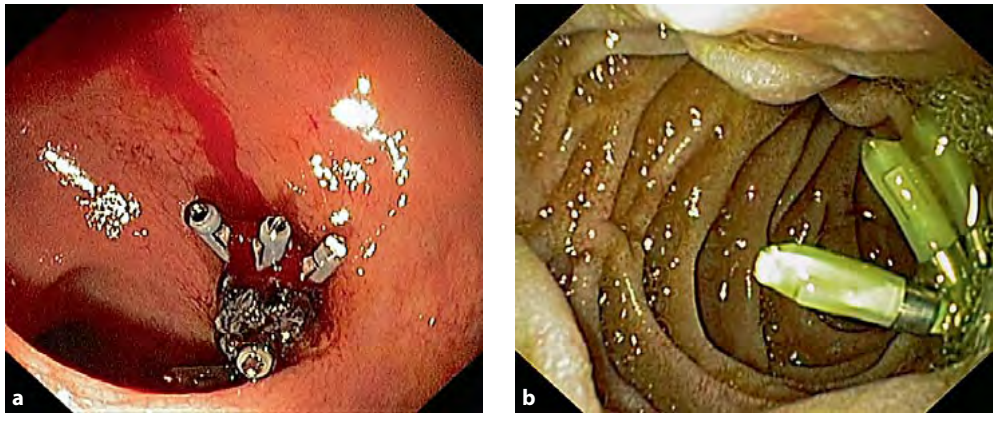

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Fig. 4. **a** Injection of a mixture of epinephrine/saline with a sclerotherapy needle. This patient bled from a gastric lesion after resection of a submucosal tumor. **b** Multiple clips were placed to close the mucosal defect and to stop active bleeding. **Fig. 5.** **a** Multiple clips were placed for this bleeding duodenal ulcer located in the posterior duodenal bulb. Before placing the clips partial hemostasis had been achieved with epinephrine/saline solution. In cases with massive gastrointestinal bleeding it is important to avoid the use of epinephrine, if the endoscopist is considering the use of angiography. Epinephrine will constrict the vessels and the radiologist will be limited in his ability to find the bleeding vessel and to apply coils or foam. Photos with the courtesy of Klaus Mönkemüller, MD, PhD (Germany). **b** Another patient with a bleeding duodenal ulcer which was controlled with combination therapy.

Inc.) introduced a multiclip applier with 4 endoclips. The jaws of this device open to a width of 14 mm; the clips are 7 mm when open and have an interlocking distal closure when placed.

Reusable clip deployment devices (EZ Clip) from Olympus are also available mostly in Europe but used infrequently in the United States mainly because they are difficult to clean and sterilize. They are available in 6 different models and sizes.

According to the FDA recommendations, the use of endoclips should be restricted to blood vessels of less than 2 mm in diameter, mucosal or submucosal defects of smaller than 3 cm in size, polyps of smaller than 1.5 cm in diameter, and intestinal perforations of smaller than 2 cm, but all of the aforementioned can be overcome by devices that have a wider span and stronger clip prongs. Loading of the hemoclip onto the applicator must be quick and proper; therefore endoscopy assistants ought to be familiar with its use. Clipping is easiest when the endoscope is

Table 3. Treatment options for acute variceal bleeding (adapted from ref. 11, 32)

	Manufacturers	Catalog No.	Bands per cap, n	Endoscope tip diameter mm
Variceal band ligators				
Stiegmann-Goff and S-G ClearVue endoscopic ligators	ConMed	100225, 200221, 000230, 000227	1	9–11
Auto-Band Ligator multiple-band ligator	Scandimed International ConMed		5, 7, 10	8.6–11.5
Speedband, Superview Super 7 multiple band ligator	Boston Scientific		7	8.6–11.5
Shooter Saeed multiband ligators	Wilson-Cook	MBL-4, MBL-6, MBL-10 (XS)	4, 6, 10	8.5–14
			Individual injection volume, ml	Total dose ml
Sclerotherapy (sclerosants)				
Ethanolamine oleat, 5%	Ethamolin QOL Medical		1.5–5	20
Sodium morrhuate, 5%	Scleromate, Glenwood LlC		0.5–5	15
Sodium tetradecyl sulfate, 1 and 3%	Sotradecol, Bioniche Life Sciences Trombovein, Omega Pharmaceuticals Ltd Fibro-vein, STD Pharmaceutical		0.5–2	10
Polidocanol, 0.5–3%	Ethoxysklerol, Kreussler Pharma Sclerovein, Resinag AG		1–2	15–20
Ethanol 99.5%			0.5–1	4
Tissue adhesives				
N-butyl-2-cyanoacrylate	Histoacryl, Braun Glubran, GEM S.r.l.			
Mechanical hemostasis				
Sengstaken-Blakemore tube				
Covered self-expandable metallic stents, SX Ella Danis	Ella Corp			

kept in a straight position with the possibility of an axial push into the tissue, but the tangential access can sometimes be used to anchor the visible blood vessel. Clips are most easily placed on small lesions where the tissue can be approximated by the clip. The proper orientation of the clip can be achieved by rotating the endoscope shaft with the right hand or, using small wheel turns, maneuvering the target lesion into the desired position. The orientation of the clip can be further adjusted by rotating the handle of the applicator. As the clip is deployed, suction should be applied to draw tissue between the prongs. If the colonoscope is flexed, pushing the clip

Table 4. Injection needles

	Manufacturers	Product No./ Order No.	Needle gauge	Usable for channel size	Catheter length cm	Needle tip extension mm	Single use
Preset variable injection needles							
AcuJect	Wilson-Cook	G22525/VIN-23 G22526/VIN-25	23 25	2.8	220 220	4 4	yes yes
Disposable variceal injector Luer slip handle Enteroscopy	Wilson-Cook	G21694/LDVI-23 G21866/LDVI-23-240 G21697/LDVI-25 G21649/LDVI-25-240 G22722/LDVI-23E G22723/LDVI-25E	23 23 25 25 23 25	2.8 2.8 2.8 2.8 2.8 2.8	200 240 200 240 320 320	4 4 4 4 4 4	yes yes yes yes yes yes
Interject	Boston-Sci	M00518 (151, 161, 251, 261, 351, 361, 111, 301, 311)	23, 25	2.0, 2.8	200/240	4, 6	yes
Vari-Safe	US-Endoscopy	00711818, 819, 820	23	2.8	230	4, 5, 7	yes
Bipolar cautery							
Injection Gold Probe	Boston-Sci	M00560150 (160)	25	2.8, 3.7	210		
Lockable needle							
Carr-Locke	US Endoscopy	00711811	25	2.8	230	4, 5	
Click-Tip	ConMed/Bard	02-23-180 through 06-19-230	19, 22, 25	2.0, 2.8	180, 230	4, 6	
Injector Force	Olympus	NM-200L/200U/201L	21, 23, 25	2.8	165/230	4, 5, 6, 8	
Flexible tip							
FlexiTip	ConMed/Bard	000215-000138	25	2.8	160, 230	4, 5, 6	
Metal hub on tip							
With metal hub	Wilson-Cook	G22992/LDVI-23-MH G22994/LDVI-25-MH	23 25	2.8 2.8	200 200	4 4	
Irrigation channel							
Injectaflow	Wilson-Cook	G22747/VINF-23 G22748/VINF-25	23 25	2.8 2.8	220 220	4 4	yes yes
Fully metal sheath							
Articulator	US Endoscopy	00711803, 804, 807, 808	25	2.8	160/230/ 350	4, 5	
SureShot	ConMed/Bard	100218	25	2.8	230	5	
Disposable needle	Olympus	NM-8L-1;NM-9L-1	23	2.0	165, 230	4, 6	

Adapted from Nelson et al. [7].

Table 5. Endoscopic clips

	Manufacturer	Article No.	Ready to use	Working channel mm	Working length cm	Maximum opening width, mm	Rotability/ re-opening
Rotating Clip	Olympus	HX-5LR/QR-1 HX-6UR-1	no	≥2.8 (5LR/QR >3.2 (6UR)	230 (6U) 195 (5Q) 165 (5L)	11	yes/no
Quick Clip2	Olympus	HX-201LR/UR-135	yes	≥2.8	240 (UR) 165 cm (LR)	9.5	yes/no
Quick Clip 2 Long	Olympus	HX-201LR/UR-135L	yes	≥2.8	240 (UR) 165 (LR)	11	yes/no
EZ Clip	Olympus	HX-610-090, 090L, 090S, 135, 135S, 090SC	yes	≥2.8	165 and 230	8	yes
Resolution Clip	Boston Scientific	M005226XX	yes	≥2.8	235 and 155	11	no/5 times
TriClip	Wilson Cook	TC-8-12	yes	≥2.8	205	12	no/no
TriClip	Wilson Cook	TC-7-12	yes	≥2.8	207	12	no/no
InScope Multiclip applier	InScope, Ethicon Endo-Surgery						yes/yes

Adapted from Cipoletta et al. [18], Raju et al. [19] and Yeh et al. [20].

applicator out of the working channel is difficult; therefore, it is sometimes necessary to withdraw the endoscope slightly, advance the applicator out of the endoscope in the straightened position, and then again try to reach the bleeding lesion. Prongs should always be fully opened in the lumen but not against the intestinal wall.

Band Ligation (fig. 1)

The most common indication for endoscopic band ligation is the prophylaxis and treatment of esophageal variceal bleeding. For primary prevention of esophageal variceal bleeding, endoscopic variceal banding or band ligation has been shown to be safer and possibly more effective than non-selective β-blockers (propranolol or nadolol) [21–24]. Endoscopic band ligation is also superior to sclerotherapy for secondary prevention of variceal bleeding [24].

The data on endoscopic band ligation for the management of non-variceal bleeding are scarce and mostly in the form of case reports. They include the use of band ligation to control bleeding from Mallory-Weiss tear, Dieulafoy's lesion, arteriovenous malformations, colonic diverticula, as well as from the ulcer and post-polypectomy bleeding [14, 15, 25]. Endoscopic banding devices that are commercially available include single-band and multiband devices (table 3). Single-band ligators require the placement of an overtube for repeated intubations.

Table 6. Thermal modalities

	Manu-facturer	Product No./ order No.	OD mm	Working channel mm	Working length cm	Pulses, n/pulse duration, s	Power setting
Heat probe							
	Olympus	HPU-20 + CD-110U, 120U		2.8, 3.7	230, 230	4/8–10	15–30 J
	Olympus	HPU + CD-110U, 120U		2.8, .7	300, 300	4/8–10	15–30 J
MPEC Probes							
BICAP 5, 7, 10 Fr	Circon			2.2, 2.8, 3.7		/6–10	15–20 W
Gold Probe 7, 10 Fr	Boston Scientific			>2.8, 3.7		/6–10	15–20 W
Injection Gold Probe 7, 10 Fr	Boston Scientific			>2.8, 3.7		/6–10	15–20 W
Quicksilver 7, 10 Fr	Wilson Cook			>2.8, 3.7			15–20 W
HEMArrest 7, 10 Fr	Bard			>2.8, 3.7			15–20 W
Bipolar coagulation probe dual plug	Diagmed	711841	7	2.8	350		
Bipolar coagulation probe single plug	Diagmed	711843	7	2.8	350		
Bipolar coagulation probe single plug	Diagmed	711 847	10	3.7	350		
APC probes							
1500 A	ERBE	20132-183	1.5		150	Cleaning in washer disinfector max 95°C Sterilization in autoclave max 138°C; one piece per pack; beam forms (axial, circumferential, side fire conical and side fire wide beams)	
1000 A	ERBE	20132-178	2.3		100		
2200 A	ERBE	20132-177	2.3		220		
2200 SW	ERBE	20132-180	2.3		220		
2200 SC	ERBE	20132-181	2.3		220		
3000 A	ERBE	20132-179	2.3		300		
2200 A	ERBE	20132-182	3.2		220		
1500 A	ERBE	20132-155	1.5		150		
3000 A	ERBE	20132-212 for double enteroscopy	1.5		300	Suitable for double balloon; disposable; 10 pieces/pack	

Table 6. Continued

	Manu-facturer	Product No./ order No.	OD mm	Working channel mm	Working length cm	Pulses, n/pulse duration, s	Power setting
2200 A	ERBE	20132-156	2.3		220	Disposable; 10 pieces/ pack	
2200 SC	ERBE	20132-167	2.3		220		
2200 C	ERBE	20132-186	2.3		220		
3000 A	ERBE	20132-166	2.3		300		
2200 A	ERBE	20132-157	3.2		220		
APC probe	ConMed		2.3				
APC probe	Olympus	MAJ-1012-N1034560		2.8	220	Single use; 10 pieces/ pack	
	Olympus	MAJ-1011-E0427826		3.2	220		
	Olympus	MAJ-1011-N1034460		2.8			
	Olympus	MAJ-1011-E0427825		3.2			
Hot biopsy							
Radial Jaw 3	Boston Scientific	M00515501	2.2	2.8	240		
Endobite hot	Medical Innovations	Hot1c123230		2.8–4.2		Hot oval cup insulated	
Hot biopsy forceps	MTW Endoscopie		1.8, 2.2, 2.6, 3.4	2.0–4.2	160, 230	Oval spoon-shaped mouth	
Hot biopsy forceps	Fujinon		2.3, 2.5	2.8	180, 230	Oval spoon-shaped mouth with window, coil distal tapered, Teflon-coated	
Hot biopsy forceps	Olympus	FD-1L-1 FD-1U-1	2.8	3.2	165, 230		
Hot Maxx	Cook		2.5	2.8	230	Non-spiked	
Odon	Alkapharm		2.5	2.8	220	Oval cup	
Precisor Hot	Conmed					Disposable Oval cup active	

www.omed-catalogue.com/sscategoriedes; www.endocompare.com; www.erbe-med.com/

Table 7. Electrosurgical units

ESI	Manufacturer	Product No.	Description	Cutting power W	Blended cutting	Coagulation	Bipolar
Aaron 1250™	Bovie Medical Corporation		The Aaron 1250™, by Bovie®, features cut, blend, coagulation, fulguration, and bipolar modes. Bovie incorporates automatic safety features into the Aaron 1250 such as self-test circuits, audible tones, discreet outputs, isolated circuitry, and Bovie NEM™ (neutral electrode monitoring)	120	90	80/40	30
Aaron 2250™	Bovie Medical Corporation		Large illuminated digital displays 5 output modes: cut, blend, coagulation (pinpoint and fulguration) and bipolar	200	200	120/80	80
Aaron 3250™	Bovie Medical Corporation		Nine presets large illuminated digital displays 6 output modes: cut I, cut II, blend, coagulation (pinpoint and fulguration) and bipolar	300/ 300	200	120/80	80
ICON Gi	Bovie Medical Corporation	GI120		200	100	120/80	80/50
BICAP®II	Conmed		Bipolar output. Precision timer helps regulate applications. Designed specifically for BiCap® bipolar accessories. Integral fluid pump permits irrigation 80 ml/min nominal fluid flow rate. Monopolar and bipolar capabilities				
Surgitron® Dual Frequency RF/120 IEC	Ellman		www.ellman.com/ products/medical/ radiosurgical_units.htm				
VIO 300D	ERBE		VIO Cut Modes: AUTOCUT™ Monopolar Cutting-Automated Software Power Dosing. HIGHCUT™ – unique cutting mode with broad power curve and 8 different effects for hemostasis. DRY CUT™ – intense hemostasis with slower cutting speed for cuts requiring primary hemostasis. ENDO CUT™ IQ –two different modes for spincterotomy and snare procedures. VIO Coag Modes:				

Table 7. Continued

ESI	Manufacturer	Product No.	Description	Cutting power W	Blended cutting	Coagulation	Bipolar
VIO 300D	ERBE		SWIFT COAG™ – fast coagulation for dissection with a high degree of hemostasis. SPRAY COAG™ – non-contact surface coagulation, low penetration depths. VIO Bipolar Modes: BIPOLAR CUT™ – For applications requiring cutting of a structure with restricted return pathway. BIPOLAR SOFT COAG™ – low voltage penetration based on effect level and time of activation. AUTOSTART™ – instrument activation without a foot pedal. AUTOSTOP™ – automatic end of tissue activation based on resistance. BIPOLAR FORCED COAG™ – fast Bipolar coagulation ENDO CUT IQ. The new ENDO CUT IQ offers two new procedures suitable for GI intervention: ENDO CUT IQ lets you program 4 levels of hemostasis and 8 levels of cutting speed to meet the demanding needs of your individual technique. I is the mode Used for needle electrodes and sphincterotomies. Q is the mode used for snare wire or loop electrodes				
ICC 200 E and ICC 200EA	ERBE		Power on Demand ENDO CUT™ – the physicians choice for polypectomy and sphincterotomy. FORCED COAG™ SOFT COAG™ expandable for argon use. Compatible with all accessories, including: snare wires, sphincterotomes, hemostasis probes, hot biopsy forceps				
Valleylab SurgiStat™ II	Valleylab		Includes both monopolar and bipolar outputs. Increased patient safety with a return electrode contact quality monitoring system (RECQMS). The RECQMS system continually monitors patient impedance levels and deactivates the generator if a fault in the patient/return electrode contact is detected				

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Table 8. Endoscopic methods to stop bleeding from ulcer, Mallory-Weiss tears, angiodysplasia, watermelon stomach, and Dieulafoy lesion

	Ulcer	Mallory-Weiss tear	Dieulafoy[1]	GAVE	Angiodysplasia
Injection therapy solution	Yes Epinephrine solution (1:10,000) Ethanol (99%) Hypertonic saline, thrombin, fibrin glue, polidocanol sodium tetradecyl sulfate	Yes Epinephrine solution (1:10,000) Polidocanol	Yes Epinephrine solution Polidocanol cyanoacrylate glue, sodium tetradecyl sulfate, hypertonic glucose, ethanol	No	Yes No Tetradecyl sulfate
Heater probe	Yes	Yes	Yes	Yes	Yes
Probe size	Large/small	Large/small	Large	Large	Large/small
Power settings, J	15–30	20	30	30	10–20
Pulses, n	4–5	3	4		
MPEC					
Bipolar or Gold probe	Yes	Yes	Yes	Yes	Yes
Probe size	Large/small	Large/small	Large	Large/small	Large/small
Power settings, W	15–25	15–20	15–20	10–15	10–15
Pulse duration, s	6–14	4	8–10	1–2	1–2
APC	Yes	No	Yes	Yes	Yes
Power settings, W			60–80	60–80	60–8W
Argon flow, liters/min			1–2	1–2	1–2
Band ligators	Yes?[2]	Yes	Yes	No	Yes?[2]
Endoclips	yes	yes	yes	no	no

Adapted from Thomas et al. [26].
[1] Mechanical methods (clipping or banding) and combined therapy using injection of different solution including epinephrine (1:10,000) or 5% ethanolamine oleate solution followed by thermal coagulation is significantly better than injection methods alone [14, 27–29, 33].
[2] Limited data [15, 29–31].

Endoscopic Therapeutic Options for Various Bleeding Conditions

Acute Variceal Bleeding

Endoscopy is an essential step in the diagnosis and treatment of acute variceal bleeding. The goal of therapeutic endoscopy is to stop acute variceal bleeding by creating an intravariceal thrombus. Repeated procedures may ultimately induce variceal obliteration. Two techniques are in common use: endoscopic sclerotherapy and endoscopic variceal ligation. In endoscopic sclerotherapy, an irritant solution (e.g., sodium morrhuate, ethanolamine or polidocanol) or a dehydrating chemical (e.g., sodium tetradecyl sulfate) is injected into an esophageal varix or its adjacent supporting tissues. Variceal ligation has proved more effective and safer than

Table 9. Accessories used for hemostasis in small bowel

	Manufacturer	Catalog No.	Channel size, mm
APC probes	ERBE	20132-212	2.2
		20132-166	2.8
		20132-179 (reusable)	2.8
Lubricant	Fresenius Kabi	MCT oil	
Injection needles	Fujinon	F2EZTV1805250HP-S	2.2
	Medwork	500753	
Endoclips	Boston Sci	Resolution Clip 22612	2.8
	Olympus	Quick Clip HX-201UR-135	2.8
Hot biopsy forceps	Fujinon	F6HOPK2304250X	2.8
Fibrin glue (Beriplast®)	Various providers (Canteon, Marburg, Germany)		
Epinephrine solution			

Adapted from Schäfer and Stange [34].

sclerotherapy and is currently the endoscopic treatment of choice for esophageal varices. Besides, it is worth noting that in acute bleeding, vasoactive drugs and antibiotic prophylaxis should be started before endoscopy and maintained for 2–5 days. The efficacy of vasoactive drugs is improved when associated with emergency endoscopic therapy.

Non-Variceal Upper Gastrointestinal Hemorrhage

Acute upper non-variceal GI bleeding is a medical emergency. Peptic ulcer is the most common cause of upper non-variceal GI bleeding. Less common causes include Mallory-Weiss tears, Dieulafoy's lesions, erosive esophagitis, tumors and telangiectasias. Several endoscopic methods have been used to control GI hemorrhage. Endoscopic diagnosis and treatment of severe upper GI bleeding should be performed with therapeutic video endoscopes that have a single large suction channel (3.7–6 mm diameter) or two suction channels, if available.

A number of endoscopic methods for upper GI bleeding hemostasis have been evaluated. Because of their efficacy, safety and relatively low cost they range from well-known thermal devices (multipolar probes and heater probes) to novel redesigned mechanical devices such as endoscopic hemoclips that have also been widely adopted. Tables 4–7 are lists and information on various types of hemostatic devices.

Any of these methods can be used with or without prior injection of dilute epinephrine (1:10,000 to 1:20,000). Epinephrine injection is often used initially (before thermal coagulation or hemoclipping) to treat bleeding lesions or to prevent re-bleeding induced by clot removal or contact with accessories.

Table 10. Endoscopic modalities for lower gastrointestinal bleeding

	Diverticula	Angiectasia	Radiation proctitis	Postpolypectomy bleeding	Cancer
Injection therapy solution	Yes Epinephrine solution (1:10,00)	Yes Various sclerosants		Yes Epinephrine solution (1:10,00)	Yes Epinephrine solution (1:10 000) Ethanol (99%)
Heater probe	Yes	Yes	Yes	Yes	Yes
Probe size, Fr	7 or 10	7 or 10	7 or 10	10	10
Power settings, J	10–15	10–15	10–15	10–20	20–25
Pulses, n	Until bleeding stops		Until bleeding stops; white coagulation	Until bleeding stops	Until bleeding stops
MPEC					
Bipolar or Gold probe					
Probe size, Fr	Yes	Yes	Yes	Yes	Yes
Power settings, W	7–10	7 or 10	7 or 10	10	10
Pulse duration, s	12–16 1–2	10–16 1	10–16 1	10–20 1–2	16–20 1–2
APC	No	Yes	Yes	Yes if diffuse after EMR	No data available
Power settings, W		15–40	15–40		
Argon flow, liters/min		1	1	40–60	
VIO technology				1–2	
Power setting, W		10–30 mode pulsed 2; thinner wall precise mode. High risk of rebleeding	10–30 mode pulsed 2; thinner wall precise mode. Retreatment often needed		
Band ligators	Yes?[1]	No	No	No	No
Endoclips	Yes	No	No	Yes	No

[1] Needs to be proven in larger case-series.

Bleeding Peptic Ulcer

Endoscopic treatment of a bleeding peptic ulcer is determined by its endoscopic appearance. The majority of bleeding from gastric and duodenal ulcers is self-limited. There is general agreement that endoscopic therapy is indicated for actively bleeding lesions as well as for high-risk stigmata of recent hemorrhage, including visible vessel, and possibly an adherent clot. Endoscopic therapies include: injection therapy, such as epinephrine or sclerosant injection; ablative therapy, such as heater probe or argon plasma coagulation, and mechanical therapy, such as endoclips or endoscopic banding. Endoscopic therapy reduces the risk of re-bleeding, the need for blood transfusions, the requirement for surgery, and patient morbidity (table 8). In achieving primary

hemostasis and prevention of re-bleeding none of the methods is ideal but outcomes after endoscopic clip application alone or in combination with injection therapy seem to be advantageous but not superior over other endoscopic treatment modalities [14].

Bleeding from the Small Intestine

The double-balloon enteroscope has a working length of 200 cm and an outer diameter of 8.5 or 9.5 mm, and it has flexible overtube with a length of 145 cm and an outer diameter of 12 or 13 mm. The soft latex balloons are attached to the tips of both the enteroscope and the overtube and are inflated and deflated by a specifically designed pump. The examination can either be orally or per anally. The diagnostic yield of double balloon enteroscopy in the diagnosis of obscure GI bleeding is 43–87% and the therapeutic impact is 62–84% [34–36]. In this setting, the double balloon technique is complementary to capsule endoscopy and its therapeutic impact in achieving hemostasis is 62–84%. Despite the temporary limitation in available accessories that are sufficiently long and slim to be passed through the working channel of the enteroscope, there is an increasing range of accessories that can be used to achieve hemostasis in small intestine (table 9).

Lower Gastrointestinal Bleeding

Table 10 shows the possible endoscopic modalities for lower GI bleeding.

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