Colonoscopic Polypectomy

9

Sung Noh Hong and Chang Kyun Lee

Contents

Key Summary

- Colonoscopic polypectomy (CPP) is the most commonly performed therapeutic procedure during colonoscopy.
- All neoplastic colorectal polyps, even small/diminutive lesions, should be removed in theory, because malignant potential of them is never known before adequate pathologic evaluation.
- Prior to the CPP, the endoscopists should consider the natural history of individual lesions, the age and comorbidity of the patient, and the risks of the intervention, whereas the patients should understand the benefit and risks of CPP, including the consequences of perforation and bleeding.
- CPP techniques have evolved substantially in recent years and there is now a range of equipment and techniques available for different clinical settings. The endoscopists should select the appropriate technique, based on the polyp size, morphological characteristics, and the position within the colon.
- Identifying the characteristics of the lesion, especially the attaching area with colonic wall, optimizing the view and scope position, familiarity with the accessories and electrosurgical unit, and good communication with the assistant are essential for safe and successful CPP.
- Endoscopic tattooing of colonic polyps and CPP sites is helpful to localization for colorectal polyps, when surgery or postpolypectomy surveillance will be needed.

S.N. Hong
Department of Gastroenterology, Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, Korea
e-mail: gisnhong@gmail.com

C.K. Lee (✉)
Department of Internal Medicine, Kyung Hee University Hospital, Kyung Hee University School of Medicine, Seoul, Korea
e-mail: gidrlee@gmail.com

H.J. Chun et al. (eds.), *Therapeutic Gastrointestinal Endoscopy: A Comprehensive Atlas*, DOI 10.1007/978-3-642-55071-3_9

9.1 General Information

Colorectal cancer (CRC) is a major health problem in most industrialized countries, with an annual incidence of 1 million cases and an annual mortality of more than 550,000 cases [1]. The incidence of CRC has been steadily increasing and, to date, the lifetime risk for CRC for an average-risk population is about 5 % in industrialized countries [1]. In this regard, colonoscopic polypectomy is a fundamental therapeutic procedure for the prevention of CRC. Early detection and removal of adenomatous polyps have been shown to decrease the incidence of CRC and cancer-related mortality [2, 3]. However, the colonoscopic polypectomy is recently regarded as a highly operator-dependent procedure. Practice of colonoscopic polypectomy and therapeutic outcome of the procedure are highly variable with endoscopists [4, 5]. All physicians who perform colonoscopy must be sufficiently trained in basic polypectomy technique and should be able to perform the procedure safely and effectively. In this chapter, we will discuss the prerequisite, instruments, basic principle and various techniques, and finally complications of colonoscopic polypectomy.

9.2 Indication

- Theoretically, any superficial colorectal neoplasia can be an indication of colonoscopic polypectomy. Colonoscopic polypectomy encompasses various techniques according to the use of electrocautery, forceps, and snares (Table 9.1). The endoscopist should consider the size, morphological characteristics, and the location within the colon before choosing the appropriate technique.
- However, further therapeutic options should be considered in cases of definite or suspicious malignant colorectal polyps, including endoscopic submucosal dissection (ESD) and surgery (see Chap 10, ESD for colorectal neoplasia). Generally, a non-lifting sign in sessile polyps indicates massive invasion of cancer, which is an absolute contraindication for colonoscopic polypectomy (Fig. 9.1).
- Diminutive polyps up to 5 mm can be removed by using forceps from anywhere in the colon (cold biopsy or cold forceps polypectomy). Hot biopsy using an electrosurgical unit is not currently recommended method for removing diminutive polyps, due to low complete resection rate, concern for delayed bowel perforation, and inadequate histological assessment of the resected specimen.
- Slightly larger sessile polyps (up to 7 mm) are best removed by cold snaring, hot snaring, or endoscopic mucosal resection (EMR) technique.
- Large pedunculated polyps are removed by hot snare. Prophylactic procedures (e.g., detachable snare or clip placement) help to prevent early bleeding during the removal of pedunculated polyps with thick stalk (>1 cm).
- Larger sessile polyps may be removed by standard hot snaring, but EMR is growing in popularity and is probably safer, especially when removing lesions from the right colon. Submucosal injection during polypectomy helps to prevent early bleeding, although the preventative effect on delayed bleeding is not clear.
- The endoscopist should aim to en bloc resection at a single snaring but can consider a piecemeal resection for lesions >2 cm.
- Although flat and depressed colorectal lesions should be removed by EMR successfully, it should be remembered that depressed lesions have a particularly high incidence of submucosal invasion of carcinoma, which should be removed completely by ESD or surgery.

Table 9.1 Various polypectomy technique according to the size and shape of the target lesion

Technique	Ideal therapeutic target
Cold forceps polypectomy	Diminutive (≤5 mm) polyps
Cold snare polypectomy	Small (4–6 mm) sessile polyps
Hot snare polypectomy	Sessile or pedunculated polyps (7–9 mm)
Saline-assisted polypectomy	Any polyps of 5–20 mm size
Endoscopic piecemeal mucosal resection	Sessile polyps ≥ 20 mm size

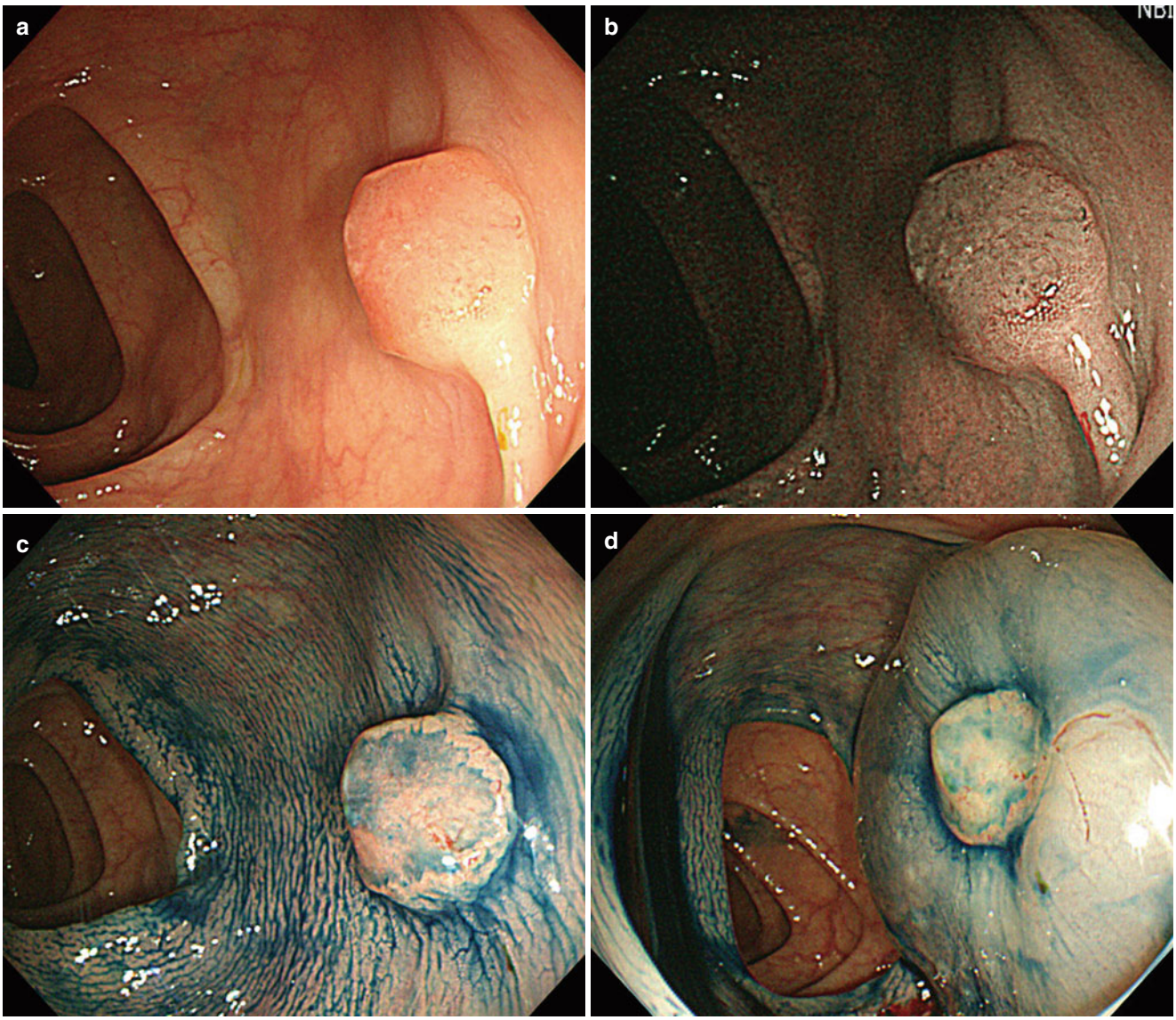

Fig. 9.1 Non-lifting sign of a malignant sessile polyp. (**a**) White light image of a 10 mm, 0-Is-type lesion at the descending colon. (**b**) NBI image of the same lesion. (**c**) Image after indigo carmine dye spraying over the lesion. (**d**) Effective elevation of the lesion following injection of submucosal solution is not found (non-lifting sign of malignant polyp), which is a contraindication for colonoscopic polypectomy

9.3 Prerequisite

- Postpolypectomy bleeding is the most common complication associated with colonoscopic polypectomy. Discontinuation of anticoagulants and antiplatelet agents to treat cardiovascular and cerebrovascular diseases should be considered according to the recent practice guidelines proposed by professional gastrointestinal endoscopy societies [6, 7].
- Adequate bowel preparation is crucial for safe and effective colonoscopic polypectomy. Inadequate bowel preparation may decrease technical performance of colonoscopic polypectomy and subsequently may increase potential risk of procedure-related complications. Split-dose bowel preparation for morning colonoscopy and same-day preparation for afternoon colonoscopy are appropriate.
- Several ancillary devices should be equipped prior to starting polypectomy, such as hemostatic clip devices and ligating devices (detachable snare).

9.4 Instruments

9.4.1 Electrosurgical Unit

- Electrosurgical unit (ESU) transforms high-frequency electric current into heat, with the resulting effect of cutting and/or coagulating tissue at the point of current application.
- Electrosurgical waveforms may be set to result effect of cutting and/or coagulating tissue at the point of current application. The proportion of cells coagulated to those cut can be varied, resulting in a "blended" or "mixed" effect:
  - Coagulation: Temperature rises within cells, which then dehydrate and shrink.
  - Cut: Heating of cellular water occurs so rapidly that cells burst.
- The rise in tissue temperature at the point of current application is governed by Joule's law:
  - $Q = I^2 \times R \times t$ (Q, heat; I, current intensity; R, tissue electrical resistance; t, time).
  - Heat generated in the colonic mucosa is directly proportional to the square of current intensity (e.g., if current intensity is doubled or tripled, the heat generated increases by a factor of 4 or 9, respectively).
- Electrical circuit
  - Monopolar mode: Electricity flows from the active electrode (accessories usually inserted through the working channel of the endoscope) to the neutral electrode (patient plate) placed on patient skin (Fig. 9.2a).
  - Bipolar mode: Electricity flows from the active to the neutral electrode, both of them being located in close proximity on a single endoscopic device. The current does not pass through the rest of the patient's body and no patient plate is required (Fig. 9.2b).
- Current frequency: Human myocardium is sensitive to currents of low frequency, whereas high-frequency currents increased the risk of electrostatic losses, which are associated with the risk of burns. Therefore, ESU usually employs the high-frequency currents in the range of 300–1000 kHz.
- Current waveforms: High-frequency currents generated by ESUs consist of one of the two following types:
- Crest factor: Ratio of the peak to the root-mean-square voltage.
  - Pure sinusoidal current waveform (Fig. 9.3a): The crest factor is constant at 1.4 for every wave; higher peak voltages provide more intense coagulation/hemostasis effects; voltage peak (Vp) below 200 V is ideal for soft coagulation with minimal cutting effect; and Vp of approximately 300 V enable pure cutting effect with the minimal coagulation effect.

- Amplitude-modulated current waveforms (Fig. 9.3b): The crest factor varies between 1.5 and 8, with increasing crest factors providing deeper coagulation effect; ESU provides amplitude-modulated current waveforms, named as "Blend Cut" or "Dry Cut" and "Fulgurate" and "Forced Coag" or "Spray Coag," respectively.
- ESU can provide combined cutting and coagulation waveforms in one mode that alternates each type of waveform, named as "Endocut (ERBE, Tubingen, Germany)" or "Pulsecut (Olympus, Tokyo, Japan)" mode (Fig. 9.3c). These settings can be adjusted by the endoscopist including the duration of the cutting phase, the interval duration between cutting phases, and the coagulation effect.

• Practical applications
  - The current density administered through the snare differs according to cross-sectional areas (Fig. 9.4). All other settings being same, the larger the base of the polyp or the snare wire, the more energy will be required to resect it.
  - Manufacturer-recommended settings for various applications are presented in Table 9.2. Settings can be adjusted before and during the CPP according to the endoscopist's preferences and desirable therapeutic response (i.e., in the ERBE Endocut mode, no coagulation is applied between cutting cycles if the lowest "effect" level is selected, which may be useful at limiting coagulation-related damage in the cecum.)

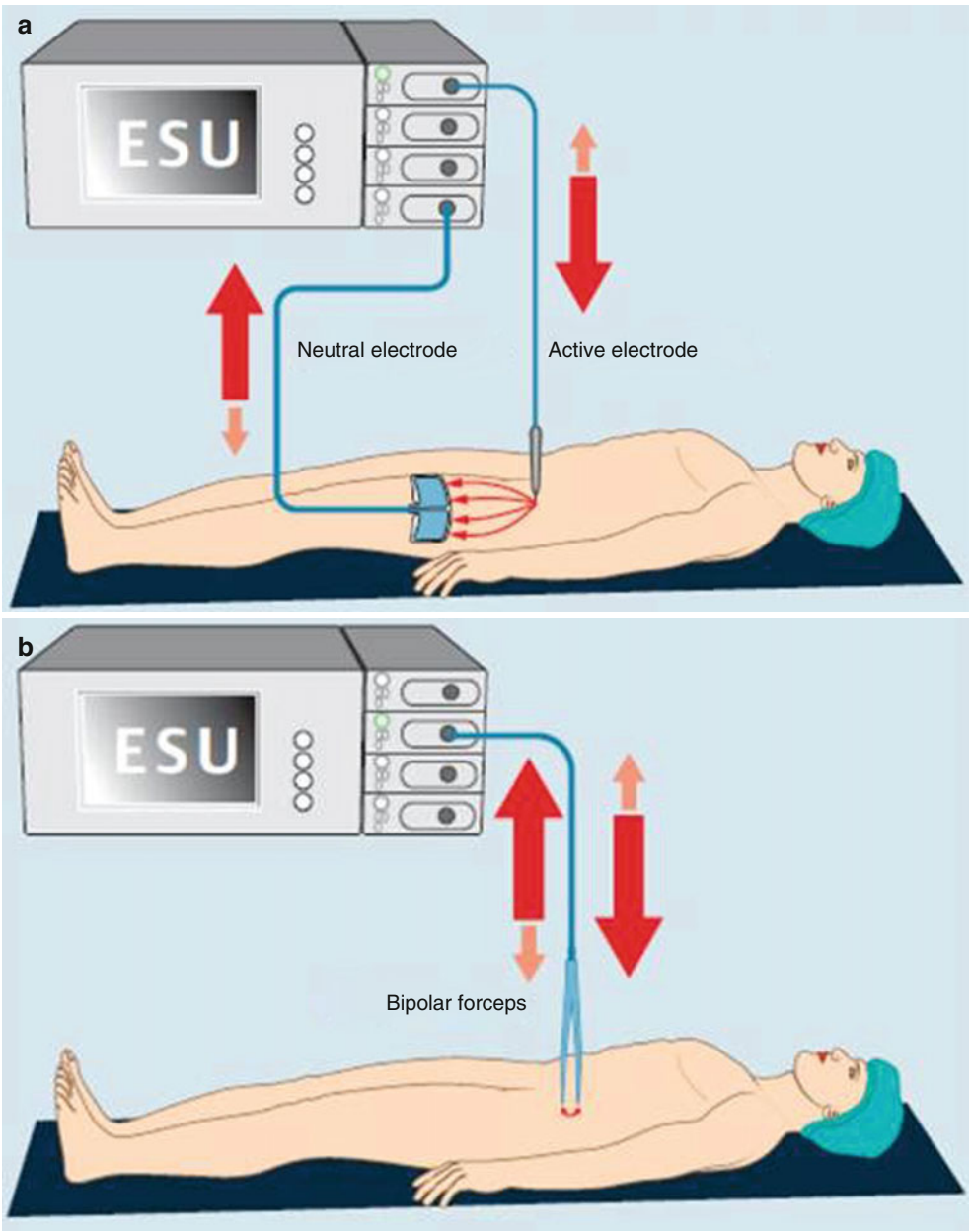

Fig. 9.2 Electrical circuit. (**a**) Monopolar mode, (**b**) bipolar mode

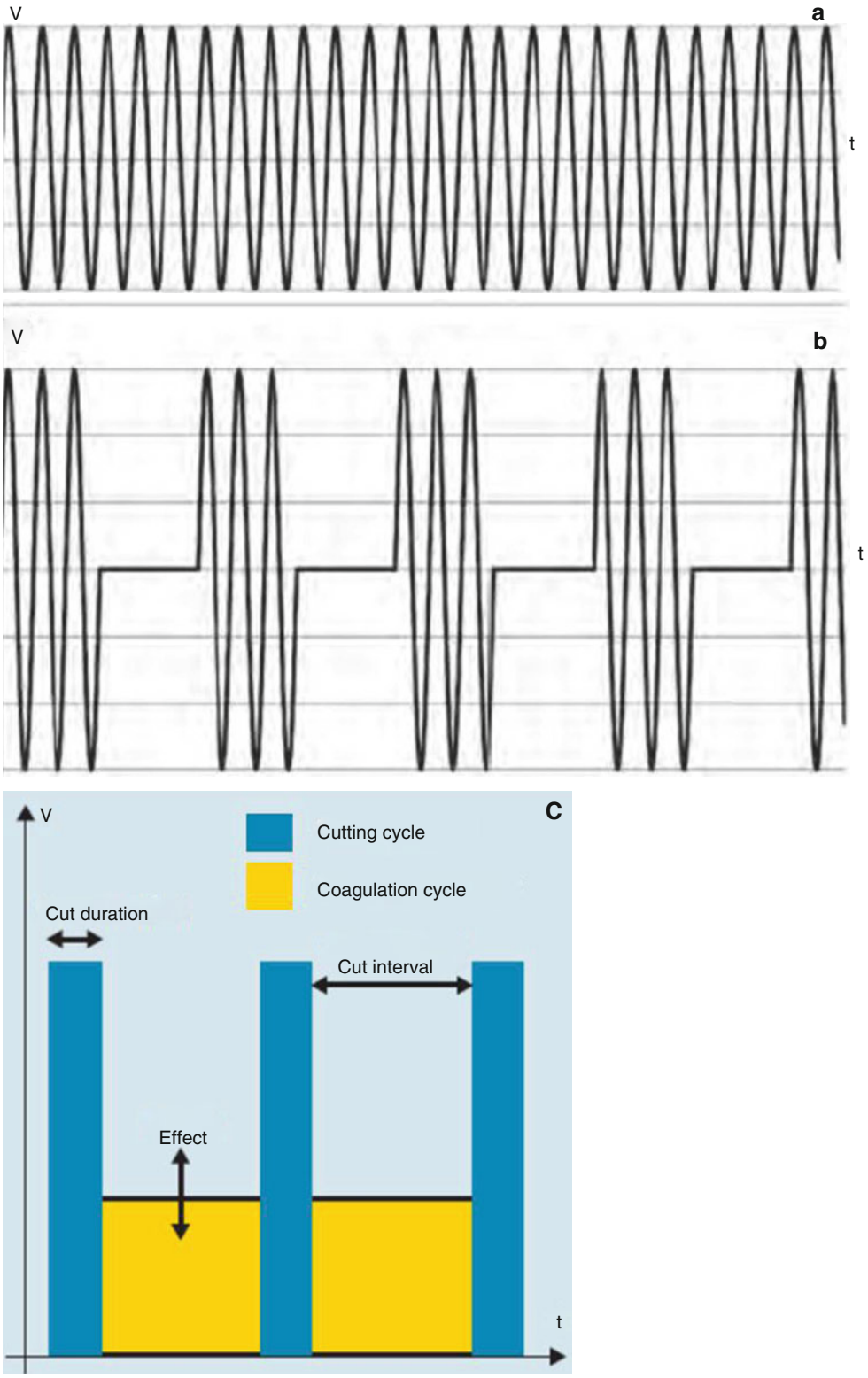

Fig. 9.3 Current waveforms used in ESU. (**a**) Pure sinus current waveform (crest factor = 1.4), (**b**) amplitude-modulated current waveforms (crest factor = 1.5 ~ 8), (**c**) Endocut and Pulsecut modes, consisting of alternating cutting and coagulation currents

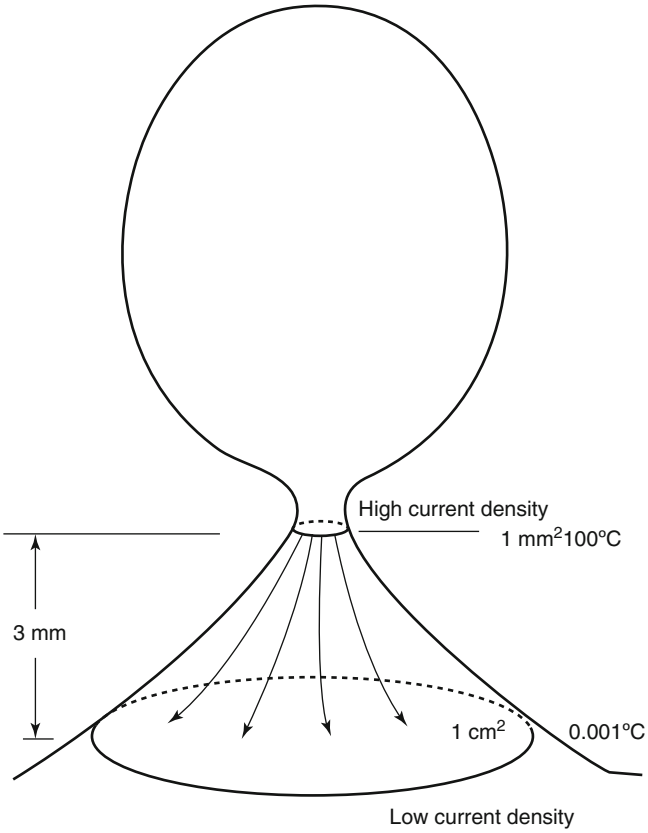

Fig. 9.4 The principle of current density during CPP at various levels of a polyp stalk

Table 9.2 Settings recommended by manufacturer for various endoscopic interventions

Electrosurgical unit manufactured by ERBE		
	ICC 200	VIO 200 S/VI0 200 D
Polypectomy		
Stalk diameter < 1 cm	Endocut, Effect 2, 120 W	Endocut Q, Effect 1–2
Stalk diameter > 1.5 cm	Endocut, Effect 2 or 3, 160–180 W	Endocut Q, Effect 3
Marking a lesion	Soft Coag, 50 W	Endocut, Effect 3, 50 W
	Forced Coag, 20 W	Forced Coag, Effect 1, 20 W
Mucosectomy	Endocut, Effect 2, 120 W	Endocut Q Effect 2
Hemostasis stomach/rectum/colon	APC, 40 W	Pulsed APC, Effect 2, 20 W
Hemostasis duodenum/right colon	APC, 20 W	Precise APC, Effect 4
Radiation proctitis	APC, 40 W	Pulsed APC, Effect 2, 20 W
Tumor ablation	APC, 60 W	Forced APC, 20–60 W
Electrosurgical unit manufactured by Olympus		
	ESG-100 settings	
Snare resection of a polyp measuring		
<5 mm	Pulsecut slow, Level 120/Alternative mode: Forced Coag 2 Level ≤20	
5–10 mm	Pulsecut slow, Level 120/Alternative mode: Forced Coag 2 Level 20	
10–20 mm	Pulsecut slow, Level 120/Alternative mode: Forced Coag 2 Level 20–25	
20–30 mm	Pulsecut slow, Level 120/Alternative mode: Forced Coag 2 Level 20–30	
30–40 mm	Pulsecut slow, Level 120/Alternative mode: Forced Coag 2 Level 30	
Hot biopsy	Cut 2, Level 40	
Marking	Forced Coag 1, Level 20/Soft Coag, Level 50	
Hemostasis (snare)	Forced Coag 1–2, Level 30	
Hemostasis (bipolar probe)	Soft Coag, Level 30	
EMR (snare)	Pulsecut slow, Level 120/Alternative mode: Forced Coag 2 Level 30	

Adapted by Rey et al. [9]

9.4.2 Biopsy Forceps

- Biopsy forceps used for CPP include both cold biopsy devices (Fig. 9.5a) and hot biopsy devices (Fig. 9.5b)
- Cold biopsy forceps equipped with a needle spike between the opposing biopsy cups. Biopsy cup jaws may be round, oval, or elongated, fenestrated or non-fenestrated, and smooth or serrated. Other variations on the standard designs that may offer advantages in challenging circumstances include "swing-jaw," "rotatable," and "angled" forceps.
- The hot biopsy forceps is electrically insulated through which electrical current flows to direct electrical energy around the tissue held within the jaws, enabling simultaneous electrocautery of a base of polyp while obtaining a biopsy specimen.

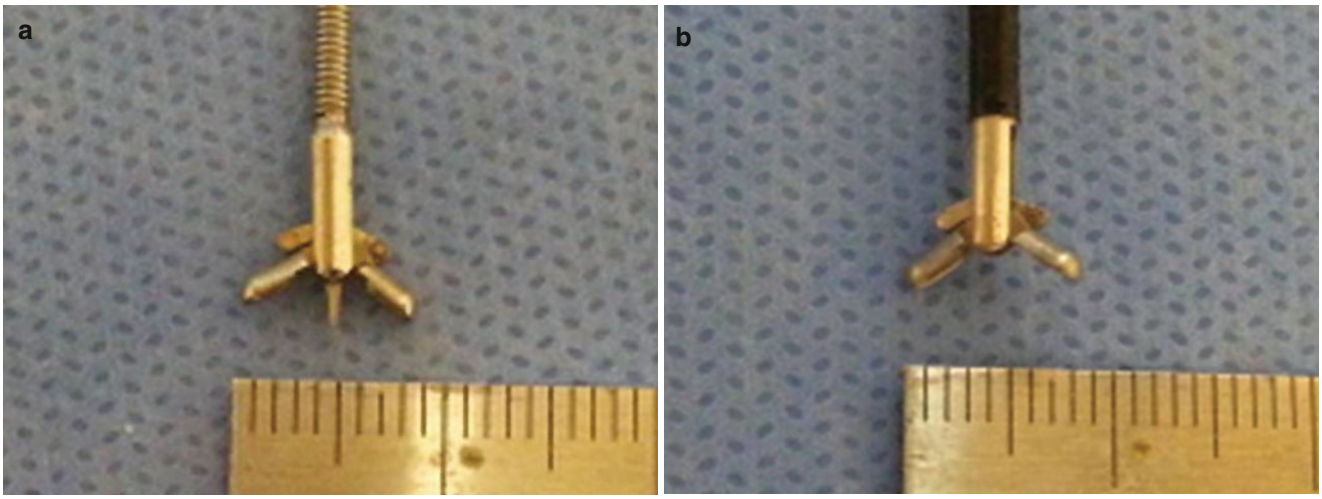

Fig. 9.5 Biopsy forceps used for CPP. (**a**) Cold biopsy forceps. (**b**) Hot biopsy forceps

9.4.3 Snares

- Polypectomy snares include a monopolar wire loop electrode that is advanced beyond a plastic insulating catheter to encircle the target tissue, which is then transected via mechanical and electrosurgical cutting as the loop is withdrawn into the catheter.
- Snares are designed to a variety of sizes and shapes to facilitate ensnaring polyps with variable size and shape and the different position within the colon. The shape of snare is round, oval, hexagonal, or crescent shaped (Fig. 9.6a). The standard large snare is about 6 cm in length by 3 cm wide, and the small snare is 3 cm in length and 1.0 cm in width (Fig. 9.6b) [10].
- Cold or hot techniques can be applied with any device.
- Snares with barbed-type edges facilitate positioning and grasping of tissue at the base of polyps (Fig. 9.6c).

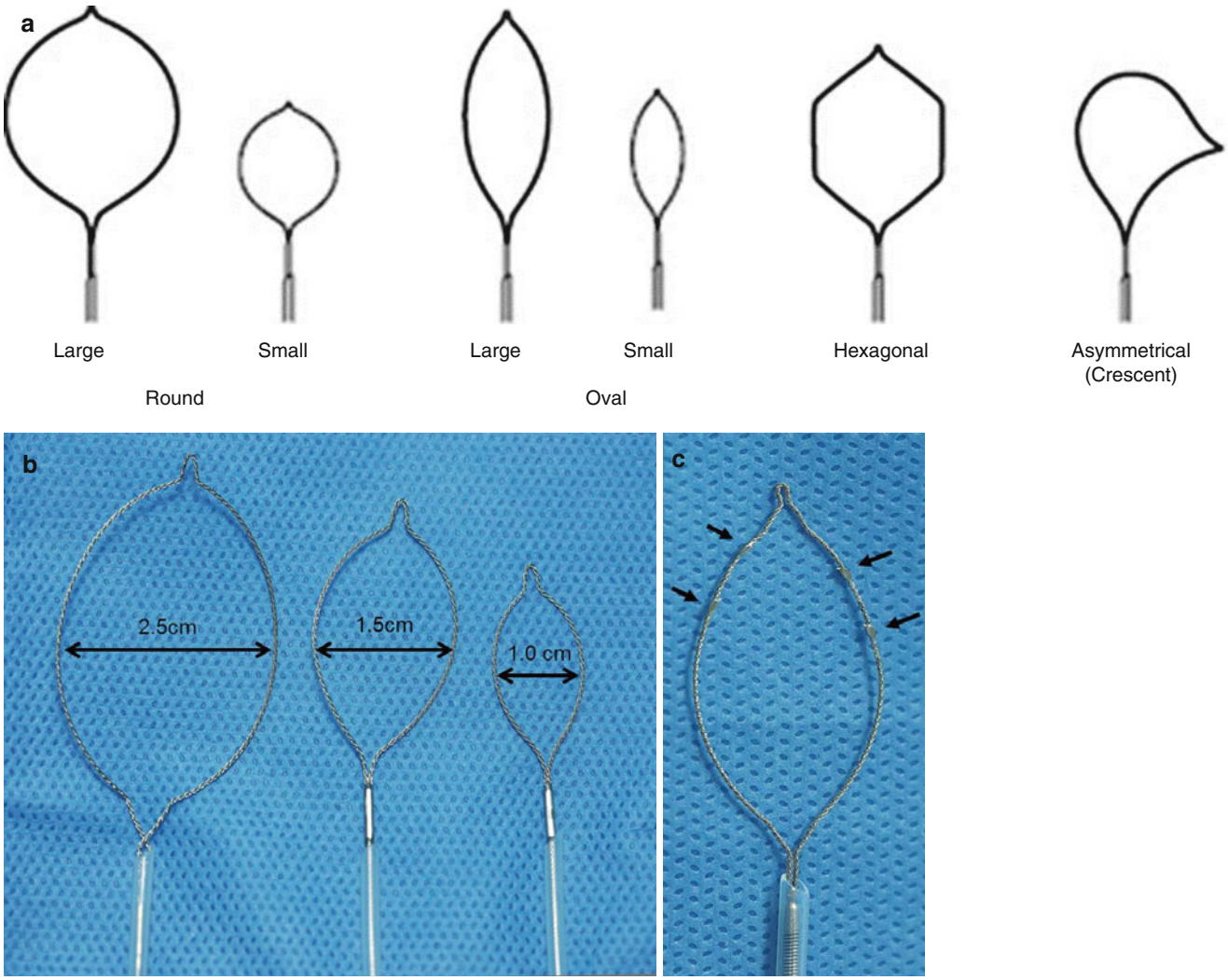

Fig. 9.6 Polypectomy snares. (**a**) Illustration of snares designed to a variety of sizes and shapes, (**b**) round- and oval-shaped snares, (**c**) snares with barbed-type edges (spiral snare)

9.4.4 Submucosal Injection Agents

- A 23- or 25-gauge injection needles provide liquid injection agents into submucosal layer of colonic wall (Fig. 9.7).
- Submucosal injection agent induces the elevation of the target lesion to facilitate grasping using snare and to limit the depth of thermal injury within the submucosal layer of colonic wall by increasing the distance between burn and muscle layer.
- Normal saline, 50 % dextrose, glycerol, and dilute hyaluronic acid have been evaluated for their ease of injection and duration of cushion effect:
  - Normal saline is safe and effective to create submucosal bleb, but cushions rapidly disperse into surrounding tissues.
  - 50 % dextrose and glycerol are readily available and produce a longer-lasting submucosal bleb than normal saline solution.
  - Hyaluronic acid is expensive but retained far longer than other available submucosal injection agents.
- Additives include epinephrine for hemostasis and indigo carmine for demarcation of the polyp margins and submucosal layers (Fig. 9.8).
- Submucosal injection during polypectomy helps to prevent early bleeding, but the preventative effect on delayed bleeding is not clear.

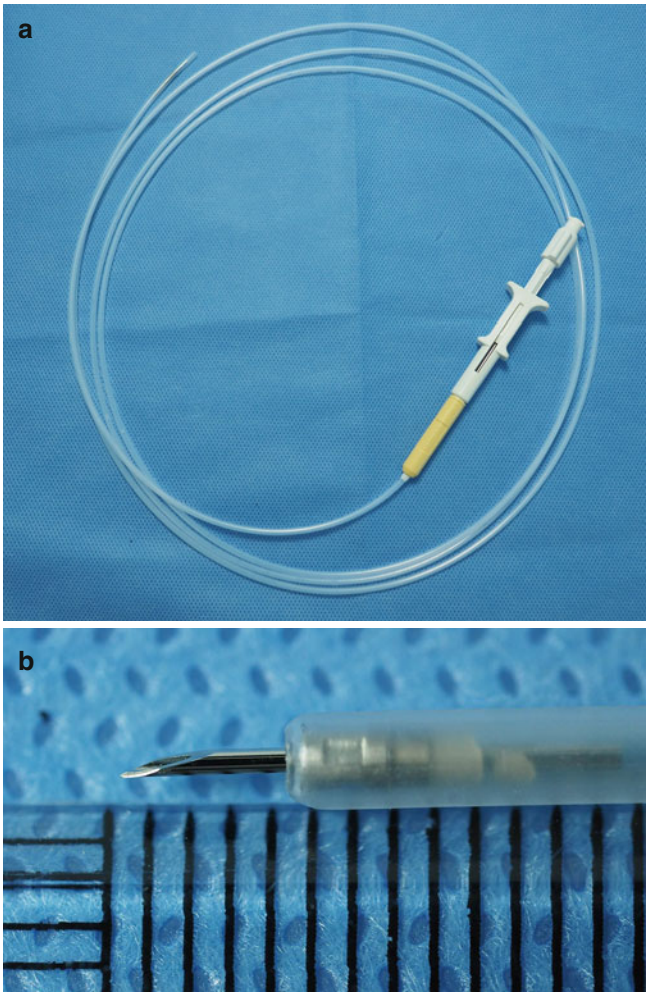

Fig. 9.7 Submucosal injection needles

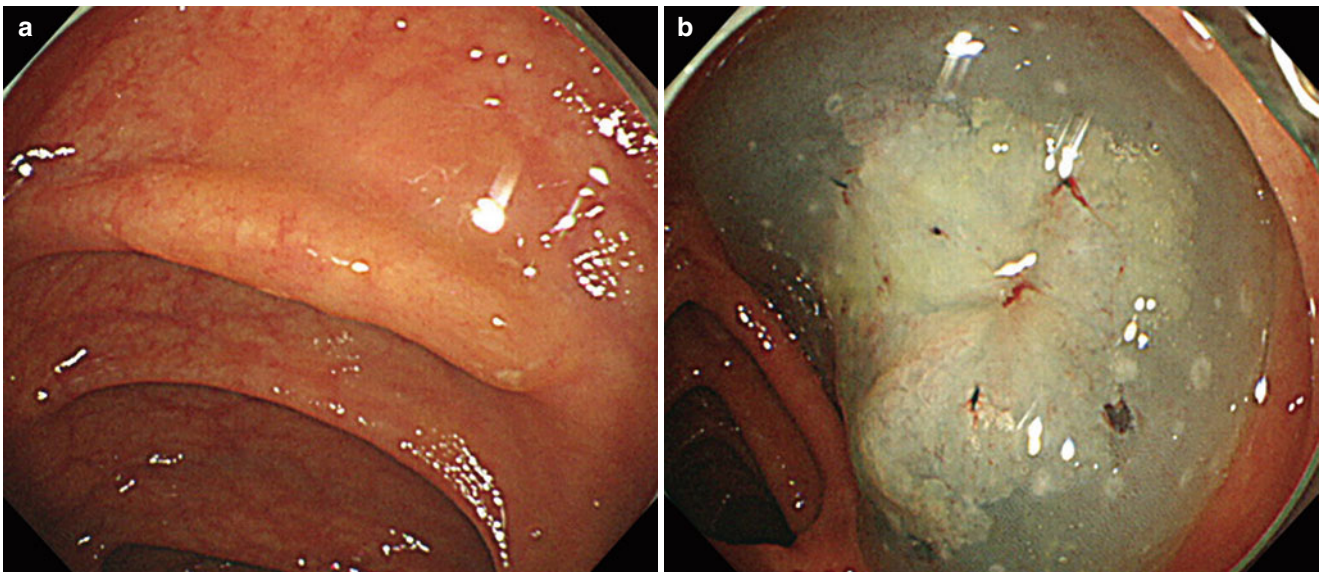

Fig. 9.8 The mixture with indigo carmine readily demonstrates the demarcation of the polyp margins and submucosal layers. (**a**) White light view before submucosal injection, (**b**) submucosal injection using normal saline with indigo carmine

9.4.5 Ancillary Devices

- Ancillary devices for the performance of CPP include clips, detachable snares, transparent caps, retrieval accessories, tattooing, and ablation devices (i.e., argon plasma coagulation devices, monopolar and bipolar probes, and lasers). Information about ancillary devices are mentioned in detail in techniques of ancillary device-assisted CPP.

9.5 Technique

9.5.1 Basic Principle of Colonoscopic Polypectomy

- Polypectomy technique should be individualized according to the location, size, and gross morphology of the target lesion to be removed. Different polyps require different resection techniques for successful removal [11].
- Careful mucosal inspection is critical for clear delineation of margins and subsequent complete removal of colon polyps, especially non-polypoid flat neoplasms and serrated lesions (Fig. 9.9). Image-enhancing technique such as chromoendoscopy and narrow band imaging (NBI) technology is useful for this purpose.
- The colonoscope should be straight without its bending or looping during the procedure, and the operative field should not be outside in sight throughout the procedure.
- The lesion should be placed at the 5–6 O'clock position before snaring through rotation of the colonoscope (Fig. 9.10). Inadequate position of colonoscope is one of potential causes of incomplete snaring (Fig. 9.11).
- Meticulous assessment of the resection margins whether there is remnant adenomatous tissue is crucial for the confirmation of complete polyp removal (Fig. 9.11).
- Cooperation with endoscopy nurse is essential for successful procedure, especially in manipulation of endoscopic accessories such as biopsy forceps and snares.
- All resected specimens are recommended to be immediately retrieved. In case of multiple colorectal polyps, all retrieved specimens must be contained in a separate jar and should be sent for histopathologic assessment. Surveillance colonoscopy interval after polyp resection primarily depends on the number, size, and histopathologic result of individual neoplastic lesion (Fig. 9.12).
- "Resect and discard" strategy without retrieval of resected specimen may be applied for diminutive polyps ≤ 5 mm in size if the histopathology can be assessed with high confidence by expert endoscopists using endoscopic observation with white light and/or virtual chromoscopy such as narrow band imaging.

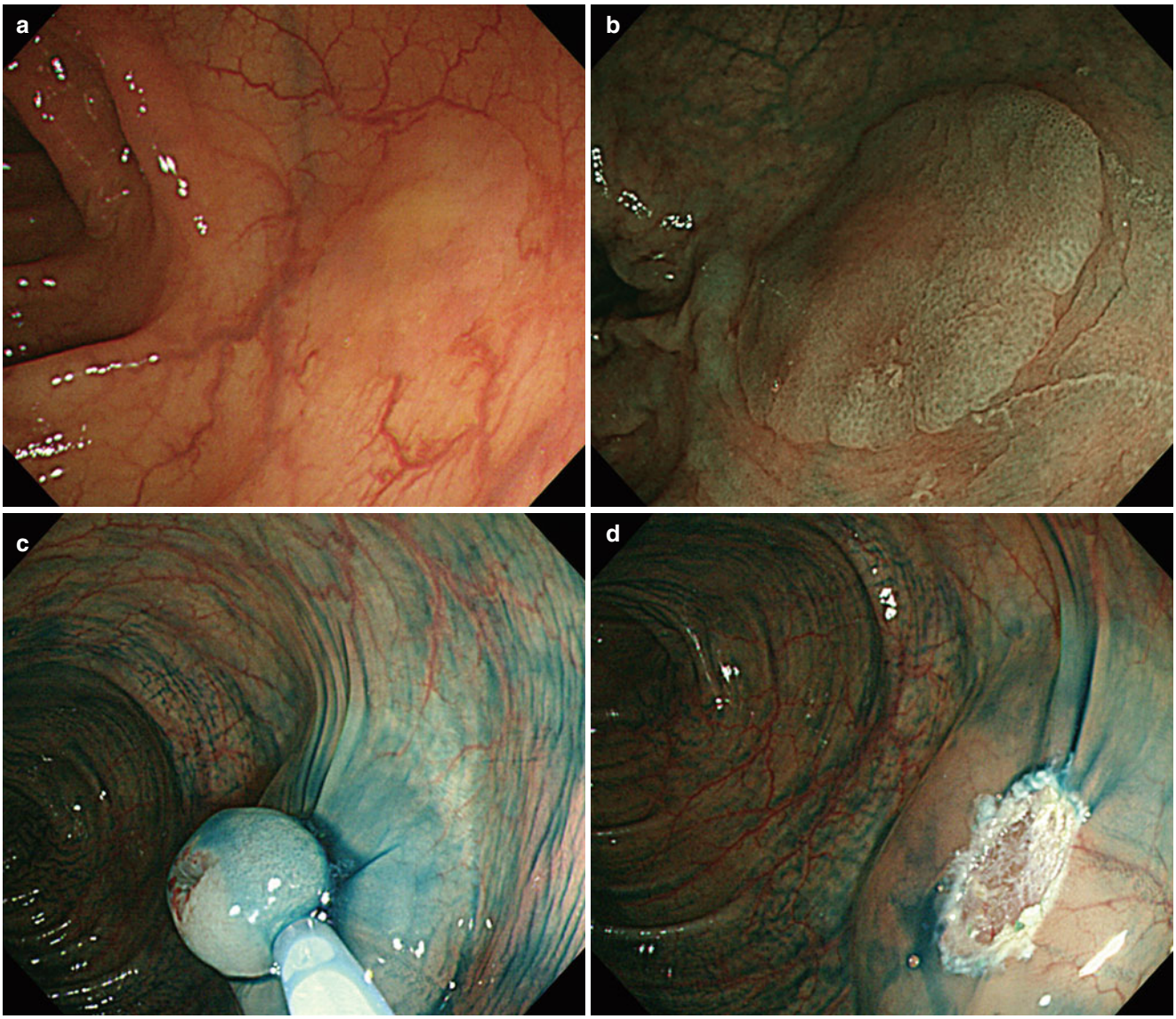

Fig. 9.9 Colonoscopic polypectomy of sessile serrated adenoma. (**a**) White light image of a 15 mm, 0-IIa-type sessile serrated adenoma at the transverse colon. (**b**) NBI image of the same lesion shows a clear delineation of margins. (**c**–**d**) Saline-assisted polypectomy

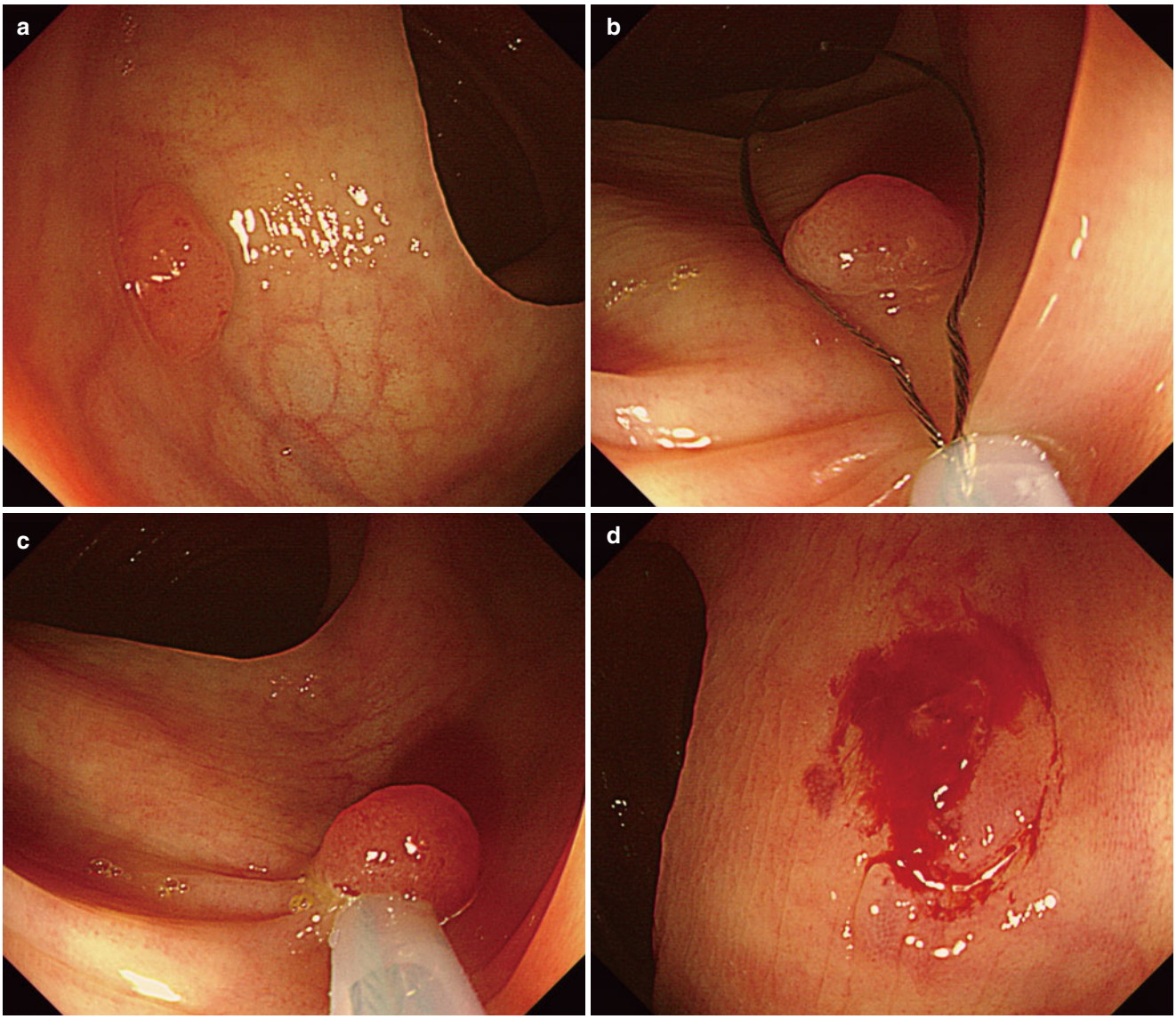

Fig. 9.10 The 6 O'clock positioning. (**a**) A 5 mm, 0-IIa-type diminutive adenoma found at the 8–9 O'clock position of endoscopic field. (**b**–**d**) Repositioning of the polyp into 6 O'clock location through a rotation of the colonoscope and cold snaring of the same lesion

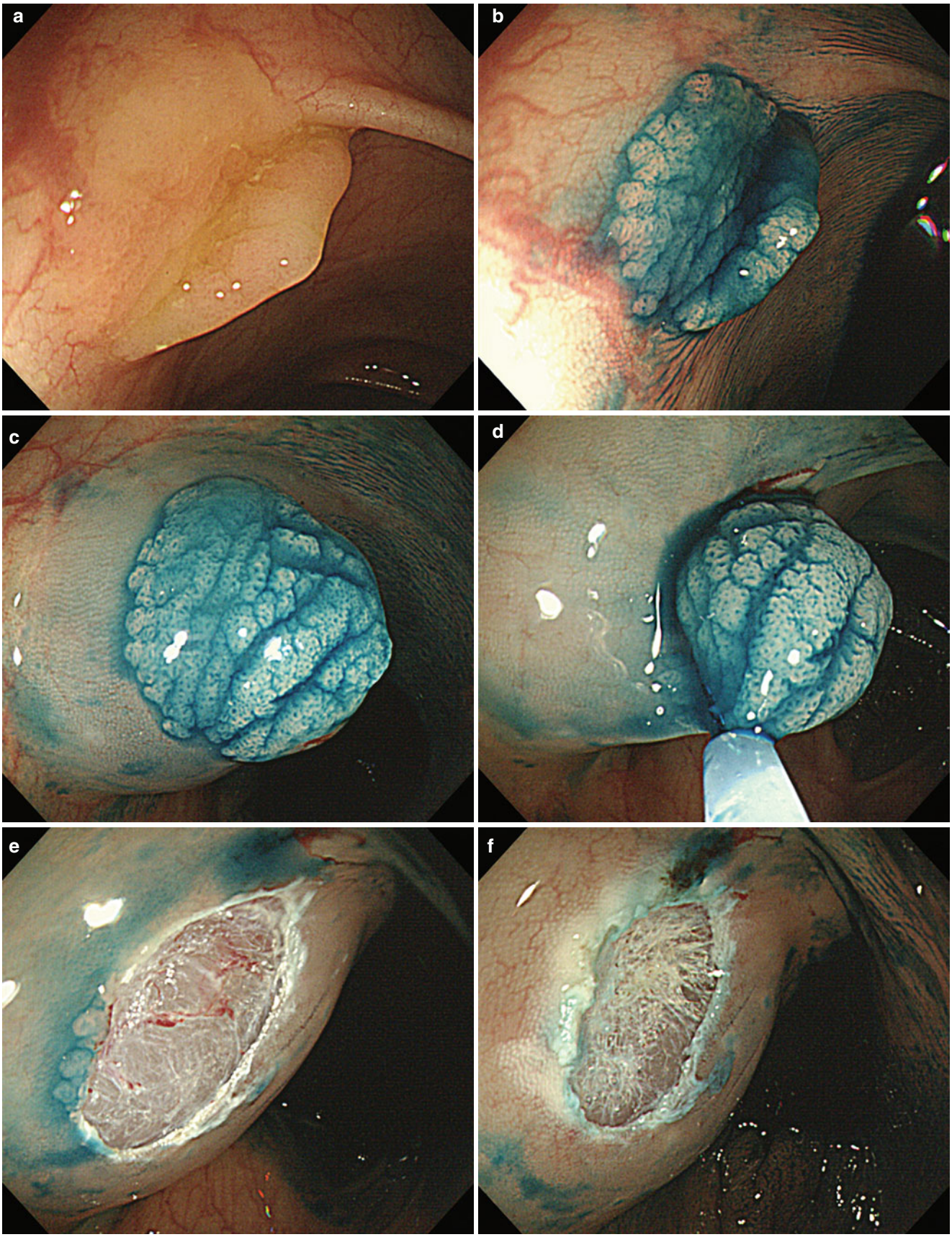

Fig. 9.11 Saline-assisted polypectomy of sessile serrated adenoma. (**a**) White light image of a 22 mm, 0-IIa, sessile serrated adenoma with mucus cap in the ascending colon. (**b**) The same lesion following indigo carmine dye spraying for the delineation of lateral margins of the tumor. (**c**) Image following submucosal saline injection. (**d**) Incomplete snaring at the 9 O'clock position. (**e**) Residual tumor tissue is shown at the lateral margin following polypectomy. (**f**) Residual tumor ablation using argon plasma coagulation

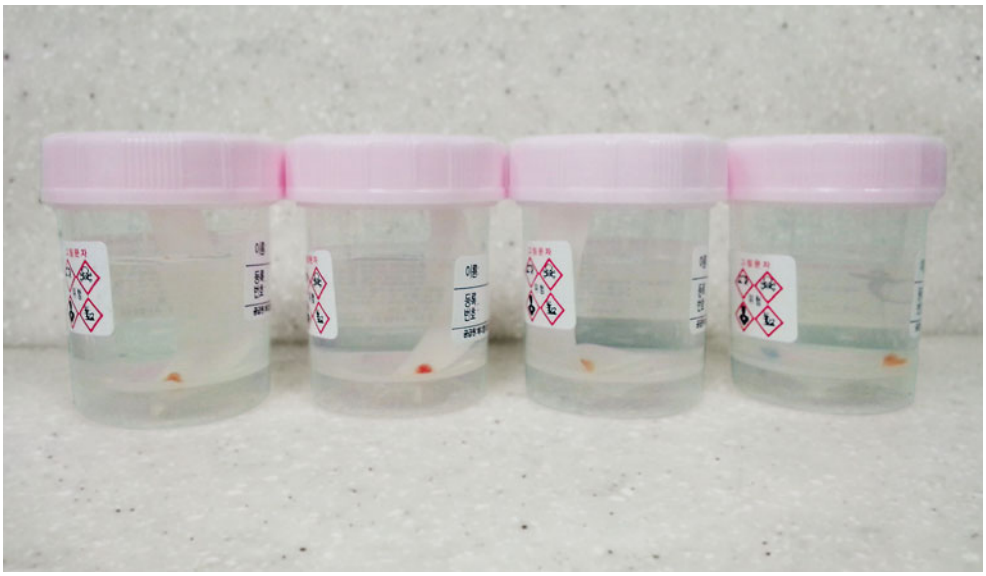

Fig. 9.12 Containers of polypectomy sample. All retrieved specimens must be contained in a separate jar

9.5.2 Cold Forceps Polypectomy

- Cold forceps polypectomy using a standard-capacity forceps is the most frequently used method for the removal of diminutive (≤5 mm in size) colorectal polyps. However, considerable rate of incomplete polyp removal has been reported (Fig. 9.13).
- A recent randomized study showed that cold forceps polypectomy was ideal for polyps 1–3 mm in size, which can be completely removed by one or two consecutive biopsies (Fig. 9.14) [8].
- The forceps equipped with a central needle spike is useful for the prevention of slippage of a first tissue sample during collection of a second bite when performing double-biopsy technique.
- Large- or jumbo-capacity forceps which sample a larger volume of tissue during one bite than standard-capacity forceps are also useful for the effective removal of diminutive polyps (Fig. 9.15).
- Diminutive polypectomy using cold forceps is usually safe in patients taking antiplatelet or anticoagulant agents.

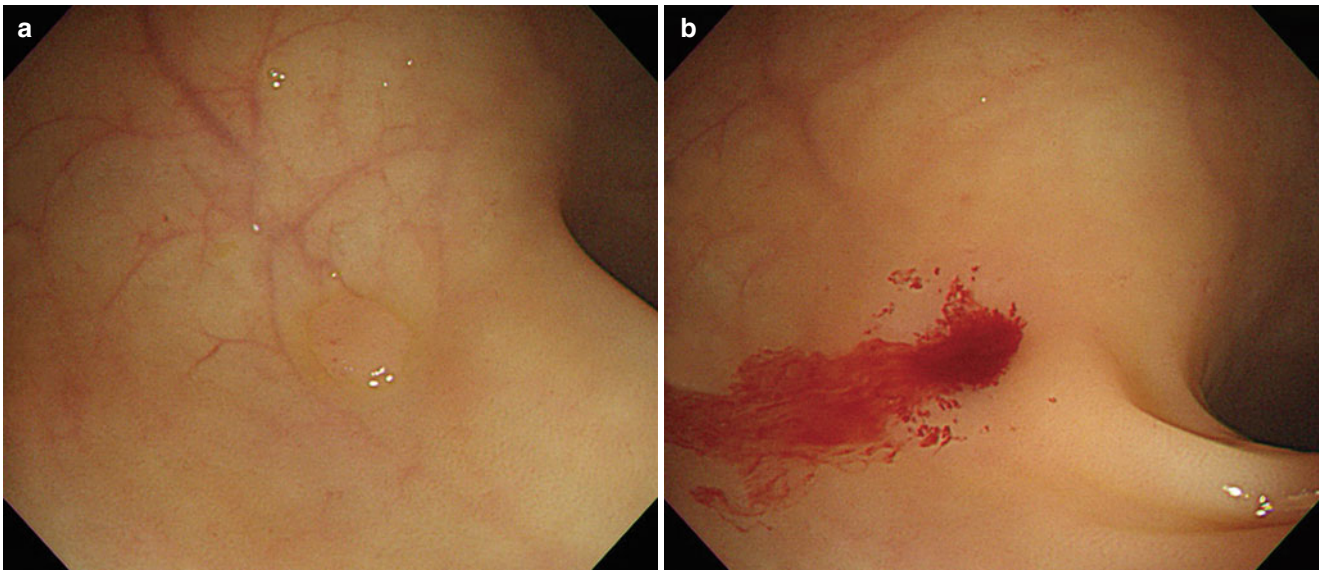

Fig. 9.13 Tumor recurrence after cold forceps polypectomy. (**a**) A white image of 2 mm, 0-IIa diminutive adenoma in the sigmoid colon. (**b**) Mucosal bleeding after single bite of cold forceps polypectomy. (**c**) Tumor recurrence after 5 years later at the diminutive polypectomy scar (*arrow*). (**d**) Observation with NBI imaging of the same lesion. (**e–f**) Resection of recurrent tumor by saline-assisted polypectomy

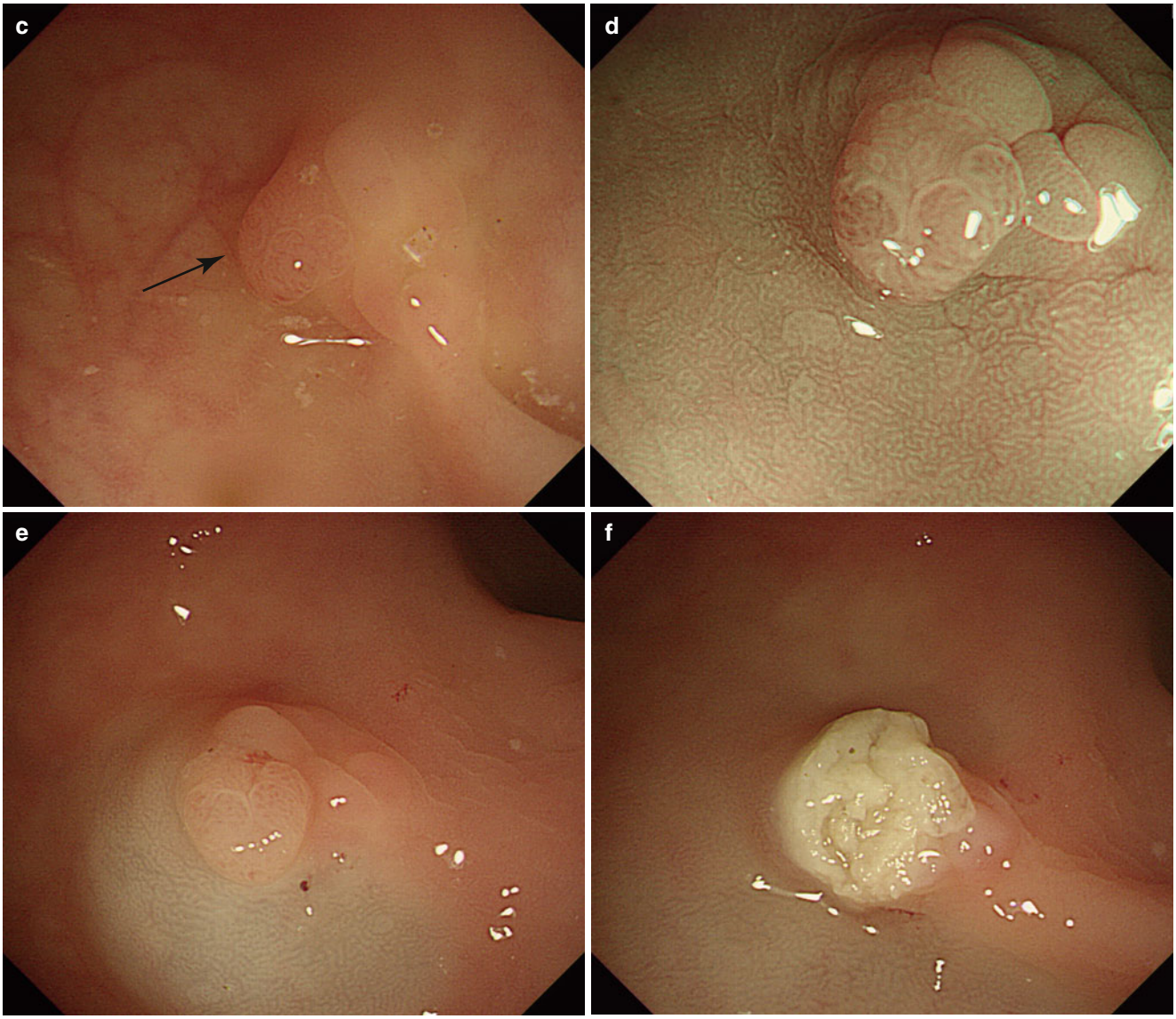

Fig. 9.13 (continued)

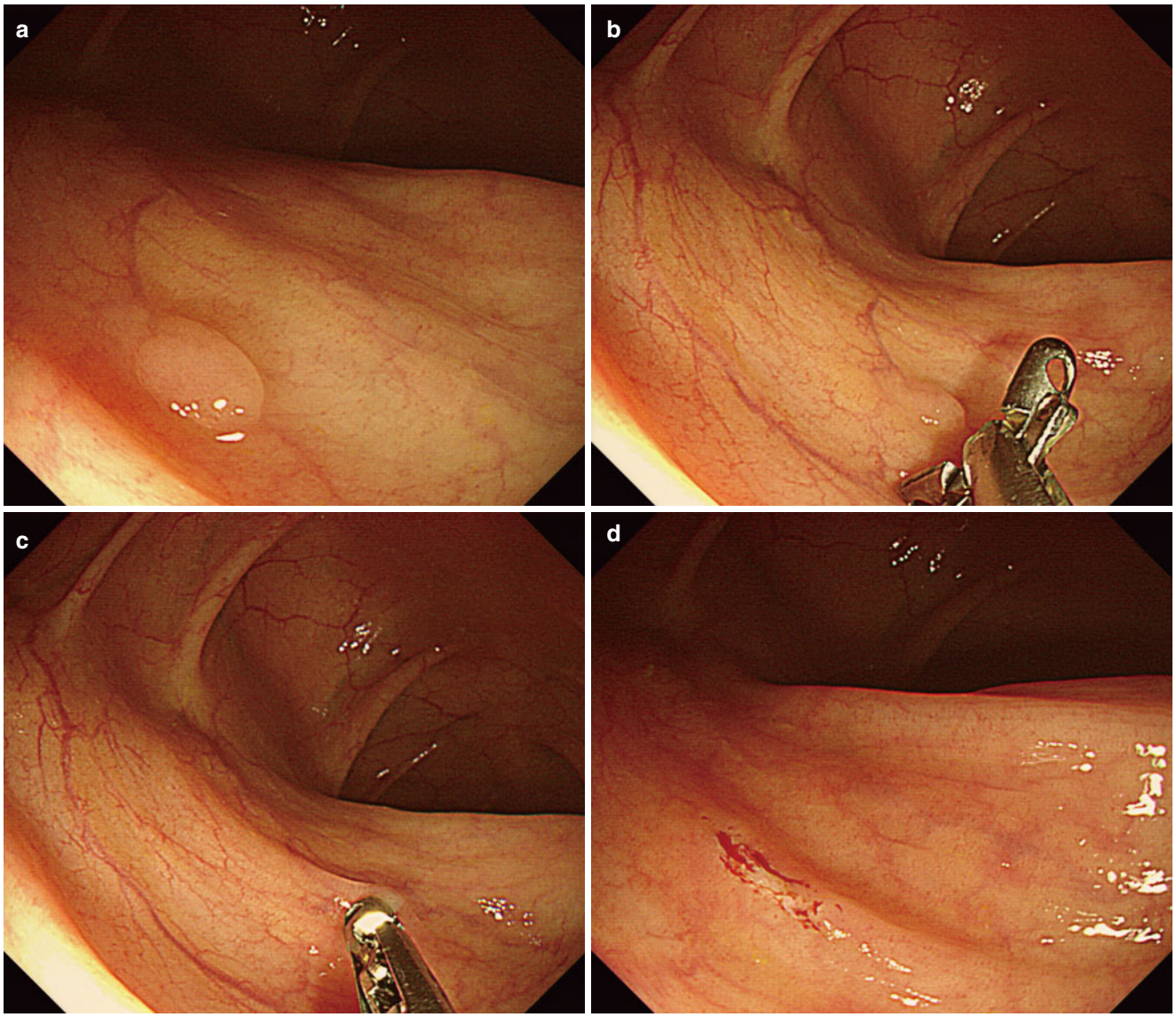

Fig. 9.14 Cold forceps polypectomy of a diminutive polyp. (**a**) A 3 mm, 0-IIa-type polyp in the transverse colon. (**b**) The lesion is being removed by single standard-capacity forceps bite. (**c**) The lesion is completely engulfed by the cups of forceps. (**d**) Remnant tumor is not found at the same site

Fig. 9.15 Diminutive polypectomy using a jumbo-capacity forceps. (**a**) A 4 mm 0-IIa-type polyp at the descending colon. (**b–c**) Opening a jumbo-capacity forceps and subsequent capture of the polyp. (**d**) Complete visual eradication of the polyp with a single forceps bite

9.5.3 Hot Forceps Polypectomy

- Hot forceps polypectomy or named as hot biopsy technique is another method to remove diminutive polyps by using a hot biopsy forceps device. This technique should be applied only for the removal of diminutive pedunculated polyps with a diameter up to 5 mm.
- The tip of polyp is partially captured within the cups of a hot forceps and is slightly tented by pulling of the forceps. Electrosurgical current is applied until appearance of white discoloration at the base of the polyp. During application of electrical current, the tip of forceps must not be in contact with adjacent normal colonic wall. Final polyp eradication is acquired by mechanical withdrawal of forceps engulfing polyp (Fig. 9.16).
- Hot forceps polypectomy is not encouraged for removal of any polyps larger than 5 mm because of potential risk of complications associated with electrocautery including hemorrhage, coagulation syndrome, delayed perforation, and inadequate histopathologic interpretation of polypectomy specimens. Authors do not use this technique anymore, even in polyps smaller than 5 mm in size.

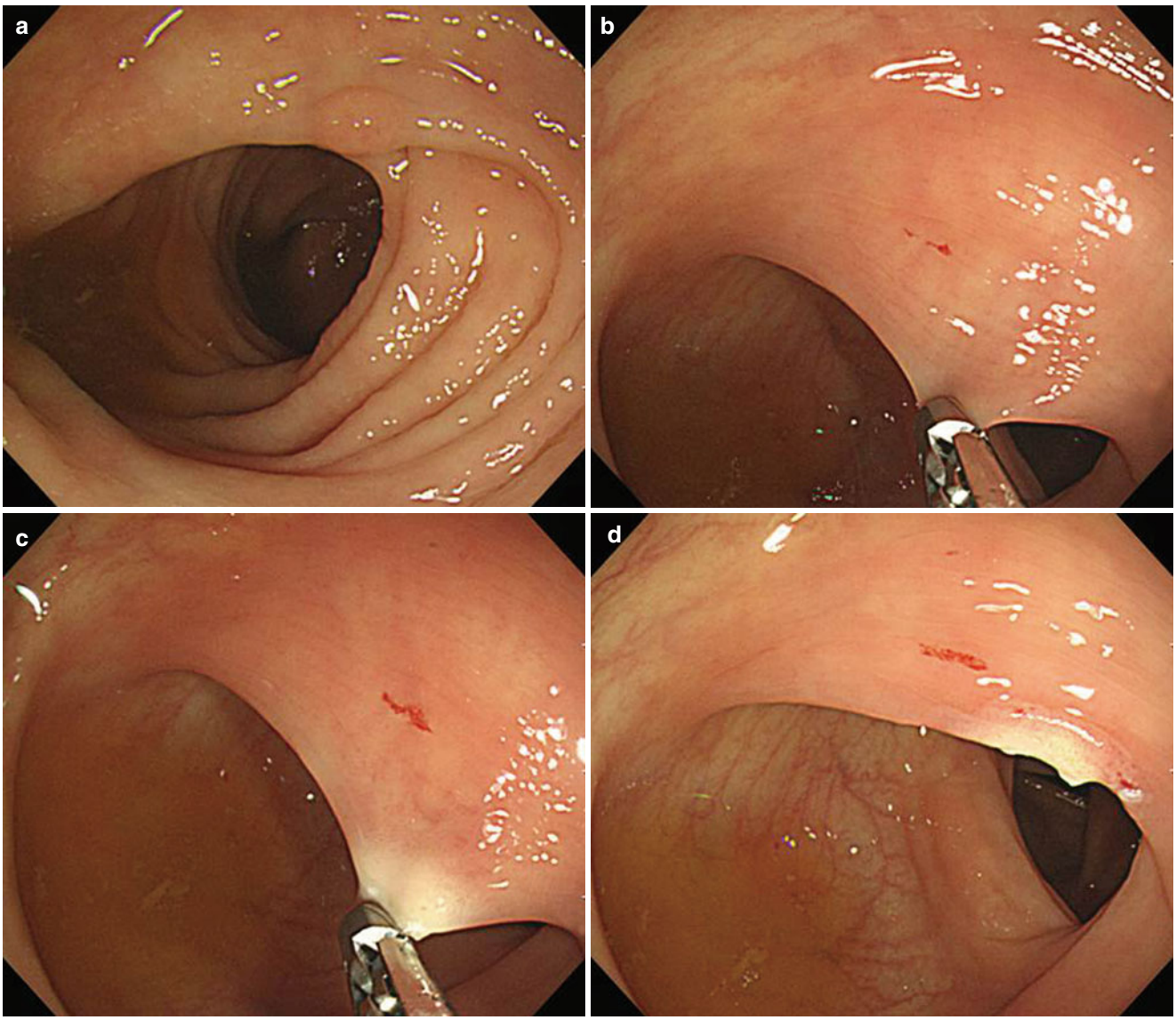

Fig. 9.16 Removal of a diminutive polyp by using a hot forceps technique. (**a**) A 3 mm, 0-IIa-type diminutive adenoma in the ascending colon (*arrow*). (**b**) Capture of the polyp using a hot forceps. (**c**) Electrical current should be stopped as soon as white discoloration is seen at the polyp base. (**d**) Polypectomy ulcer after removal of diminutive polyp

9.5.4 Cold Snare Polypectomy

- Cold snare polypectomy (CSP) is a safe and effective method for endoscopic resection of small (<10 mm size) colorectal polyps, but this technique is ideal for small sessile polyps 4–6 mm in size (Fig. 9.17). CSP is free from the potential risks related to the use of electrocautery, such as perforation and inadequate interpretation of histopathology. Mini-oval-type snare of 10–13 mm size at its full expansion is appropriate for CSP.
- A recent randomized study shows that CSP technique is superior to cold forceps polypectomy technique in the endoscopic treatment of diminutive polyps, regarding completeness and procedure time [8].
- After slight deflation of luminal air, the polyp including 1–2 mm rim of surrounding normal mucosa is captured and mechanically transected by squeezing of a snare. Tenting of the lesion causes the resected specimen to leap out outside endoscopic field and to fail polyp retrieval. Transection should be fast because slow transection may cause abundant submucosal tissue injury and subsequent bleeding unnecessarily.
- Next important step is subsequent suctioning of the resected specimen at the polypectomy site through the colonoscope channel into the trap. After transection of the polyp, the tip of colonoscope should be directed forward to the resection site and subsequent suction is applied.
- Concerns for CSP technique include polyp retrieval failure and immediate mucosal bleeding. The rate of polyp retrieval has been reported, ranging from 93.2–96.0 % in recent randomized trials. The risk of significant bleeding is exceedingly rare, and most of immediate mucosal bleeding spontaneously ceases in patients who are not taking antiplatelet or anticoagulant agents (Fig. 9.18).

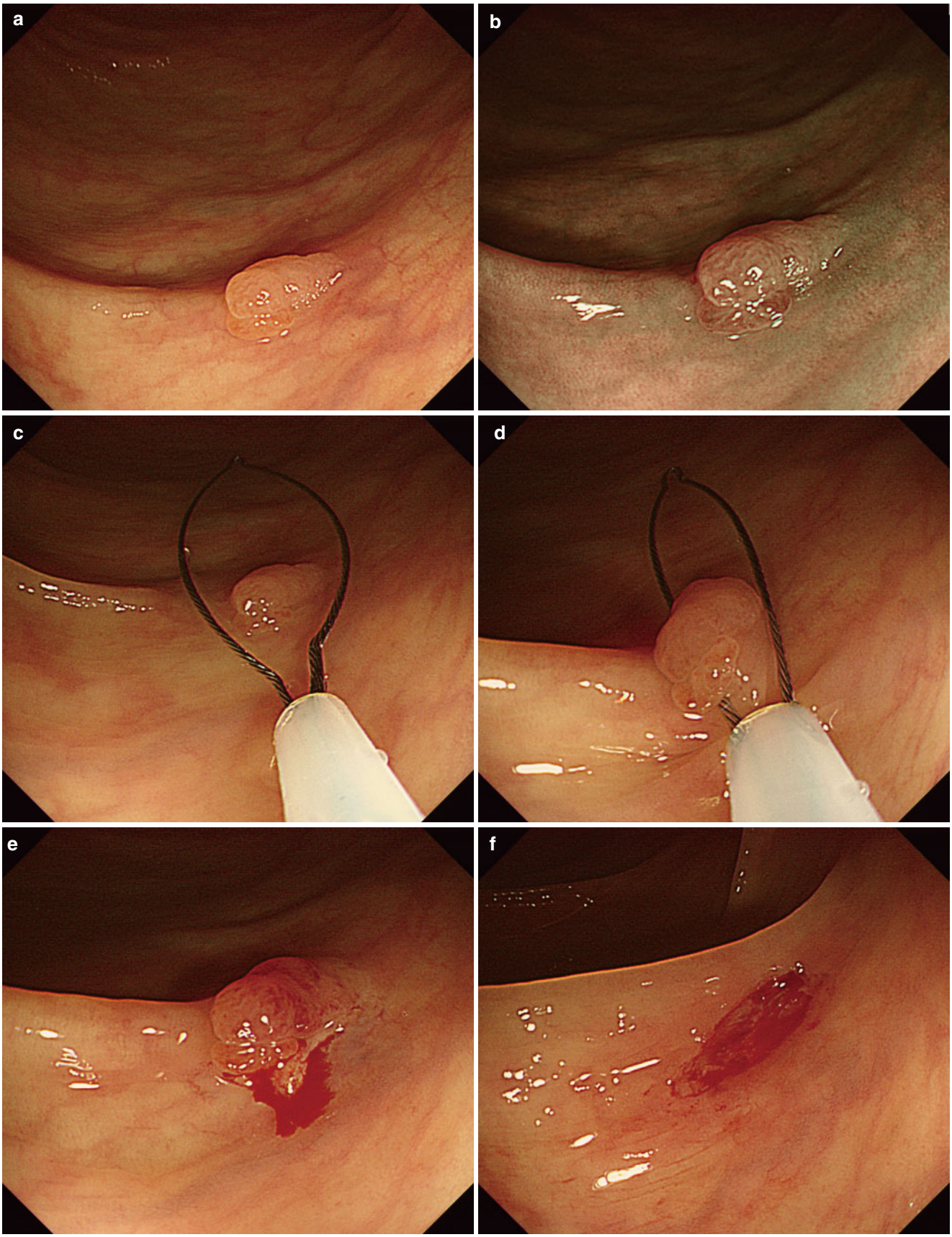

Fig. 9.17 Cold snare polypectomy of a small sessile polyp. (**a**) A 5 mm, 0-Is-type sessile adenoma at the rectum. (**b**) NBI image of the same lesion. (**c**) Expansion of a 10 mm micro-oval snare above the lesion. (**d**) Capture and rapid transection of the lesion with a 1–2 mm surrounding normal mucosa. (**e**) The resected specimen remained on the polypectomy site. (**f**) Polypectomy ulcer after polyp retrieval

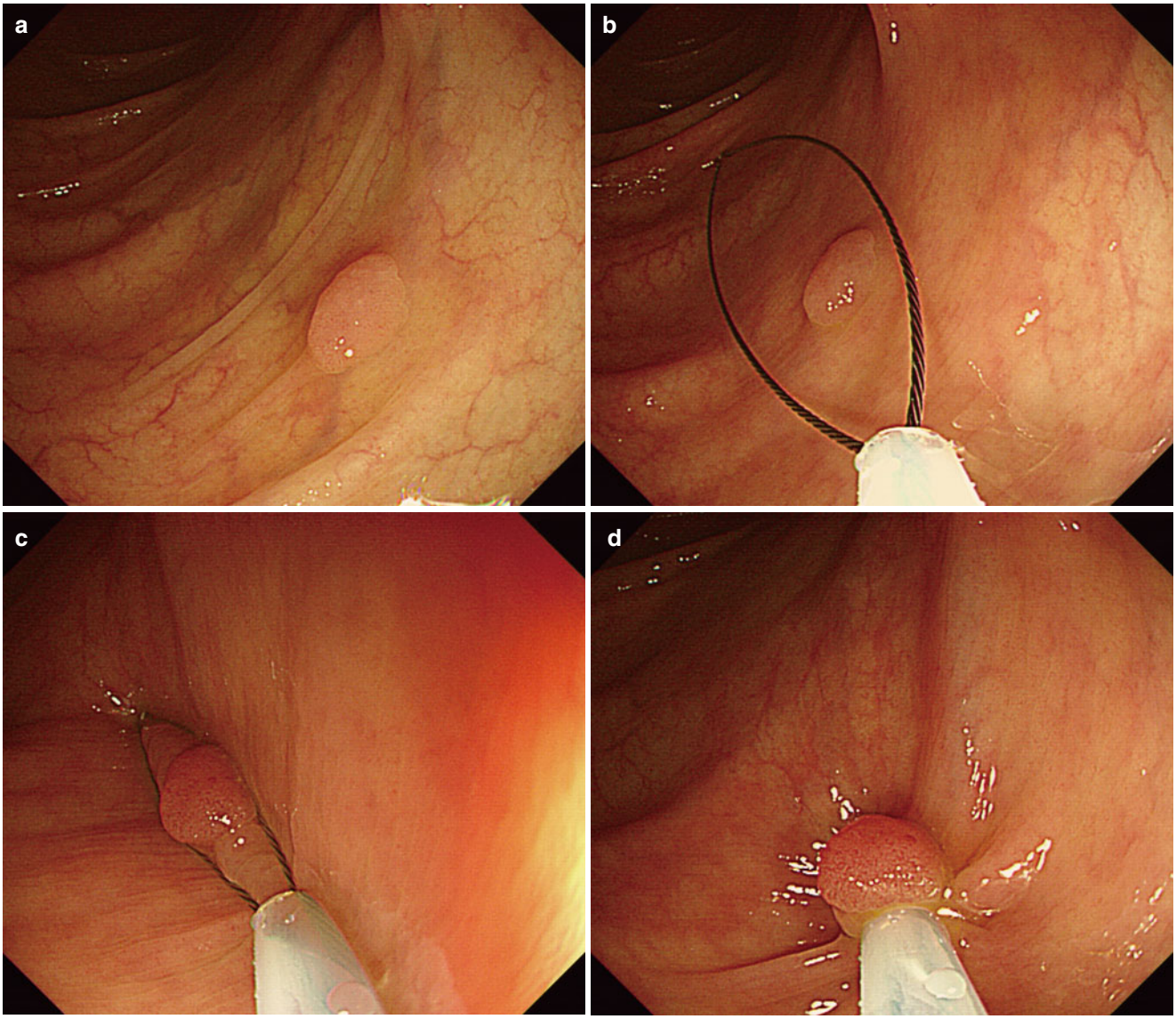

Fig. 9.18 Cold snare polypectomy of a diminutive polyp. (**a**) A 4 mm, 0-IIa-type adenoma at the transverse colon. (**b**) Expansion of a mini-oval snare over the lesion. (**c**) Capture of the lesion with a 1–2 mm surrounding normal mucosa. (**d–e**) Mechanical transection of the lesion. (**f**) Mucosal bleeding after polyp retrieval. (**g**) Spontaneous hemostasis of mucosal bleeding. (**h**) A retrieved specimen mounted on a polystyrene board. Note a tumor with a rim of surrounding normal mucosa

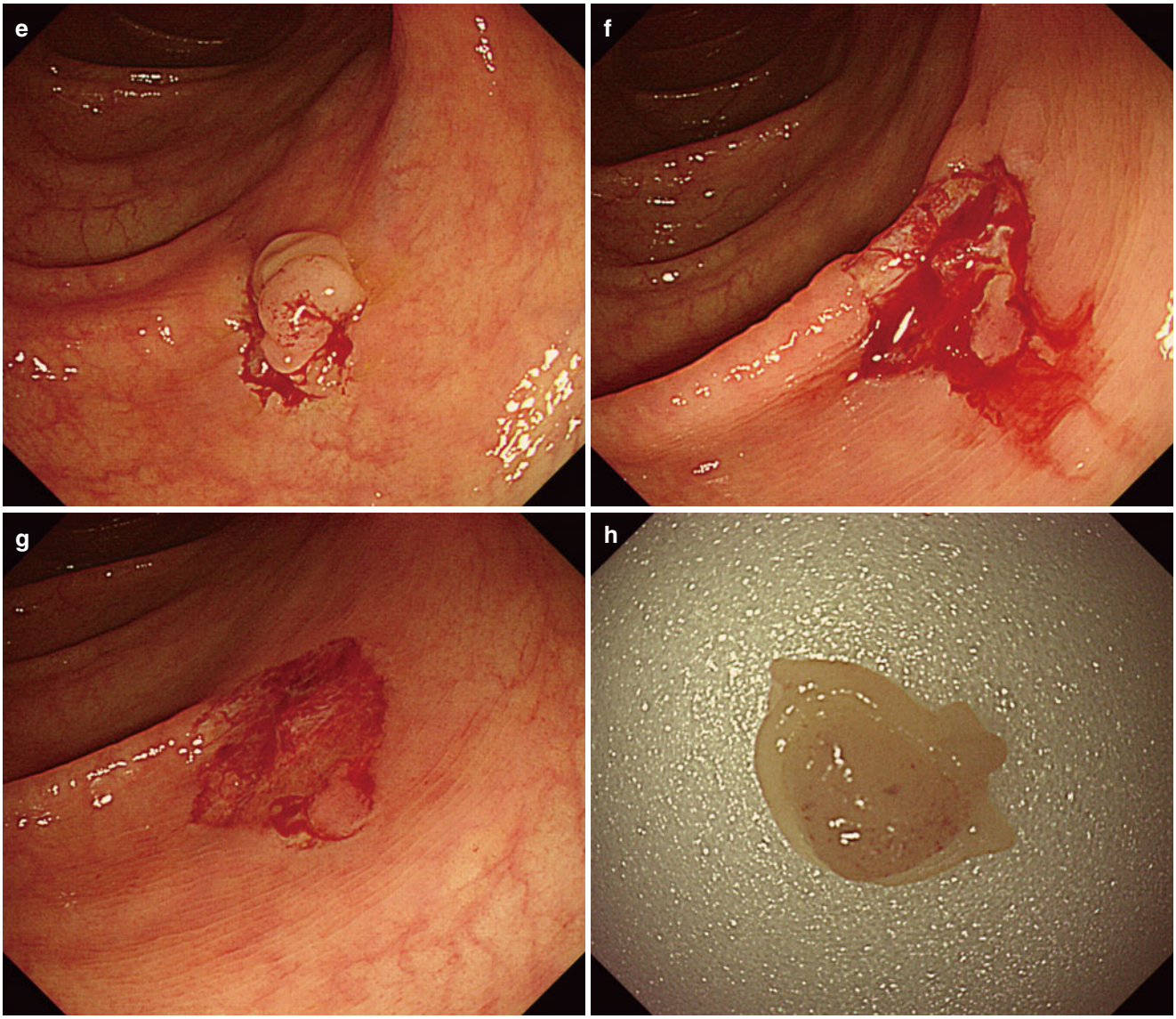

Fig. 9.18 (continued)

9.5.5 Hot Snare Polypectomy

- Hot snare polypectomy (HSP) is one of several effective methods for endoscopic resection of sessile or pedunculated polyps. However, resection of larger sessile polyps having broad base or thick pedicle by using HSP is not encouraged because of potential risk of perforation or bleeding.
- In case of a sessile polyp, the target lesion should be ensnared without capture of a surrounding normal mucosa if feasible. During application of electrical current, the ensnared polyp tissue should be tented from the surrounding normal colonic wall to minimize the risk of transmural burn (Fig. 9.19). Inadvertent cold cutting may cause mucosal bleeding.
- In case of a pedunculated polyp, the snare is placed at the one third or one half from the polyp head to leave residual stalk (Fig. 9.20). If the immediate bleeding following polyp resection occurs, the bleeding can be effectively controlled with gentle grabbing of remnant stalk with a snare or clip application.

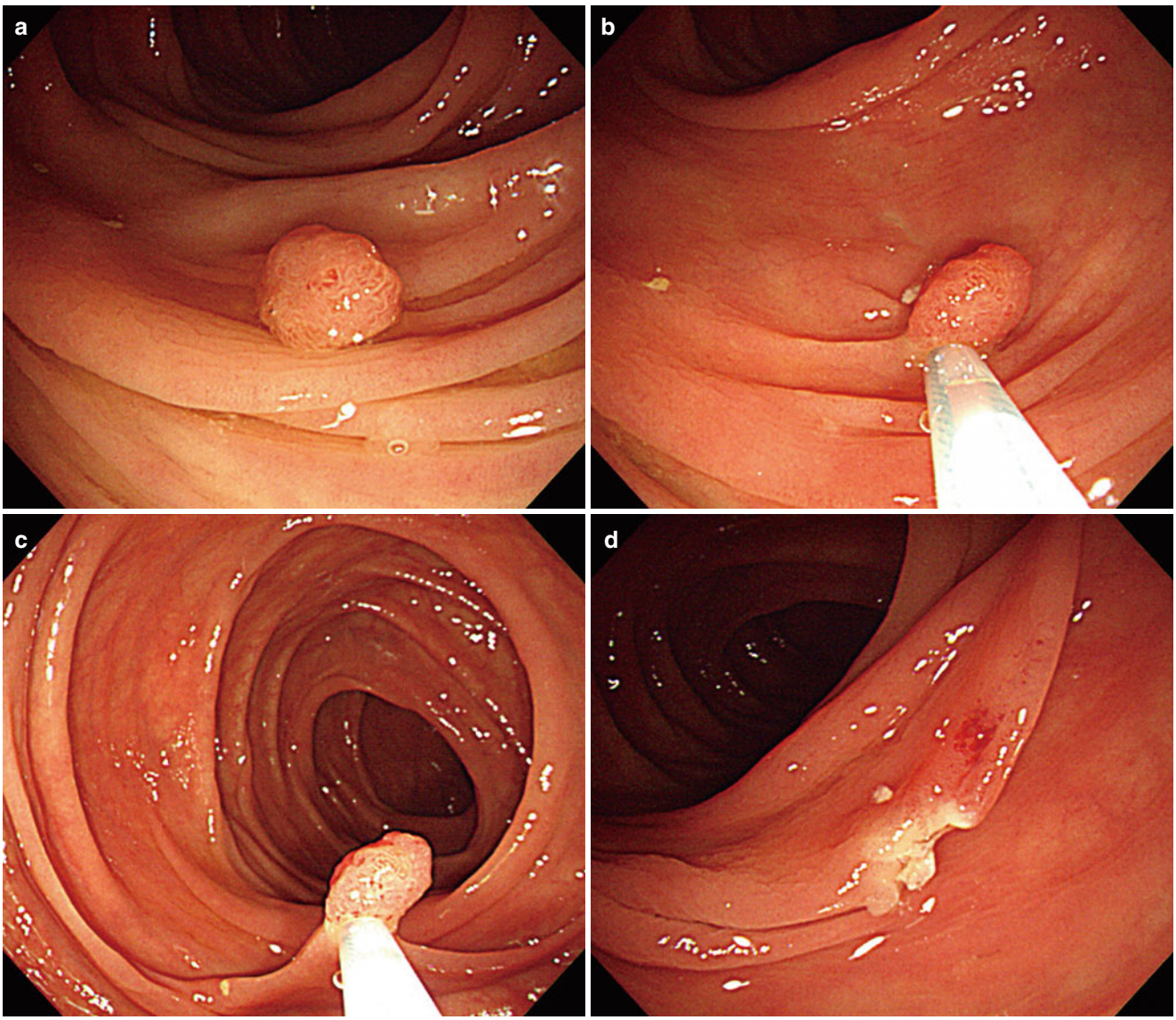

Fig. 9.19 Hot snare polypectomy of a small sessile polyp. (**a**) A 6 mm, 0-Is-type polyp at the ascending colon. (**b**) Capture with snare. (**c**) Electric current should be applied shortly after tenting of the ensnared polyp from the surrounding normal colonic wall. (**d**) Polypectomy ulcer following resection

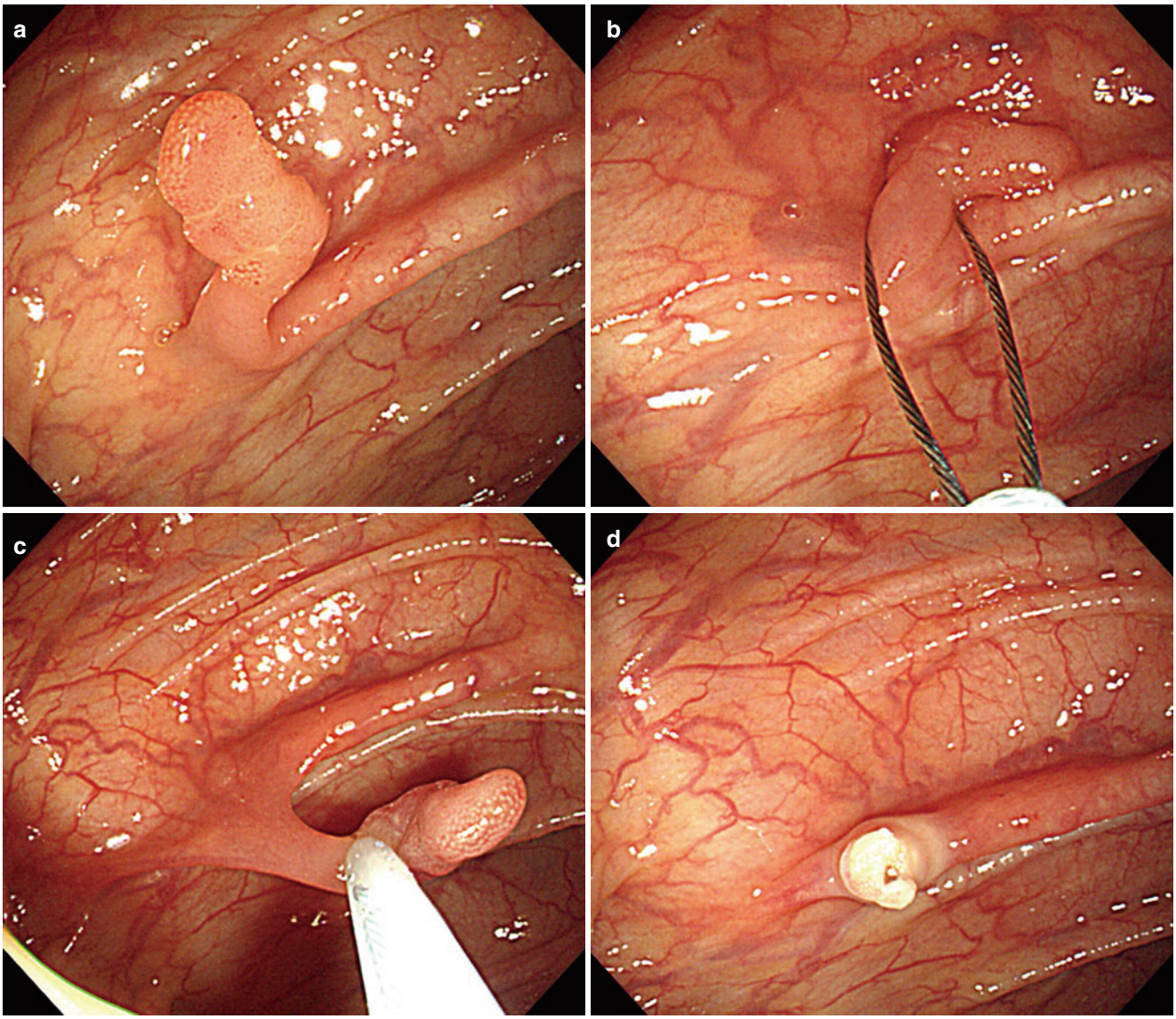

Fig. 9.20 Hot snare polypectomy of a pedunculated polyp. (**a**) An 8 mm, 0-Ip-type polyp at the ascending colon. (**b**) Snaring at the one half from the polyp head. (**c**) Electric current should be applied shortly after tenting of the ensnared polyp from the surrounding normal colonic wall. (**d**) Polypectomy ulcer following resection

9.5.6 Endoscopic Mucosal Resection (EMR)

- The appropriate indications of EMR include lesions that are (1) type O-IIa less than 2 cm, (2) type O-IIb less than 1 cm, (3) type O-IIc less than 1 cm, or (4) well-differentiated or moderately differentiated tumors confined to the mucosa. Successful removal of lesions larger than 2 cm has been well documented using piecemeal fashion but is associated with higher recurrence rates.
- Contraindications include (1) the lesions that are suspicious for submucosal invasion, lymph node or distant metastasis; (2) the non-lifting sign, defied as the failure of a lesion to elevate above the surrounding mucosa after submucosal injection underneath the lesion; (3) patients who have coagulopathy due to the risk of bleeding; (4) any contraindication to standard endoscopy such as severe cardiopulmonary comorbidities.
- Before performing EMR, the endoscopist should identify the margins and extents of the lesion in order to avoid incomplete resection.
- Several EMR techniques have been developed, all based on the principles of "lifting" the target mucosa and resection using the application of cautery (Fig. 9.21).
- When lesion was captured using snare, reducing wall tension by aspirating luminal air helps to draw the lesion into the loop of the snare. It is recommended to take a margin consisting of normal tissue with the lesion. The entrapped lesion should be moved to and fro to ensure the muscle layer has not been snared and then diathermy is applied in the usual way.

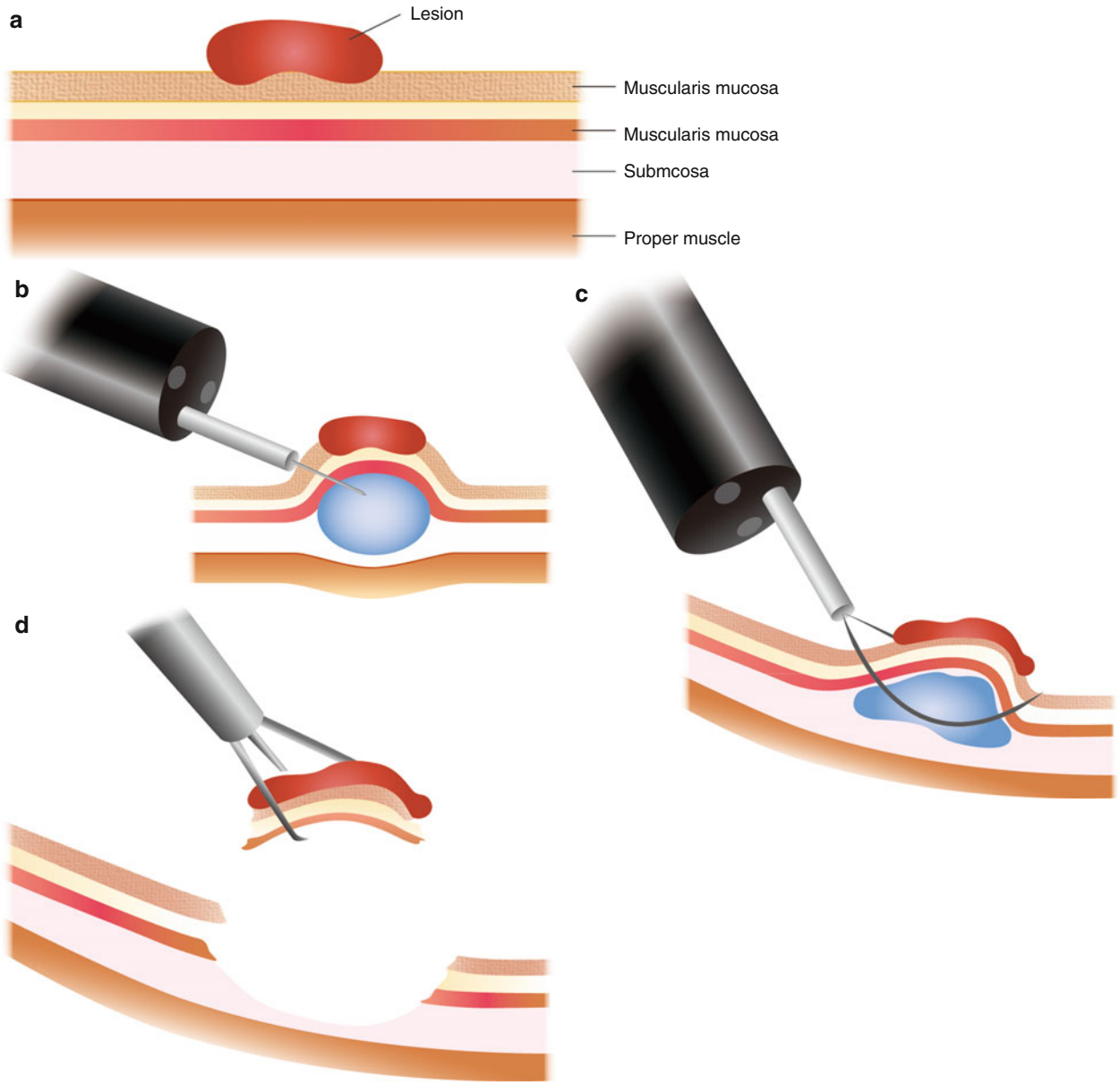

Fig. 9.21 The principle of endoscopic mucosal resection. (**a**) Identify and delineate the margin of the superficial colorectal lesion. (**b**) Submucosal injection. (**c**) Capture with snare. (**d**) Cutting with electric current application

9.5.6.1 Injection-Assisted EMR

- The injection-assisted technique, or "inject-and-cut" technique, consists of submucosal injection of a liquid submucosal agents followed by the application of snare cautery for lesion resection.
- Submucosal injection has potential benefits to facilitate grasping using snare and to limit the depth of thermal injury within the submucosal layer of colonic wall.
- If possible, the approach by the injection needle should be tangential to the mucosal surface instead of perpendicular.
- A first injection just oral to the margin of the lesion is often advised, because the submucosal bleb tilts the lesion toward the endoscope making it easier to snare.
- When difficult to find the submucosal layer, the injection should start while the needle is still in the colonic lumen. As the needle tip passes into the loose submucosal connective tissue, the saline rapidly expands the space producing the successful bleb.
- It is within the endoscopist's discretion to select the injection agents and decide the injection volume, ensuring adequate separation between the lesion and the muscle layer.
- Submucosal invasive cancers, which show the "non-lifting sign," should not be removed by the "inject-and-cut" technique.

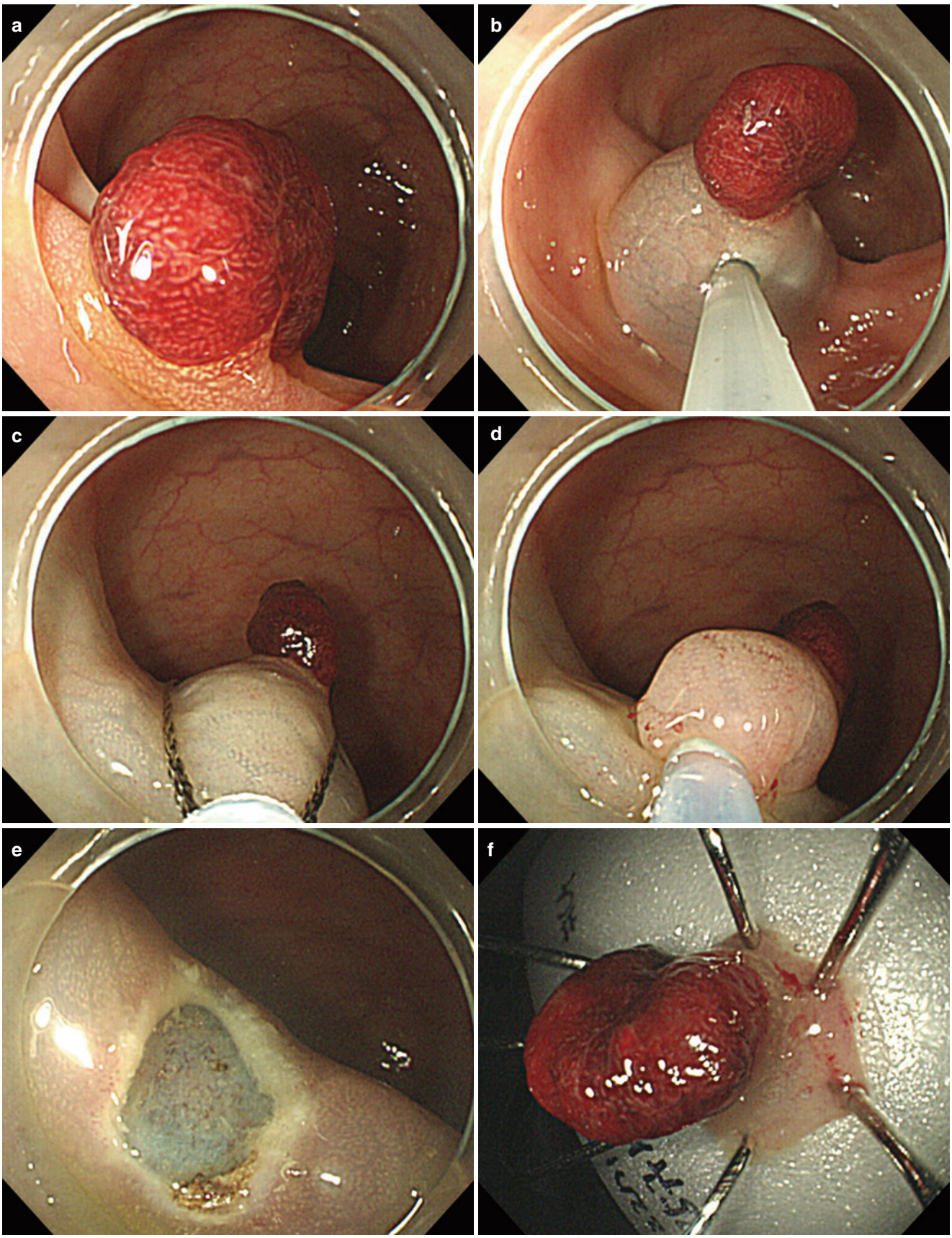

Fig. 9.22 Injection-assisted EMR (inject-and-cut). (**a**) An approximately 8 mm-sized type O-Is rectal polyp. (**b**) Injection of submucosal saline solution. (**c**) Capture with snare. (**d**) Cutting with electric current application. (**e**) Clear, post-EMR ulcer. (**f**) Resected specimen

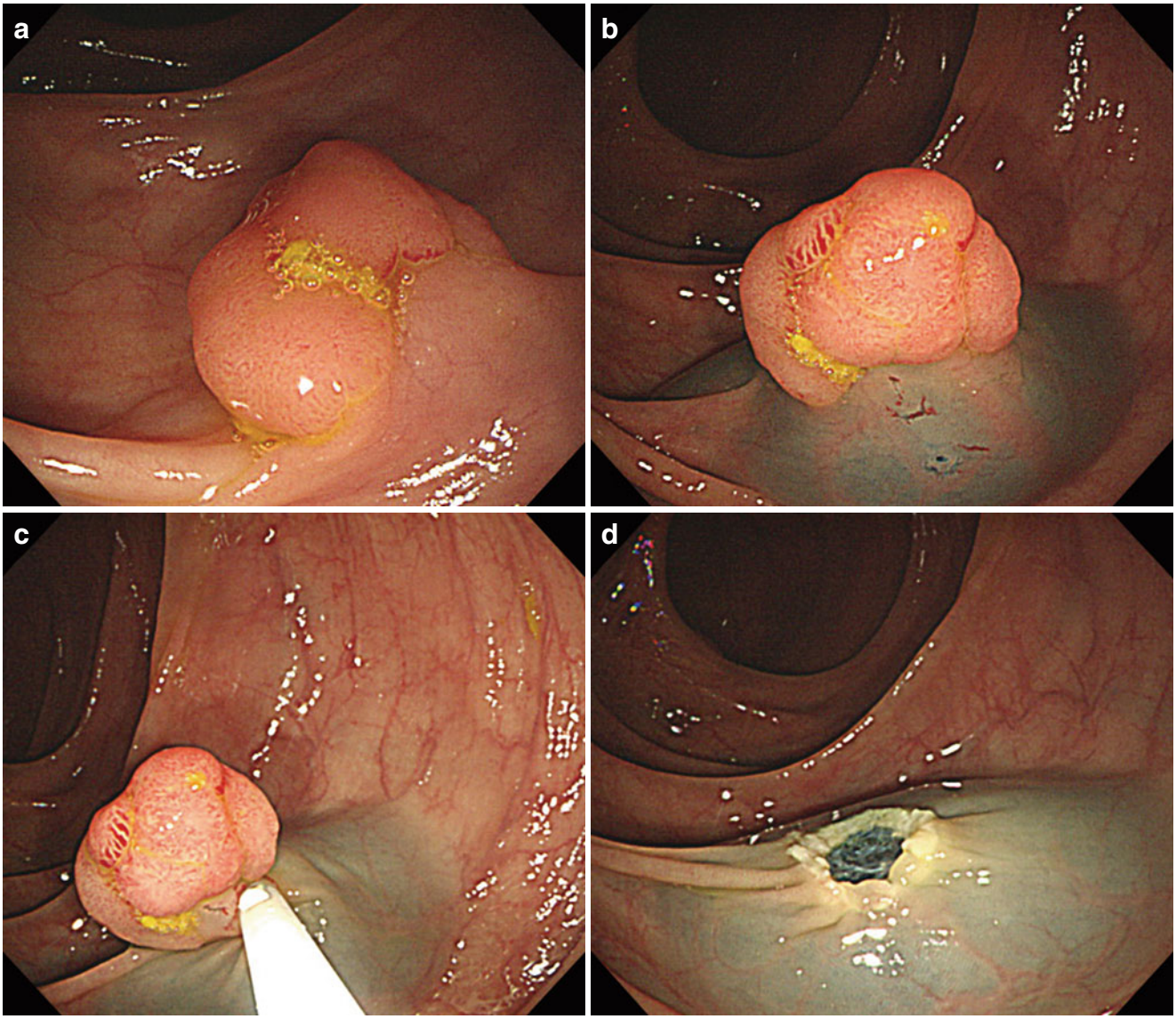

Fig. 9.23 Injection-assisted EMR (inject-and-cut). (**a**) An approximately 12 mm-sized type O-Is rectal polyp. (**b**) Injection of submucosal saline solution. (**c**) Cutting using snare. (**d**) A clear, post-EMR ulcer

9.5.6.2 Cap-Assisted EMR (EMR-C)

- Cap-assisted EMR (EMR-C) uses a combination of submucosal injection, aspiration of tissue into a clear soft plastic cap attached to the tip of the endoscope, and snare excision (Fig. 9.24).
- EMR-C used specially designed cap and snare. The snare is opened within the distal internal rim of the cap, tissue is aspirated within the cap and snare, the snare is closed around the captured tissue, and standard snare cautery is applied to excise the tissue.

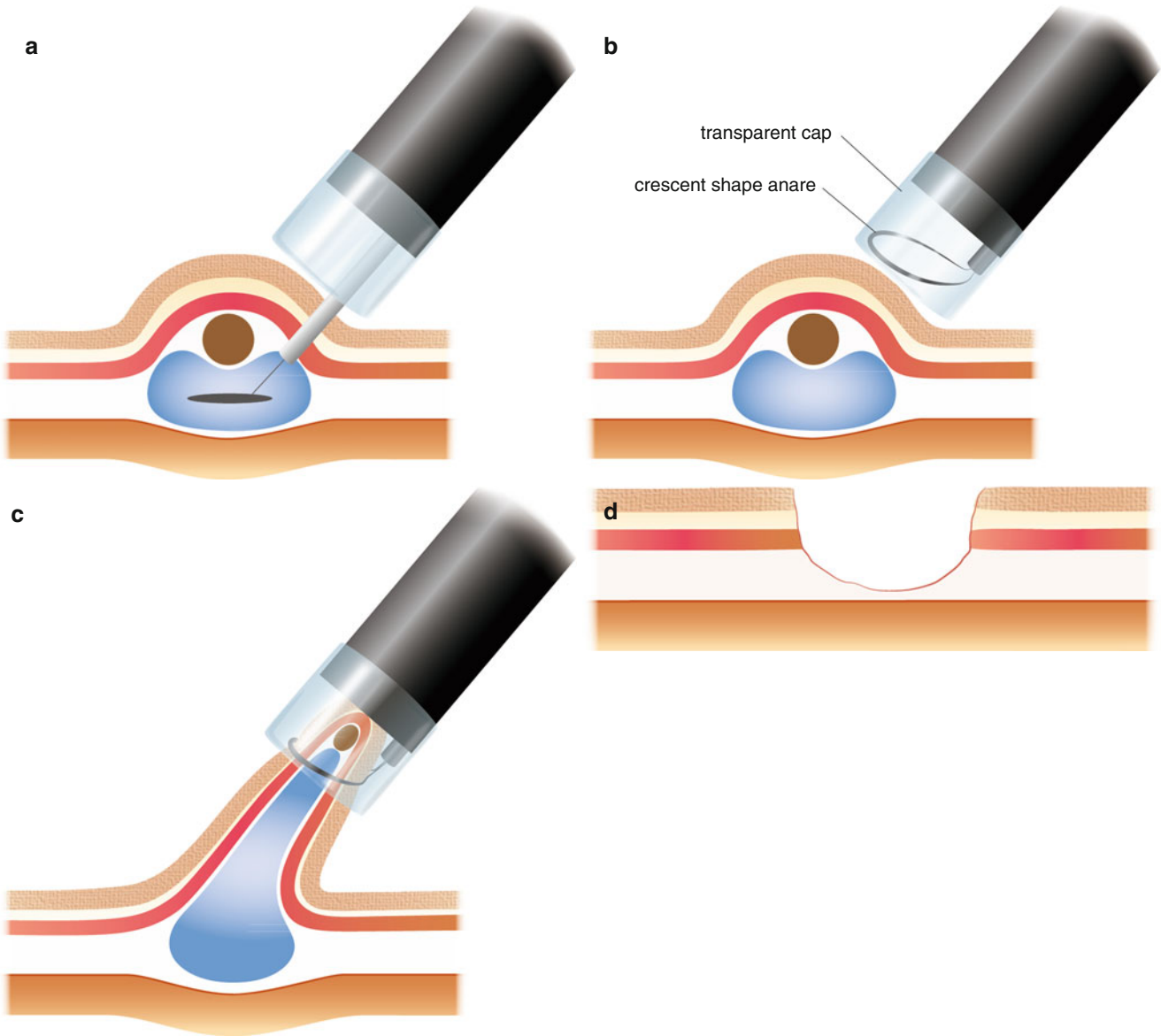

Fig. 9.24 The principle of cap-assisted EMR. (**a**) Delineate the lesion and inject submucosal solution. (**b**) Open snare within the distal internal rim of the cap. (**c**) Aspiration of tissue within the cap and snaring around the captured tissue. (**d**) Standard snare cautery to excise the tissue

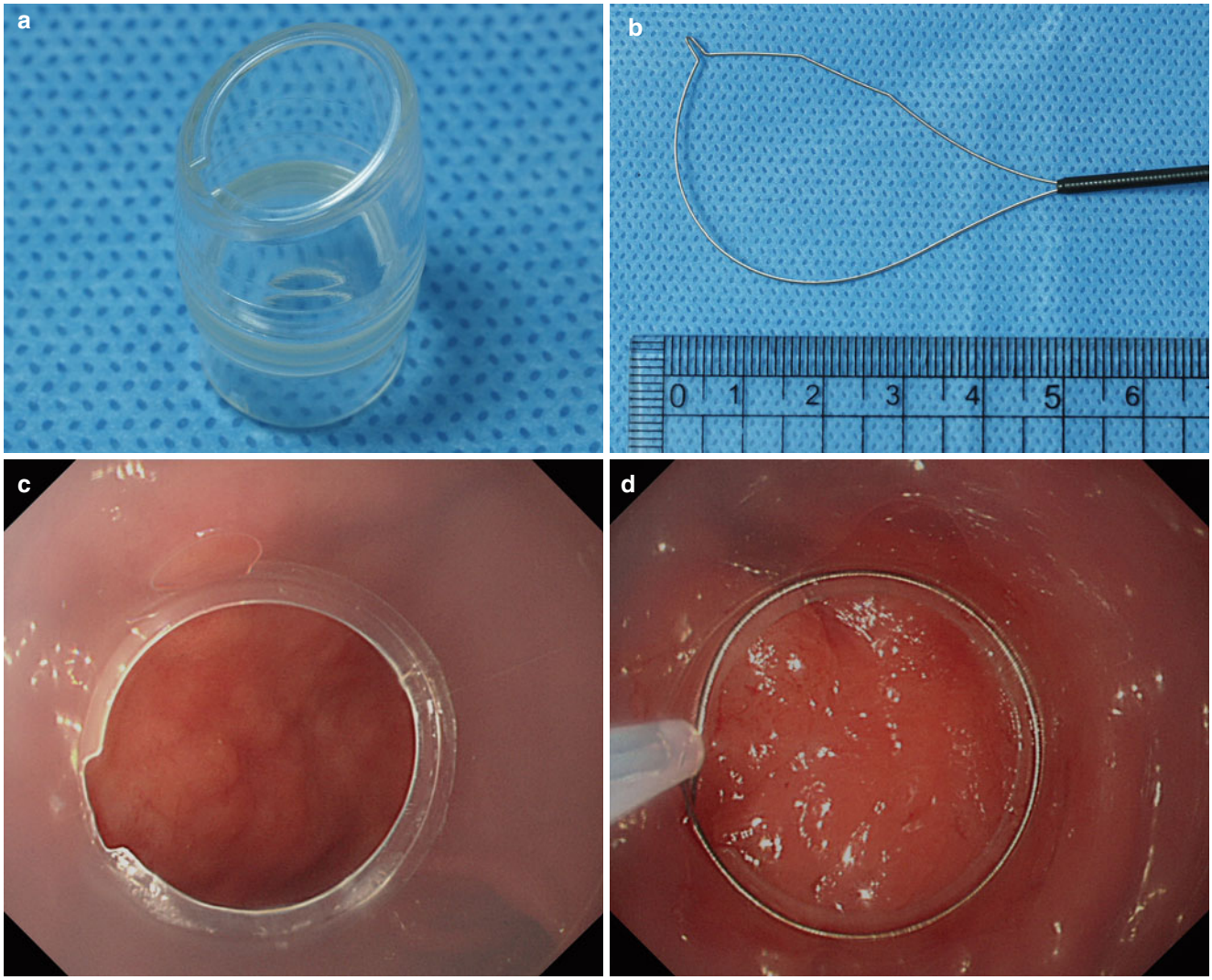

Fig. 9.25 Cap-assisted EMR (EMR-C). (**a**) Transparent cap for EMR-C. (**b**) Crescent-type snare for EMR-C. (**c**) An approximately 6 mm-sized type O-IIa flat superficial lesion on the mid rectum. (**d**) Snare open within the distal internal rim of the cap. (**e**) Aspiration of tissue and snaring around the captured tissue followed by standard snare cautery. (**f**) Post-EMR ulcer. (**g**) Hemostasis. (**h**) Resected specimen

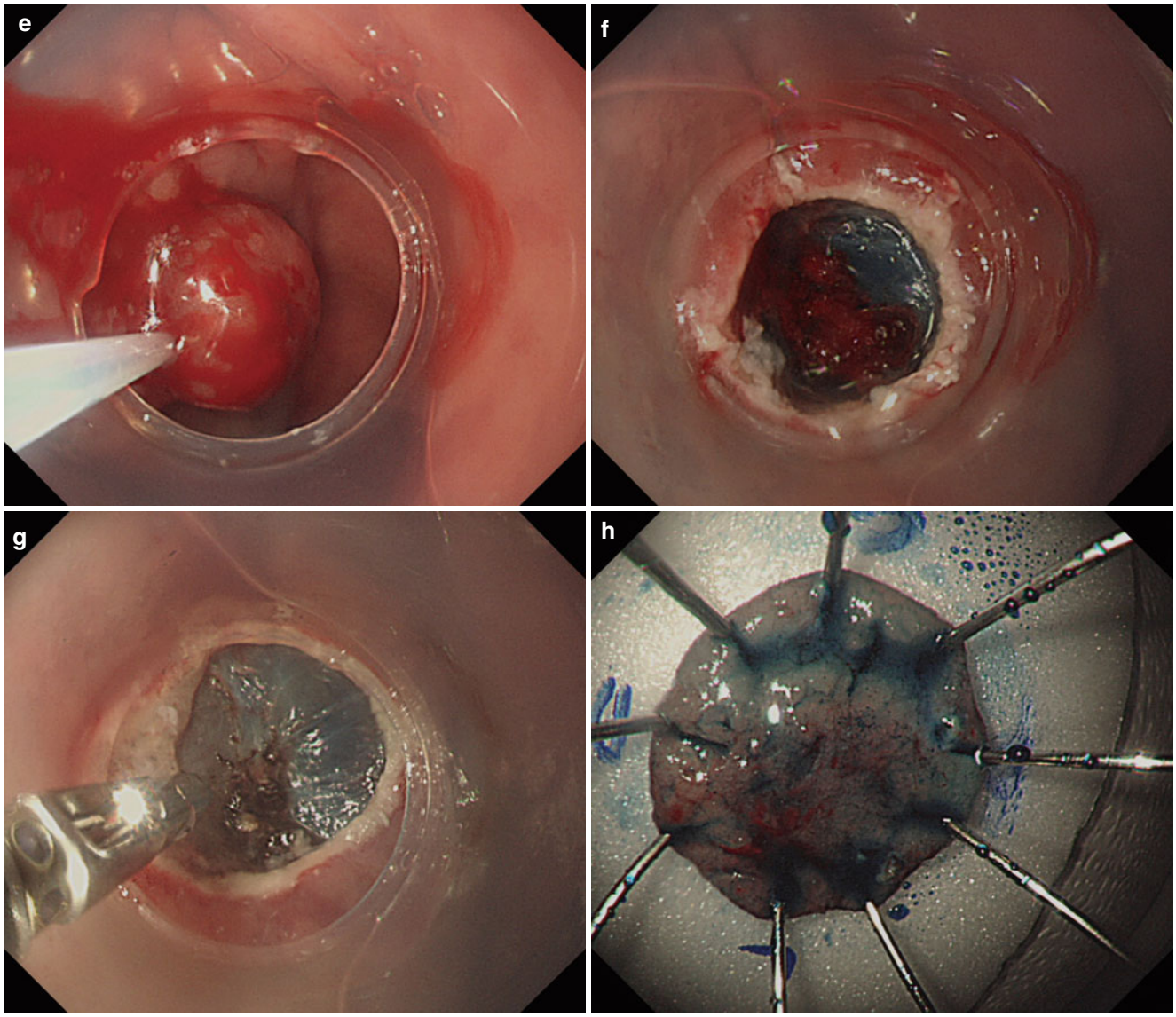

Fig. 9.25 (continued)

9.5.6.3 Ligation-Assisted EMR

- Endoscopic variceal ligation (EVL) band will incorporate the mucosal and submucosal layers while leaving the proper muscle due to insufficient contractile force.
- A standard EVL device is used to aspirate the target lesion and apply a band around it. Following removal of the banding device, a separate snare is then used to resect the lesion.

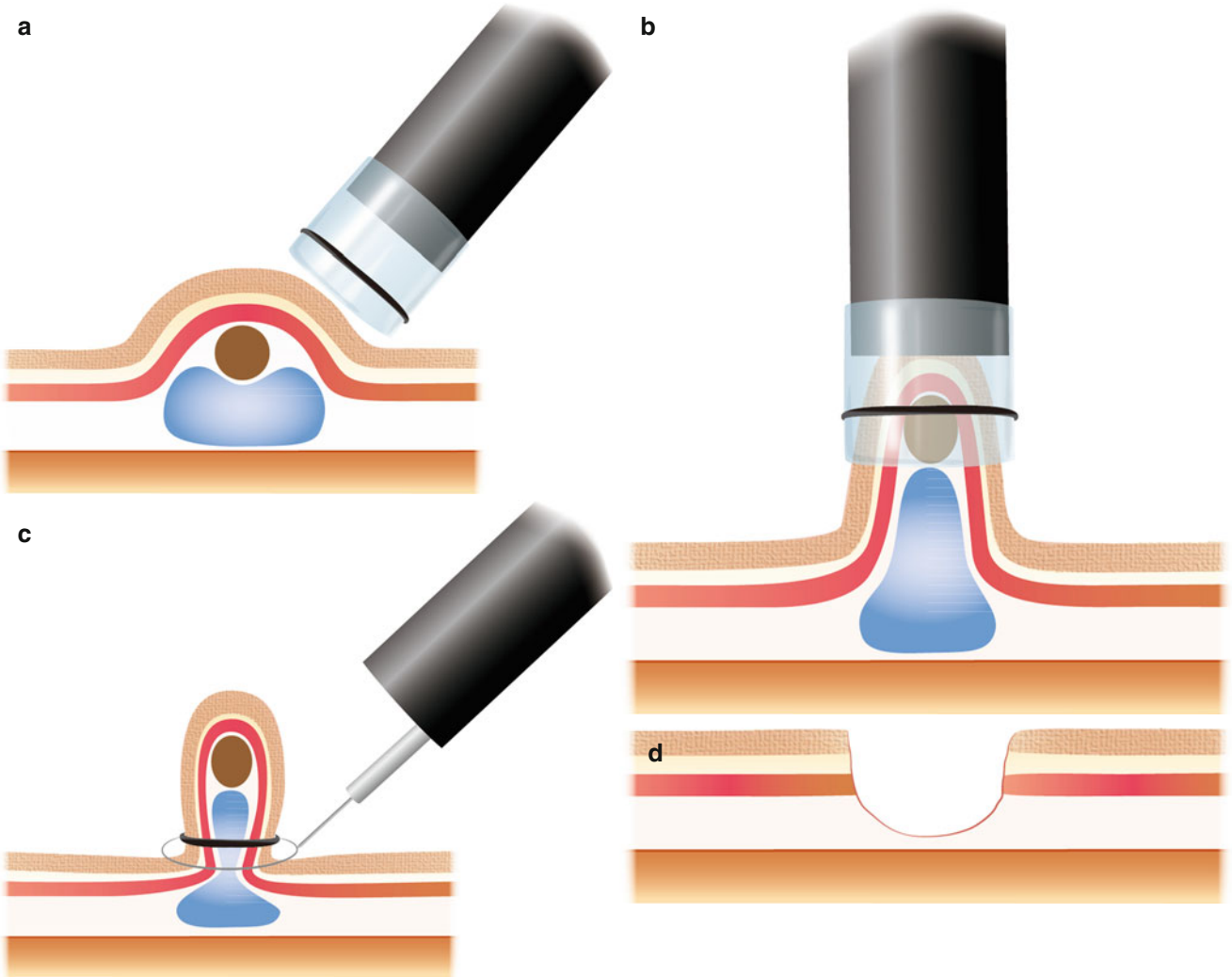

Fig. 9.26 Ligation-assisted EMR (EMR-L). (**a**) Delineate the lesion and inject submucosal solution. (**b**) Aspirate lesion within the cap and apply a band around it. (**c**) Snaring below the captured band. (**d**) Standard snare cautery to excise the tissue

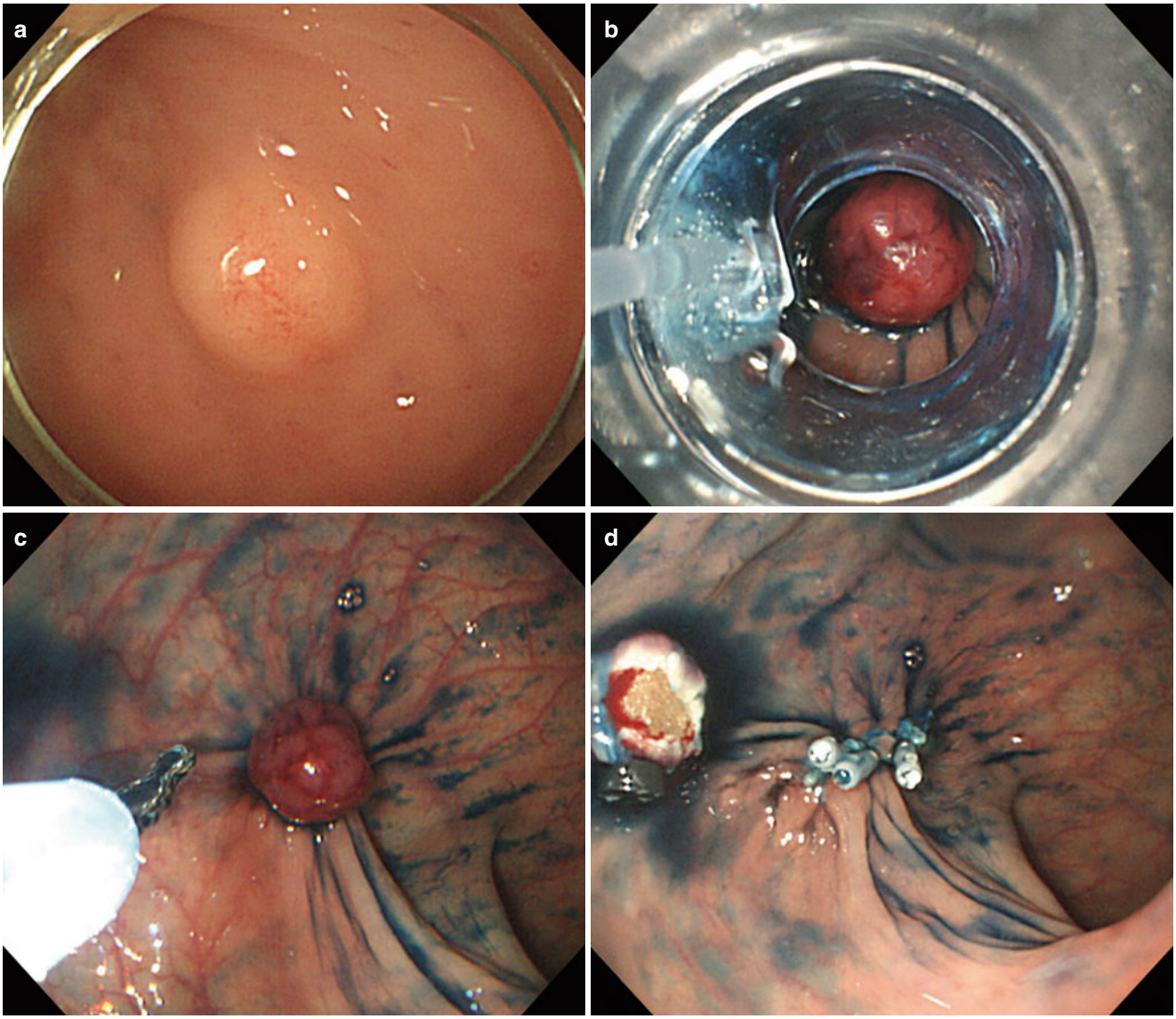

Fig. 9.27 Ligation-assisted EMR (EMR-L). (**a**) An approximately 6 mm rectal carcinoid tumor. Aspiration of a carcinoid tumor into the ligating device. (**b**) Deployed elastic band. (**c**) Snare resection performed below the band. (**d**) Resected specimen

9.5.6.4 EMR with Precutting (EMR-P)

- EMR with a circumferential incision at the edges of the lesion by snare tip or ESD knife before snaring facilitates the lesion to be snared easily, thus achieving en bloc resection of large.
- This technique, also called as EMR-incision technique (IT-EMR) or circumferential submucosal incision-EMR (CSI-EMR), could be an alternative to ESD as a tool to achieve en bloc resection of selected lesions.

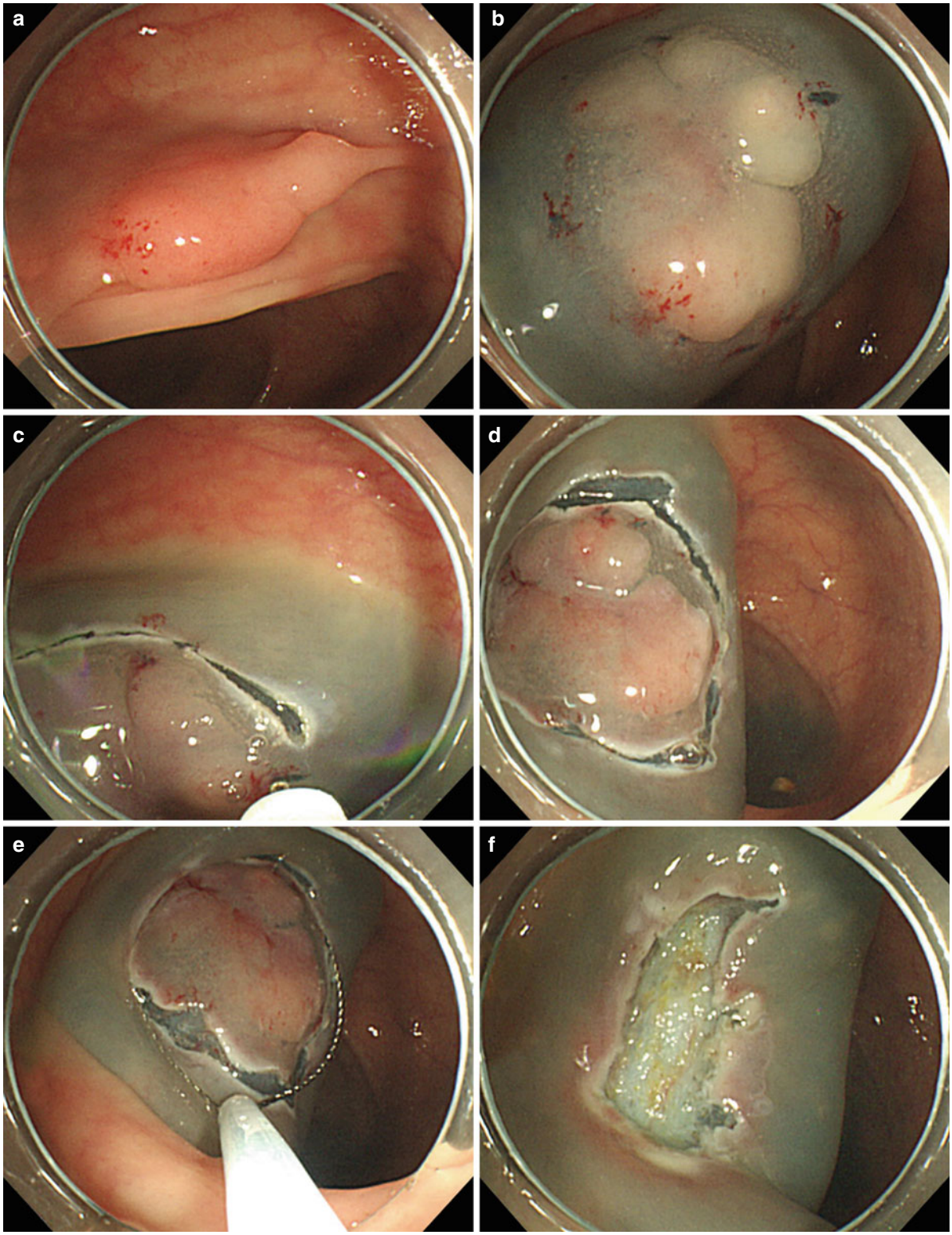

Fig. 9.28 EMR with precutting. (**a**) An approximately 16 mm-sized type O-IIa lesion on the sigmoid colon. (**b**) Submucosal injection. (**c**) Mucosal incision using dual knife. (**d**) Circumferential mucosal incision. (**e**) Snaring along the mucosal incision. (**f**) Clear, post-EMR ulcer

9.5.7 Endoscopic Piecemeal Mucosal Resection (EPMR)

- En bloc resection with one application of the snare may be achieved in polyps up to 2 cm in diameter, but larger polyps may require several piecemeal transections. EPMR has gained wide acceptance due to its simplicity, rapidity, and low complication rates, despite increased risk of residual lesion and high incidence of local recurrence.
- EPMR can be performed with or without submucosal injection.
- EPMR should be done in the lowest number of fragments as possible in order to reconstruct and "reset" the lesion as close as possible to the original unfragmented status.
- An opened snare is positioned on the part of the polyp that is intended to be removed. Then air suction is performed to draw the polyp tissue into the snare. The snare is gently closed until resistance is felt, air is insufflated to recover good visibility, and electrical current is applied. The size of pieces cut varies between 0.5 and 1.5 cm.
- In the nodular mixed-type laterally spreading tumor, the largest nodule or area suspected to contain malignant change should be resected in one piece.
- If necessary, argon plasma coagulation can be used to treat the post-EPMR ulcer base in an attempt to destroy any residual polyp.

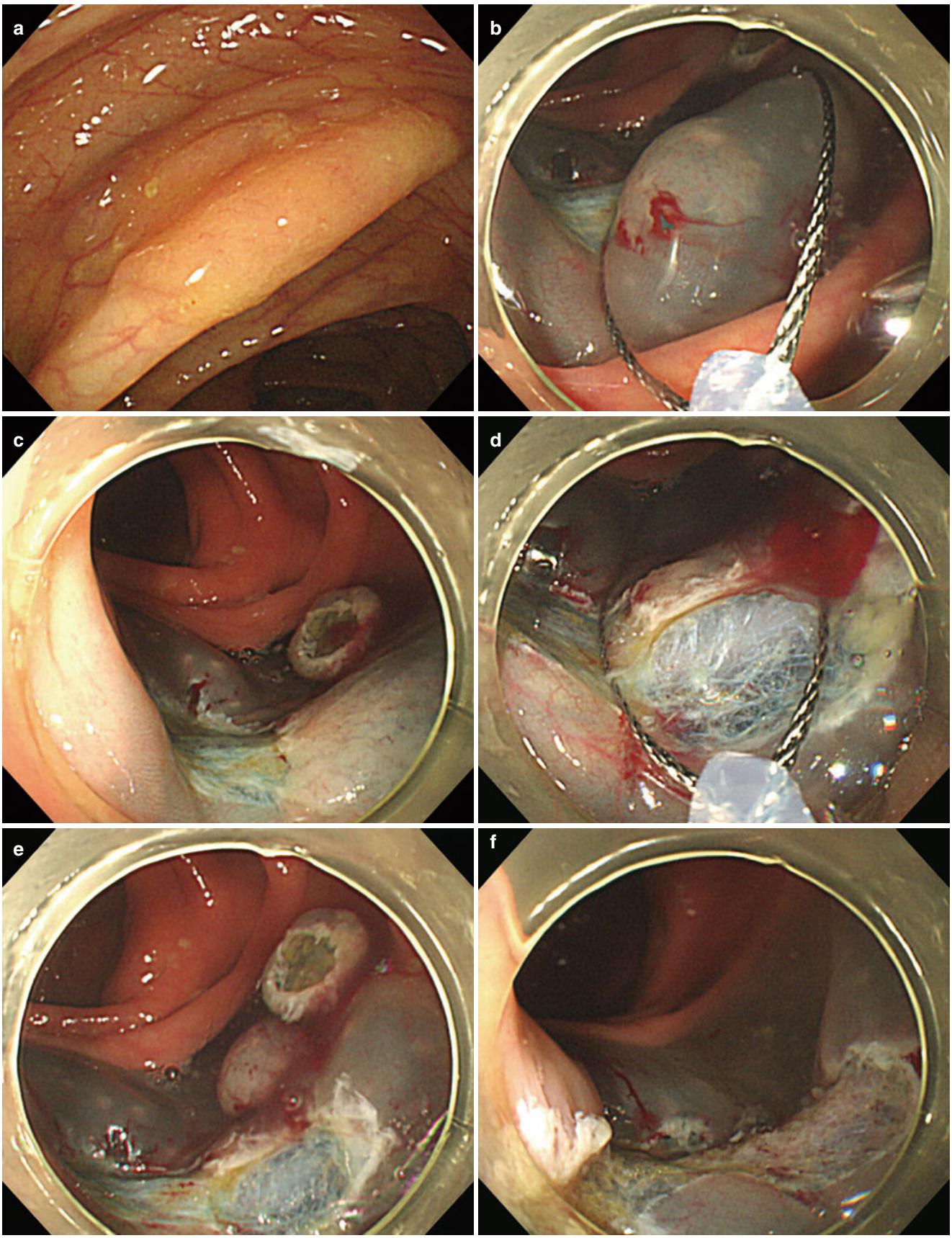

Fig. 9.29 Endoscopic piecemeal mucosal resection (EPMR) of a large sessile polyp. (**a**) Endoscopic view of the ascending colon showing a 30 mm-sized sessile polyp. (**b**–**e**) Piecemeal polypectomy was performed. (**f**) Clear, post-EMR ulcer

9.5.8 Detachable Snare Loop or Clip for Polypectomy

- Clip and detachable snare loop are available for polypectomy of large (>1 cm), pedunculated polyps. Detachable snare loop or clip placement helps to prevent early bleeding during the removal of large, pedunculated polyps, but the preventative effects of these procedures for delayed bleeding are not clear.
- The detachable snare loop is a nylon ligature that can be placed over a stalk of pedunculated polyp and tightened with a silicone rubber stopper, which prevents opening of the loop after it has been closed. If the stalk of polyp is encircled successfully, it is necessary that the loop be placed on the pedicle enough toward the colonic wall to allow transection of the stalk above the loop with sufficient margin to ensure safety if the polyp contains invasive cancer. After placement close to the bowel wall, polypectomy is performed above the loop ligature. The loops spontaneously slough in 4–7 days and endoscopy following detachment of the loops shows residual shallow ulcers [12].

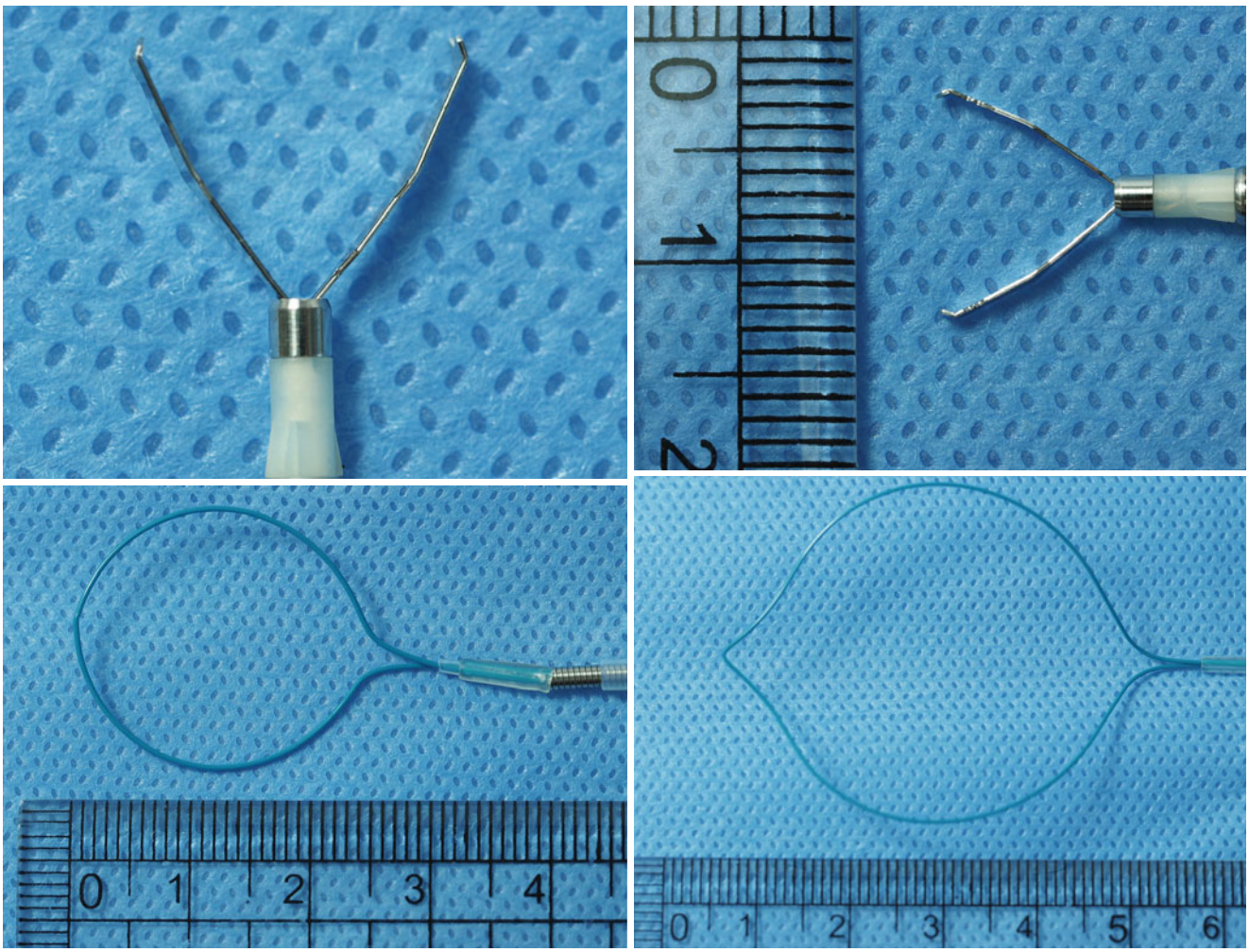

Fig. 9.30 Clips and detachable snares

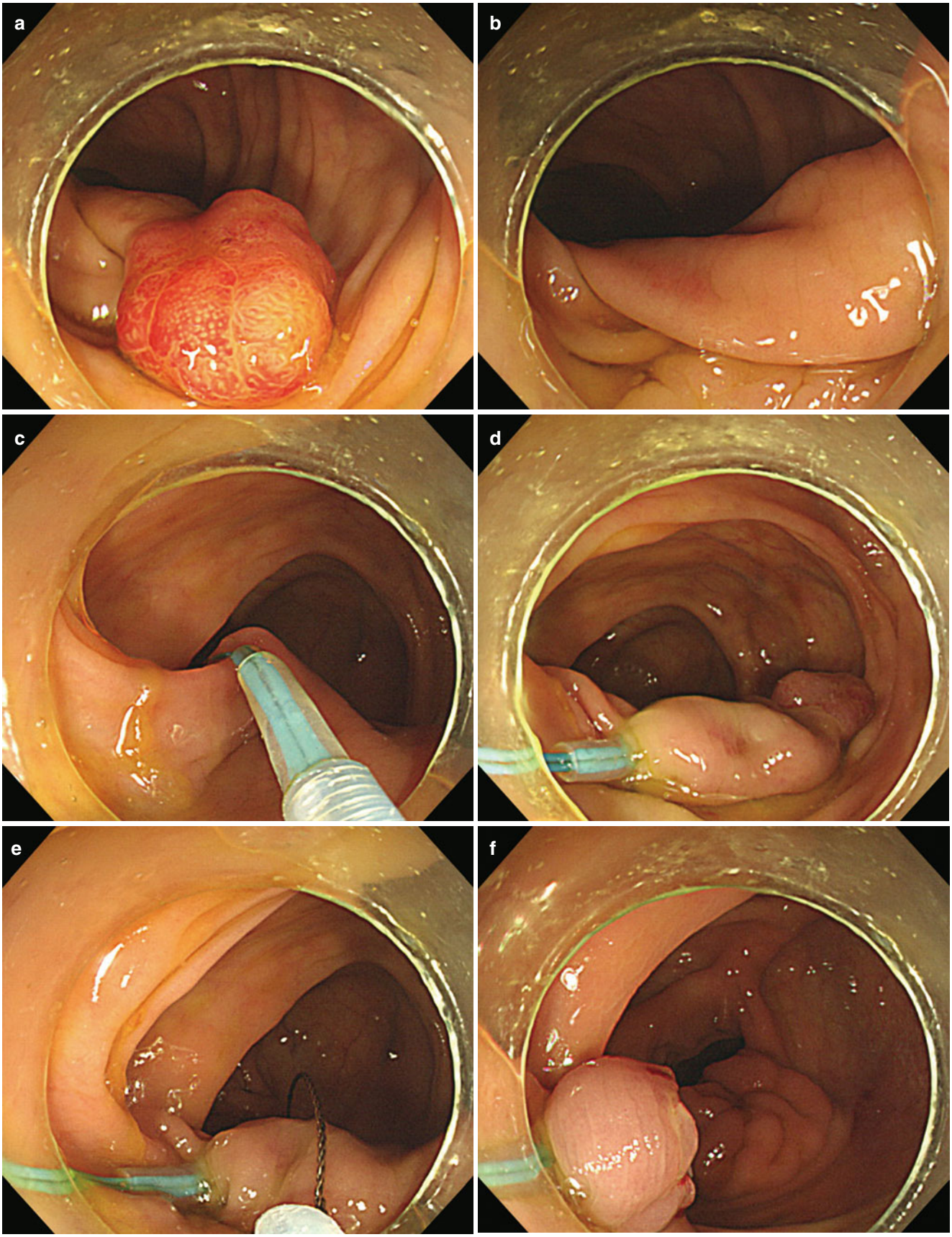

Fig. 9.31 Detachable snare loop for polypectomy. (**a**, **b**) Two centimeter sized pedunculated polyp on the ascending colon. (**c**, **d**) The two-thirds portion of stalk was tied using a detachable snare. (**e**) Snare polypectomy was performed above the loop ligature. (**f**) The detachable snare was attached to the ulcer base

9.6 Choosing the Appropriate Technique

- The endoscopist should consider the size, morphological characteristics, and the location within the colon before choosing the appropriate technique.
- Diminutive polyps up to 5 mm in diameter may be removed by cold biopsy irrespective of morphology from anywhere in the colon. Hot biopsy is not a recommended method for removing diminutive polyps, due to the low complete resection rate, safety, and histological quality of hot biopsy specimen.
- Slightly larger sessile polyps (up to 7 mm) are best removed by cold snaring, hot snaring, or EMR.
- Large pedunculated polyps are removed by hot snare. Prophylactic procedures (e.g., loop or clip placement) help to prevent early bleeding during the removal of pedunculated polyps with thick stalk (>1 cm).
- Larger sessile polyps may be removed by standard hot snaring, but EMR is growing in popularity and is probably safer, especially when removing lesions from the right colon. Submucosal injection during polypectomy helps to prevent early bleeding, although the preventative effect on delayed bleeding is not clear.
- The endoscopist should aim to en bloc resection but can consider piecemeal resection for lesions >2 cm.
- Although flat and depressed lesions can be removed by EMR successfully, it should be remembered that depressed lesions have a particularly high incidence of submucosal invasion of cancer which should be removed completely by ESD or surgery if complete resection appears to be difficult by EMR technique.

9.7 Complications

- CPP is generally safe in experienced centers, although several complications have been described.

9.7.1 Bleeding

- Bleeding is the most common complication of CPP, reported up to 10 % of patients in recent large series.
- Immediate bleeding is typically managed by the application of hemostatic clips, hot biopsy forceps, or bipolar coagulation.
- Delayed bleeding, occurring from 6 h to 7 d after CPP, has been reported in 0.7–2.5 % of cases involving a snaring resection and in 0.4 % of cases involving a hot biopsy. Immediate bleeding has been identified as an independent predictor of delayed hemorrhage.

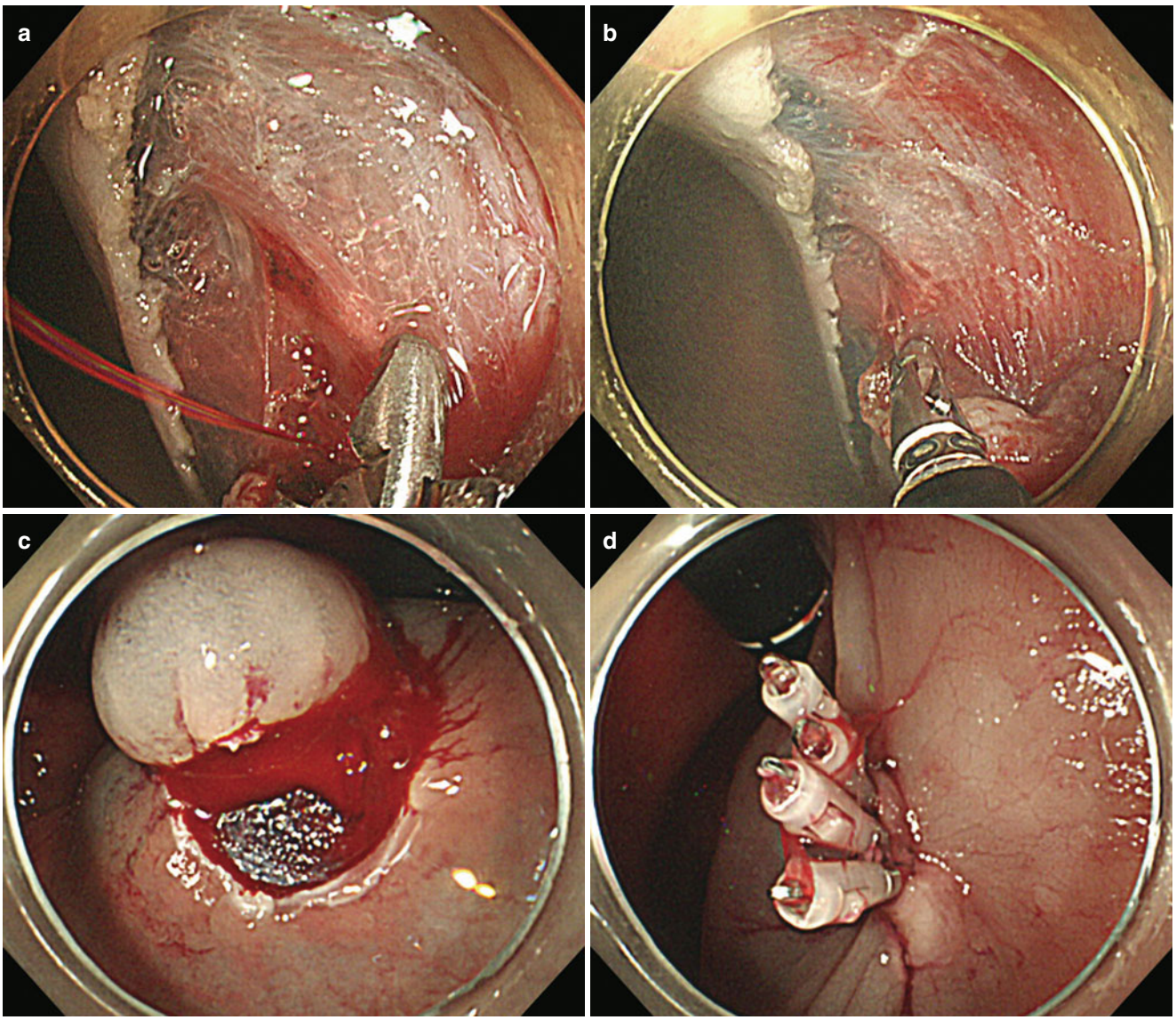

Fig. 9.32 Immediate postpolypectomy bleeding. (**a**) Arterial pumping after polyp resection. (**b**) Hemostasis using Coagrasper. (**c**) Active blood oozing after polyp resection. (**d**) Hemostasis using clips

9.7.2 Perforation

- Perforation is a rare complication of CPP, with reported rates of 0.3–0.5 %.
- Small perforations are amenable to endoscopic closure using clips.
- Urgent surgical consultation and intravenous broad-spectrum antibiotics are indicated for larger defects.

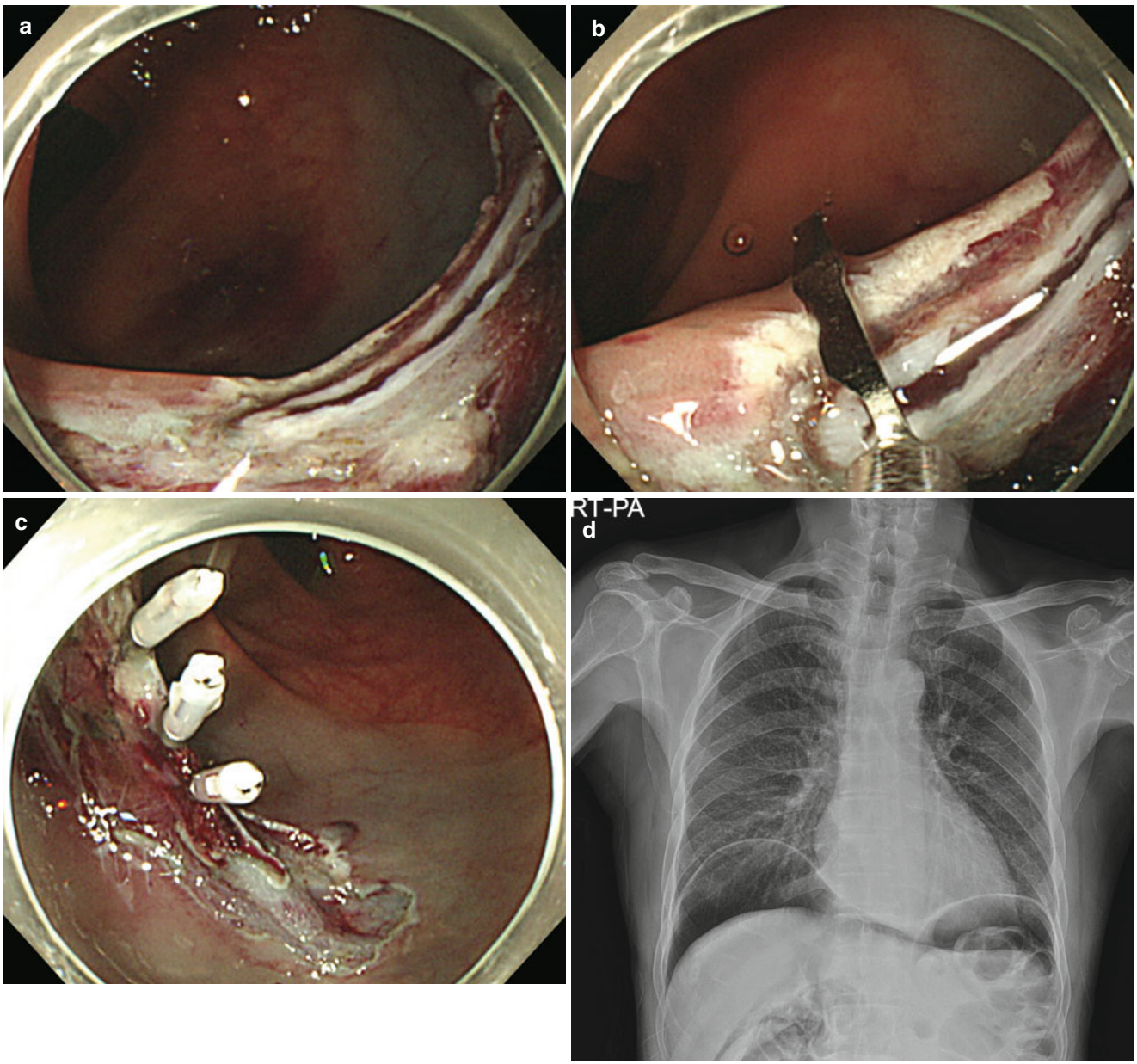

Fig. 9.33 EMR-induced perforation. (**a**) Approximately 2 cm-sized linear frank perforation after EPMR. (**b**, **c**) Closure with clips. (**d**) Free air under the diaphragm on a chest X-ray

9.8 Postpolypectomy Colonoscopic Surveillance

- Postpolypectomy surveillance is an essential part of management.
- Patients should be considered at high risk for subsequent advanced neoplasia at surveillance colonoscopy when one or more of the following conditions have been detected at index colonoscopy: (1) 3 or more adenomas, (2) any adenoma larger than 10 mm, (3) any tubulovillous or villous adenoma, (4) any adenoma with high-grade dysplasia, and (5) any serrated polyps larger than 10 mm [13].
- In patients with a high risk of subsequent advanced neoplasia, surveillance colonoscopy should be performed 3 years after index colonoscopy, whereas surveillance colonoscopy should be performed 5 years after index colonoscopy in those without aforementioned high risk for metachronous advanced neoplasia.
- However, the surveillance interval can be shortened if the quality of the index colonoscopy was not high or if a high-risk finding was observed in a colonoscopy prior to the index colonoscopy.

References

1. Garborg K, Holme Ø, Løberg M, et al. Current status of screening for colorectal cancer. Ann Oncol. 2013;24:1963–72.
2. Winawer SJ, Zauber AG, Ho MN, et al. Prevention of colorectal cancer by colonoscopic polypectomy. The national polyp study workgroup. N Engl J Med. 1993;329:1977–81.
3. Zauber AG, Winawer SJ, O'Brien MJ, et al. Colonoscopic polypectomy and long-term prevention of colorectal-cancer deaths. N Engl J Med. 2012;366:687–96.
4. Singh N, Harrison M, Rex DK. A survey of colonoscopic polypectomy practices among clinical gastroenterologists. Gastrointest Endosc. 2004;60:414–8.
5. Pohl H, Srivastava A, Bensen SP, et al. Incomplete polyp resection during colonoscopy-results of the complete adenoma resection (CARE) study. Gastroenterology. 2013;144:74–80.
6. ASGE Standards of Practice Committee, Anderson MA, Ben-Menachem T, Gan SI, et al. Management of antithrombotic agents for endoscopic procedures. Gastrointest Endosc. 2009;70:1060–70.
7. Boustière C, Veitch A, Vanbiervliet G, et al. Endoscopy and antiplatelet agents European Society of Gastrointestinal Endoscopy (ESGE) Guideline. Endoscopy. 2011;43:445–61.
8. Lee CK, Shim JJ, Jang JY. Cold snare polypectomy vs. Cold forceps polypectomy using double-biopsy technique for removal of diminutive colorectal polyps: a prospective randomized study. Am J Gastroenterol. 2013;108:1593–600.
9. Rey JF, Beilenhoff U, Neumann CS, et al. European society of gastrointestinal endoscopy (ESGE) guideline: the use of electrosurgical units. Endoscopy. 2010;42:764–72.
10. Carpenter S, Petersen BT, Chuttani R, et al. Polypectomy devices. Gastrointest Endosc. 2007;65:741–9.
11. Lee SH, Shin SJ, Park DI, et al. Korean guideline for colonoscopic polypectomy. Clin Endosc. 2012;45:11–24.
12. Stuart AR (2008) Colonoscopic polypectomy and endoscopic mucosal resection: a practical guide. www.bsg.org.uk/clinical-guidance/endoscopy/colonoscopic-polypectomy-and-endoscopic-mucosal-resection-a-practical-guide.html
13. Hong SN, Yang DH, Kim YH, et al. Korean guidelines for postpolypectomy colonoscopy surveillance. Korean J Gastroenterol. 2012;59:99–117.