

Endoscopic Caps

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Endoscopic caps are commonly used accessories for both endoscopic therapy and diagnosis. Many variations of endoscopic caps are available. Cap assisted endoscopic mucosal resection is the most common application. Caps are also used for hemostasis, foreign body removal, magnifying endoscopy, and improved visualization of lesions that are difficult to access. Novel endoscopic caps have been developed for en bloc resection of large lesions that typically require piecemeal resection. Endoscopic caps are easy to use. Appropriate selection of an endoscopic cap based on indication and location of the lesion is important for procedural success.

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Endoscopic caps are commonly used for both diagnosis and therapy during endoscopy. A variety of endoscopic caps are currently available in clinical practice. Cap assisted endoscopic mucosal resection (EMRC) is the most common application of endoscopic caps.¹ In addition, they may also be used for hemostasis, foreign body removal, magnifying endoscopy, screening colonoscopy, and improved visualization of lesions that are difficult to access, such as tangentially located lesions and those located within a limited luminal space. More recently, innovative endoscopic caps have been developed for en bloc resection of lesions larger than 2 cm. This article describes endoscopic caps and their clinical applications.

Devices

Straight Caps

Straight caps are hard transparent caps that are attached to the distal end of the endoscope for endoscopic mucosal resection of lesions smaller than 10 mm (Fig. 1A). Currently two different sized caps are available with an outer diameter of 13.9 mm and 14.9 mm, respectively, and measuring 12 mm in length (Olympus America, Inc., Melville, NY). These are commercially available as part of an EMRC kit (EMR-Kit, Olympus America, Inc.), which contains all the endoscopic accessories required to complete an EMRC: a dye spraying catheter for chromoendoscopy, a specially designed crescent-shaped snare, an injection needle for submucosal injection, and an endoscopic cap. A variety of EMRC kits are available, each one containing a different sized cap to fit on either a

diagnostic endoscope or a therapeutic endoscope. Once the cap and the endoscope are selected for EMRC, surgical adhesive tape may be used to secure the cap to the endoscope.

Oblique Caps

Oblique caps (Fig. 1B and C) are used for resection of larger surface areas and tangentially located lesions. These caps are generally larger with an outer diameter of 16.1 mm and 18 mm for hard and soft caps, respectively, and measuring 14 mm in length (Olympus America, Inc.).² In addition, oblique caps of different sizes are manufactured but are not available commercially in the USA. Oblique caps have a slit at the distal end, and when attaching the cap to the distal end of the endoscope, the slit should be adjusted so that it is aligned with the endoscope working channel, ensuring the appropriate positioning of the crescent snare within the cap.

Soft Caps

Endoscopic intubation with a hard cap can be challenging, whereas soft compressible caps make it easier to intubate. Hence, soft caps should be used whenever a larger resection is contemplated. Hard caps may be sterilized and re-used, although this is not recommended in clinical practice. Soft caps are single use only.

Novel Endoscopic Caps

Hood Knife Cap

Current EMR techniques are limited by a lesion size greater than 2 cm in diameter necessitating piecemeal resection. Development of a new EMR technique capable of removing large surface areas of mucosa en bloc is desirable, especially in the management of large lesions. The benefits of such a technique would include avoiding the need for piecemeal resection, ensuring resection of the entire lesion, improved histologic assessment, and in some patients provide therapy

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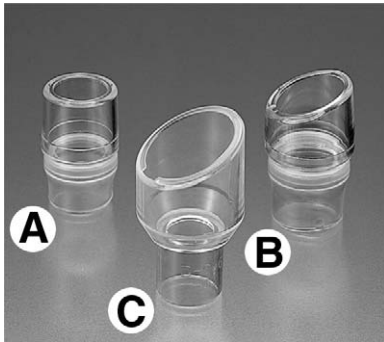


Figure 1 Endoscopic caps for cap assisted endoscopic mucosal resection. (A) Hard straight cap. (B) Hard oblique cap. (C) Large caliber soft oblique cap.

with essential information on disease staging. Widespread endoscopic mucosal resection (WEMR) was conceptualized as such a procedure, capable of removing >2 cm of mucosa en bloc. Based on preclinical studies from our Developmental Endoscopy Unit, a modified transparent cap or “hood knife” (Olympus, Tokyo) was developed to resect large esophageal lesions en bloc.³ Longitudinal and circular hood knives are available (Fig. 2A and B). Both hood knives consist of a transparent cap with an electro-surgical wire positioned in either the longitudinal or horizontal plane. The electro-surgical wire runs along the endoscope and is secured with adhesive tape. The cap is attached to the distal end of the endoscope similar to EMRC. The details of the procedure have been previously described.³ A clinical pilot study using this technique in patients with Barrett’s esophagus and high grade dysplasia is currently in progress.

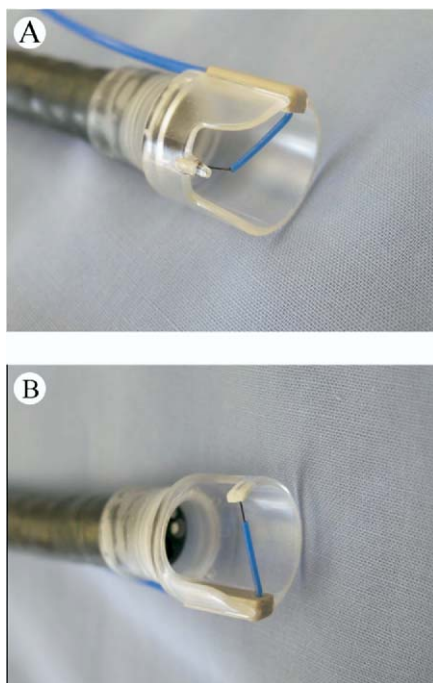


Figure 2 Hood knives for widespread endoscopic mucosal resection. (A) Longitudinal hood knife. (B) Circular hood knife. (Color version of figure is available online.)

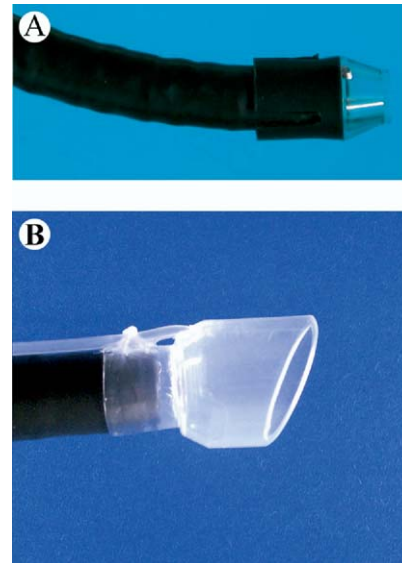


Figure 3 (A) Tapered tip transparent cap for endoscopic submucosal dissection. (B) Large caliber endoscopic cap with water flushing port. (Color version of figure is available online.)

Tapered Tip Transparent Cap

Endoscopic submucosal dissection (ESD) was developed for en bloc resection of superficial, large neoplastic lesions. This technique has been widely applied to the esophagus, stomach, and colon in Japan. The technique involves a circumferential incision along the border of the lesion using a needle knife or an insulated thermal knife with a ceramic tip. This is followed by dissection of the submucosa under the lesion. Yamamoto and coworkers developed a tapered tip transparent cap to facilitate the ESD technique.⁴ The cap is fitted on the distal end of the endoscope, which is then placed within the submucosal space providing a clear view of the submucosal dissection plane (Fig. 3A).

Cap with a Flushing Port

The use of an irrigation tube attached to an EMR cap for irrigation and easy removal of blood and mucus while maintaining a clean endoscopic field during hemostasis and EMR has been described (Fig. 3B).^{5,6}

Cap Assisted Endoscopic Diagnosis and Therapy

Cap Assisted Endoscopic Diagnosis

Despite technological advances in flexible colonoscopy, complete visualization of the back or blind side of colonic folds remain difficult, increasing the likelihood of missing small or flat lesions in this region. Endoscopic caps can help improve visualization of these obscured lesions by hooking and straightening the colonic haustral fold with the edge of the cap. Caps can also help maintain luminal patency with minimal insufflation of air during scope insertion. Soft caps are used preferentially for improved maneuverability of the endoscope, especially around sharp angulations. Clinical studies comparing colonoscopy with and without the use of endoscopic caps have demonstrated an improved polyp detection rate with screening colonoscopy and no significant difference in insertion time to the cecum or patient discom-

fort.^{7,8} However, beyond the rectosigmoid region, caps should be used with caution due to the increased risk of perforation, especially in patients with a past history of abdominal surgery.

Magnifying endoscopy is used in some practices to provide detailed views of the mucosal surface and microvasculature, which can help differentiate neoplastic from malignant lesions and determine the surface extent of a lesion allowing for more complete resection. During maximal image magnification, the use of a cap facilitates the ability to maintain an appropriate distance from the target mucosa to obtain a focused image.⁹⁻¹¹ A soft cap is recommended to minimize contact bleeding with friable lesions.

Cap Assisted Endoscopic Therapy

Cap Assisted Endoscopic Mucosal Resection (EMRC)

Endoscopic mucosal resection (EMR) is an established and widely accepted treatment modality for the removal of both benign and mucosal-based malignant lesions of the gastrointestinal tract in the absence of lymph node metastases. Since EMRC was introduced by Inoue and coworkers in 1992, the technique has become popular and is now widely used.¹ Cap assisted endoscopic mucosal resection has several advantages. It is technically simple to perform given the similarity to endoscopic band ligation, and endoscopists familiar with band ligation would require minimal additional training. It is a relatively quick procedure. Finally, it can be applied to virtually any part of the gastrointestinal tract, including areas where endoscopic visualization is difficult, particularly in the esophagus, posterior wall and lesser curve of the stomach, posterior wall of the duodenal bulb, behind a colonic fold, and anorectal region. Cap assisted endoscopic mucosal resection is generally used for resection of large or difficult lesions by providing en face views of tangentially located lesions.

Steps

Step I: Marking of Lesions

Before performing EMRC, marking the margins of the targeted lesion is recommended, especially when the lesion is visible only by chromoendoscopy. Furthermore, the margins can become indistinct and difficult to identify after a submucosal injection and/or with mucosal edema following piecemeal resection. Marking can be achieved by placing cautery points with the tip of a snare or needle knife at intervals around the lesion at approximately 2 mm from the margin of the lesion. However, in practice, this step is often omitted when lesions have distinct margins or in an effort to minimize procedure time.

Step II: Submucosal Injection

A submucosal protective fluid cushion is critical to minimize the risk of perforation and thermal injury (Fig. 4A). The fluid cushion isolates the mucosa from the muscularis propria before resection. We use 0.83% hydroxypropyl methylcellulose, which is a cellulose derivative with viscoelastic properties that is used in certain ophthalmic operations such as cataract removal and lens implantation. It provides a substantially more durable protective cushion that is essential for any prolonged procedure. A study from our Developmental Endos-

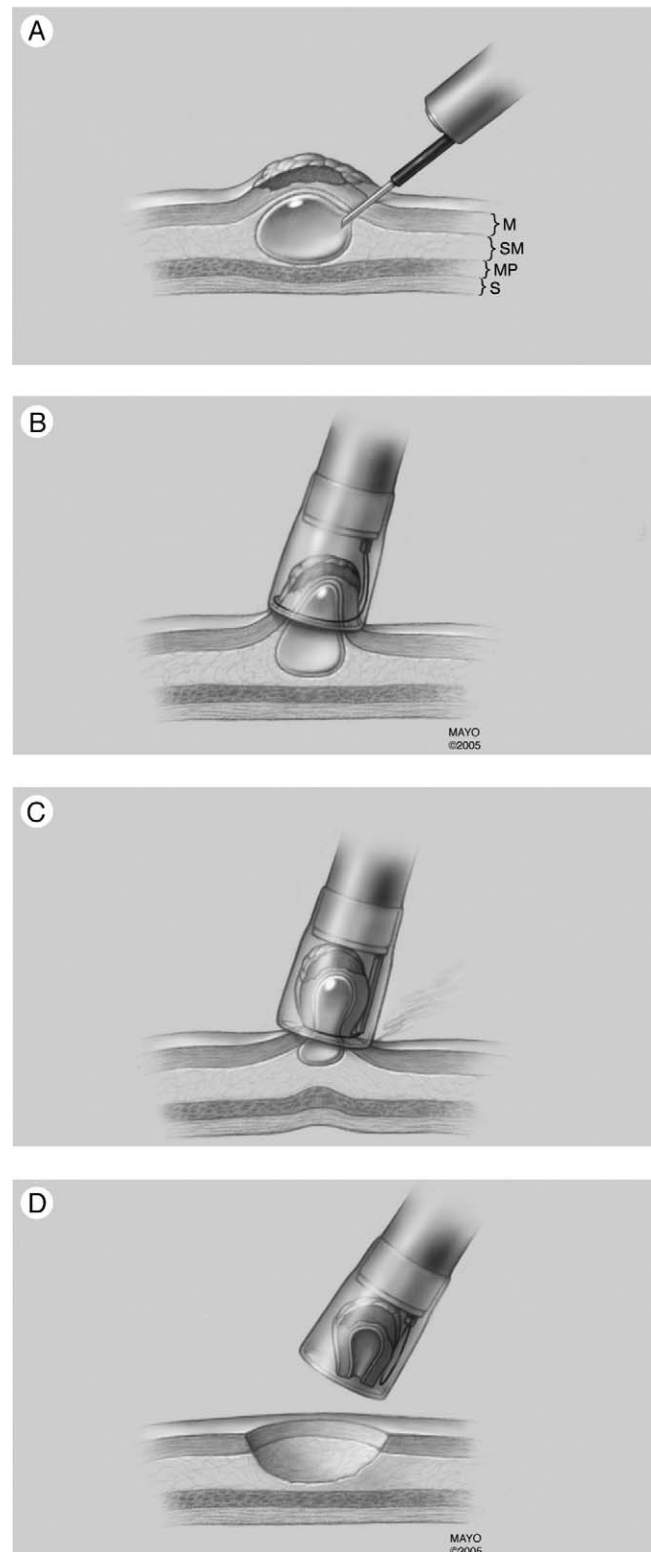


Figure 4 Schematic representation of cap assisted endoscopic mucosal resection. (A) Submucosal injection. (B) The lesion is aspirated into the cap. (C) The targeted mucosa is strangulated with the pre-looped snare. (D) Resection is performed with a blended current.

copy Unit recorded the duration of the submucosal fluid cushion at approximately 35 minutes.¹²

The total volume of a submucosal injection depends on the size of the lesion. In general, approximately 5 mL of solution is injected in four quadrants (total of 20 mL) or into the center of the lesion. The more solution injected, the safer the

procedure; however, the margins can sometimes become indistinct particularly with flat lesions and so in this setting the use of cautery marks are helpful. The most distal aspect of the lesion should be injected initially to ensure that the lesion is lifted into the field of view. If the submucosal cushion dissipates, especially following piecemeal resection or a prolonged procedure, repeat injections can be applied, but the fluid has a tendency to leak through the resected sites, highlighting the importance of creating and maintaining an adequate fluid cushion before resection and the use of the appropriate fluid for a more durable submucosal cushion. Typically, normal saline alone or normal saline with diluted epinephrine (1: 100,000 or 1:10,000) may be used for short procedures. However, for prolonged procedures requiring piecemeal resection, hydroxypropylmethylcellulose is preferred. A total of 15 ml of hydroxylpropyl-methylcellulose is mixed with 30 ml of normal saline and injected through a sclerotherapy needle. The absence of an adequate submucosal lift is indicative of submucosal invasion tethering the lesion to the underlying wall, and EMRC should be avoided in such cases.

Step III: Resection

The cap of choice is attached to the distal end of the endoscope. The esophagus is intubated under direct vision and the endoscope with the attached cap advanced to the lesion. Marking of the lesion and submucosal injection may be performed through the cap to minimize the number of esophageal intubations. Before resection, a thin crescent-shaped snare is prelooped inside the rim of the cap. The crescent snare has an inherent memory and loses its configuration/shape with snare opening or use. Hence, these snares should not be opened before use and should be discarded after a resection. The snare is inserted through the endoscope working channel into the cap. The snare wire is prelooped along the rim of the cap by gently suctioning normal mucosa remote from the lesion to seal the outlet of the cap, and then slowly opening the snare wire by placing the tip of the snare against the rim. Once the snare has been prelooped, the endoscope is advanced to the target lesion. Then, moderate to high suction is applied, and the lesion is suctioned into the cap (Fig. 4B). Once the entire lesion is within the cap, the prelooped snare is closed (Fig. 4C). The strangulated lesion is resected within the cap while still applying suction (Fig. 4D), using a blended current (16-20 W; Meditron Devices, Inc., Hackensack, NJ). After resection, suction is continued so as to ensure that the resected tissue remains within the cap while the endoscope is withdrawn. Once the endoscope is removed, the resected tissue within the cap can be retrieved for histopathology. This process is repeated until the entire lesion is removed when piecemeal resection is undertaken. Resection can also be performed outside of the cap by pushing out the snare beyond the cap; this maneuver allows direct visualization of the resection. However, the disadvantage is the need to retrieve the tissue following resection.

Cap Assisted Endoscopic Hemostasis

Endoscopic caps may be used for hemostasis, particularly for bleeding sites that are difficult to visualize or access due to tangential location or limited luminal space as previously discussed. The use of a cap aids in keeping the lumen open,

provides an en face view, and improves visualization and access for therapy. Endoscopic caps similar to those used in EMRC but rimless (ie, without the inner rim) are the caps of choice. This ensures that accessories do not abut or hook the inner rim. Use of soft caps is preferred when available to minimize contact bleeding in areas that are typically ulcerated or friable. Accessories such as sclerotherapy needles, gold probes, and heater probes can be passed with ease through the cap. Hemoclips may be used, and disposable clips (Olympus America, Inc.) with a narrower jaw span (7 mm) are preferred; however, if reusable/larger clips are considered, then a large (16 mm) cap is required.¹³

Cap Assisted Endoscopic Foreign Body Removal

The use of an overtube or protector hood (condom hood) during foreign body removal is important in preventing complications such as mucosal injury or aspiration. Large caliber soft and rimless EMRC caps can be used to capture sharp objects such as safety pins or press-through tablet packages, and in the management of esophageal food impaction.^{14,15} The foreign object is grasped using a grasping forceps, snare, or Roth basket and then pulled into the endoscopic cap during endoscope removal.

Summary

Many variations of endoscopic caps are available. Overall, the caps are easy to use facilitating endoscopic diagnosis and therapy, and are especially helpful with lesions located in poorly accessible regions of the gastrointestinal tract. The appropriate selection of an endoscopic cap based on indication and location of the lesion is important for procedural success.

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