The endoscopic cap that can (with videos)

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"I . . . think . . . I . . . can . . . I . . . thought . . . I . . . could . . . I . . . thought . . . I . . . could. I thought I could. I thought I could. I thought I could." And singing its triumph, it (the Little Engine) rushed on down toward the valley.

—Reverend Charles S. Wing, 1906

The endoscopic caps often bridge the *can* to the *could*. It is among the best inventions in endoscopy. The cap adds practical functionality to the endoscope – some of which cannot be accomplished without it. Indeed caps have been used for more than 2 decades for a variety of indications, and are available in different materials, sizes, shapes, and features (Fig. 1; Table 1). Worldwide, endoscopic caps have been used routinely for variceal ligation[1] and, increasingly, for endoscopic mucosal resection (EMR).[1-3] In Japan, caps have been used for a wider range of diagnostic and therapeutic applications, such as for detailed magnification endoscopy and to maintain the precise dissection plane during submucosal dissection.[4,5] Recently, an increasing body of literature examines the potential utility of caps to augment mucosal examination behind folds or at angulations for screening colonoscopy.[6-30] This review summarizes the science and the art of use of the endoscopic cap and, most importantly, provides practical examples of its use in day-to-day endoscopic practice. Thus, we will focus on caps that are commercially available in the United States.

Abbreviations: ADR, adenoma detection rate; ESD, endoscopic submucosal dissection; NOTES, natural orifice transluminal endoscopic surgery; POEM, peroral endoscopic myotomy; STER, submucosal tunneling endoscopic resection.

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REVIEW METHOD

We searched the MEDLINE and Evidenced Based Medicine Reviews (Cochrane Central Register of Controlled Trials and Cochrane Database of Systematic Review) computerized databases through November 1, 2011 by using the keywords *cap, cap-fitted, distal attachment, hood, colonoscopy,* and *endoscopy;* manually reviewed the references; and obtained those that contained relevant information. We ranked the strength of reported evidence and recommendations based according to "Evidence Based Gastroenterology and Hepatology"[31] (Appendix 1, available online at www.giejournal.org). More importantly, in order to provide an objective review of the literature on the application of caps for screening colonoscopy; we performed a meta-analysis comparing the quality of colonoscopy with and without a distal attachment cap (Appendix 2, available online at www.giejournal.org).

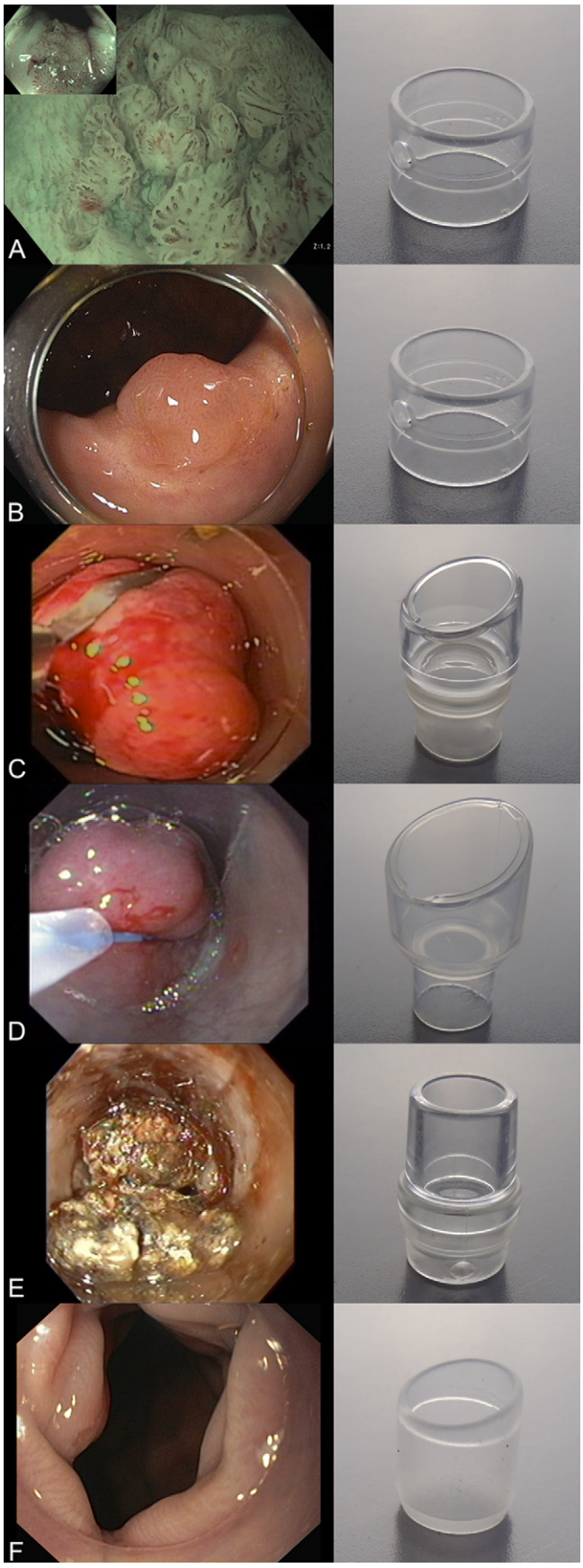
TECHNICAL ASPECTS

Cap types and their attachment to the endoscopes

Caps are transparent, opaque, or colored hollow cylinders that can be attached to the distal tip of the endoscope (Video 1, available online at www.giejournal.org). They are available in a variety of sizes and forms and are made of different materials. The proximal part of the cap fits the outer aspect of the distal end of the endoscope. To prevent displacement or even dislodgement of the cap, the cap can be secured to the endoscope by using waterproof adhesive tape (Hy-Tape pink tape; Hy-Tape International, Patterson, NY).

The distal part of the cap is its working part. It can be conic, straight, or funnel-shaped with a horizontal or oblique end, which, in turn, may be rounded or internally beveled. Some caps have one or more side holes designed to prevent fluid accumulation within the cap. The cap designed for EMR has a small cut on the rim of the bevel that is used to align its placement with the direction of the working channel. Retractable caps have been described but are not commonly used.

The depth of the cap is important for its diagnostic and therapeutic applications (Video 1). Although some caps



have predetermined depth, the distal attachment caps (Olympus America, Inc, Center Valley, Pa) can be adjusted. The depth of the cap may be classified as short (1-2 mm), medium (3-4 mm), and long (>4 mm).

Mechanisms of function

Caps have a number of mechanical functions (Table 2). They keep mucosa within range of the focal depth of the endoscope. They also are useful to push aside folds, angulations, or tissues. Caps can stabilize positioning of the tip of the endoscope (Fig. 2). The caps can help align the target for therapy with the axis of the working channel. When caps are used to allow visualization of a diseased area for snaring or clipping, the cap must be positioned with enough depth to allow housing the snare or clip within the cap and, at the same time, to keep the mucosa away from the lens. The cap also can provide stability and housing for an endoscopic accessory. For example, a needle-knife can be used within the cap in order to allow a very precise cut, and clips can be stationed within the cap while awaiting the target tissue to be suctioned.[5]

Another major function of the cap is that it extends the capability of the endoscope to suction selectively to within its opening. This is particularly useful for aspirating tissues or foreign bodies and holding them within the cap, either partially or fully, for removal. Gentle suctioning with concomitant washing through a water jet can be performed to view a bleeding site.[32] The long cap is required to invert a bleeding diverticulum (eg, using the straight cap for EMR with cap, the variceal ligation cap, or the distal attachment cap placed in the "long" position). The depth of the cap allows the bleeding vessel at the dome to be suctioned into an awaiting open clip.[32]

Figure 1. A general representation of the available caps in the United States. **A,** The Disposable Distal Attachment caps (DAC, Olympus America, Center Valley, Pa) are available with 2-mm and 4-mm working distance types, which are intended for maintaining the optimal field of view and keeping the correct depth of field, respectively. An anal intraepithelial neoplasm was imaged under water with a 2-mm DAC in place for magnification. The cap was slightly visible under standard view (see inset). On ×1.2 digital magnification, the cap was not visible. The irregular microvessels were observed. **B,** A recurrent adenoma on an EMR scar was examined by using the DAC, which was placed at 4 mm from the tip of the endoscope. The DAC obscured the periphery of the visual field. **C,** The oblique hard endoscopic mucosal resection cap (Olympus) was used to suction a bleeding diverticulum from its dome. The cap housed a previously opened clip, which was awaiting the bleeding vessel before it was clipped. Complete hemostasis was achieved. **D,** A large oblique soft EMR was used to suction a 2-cm hemangioma in the sigmoid colon, while an endoloop was being applied. **E,** The cap of the endoscopic variceal ligation (Cook Medical, Salem, NC) was used to remove pancreatic phlegmon from inside a pseudocyst. **F,** The Halo cap (Barrx Medical, Sunnyvale, Calif), a frosted soft silicone cap that was designed to facilitate removal of coagulated esophageal tissue after radiofrequency ablation, was used to keep the gastroesophageal junction open in order to allow detailed examination.