Communication from the ASGE Technology Committee

TECHNOLOGY STATUS EVALUATION REPORT

Endoscopic retrieval devices

The American Society for Gastrointestinal Endoscopy (ASGE) Technology Committee provides reviews of existing, new, or emerging endoscopic technologies that have an impact on the practice of GI endoscopy. Evidence-based methodology is used, with a MEDLINE literature search to identify pertinent clinical studies on the topic and a MAUDE (US Food and Drug Administration Center for Devices and Radiological Health) database search to identify the reported complications of a given technology. Both are supplemented by accessing the "related articles" feature of PubMed and by scrutinizing pertinent references cited by the identified studies. Controlled clinical trials are emphasized, but, in many cases, data from randomized, controlled trials are lacking. In such cases, large case series, preliminary clinical studies, and expert opinions are used. Technical data are gathered from traditional and Web-based publications, proprietary publications, and informal communications with pertinent vendors. For this review, the MEDLINE database was searched through September 2008 using the keywords "retrieval," "retrieval device," "extraction," "endoscopic," "gastrointestinal endoscopy," and "foreign body." The Science Direct search engine (www.ScienceDirect.com) was also used with the search terms "retrieval" and "foreign body." The MAUDE database (http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfMAUDE/TextSearch.cfm)[1] was searched using text search mode for "retrieval," "retrieval device," and "foreign body."

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BACKGROUND

Endoscopic retrieval devices are used for the removal of resected polyps, foreign bodies, and esophageal food impactions. Various forceps, graspers, baskets, snares, and nets are available, and selection depends mainly on the size and shape of the target being retrieved. Some devices are designed specifically for retrieval, whereas some are designed for other interventions but can also be used for the purpose of retrieval.

The success of retrieval seems to be a function of the endoscopist's experience.[2] Proper retrieval device selection may be an important factor along with more skillful endoscope manipulation.[3] Guidelines for the management of ingested foreign bodies have been issued by the ASGE[4]; this review focuses on available devices.

TECHNOLOGY UNDER REVIEW

Endoscopic retrieval devices are designed to pass through the channel of an endoscope (Tables 1-7). Most can be used in endoscopes with a 2.8-mm channel; a few devices are designed to be used with a therapeutic channel ($\geq$ 3.2 mm). Devices come in various lengths to permit use with gastroscopes or colonoscopes. Some retrieval devices are available for specialized endoscopes, including pediatric endoscopes (channel size, 2.0-2.2 mm; Table 7) or enteroscopes (requiring catheter lengths of at least 350 cm). The endoscope length and instrument channel size should be considered before device selection. Some devices are reusable, whereas others are single use.

Selection of a retrieval device is generally dictated by the shape and size of the foreign body or tissue to be removed and the preference of the endoscopist. For example, long objects may be securely grasped with a snare or a basket, whereas smaller or round objects may be better addressed with a retrieval net. Small, flat objects such as coins are often securely grasped by forceps with longer jaws or "teeth" at the end, such as the alligator, rat-tooth, or shark-tooth forceps.

In addition to the endoscopic retrieval devices, other endoscopic accessories may be used during retrieval procedures. Esophageal overtubes may be used in some clinical situations to enhance the safety and efficiency of retrieval by protecting the airway, providing a conduit for repeated luminal access, and protecting the mucosa from trauma related to sharp objects. Overtubes are the

TABLE 1. Snares

Manufacturer	Configuration	Snare size (mm)	Length (cm)	Single use/ reusable	Cost
Boston Scientific (Natick, Mass)	Oval, crescent, hexagonal	13, 27, 30, 33	240	Single use	$36
Cook Medical (Winston-Salem, NC)	Oval, hexagonal	1 × 1.5, 2.5 × 5.5, 3 × 6	230	Single use	$24-$26
ConMed (Billerica, Mass)	Oval, crescent, hexagonal	11, 16, 23, 32	230	Single use	$36
Kimberly-Clark (Roswell, Ga)	Oval, crescent, hexagonal	Small, medium, large, jumbo	240	Single use	$19
Medi-Globe (Tempe, Ariz)	Oval, crescent, hexagonal	Small, medium, large	180, 230	Single use	$65
	Oval, crescent, hexagonal	Small, medium, large	180, 230	Reusable	$259
Olympus America (Center Valley, Pa)	Oval, crescent, hexagonal	10, 15, 25	230	Single use	$25-$34
	Oval, crescent, hexagonal	13, 15, 22, 25	105, 165, 230	Reusable	$374-$463
TeleMed Systems (Hudson, Mass)	Oval, crescent, hexagonal	10, 20, 25, 30	240	Single use	$16-$20
US Endoscopy (Mentor, Ohio)	Oval	20, 33	230	Single use	$35

TABLE 2. Retrieval forceps*

Manufacturer	Jaw design	Width of opening (mm)	Length (cm)	Cost
Cook Medical (Winston-Salem, NC)	Rat-tooth	NA	160, 230	$386
Medi-Globe (Tempe, Ariz)	Rat-tooth and alligator	NA	180, 230	$259
Olympus America (Center Valley, Pa)	Alligator jaw	7.5, 11.3	165, 230	$601
	Rat-tooth, upper endoscopy	3-19.5	165, 190	$601-$694
	Rat-tooth, colonoscopy	4.7, 8.3	230	$601
	Shark-tooth	4.7	165	$628
	Rubber tip	4.8, 7.3	165, 190	$694
TeleMed Systems (Hudson, Mass)	Rat-tooth and alligator	NA	120, 230	$215

NA, Not available.
*All are reusable.

subject of a separate technology status evaluation report.[5] A latex hood (Kimberly-Clark, Roswell, Ga) for facilitating retrieval of sharp, long, or wide objects is also available.[6] This hood is preloaded onto the tip of the endoscope and inverts on withdrawal through the esophagus, creating a protective sheath between the object and mucosa.

Snares

Any standard polypectomy snare can be used for the purpose of endoscopic retrieval (Table 1). Many manufacturers have numerous snare products with the main difference being the size of the open loop, which can be as large as 3 × 6 cm for some "jumbo" snares.[7] Some snares are rotatable, which may simplify orientation of the loop to the target. Specialized polypectomy snares (crescent, barbed, hexagonal) find application in tissue removal, but probably do not have a significant advantage when used for retrieval.

Retrieval forceps

Forceps have a variety of jaw configurations so that the endoscopist can tailor device selection to the object being retrieved (Table 2). Standard biopsy forceps generally are not useful for retrieval because of the limited capacity of the jaws and the inability to take hold of objects harder than tissue or larger than a pin or needle. Forceps with

TABLE 3. Nets*

Manufacturer	Device	Sheath diameter (mm)	Configuration	Length (cm)	Net size (cm)	Cost
ConMed (Billerica, Mass)	Nakao Spider-Net	2.3	Oval	160, 230	3 × 6	$85
US Endoscopy (Mentor, Ohio)	Roth Net Platinum food bolus	2.5	Octagonal	160	4 × 5.5	$95
	Roth Net foreign body pediatric	1.8	Oval	160	2 × 4.5	$95
	Roth Net polyp	2.5	Oval	230	3 × 6	$85
	Roth Net foreign body	2.5	Oval	160	3 × 6	$85
	Roth Net Platinum polyp	3.0	Octagonal	230	4 × 5.5	$95
	Roth Net Platinum universal	2.5	Octagonal	230	4 × 5.5	$95
	Roth Net foreign body maxi	3.0	Hexagonal	160	4 × 8	$95

*All are single use.

TABLE 4. Graspers

Manufacturer	Device	Size (cm)	Length (cm)	Single use/reusable	Cost
Cook Medical (Winston-Salem, NC)	3-prong	NA	240	Single use	$135
Hobbs Medical (Stafford Springs, Conn)	3- and 4-prong	2.0	150, 220	Reusable	$138
	3-prong	2.5	220	Single use	$72
Horizons International (Ponce, PR)	3-prong	NA	129, 160, 230	Reusable	$100
Kimberly-Clark (Roswell, Ga)	3- and 4-prong	1.5	240	Single use	$52
Medi-Globe (Tempe, Ariz)	2-prong	NA	180-230	Reusable	$259
Olympus America (Center Valley, Pa)	2-prong (V shape)	1.3	165	Reusable	$694
	3-prong	2.0	230	Single use	$138
	3- and 5-prong	2.0	165, 180, 230	Reusable	$577-$645
TeleMed Systems (Hudson, Mass)	3- and 4-prong	2.5	180, 240	Single use	$55
	3- and 4-prong	NA	230	Reusable	$215

NA, Not available.

a distal tooth (rat-tooth or shark-tooth) offer a more secure grasp on the object being retrieved. Forceps with longer jaws (alligator-jaw) may occasionally be useful, especially for flat, hard objects (eg, coins). A rubber-tip forceps is designed for small, hard objects such as needles, pins, and blades. The rat-tooth configuration is the most widely used for foreign bodies.

Nets

Retrieval nets are constructed from a soft, flexible mesh material attached to the noose of a snare. When the snare loop is opened, the mesh forms a concave compartment capable of capturing a targeted object. Closure of the snare captures the retrieval target in this compartment. These devices come in a variety of sizes and configurations (Table 3). There are slight differences in available nets that pertain mainly to the concavity of the net, the shape of the snare, and the material used for the net. Nets can be used to retrieve small objects, button batteries, and fragments of tissue after piecemeal polypectomy or endoscopic mucosal resection.

Retrieval graspers

Graspers have 2, 3, or 4, or 5 prongs that, when in the open position, extend in a radial configuration and distal to the device tip, creating a space between the prongs (Table 4). A handle similar to a polypectomy snare allows retraction of the prongs trapping the object between the prongs. The grasping ends may be pointed or have loop tips. They are typically used for retrieving soft objects, such as polypectomy specimens and food boluses. Some

TABLE 5. Baskets

Manufacturer	Device	Basket size (cm)	Length (cm)	Single use/ reusable	Cost
Cook Medical (Winston-Salem, NC)	4-wire rotatable, polyp	2 × 4, 3 × 6	240	Reusable	$327
	4-wire mini-basket	0.5 × 1.3	200	Single use	$276
	4- and 6-wire	1.5 × 3.5, 2 × 4, 2.5 × 5, 3 × 6	220	Single use	$185
Hobbs Medical (Stafford Springs, Conn)	3- and 4-wire	1.5, 2	150, 220	Reusable	$138
Horizons International (Ponce, PR)	4-wire	1.3, 2.2, 3.0	120, 160, 230	Reusable	$100
	Rotatable polyp catcher	1.3, 2.5, 3.2	230	Single use	$75
Kimberly-Clark (Roswell, Ga)	4-wire	1 × 3, 1.5 × 4.5, 3 × 6	240	Single use	$52
Medi-Globe (Tempe, Ariz)	4- and 6-wire foreign body basket	3.5, 4	180, 230	Reusable	$125
Olympus America (Center Valley, Pa)	4-wire for upper endoscopy	2.2, 3.2, 3.5	155, 165, 195, 230	Reusable	$437
	4-wire for upper endoscopy	2.2	195	Single use	$228
	4-wire for colonoscopy	3.5	230	Reusable	$437
TeleMed Systems (Hudson, Mass)	4-wire	2 × 4	180, 240	Single use	$55
US Endoscopy (Mentor, Ohio)	4-wire rotatable	3.5 × 6	230	Single use	$95

TABLE 6. Biliary stent retrievers*

Manufacturer	Device	Accessory channel (mm)	Stent to be retrieved	Cost
Cook Medical (Winston-Salem, NC)	Soehendra stent retriever	2.8-4.2	5, 7, 8.5, 10, 11.5 French	$132

*All are single use.

other foreign bodies may be retrieved with graspers, but the grip may not be as secure, particularly with heavy or impacted objects.

Baskets

Endoscopic baskets, some of which are designed for biliary stone extraction, may be useful for the retrieval of foreign bodies (Table 5). The multiple wires make it easier to capture certain objects compared with a snare. Round objects that cannot be grasped with a snare or forceps can be trapped within the basket. Retrieval baskets designed for ERCP are too short to work with a colonoscope, but colonoscopic retrieval baskets are available (Table 5). Four-wire baskets are the standard conformation; a 6-wire basket can be used for retrieving smaller objects. The baskets are made in hard (solid wire) and soft (braided wire) configurations.

Magnetic retrievers

Magnetic retrievers consist of a long, flexible wire attached to a strong magnet and have been used for retrieval of ferromagnetic foreign bodies. Before flexible endoscopy, these were commonly used for esophageal and gastric foreign body removal using fluoroscopy.[8,9] However, there exists the potential for the loss of magnetic coupling of the object during retrieval. Although magnetic retrievers may be found in some endoscopy units, they are not currently available for purchase and have largely been replaced by other devices.

Biliary stent retrieval devices

In some situations, it is preferable to remove a pancreatic or biliary stent over a wire to maintain duct access. A device, the Soehendra stent retriever (Cook Medical, Winston-Salem, NC) (Table 6) has been designed for this purpose.

TABLE 7. Retrieval devices for use with pediatric endoscopes (2.0-2.2-mm working channel)

Manufacturer	Device	Sheath size (mm)	Length (cm)	Single use/reusable	Cost
Cook Medical (Winston-Salem, NC)	Rat-tooth forceps	2.0	160	Reusable	$386
	Mini-basket	2.0	200	Reusable	$276
Hobbs Medical (Stafford Springs, Conn)	3-prong grasper	1.8	150, 220	Reusable	$138
	Basket, 3- and 4-wire	1.8	150	Reusable	$138
Kimberly-Clark (Roswell, Ga)	3- and 4-prong grasper	1.8	240	Single use	$52
	4-wire foreign body basket	1.8	240	Single use	$52
	Rat-tooth forceps	1.8	240	Single use	$52
Olympus America (Center Valley, Pa)	Rat-tooth forceps	2.0	190	Reusable	$661
	2-prong grasper	2.0	165	Reusable	$661
	3-prong grasper	1.2	115	Single use	$294
	Spiral basket, 11 mm	1.2	115	Single use	$276
	Retrieval basket	2.0	155	Reusable	$416
TeleMed Systems (Hudson, Mass)	Rat-tooth, alligator	1.8	120	Reusable	$215
	Tripod grasper	1.8	180	Single use	$55
US Endoscopy (Mentor, Ohio)	Roth Net	1.8	160	Single use	$75

This is a wire-guided, hollow spring-coil catheter with a threaded metal screwlike tip. After the lumen of the stent has been cannulated with a guidewire, the Soehendra stent retriever is advanced over the guidewire and then screwed into the distal end of the stent by clockwise rotation of the device. The stent can then be pulled out while the wire maintains duct access. Problems with stent fracture may occur in cases involving removal of stents that have been in place for a long time. Inability to adequately engage the metal threads into the lumen of the stent may also occur. Over the wire stent, retrieval may also be accomplished with a standard snare with the partially opened loop loaded over the wire. If maintenance of duct access is not required, other more readily available devices, such as snares, forceps, biliary stone extraction balloons, and baskets are frequently used to extract pancreaticobiliary stents.

Other devices

Innovative endoscopists have adapted other devices to aid in endoscopic retrieval. For example, foreign bodies that are hollow or have a hole in them may be able to be retrieved by using a through-the-scope balloon that is inflated or a forceps that is opened after being passed through the hole.[10,11] Another technique for removing hollow objects involves passing a wire[12] or long suture[13] through the channel of the endoscope and then the hole in the object and finally grasping it with a regular forceps. There is a report of slipping rubber sleeves on a rat-tooth forceps to aid in holding on to a slippery metal object that could not be securely held with other devices.[14] Dual-channel endoscopes or an accessory channel (eg, made of a separately passed nasogastric tube[15]) have been used with standard retrieval devices. Clear plastic caps preloaded onto the tip of the endoscope have also become a frequently used method to remove food boluses, relying on suction through the endoscope channel to secure the bolus in the lumen of the cap.[16]

EASE OF USE AND LIMITATIONS

Most endoscopists have extensive experience in the use of snares and forceps. The endoscopist should be familiar with the range of products that are available so that the optimal device for the clinical situation can be chosen. The length and size of the device must match the endoscope being used. Some devices may have special features that will make them easier to use. For example, rotatability of the device may make retrieval easier in some situations.

The retrieval device and technique that are most efficient are likely to be preferred. For foreign bodies, standard devices (eg, snare, net, rat-tooth forceps) will suffice for almost

all applications. More challenging situations may require use of additional devices (eg, alligator-jaw forceps, long rat-tooth forceps), additional endoscopes (eg, dual-channel endoscope, duodenoscope), or other accessories (eg, latex foreign body hood, through-the-scope balloon, overtube). Experience and judgment are critical factors to ensure success. For some objects, trial retrieval runs performed outside the patient with a similar object may be helpful.[17]

In some cases, esophageal overtubes can be used to prevent inadvertent release of an object into the trachea, protect the esophageal mucosa, and facilitate repeated endoscope insertion. Overtube use adds complexity and risk to the procedure. They should be introduced and guided into the GI tract either over an endoscope or a bougie.[18] Liberal lubrication of the inner and outer surfaces of the overtube and endoscope is critical before insertion, and marked resistance to passage of the overtube warrants reassessment. Adequate sedation is essential when using an overtube, and, as with all upper endoscopic procedures, monitoring of the patient's airway is imperative.

Objects that can be grasped securely, or long objects, typically do not require overtube use. Sharp objects can be removed without an overtube if the sharp point is ''trailing'' as the object is withdrawn; a ''leading'' sharp point can lacerate or perforate the esophagus. A latex hood can be fitted onto the tip of an endoscope, facilitating removal of sharp objects that could damage the esophagus or gastroesophageal junction on extraction.

Based on retrospective reviews, a small number of foreign bodies within the reach of the endoscope will not be able to be retrieved.[14-17] Most of these will be in the esophagus and are typically objects with sharp points that have perforated the esophagus. Immovable objects may require rigid esophagoscopy or surgery for retrieval.

EFFICACY AND COMPARATIVE DATA

There are many ways to perform endoscopic retrieval of resected tissue and foreign bodies, and studies have not been performed comparing different methods. Most of the literature on the subject consists of case series and reports. Based on large retrospective reviews of cases involving retrieval, most objects will be able to be removed with a snare or rat-tooth forceps.[19-21] Some of this literature predated the wide availability of endoscopic retrieval nets, and it seems that these devices will continue to see expanded use. Disk batteries in particular are more securely removed with a retrieval net.[3] There is one nonrandomized study[22] that compared flexible with rigid esophagoscopy in the management of consecutive patients with esophageal foreign bodies. The study concluded that both were effective, although flexible esophagoscopy did not require general anesthesia. There was a small number of patients in each group who were crossed over to the other technique after the first approach failed. This reinforces the concept that flexible endoscopy, although highly effective, is not universally successful for foreign body extraction.

SAFETY

The use of retrieval devices probably does not present additional risks to the endoscopic portion of the examination. There is a low but real complication rate when endoscopy is performed in the setting of foreign body retrieval and meat impaction. These complications include perforation, hemorrhage, mucosal laceration, infection, and aspiration.[23] Experience and judicious selection of devices may be able to limit complications and procedural efficiency. The use of overtubes should be weighed against potential complications associated with their use including perforation or mucosal laceration.[24] They are not universally required.

FINANCIAL CONSIDERATIONS

List prices of available devices are provided in the tables. Most specialized forceps are reusable, which can limit per-procedure costs. Endoscopic snares are inexpensive, and the literature suggests that they are adequate for retrieval of most foreign bodies. Endoscopic nets are slightly more expensive, but may give a more reliable grasp on some foreign bodies. For retrieval of fragments after piecemeal polypectomy, the net may allow for more efficiency because multiple pieces can be collected at one time. CPT* (Current Procedural Terminology) codes for endoscopic retrieval are listed in Table 8.

AREAS FOR FUTURE RESEARCH

Comparative analysis of various endoscopic retrieval devices warrants further study. Combination devices are being developed that will allow polypectomy and then immediate retrieval of the specimen.[25] The cost-effectiveness of these devices has not been subjected to prospective study. It is conceivable that the development of other devices may add to the therapeutic tool kit for endoscopic retrieval, particularly those related to innovative endoscopic techniques such as natural orifice transluminal endoscopic surgery. Newer devices should be compared with the simple, inexpensive, yet effective tools currently available.

SUMMARY

There are several types of endoscopic retrieval devices. Snares, forceps, and nets represent the most commonly

TABLE 8. CPT codes related to retrieval

43215	Esophagoscopy, rigid or flexible, with removal of foreign body (for radiological supervision and interpretation, use 74345)
43247	Upper GI endoscopy including the esophagus, stomach, and either the duodenum and/or jejunum as appropriate; with removal of a foreign body (for radiological supervision and interpretation, use 74345)
43269	ERCP; with endoscopic retrograde removal of a foreign body and/or change of a tube or stent (when done with sphincterotomy, also use 43262) (for radiological supervision and interpretation, see 74328, 74329, 74330)
44363	Small intestinal endoscopy, enteroscopy beyond the second portion of the duodenum, not including the ileum; with removal of a foreign body
44390	Colonoscopy through the stoma; with removal of a foreign body
45307	Proctosigmoidoscopy, rigid; with removal of a foreign body
45332	Sigmoidoscopy, flexible; with removal of a foreign body
45379	Colonoscopy, flexible, proximal to the splenic flexure; with removal of a foreign body
46608	Anoscopy, with removal of a foreign body

used, but other specialized devices may be preferred by individual endoscopists. Different devices may operate better in different locations of the GI tract, and physical characteristics of the object to be retrieved will dictate device selection. An overtube may be used in some cases, but the advantages of the overtube need to be weighed against associated risks.

Abbreviation: ASGE, American Society for Gastrointestinal Endoscopy.

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