Techniques in Vascular and Interventional Radiology

Endoscopy as an Adjunct to Image-Guided Interventions: A New Frontier in Interventional Radiology

Clifford J. Raymond, MD,* Mamdouh Khayat, MD,*
Jeffrey Forris Beecham Chick, MD, MPH, DABR,† and Ravi N. Srinivasa, MD, FSIR‡

Endoscopy is an underutilized technique in the practice of interventional radiology. The objectives of this article are to discuss potential uses of interventional radiology-operated endoscopy and to outline basic endoscopy setup and equipment uses. Endoscopy represents a new frontier to the fluoroscopically-guided procedures in biliary, gastrointestinal, and genitourinary disease that interventional radiologists commonly perform. It shows promise to improve interventional radiology procedure success rates and reduce procedure-associated risk for patients. Endoscopy has been traditionally performed by gastroenterologists and urologists and is relatively new in the practice of interventional radiology. The hand-eye coordination and manual dexterity required to perform standard image-guided procedures places interventional radiologists in a unique position to introduce endoscopy into standard practice. A focused and collaborative effort is needed by interventional radiologists to learn the techniques required to successfully integrate endoscopy into practice.
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Introduction

Endoscopy has many practical uses to assist in common interventional radiology procedures, particularly in biliary, gastrointestinal, and genitourinary interventions. Some of these techniques have been described for several decades. Despite this, few interventional radiologists currently incorporate endoscopy into their practice and the tool is underutilized in interventional radiology as a whole. The reasons for this underutilization are multifactorial, but the landscape is changing. For instance, advances in endoscope technology and reductions in prior financial disincentives are now opening the door for interventional radiologists to train in and perform endoscopy.[1] In certain clinical scenarios, the use of interventional radiology-operated endoscopy is anticipated to increase procedure efficacy and thus reduce total procedure times and procedure-associated complications. This will undoubtedly produce cost savings as well.

Interventional radiologists are in a unique position to integrate endoscopy into many of their commonly performed image-guided procedures. This is in large part due to the high level of manual dexterity required to perform routine interventional procedures. Endoscopic techniques are also considered relatively safe and are commonly performed in the outpatient setting or at the hospital bedside. These factors would facilitate a very quick learning curve for the integration of endoscopy into the interventional radiologist's

Abbreviations: ERCP, endoscopic retrograde cholangiopancreatography; EGD, esophagogastroduodenoscopy

*Department of Radiology, Division of Vascular and Interventional Radiology, The Ohio State University Wexner Medical Center, Columbus, OH.
†Division of Interventional Radiology, Department of Radiology, University of Washington, 1959 Northeast Pacific Street, Seattle, WA 98195.
‡Department of Radiology, Division of Vascular and Interventional Radiology, UCLA Medical Center, Los Angeles, CA.
Address reprint requests to Mamdouh Khayat, MD, Department of Radiology, Division of Vascular and Interventional Radiology, The Ohio State Wexner Medical Center, 395 West 12th Avenue, Columbus, OH 43210. E-mail: mamdouh.khayat@osumc.edu

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skillset. The goal of this article is to describe the role of interventional radiology-operated endoscopic techniques in producing better outcomes for a few commonly performed image-guided procedures.

Patient Preparation and Endoscopy Equipment Setup

Patient selection

When assessing the appropriateness of an endoscopic-guided intervention, consultation with both medical and surgical providers is important. This will ensure that the appropriate patients are selected and that all involved clinicians are in agreement with the planned procedure.

Obtaining percutaneous access at least 4-6 weeks before the endoscopic procedure is preferred. This allows time for a tract to mature, which should decrease subsequent leakage into the peritoneum during endoscopy. Customary techniques in cholecystostomy, cholangiography, nephrostomy, and gastrostomy should be followed. A laboratory evaluation should be conducted including a complete blood count, basic metabolic panel, and coagulation markers. In general, total platelet count should be greater than 50,000/μL, international normalized ratio above 1.5, and hemoglobin greater than 8.0. Electrolyte imbalances should be corrected to avoid the occurrence of arrhythmias.

Patient setup

Prior to endoscopy, preprocedural antibiotics should be administered in accordance with the Society of Interventional Radiology guidelines. General anesthesia is preferred, but some procedures may be performed under moderate sedation based on patient comorbidities and provider preference. To help manage potential large volumes of instilled fluid during the procedure, orogastric and rectal tubes can be placed after the induction of anesthesia. These tubes are particularly needed if the procedure time may be in excess of 1 hour.

The anesthesiologist and interventional radiologist should be aware of possible temperature changes and electrolyte disturbances which may occur due to the large volume of instilled fluid. Core temperature can be maintained with the use of a Bair Hugger device (3M Company; Maplewood, MD) and watertight drapes to reduce excess fluid contact with the skin. An appropriate drainage system should also be used to reduce fluid spillage onto the procedure suite floor.

Endoscopy setup

The basic setup includes an endoscope and an endoscopic tower, which includes a monitor and video processing unit. There are many different endoscopes available for use and selection is based upon the specific indication, preference of the provider, available route of access, and availability of a particular endoscope. Possible options include the following: a 7.95-Fr flexible reusable (Olympus America; Center Valley, PA) (Fig. 1), a 9.5-Fr flexible disposable (Boston Scientific; Marlborough, MA) (Fig. 2), a 16.5 Fr flexible reusable (Olympus America) (Fig. 3), and a 22.5-Fr rigid reusable endoscope (Olympus America) (Fig. 4).

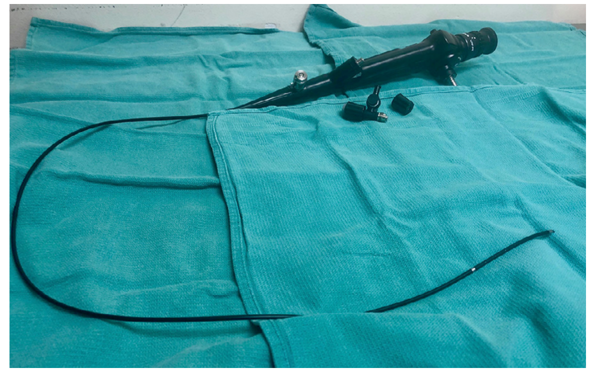

Figure 1 A 7.95-French reusable endoscope (Olympus) may be used for a variety of endoscopic biliary interventions. It has a 3.6-French working channel.

Figure 2 A 9.5-French disposable endoscope (Boston Scientific) can be used for biliary and genitourinary interventions. It has a 3.6-French working channel allowing for the coaxial delivery of a wide variety of different devices.

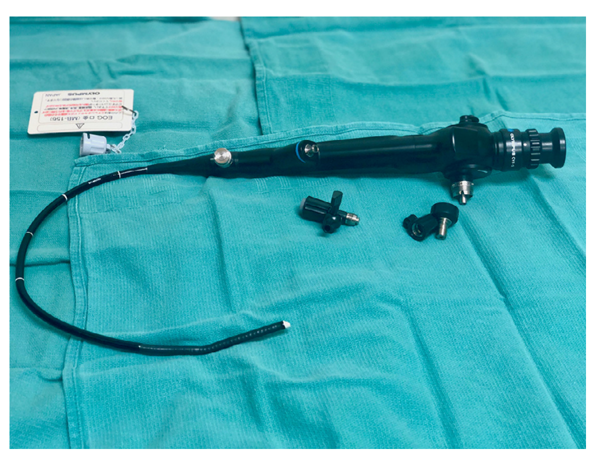

Figure 3 A 16.5-French reusable endoscope (Olympus) may be used for biliary or gastrointestinal interventions. The larger 5.5-French working channel allows for the passage of larger profile devices while maintaining adequate visualization.

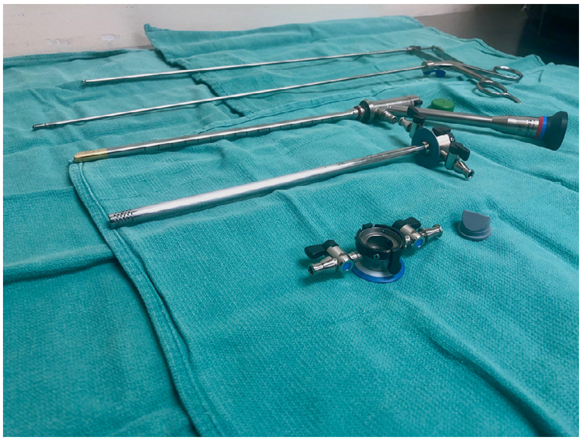

Figure 4 A 22.5-French rigid endoscope (Olympus) may be used for cholecystoscopy and cholecystolithotripsy and for genitourinary and gastrointestinal interventions. The large 4-mm working channel allows for passage of large profile devices including rigid grasping forceps and an ultrasonic lithotripter.

A continuous saline flush bag system is connected to the endoscope to constantly clear debris from the camera lens. This ensures sufficient visibility throughout the procedure. The saline bag is connected to a side port on the endoscope. A light source is also connected to the endoscope. Suction tubing is typically connected to an ultrasonic lithotripter which may be used with rigid endoscopes (Fig. 5).

After obtaining access, 2 Amplatz Super Stiff Guidewires (Boston Scientific) are inserted. One of these wires serves as a safety wire to preserve access throughout the procedure. When using an endoscope, particularly a rigid one, tract dilation is very important. This can be performed by using a high-pressure X-Force balloon (Bard; New Providence, NJ). There is often excess fluid in endoscopic procedures which must be properly expelled. This is achieved by inserting a peel-away sheath large enough to accommodate the endoscope and adjacent guidewire. The excess saline fluid can be expelled through the sheath. Various additional devices can also be passed through the central working channel of the endoscope in order to perform functions pertinent to the procedure at hand.

Figure 5 Suction tubing connected to an ultrasonic lithotripter (Olympus ShockPulse SE). Small fragmented stone debris can be seen passing through the tubing during cholecystolithotripsy.

Biliary Endoscopy

Gallstones

Biliary endoscopy is most commonly performed in the setting of symptomatic cholelithiasis. Approximately 1.4% of the population per year in the United States is affected by gallbladder stones and symptomatic duct obstruction occurs in about 1%-4% of this population.[2,3] The preferred treatment in these patients is a cholecystectomy but in those with significant comorbidities, surgery may not be advised. In the setting of a patient who cannot undergo surgery and instead receives cholecystostomy, lifelong tube exchanges may often be required. This can place a significant financial burden on the healthcare system.[4–6] However, interventional radiology-operated endoscopy can provide a solution to this clinical predicament.

Effort should be made to access the gallbladder along its long axis preferably within the fundus or body, never at the neck. This allows for a more efficient and comfortable approach for eventual stone sweeping and removal maneuvers. The percutaneous tract is dilated and a 22.5-Fr rigid endoscope may be inserted. This endoscope is preferred by some operators due to the relatively straight course from the access site to the gallbladder and its ability to extract stones. If a larger stone is encountered, ultrasonic (Olympus ShockPulse SE; Olympus Medical), electrohydraulic (Gyrus ACMI; Olympus Medical; Southborough, MA), and laser lithotripsy (VersaPulse Holmium Laser; Boston Scientific) devices can be used to fragment the stone to augment removal. The Arrow-Trerotola thrombectomy device (Teleflex Medical; Wayne, PA) and the mechanical ZeroTip Nitinol Stone Retrieval basket (Boston Scientific) can also be used to sweep and remove gallstones, respectively.

After removal of the stone, a transcystic internal–external drainage catheter and cholecystostomy drain may be placed. Alternatively, a Foley catheter can be placed in the gallbladder to relatively closely mimic the dilated tract size. Patients are then admitted for overnight observation and a second dose of antibiotics is given. Upon discharge, patients are typically given a 7-10 day supply of oral antibiotics (Augmentin, GlaxoSmithKline) and some clinicians also advocate for the prescription of ursodeoxycholic acid 300 mg twice daily to prevent gallstone recurrence. Patients return in 2 weeks for removal of the transcystic drain (if placed) and the remaining cholecystostomy tube is downsized. The cholecystostomy tube is then removed 2 weeks later.[7–9]

Intrahepatic and extrahepatic biliary duct uses

In the setting of biliary obstruction, endoscopic retrograde cholangiopancreatography is the first-line treatment. There are cases, however, where endoscopic retrograde cholangiopancreatography is technically challenging due to altered biliary anatomy, ductal strictures, or ductal compression from tumor. In these instances, percutaneous transhepatic cholecystostomy is typically performed. After the acute process has resolved or been stabilized, the tract is upsized in preparation for choledochoscopy. This is performed in a manner similar to cholecystoscopy except a flexible endoscope is utilized to allow for optimal navigation through the tortuous biliary tree.

The roles of choledochoscopy include, but are not limited to, choledocholithotripsy and stone removal, biliary cast treatment, biliary lesion biopsy, biliary stricture characterization and treatment, choledochojejunostomy anastomosis stricture stenting, and clearing of biliary sludge.[10] Postprocedural patient care is similar to that of cholecystoscopy with biliary drain downsizing and subsequent removal.

Gastrointestinal endoscopy

Retained foreign bodies

In cases of retained gastric and duodenal foreign bodies, standard esophagogastroduodenoscopy facilitated retrieval is typically performed. However, this is often technically difficult to perform in patients with altered upper gastrointestinal anatomy. Anomalies may be due to neoplasm, stricture, or another developmental or acquired anatomical abnormality. The conscious sedation used for esophagogastroduodenoscopy can also present a high risk of aspiration in patients with a history of cerebrovascular accident or other central nervous system diseases.[11−13] Due to these obstacles, other retrieval options may be needed in these specific patient populations.

Traditionally in these complicated cases, fluoroscopic-guided retrieval alone would be performed by an interventional radiologist working through a gastrostomy tube tract. This too can prove to be challenging primarily due to the 2-dimensional nature of a fluoroscopic procedure and the lack of direct visualization of the gastric and duodenal anatomy. Direct visualization of a retained foreign body through the endoscope may reduce total procedural and fluoroscopy time by increasing efficiency and may also reduce local trauma to the gastric and duodenal mucosa by increasing user accuracy of retrieval forceps. The feasibility of this procedure has been demonstrated for several foreign body types including the retrieval of fractured gastrostomy and gastrojejunostomy tubes, migrated esophageal stents, and eroded embolization coils. Of note, in the case of eroded embolization coils, intra-arterial access should be obtained and mesenteric angiography should be performed prior to coil removal. If hemorrhage were to occur during the coil removal, re-embolization could be immediately performed.[14,15]

While patients with a pre-existing percutaneous enteral access are typically the most well suited to percutaneous endoscopic interventions, fresh access may also be obtained. Traditional percutaneous technique is used for access in upper gastrointestinal interventions. This includes the placement of T-fasteners to facilitate safe tract dilation. Endoscopy may be performed in the same session as the initial percutaneous access or after allowing tract maturation. Foreign body removal in the stomach is best facilitated by rigid endoscopy and may be combined with fluoroscopy and contrast injection as needed. A 3-mm endobronchial forceps (Lymol Medical) is the preferred device for retrieval through a 22.5-French rigid endoscope. After the procedure, a gastrostomy tube is required to be in place for at least 6 weeks prior to removal to allow for tract maturation.

Colonic stents

In patients with colon cancer, obstruction can occur up to 29% of the time and standard management includes surgical resection and diverting ostomy.[16] Patient comorbidities may make recovery from a major operation very difficult. The combined fluoroscopic and endoscopic technique can assist the placement of colonic stents in inoperable malignant colonic strictures. Interventional radiologists have done this with a reported 92% technical success rate.[17,18]

Rigid or flexible endoscopes can be used in the colon. Endoscope selection depends on distance of the target stricture or other lesion from the anus. Amplatz Super Stiff or Lunderquist guidewires may be used to cross the stricture under direct visualization using the endoscope. Once the guidewire is placed through the endoscope working channel and across the stricture, a sheath can then be advanced across the stricture under fluoroscopic guidance. The colonic stent can then be deployed. The placement of colonic stents is normally for palliative purposes and there is a reported rate of restenosis of 12%, mostly due to tumor ingrowth.[19] In these instances, a cecostomy tube should be considered to facilitate decompression of the colon.

Genitourinary endoscopy

Most often the use of genitourinary endoscopy occurs in the settings of nephrolithiasis and obstructive uropathy. In cases of obstructive nephrolithiasis, the main role of the interventional radiologist is to provide percutaneous access into the renal collecting system to allow for urine division and also to facilitate nephrolithotripsy, which is usually performed by a urologist.[20] In the setting of a ureteral stricture, percutaneous access into the renal collecting system and fluoroscopic-guided balloon dilation and nephroureteral stenting is usually performed by an interventional radiologist. If the interventional radiologist is unable to safely and quickly traverse the stricture through the use of fluoroscopy alone, endoscopy can be very useful in these situations. Direct visualization of the stricture via endoscopy may allow the stricture to be traversed more easily and an internal−external nephroureteral catheter or internal double-J ureteral stent can then be placed. There are other uses of genitourinary endoscopy including renal or ureteral lesion biopsy and retrieval of migrated renal embolization coils.[21−23]

The location of percutaneous access is important to consider when performing genitourinary endoscopy. Accessing the upper pole, lower pole, or both poles are all potential options and access should be determined by the specific situation at hand. Any existing infectious process should be adequately treated prior to endoscopic-assisted intervention.

The choice of endoscope also varies depending on the specific clinical scenario. Rigid endoscopy is typically preferred to address upper tract disease and flexible endoscopy for lower tract disease. Furthermore, flexible endoscopes may be preferable for accurate targeting of ureteral strictures and targeted biopsy of malignancy. As a general rule, the smallest caliber endoscope should be used to limit the chance of urine leak after the procedure. If persistent obstructive symptoms occur, a percutaneous nephrostomy catheter can be left in place. If no longer needed, the catheter may be removed immediately following the intervention.

Discussion

Endoscopy as an adjunct to image-guided interventions represents a new and developing frontier in the field of interventional radiology. By utilizing both fluoroscopy and endoscopy, improved clinical outcomes can be expected with potential for significant decreases in costs.[24] Gastroenterologists and urologists predominately have more endoscopy experience than interventional radiologists. However, given the manual dexterity and hand eye coordination required to perform many common interventional procedures, the adoption of this tool by interventional radiologists should be uncomplicated. Certain endoscopic-facilitated procedures have already been learned with proficiency in some interventional radiology groups.[25]. Many more training institutions must become equipped in the techniques of endoscopic-assisted intervention to help the increasing patient population that could benefit from these percutaneous procedures. For instance, between the years of 1994-2009 there has been a sixfold increase in the total number of percutaneous cholecystostomy tubes placed in the United States, from 1085 to 7239.[26] A large portion of this patient population could benefit from endoscopic-assisted interventions.

As interventional radiologists begin to implement endoscopy into common practice, it is very important to maintain an open line of communication with other clinical providers. Consultation with gastroenterologists and urologists will undoubtedly facilitate the correct procedure selection for a given patient. Working with these specialists during the procedure can also be considered to promote quality and collaborative patient care and deal with any potential complications.

Currently, the utilization of endoscopy is infrequently encountered in our interventional radiology training institutions and in private interventional radiology practices. Expansion of the interventional radiology toolbox with endoscopy will require a collaborative effort of local and national interventional radiology groups. A model has already been established in Europe, which may be emulated here.[27]

Conclusion

Interventional radiology-operated endoscopy has been shown to be successful in treating many acute and chronic biliary, gastrointestinal, and genitourinary ailments. It may also help ease financial burdens placed on our healthcare system by these medical conditions. Endoscopy as an adjunct to image-guided interventions represents a new and promising frontier in the practice of interventional radiology.

Conflict of interest

The authors whose names are listed immediately below certify that they have NO affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or nonfinancial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

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