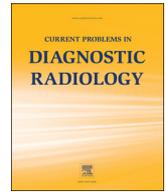




Current Problems in Diagnostic Radiology

journal homepage: www.cpdjournal.com



Interventional Radiology-Operated Endoscopy as an Adjunct to Image-Guided Interventions



Rajiv N. Srinivasa, MD*, Jeffrey Forris Beecham Chick, MD, MPH, DABR,
Kyle Cooper, MD, Ravi N. Srinivasa, MD

Department of Radiology, University of Michigan Health Systems, Ann Arbor, MI

ABSTRACT

Purpose: Interventional radiology-operated endoscopy is an underused technique, which may have a significant impact on the ability to treat patients with a variety of conditions. The purpose of this article is to discuss the setup, equipment, and potential clinical uses of interventional radiology-operated endoscopy. **Methods:** A number of new and innovative interventions may be performed in the biliary, genitourinary, and gastrointestinal systems through percutaneous access that interventional radiologists already create. When used in combination, endoscopy adds an entirely new dimension to the fluoroscopic-guided procedures of which interventional radiologists are accustomed. **Results:** Interventional radiologists are in a unique position to implement endoscopy into routine practice given the manual dexterity and hand-eye coordination already required to perform other image-guided interventions. **Conclusion:** Although other specialists traditionally have performed endoscopic interventions and local politics often dictate referral patterns, a collaborative relationship among these specialists and interventional radiology will allow for improved patient care. A concerted effort is needed by interventional radiologists to learn the techniques and equipment required to successfully incorporate endoscopy into practice.

© 2018 Elsevier Inc. All rights reserved.

Introduction

Endoscopy is an underused tool by interventional radiology departments and interventionalists as a whole. Few academic centers and proceduralists to date are currently performing endoscopic-guided procedures in interventional radiology despite its myriad of uses for biliary, genitourinary, and gastrointestinal procedures. Most of these procedures are instead being performed by other specialties such as urology and gastroenterology and often local politics dissuade other specialties from its implementation.

Interventional radiologists; however, are in a unique position to implement endoscopy into the arsenal of equipment used for image-guided procedures. On a daily basis, interventional radiologists perform numerous procedures requiring a high-degree of manual dexterity and hand-eye coordination, therefore, the learning curve for interventional radiologists to become proficient in endoscopic techniques is rather mild. As a testament to their relative safety, many of these endoscopic interventions are routinely performed at bedside or in outpatient centers including

bronchoscopy, colonoscopy, cystoscopy, esophagogastroduodenoscopy, and laryngoscopy.

The purpose of this article is to describe the role of interventional radiology-operated endoscopy as an adjunct to image-guided interventions.

General Setup and Equipment

Patient Selection

Before performing any endoscopic-guided intervention a multi-disciplinary discussion with the referring physicians is necessary. This includes both medical and surgical subspecialists to ensure that all parties are in agreement with the planned procedure. Often a surgical option may be a better treatment for the specific clinical scenario and diligence is needed to select appropriate patients.

Laboratory evaluation should include a basic metabolic panel, complete blood count and coagulation markers. Percutaneous access must be obtained prior to performing endoscopy and in general the international normalized ratio should be less than 1.5 and platelet count should be greater than 50,000/ μ L. Electrolyte disturbances should be corrected as these may lead to dangerous fluid shifts or arrhythmias during endoscopy.

Patient Setup

Before endoscopic interventions preprocedural antibiotics should be administered according to the Society of Interventional

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent was obtained from all individual participants included in the study.

* Reprint requests: Rajiv N. Srinivasa, MD, Department of Radiology, University of Michigan Health System, Michigan Medicine, 1500 East Medical Center Dr, Ann Arbor, MI 48109.

E-mail address: srajiv@med.umich.edu (R.N. Srinivasa).



FIG 1. Endoscopy tower with monitor, video processor, lithotripter, and color video printer. (Color version of the figure available online.)

Radiology guidelines. Although procedures may be performed under intravenous moderate sedation, general anesthesia is preferable. After induction of anesthesia orogastric and rectal tubes should be placed, particularly if procedure time is likely to exceed one hour in length. These tubes help to manage the large amounts of fluid that may be instilled through the endoscope during lengthy procedures. Additionally, electrolyte disturbances and temperature shifts may occur due to the large volumes of fluid instilled and therefore the anesthesiologist should be aware of these possibilities and Bair Hugger (3M Company; Maplewood, MN) devices should be used to maintain core temperature. Watertight cranial drapes may also prevent hypothermia. Lastly, a Neptune Drainage System (Stryker; Kalamazoo, MI) should be used to decrease spillage of fluid onto the floor.

Obtaining Access

Depending on the clinical scenario percutaneous access should be obtained into the structure of interest. Standard techniques used for cholangiography, cholecystostomy, nephrostomy, and gastrostomy are performed. Although these techniques may be performed in the same session as endoscopy, it is preferred that access be obtained at least 4–6 weeks before endoscopy to allow time for tract maturation. It is thought that this may decrease the risk of leakage and pain following endoscopy, particularly when larger endoscopes are used.

Available Endoscopes and Setup

All endoscopes require an endoscopy tower with monitor and video processing unit (Fig 1). Several different endoscopes are available for use, the choice of which is dependent on the

particular indication, the access route, the availability and the operator's preference. The available endoscopes include: a 7-Fr flexible reusable (Storz; Tuttlingen, Germany) (Fig 2), 9.5-Fr flexible disposable (Boston Scientific; Marlborough, MA) (Fig 3), 9-Fr flexible reusable (Olympus America; Center Valley, PA), 16.5-Fr flexible reusable (Olympus America) (Fig 4), and 22.5-Fr rigid reusable endoscope (Olympus America) (Fig 5).

For adequate visibility, the endoscope must be connected to a continuous saline flush bag system to constantly clear debris from the lens of the camera. This is connected to a port on the side of the endoscope. In addition, a light source and suction device are connected to the endoscope.

After access is obtained, 2 Amplatz Super Stiff Guidewires (Boston Scientific) are inserted, one of which serves as a safety wire to maintain access at all times during endoscopy. Tract dilation is often necessary, particularly when using the rigid endoscope and is performed using a high-pressure X-Force balloon (Bard; New Providence, NJ). A peel-away sheath large enough to accommodate the chosen endoscope and the adjacent wire is inserted over one of the guidewires and allows for efflux of excess fluid during endoscopy. Each endoscope has a working channel of varying size that allows for passage of various devices directly into the line of sight of the endoscope. Many ancillary devices may be used through the endoscopes (Fig 6).

Biliary Endoscopy

Biliary endoscopy is most often performed in the setting of stone disease. Gallstones affect approximately 1.4% of the population per year in the United States and result in symptomatic cystic duct obstruction in 1%–4% of patients [1,2]. In such cases, surgical



FIG 2. A 7-Fr flexible reusable endoscope. (Color version of the figure available online.)



FIG 3. A 9.5-Fr flexible disposable endoscope. (Color version of the figure available online.)

removal of the gallbladder is the preferred treatment; however, in patients with comorbidities that preclude them from surgery, cholecystostomy may be required. In the case of calculous cholecystitis, unless the gallstones are removed, a patient that cannot undergo surgery may require lifelong tube exchanges, significantly limiting the patient's quality of life and placing a large financial burden on the healthcare system [3,4]. This clinical dilemma readily offers itself to treatment by interventional radiology-operated endoscopy.

When creating access for cholecystostomy, effort should be given to accessing the gallbladder along its long-axis to allow a more ergonomic approach for stone sweeping and extraction. After dilating the tract the use of a 22.5-Fr rigid endoscope is preferred due to the relatively straight course from the skin surface to the gallbladder and ability to easily remove stones. Electrohydraulic (Gyrus ACMI; Olympus Medical; Southborough, MA) and ultrasonic lithotripsy (Olympus ShockPulse SE; Olympus Medical) devices may be used to fragment larger stones. Mechanical ZeroTip Nitinol Stone Retrieval baskets (Boston Scientific) and the Arrow-Trerotola thrombectomy device (Teleflex Medical; Wayne, PA) may also be used to remove and sweep stones, respectively.

Upon completion, a transcystic internal-external drainage catheter and cholecystostomy drain are replaced. Catheter size is determined by operator preference and final tract size such that the 2 drains in combination closely equal the size of the tract created. Patients are admitted for observation and a second dose of antibiotics should be given. Patients are then discharged with oral antibiotics such as Amoxicillin-Clavulanate 875-125 mg (Augmentin; GlaxoSmithKline; Brentford, UK). Additionally some operators prescribe ursodeoxycholic acid 300 mg twice daily to prevent gallstone recurrence.

After 2 weeks the patient returns and the transcystic drain is removed and the remaining cholecystostomy tube is downsized until it may eventually be removed. The reported outcomes following cholecystostomy and cholecystolithotripsy have been positive, allowing for more complete removal of stones compared to percutaneous cholecystolithotripsy performed with fluoroscopic-guidance alone [5-8].

In the setting of intrahepatic or extrahepatic biliary ductal obstruction endoscopic retrograde cholangiopancreatography is the first-line treatment to relieve obstruction. However, in many cases endoscopic retrograde cholangiopancreatography is technically challenging either due to stricturing or altered anatomy. For such patients, percutaneous transhepatic biliary drainage is performed to relieve obstruction. Once the active infection has resolved the tract is upsized and allowed to mature in preparation for choledochoscopy of the biliary tree.

Choledochoscopy is performed similarly to cholecystoscopy, however, a flexible endoscope is used to navigate through the biliary tree. Utilities for choledochoscopy include clearing of biliary sludge and treatment of choledocholithiasis and biliary casts. Additionally, other filling defects and strictures within the biliary tree may be characterized, biopsied and treated with endoscopic guidance. Postprocedure management after choledochoscopy is the same as for cholecystoscopy with eventual downsizing and removal of the biliary drain.

Genitourinary Endoscopy

The most common use of genitourinary endoscopy is in the treatment of stone disease and obstructing uropathy. In many



FIG 4. A 16.5-Fr flexible reusable endoscope. (Color version of the figure available online.)

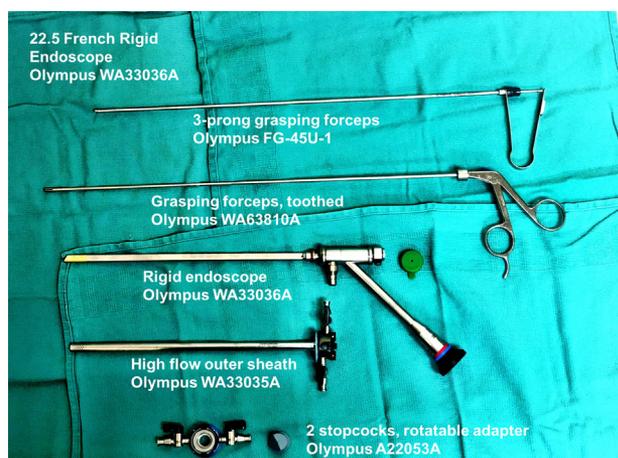


FIG 5. A 22.5-Fr rigid reusable endoscope. (Color version of the figure available online.)

centers the primary role of interventional radiology in such cases, if any, is to obtain percutaneous access into the renal collecting system for nephrolithotripsy which is usually performed by Urology [9]. However, in the setting of ureteral strictures, balloon dilation, and nephroureteral stenting are often performed by interventional radiologists under fluoroscopic-guidance. Often though traversal of ureteral strictures proves difficult by fluoroscopy alone in which case interventional radiology-operated genitourinary endoscopy may be of aid. Once the stricture is directly visualized, it may be more easily crossed to allow placement of an internal-external nephroureteral catheter or internalized ureteral stent, procedures already often performed by interventional radiology. Other uses of genitourinary endoscopy include foreign body retrieval from the renal collecting system. Although rare, reports of migrated renal arterial embolization coils have been retrieved from the renal collecting system using interventional radiology-operated nephroscopy [10–13].

When creating percutaneous access for genitourinary endoscopy, the location of access should be determined based on the specific scenario being addressed. Upper pole, lower pole, or both may be needed based on the specific situation. Single-session percutaneous access followed by balloon dilation using a high-pressure X-force balloon and endoscopy may be performed, however, patients should be appropriately treated for any urinary tract infection before undergoing endoscopy.

In general, rigid endoscopy is preferred for treatment of upper tract disease, whereas flexible endoscopy is appropriate for distal

disease. The choice of endoscope should be determined by the procedure being performed. For example, in the case of recurrent malignancies or ureteral strictures, flexible endoscopic guidance may be used to accurately direct biopsies. The smallest caliber endoscope should be used for the planned intervention based on the size of the working channel to limit the possibility of urinary leakage after the procedure. Following genitourinary endoscopy, a percutaneous nephrostomy catheter may be left in place if there is persistent obstruction, or may be removed immediately if no longer needed.

Gastrointestinal Endoscopy

Upper gastrointestinal endoscopy may be performed by interventional radiologists after percutaneous gastrostomy. In patients with altered surgical anatomy this approach may prove advantageous over esophagogastroduodenoscopy. Removal of gastric foreign bodies including broken plastic or metallic stents or eroded embolization coils may be performed percutaneously and are aided by the combined use of fluoroscopy and endoscopy. In the latter scenario, transarterial access to prepare for arterial embolization may be necessary before removing eroded coils.

Lower gastrointestinal endoscopy in general is performed by gastroenterology, however, combined endoscopic and fluoroscopic interventions offer a new horizon for interventional radiologists. Patients with colon cancer may develop complete or partial colonic obstruction in up to 29% of cases [14]. The standard management for malignant colonic obstruction involves surgical decompression and diverting ostomy; however, in patients with comorbidities precluding surgery, interventional radiology-operated endoscopy may be an option. Combined fluoroscopic and endoscopic-guided placement of colonic stents have been performed by interventional radiology for inoperable malignant strictures with a 92% rate of technical success reported [15,16]. The use of endoscopy aids in the traversal of severe strictures.

Creating access for upper gastrointestinal interventions is performed by the traditional technique for placing a gastrostomy tube with T-fasteners placed to permit safe tract dilation. Endoscopy may be performed in a single-session at the same time the access is created. Rigid endoscopy is preferred for most interventions involving the stomach for foreign body retrieval and may be combined with fluoroscopic visualization and contrast injection as necessary. A gastrostomy tube must remain in place for at least 6 weeks after the intervention to allow tract maturation after which time it may be removed.

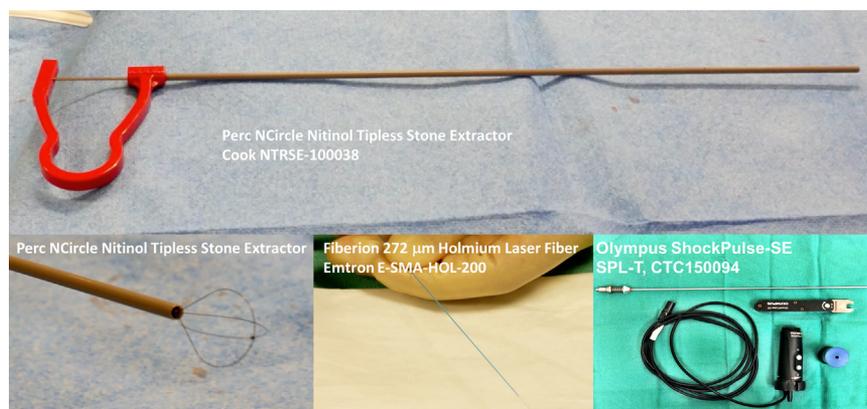


FIG 6. Multiple ancillary devices including the tipless stone extractor, holmium laser, and shockpulse lithotripter. (Color version of the figure available online.)

Interventional radiology-operated endoscopy of the colon may be performed using rigid or flexible endoscopes depending on the distance of the target lesion from the anus. An Amplatz Super Stiff guidewire or Lunderquist guidewire may be passed through the working channel of the endoscope and used to cross colonic strictures under direct visualization. Once a wire has been placed a long sheath may be advanced across the stricture under fluoroscopic-guidance, straightening the colon, and then can be used to deploy colonic stents. In general, placement of colonic stents is palliative with a rate of restenosis due to tumor ingrowth reported as 12% [17]. In such patients cecostomy tubes may also be placed to allow for palliative colonic decompression.

Discussion

Interventional radiologists are well suited to implement endoscopy into routine practice. The ease of assembly and usage of modern endoscopes makes its incorporation by interventional radiologists facile. Endoscopy adds a new dimension to the procedures that may be performed and when used in combination with other image-guided interventions creates an opportunity to perform treatments that no other specialist outside of interventional radiology may provide. Although gastroenterologists and urologists may be more familiar with the use of endoscopes, the learning curve is mild and proficiency with their usage has been mastered in a short time period by both trainees and faculty members at this institution.

The key to the successful implementation of interventional radiology-operated endoscopy is in communication with other specialists and referring clinicians. This will ensure that patients are selected appropriately for such procedures. Combined procedures involving gastroenterology and urology may also be beneficial in order for all specialists to share knowledge and offer better care for patients by working together. As experience is gained in performing endoscopy and good patient outcomes are achieved, additional referrals for interventional radiology-guided endoscopy procedures will likely follow.

A clinically oriented model of interventional radiology practice is necessary to implement endoscopic interventions. Patients are usually admitted for overnight observation following endoscopic interventions. A collegial relationship with gastroenterology, surgery and urology will help ensure the safety of patients in the event of unforeseen complications.

There is currently little exposure to interventional radiology-operated endoscopy in training programs within the United States and the process for gaining experience is not well established. In Europe; however, the British Society of Gastrointestinal and Abdominal Radiology has established endoscopic training guidelines [18]. Although there are a few workshops for gaining exposure to endoscopy, more effort is needed by interventional radiologists to successfully expand its usage in practice. The use of interventional endoscopy has the potential to revolutionize the practice of interventional radiology as an adjunct to image-guided interventions.

Conclusion

Interventional radiology-operated endoscopy is an underutilized tool that has the potential to improve patient care by providing new and innovative treatments for a variety of conditions involving the biliary, urinary, and gastrointestinal systems.

COI Statement

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 article.

Conflict of Interest

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent was obtained from all individual participants included in the study.

References

- Halldestam I, Enell EL, Kullman E, et al. Development of symptoms and complications in individuals with asymptomatic gallstones. *Br J Surg* 2004;91(6):734–8.
- Halldestam I, Kullman E, Borch K. Incidence of and potential risk factors for gallstone disease in a general population sample. *Br J Surg* 2009;96(11):1315–22.
- Hsieh YC, Chen CK, Su CW, et al. Outcome after percutaneous cholecystostomy for acute cholecystitis: A single-center experience. *J Gastrointest Surg* 2012;16(10):1860–8.
- Arnaud J-P, Pessaux P. Percutaneous cholecystostomy for high-risk acute cholecystitis patients. *South Med J* 2008;101(6):577. <https://doi.org/10.1097/smj.0b013e31817308bd>.
- Kim HJ, Lee SK, Kim MH, et al. Safety and usefulness of percutaneous transhepatic cholecystostomy examination in high-risk surgical patients with acute cholecystitis. *Gastrointest Endosc* 2000;52(5):645–9. <https://doi.org/10.1067/mge.2000.107286>.
- Wong SKH, Yu SCH, Lam YH, et al. Percutaneous cholecystostomy and endoscopic cholecystolithotripsy in the management of acute cholecystitis. *Surg Endosc* 1999;13(1):48–52. <https://doi.org/10.1007/s004649900896>.
- Picus D, Hicks ME, Darcy MD, et al. Percutaneous cholecystolithotomy: Analysis of results and complications in 58 consecutive patients. *Radiology* 1992;183(3):779–84. <https://doi.org/10.1148/radiology.183.3.1533946>.
- Kim YH, Kim YJ, Shin TB. Fluoroscopy-guided percutaneous gallstone removal using a 12-Fr sheath in high-risk surgical patients with acute cholecystitis. *Korean J Radiol* 2011;12(2):210. <https://doi.org/10.3348/kjr.2011.12.2.210>.
- Oberlin DT, Flum A, Bachrach L, et al. Contemporary surgical trends in the management of upper tract calculi. *J Urol* 2014;191(4). <https://doi.org/10.1016/j.juro.2014.02.698>.
- Phan J, Lall C, Moskowitz R, et al. Erosion of embolization coils into the renal collecting system mimicking stone. *West J Emerg Med* 2012;13(1):127–30. <https://doi.org/10.5811/westjem.2011.7.6784>.
- Savoie P-H, Lafolie T, Gabaudan C, et al. Complication tardive d'une artériomembolisation sélective rénale après chirurgie per-cutanée: Une coïlque néphrétique. *Prog Urol* 2007;17(4):869–71. [https://doi.org/10.1016/s1166-7087\(07\)92311-8](https://doi.org/10.1016/s1166-7087(07)92311-8).
- Kumar S, Jayant K, Singh SK, et al. Delayed migration of embolized coil with large renal stone formation: A rare presentation. *Case Rep Urol* 2014. <https://doi.org/10.1155/2014/687965>.
- Rutchik S, Wong P. Migration of arterial embolization coils as nidus for renal stone formation. *J Urol* 2002;2520. [https://doi.org/10.1016/S0022-5347\(05\)65020-3](https://doi.org/10.1016/S0022-5347(05)65020-3).
- Tuca A, Guell E, Martinez-Losada E, et al. Malignant bowel obstruction in advanced cancer patients: Epidemiology, management, and factors influencing spontaneous resolution. *Cancer Manag Res* 2012;4:159–69. <https://doi.org/10.2147/cmar.s29297>.
- De Gregorio MA, Mainar A, Rodriguez J, et al. Colon stenting: A review. *Semin Intervent Radiol* 2004;21(03):205–16. <https://doi.org/10.1055/s-2004-860941>.
- Mauro MA, Koehler RE, Baron TH. Advances in gastrointestinal intervention: The treatment of gastroduodenal and colorectal obstructions with metallic stents. *Radiology* 2000;215(3):659–69. <https://doi.org/10.1148/radiology.215.3.r00jn30659>.
- Watt AM, Faragher IG, Griffin TT, et al. Self-expanding metallic stents for relieving malignant colorectal obstruction: A systematic review. *Ann Surg* 2007;246(1):24–30. <https://doi.org/10.1097/01.sla.0000261124.72687.72>.
- Endoscopy training. British society of gastrointestinal and Abdominal Radiology. (<https://www.bsgar.org/juniors/endoscopy-training-1/>). Accessed November 8, 2017.