Fundamental of Endoscopic Surgery: Online Study Guide
Module 1 – Technology

Welcome to the Fundamentals of Endoscopic Surgery (FES) offered by the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES).

FES is an off-the-shelf program with the goal of establishing a baseline level of skills and knowledge in flexible gastrointestinal (GI) endoscopy. The program includes web-based didactic material along with a written test of knowledge and a hands-on skills test. When coupled with clinical experience, a post-graduate year two or three surgery resident who has completed a flexible endoscopy rotation should be able to pass the FES exam. Gastroenterology fellows should be able to pass FES at the end of their first year of fellowship.

This course presents an introduction to flexible GI endoscopy. There are twelve modules:

- Module 1: Technology
- Module 2: Patient Preparation
- Module 3: Sedation and Analgesia
- Module 4: Upper Gastrointestinal Endoscopy
- Module 5: Lower Gastrointestinal Endoscopy
- Module 6: Performing Lower GI Procedures
- Module 7: Lower GI Anatomy, Pathology, and Complications
- Module 8: Didactic Endoscopic Retrograde Cholangiopancreatography (ERCP)
- Module 9: Hemostasis
- Module 10: Tissue Removal
- Module 11: Enteral Access
- Module 12: Endoscopic Therapies

Learning Objectives

After finishing this module, you will be able to:

- Describe the characteristics of endoscopes
- Perform the setup of equipment for an endoscopic procedure
- Describe how to care for endoscopic equipment
- Describe how to troubleshoot in the endoscopic lab

Characteristics of Endoscopes

Introduction

Endoscopes come in various diameters and lengths. They are chosen based on the portion of the alimentary system being evaluated, the diagnostic or therapeutic intervention to be provided, the patient's underlying anatomy, and the preference of the endoscopist.

Flexible scopes are designed to view the lumen either in a front or side viewing manner.

The front viewing scope is most commonly used in endoscopic procedures.

The side viewing scope allows for optimal evaluation of and access to certain lesions in the stomach and the duodenum. This scope is most commonly utilized when performing biliary and pancreatic ductal imaging through the ampulla of Vater.

Fiber Optic Endoscopes

Fiber optic endoscopes are based on fiber optic light transmission technology.

Light is conveyed through two bundles of fine glass fibers, each smaller than a human hair (8 to 10 μm in diameter), packed tightly together in the shaft of the scope. One bundle of fibers carries light into the examined organ, and a second bundle transmits the image from the organ to the viewing optic. The latter bundle must have all the fibers arranged in a coherent bundle. This method of bundling produces the image on the monitor in its correct orientation.

Each fiber is clad in a wrapping of higher optical density, creating a reflective layer that causes light to bounce back and forth within the fiber. This configuration allows for minimal light loss. Although the cladding does not transmit light, it does appear as a dark rim around the portion of the image transmitted by the fiber, giving images seen through a fiber optic endoscope a newsprint-like quality.

A major disadvantage of a flexible fiber optic endoscope is fragility of the fibers. When individual fibers break, light transmission decreases and the visual image develops dark spots.

Fiber optic endoscopes are generally direct-viewing, meaning the endoscopist looks directly into an eyepiece. An optical beam splitter allows a second observer to view the image through a separate eyepiece. Alternatively, a small video camera may be placed on the end of the endoscope and the image viewed on a video screen. Adding side-arms and external video screens introduces optical interference that reduces visual clarity.

Fiber optic endoscopes are most often used when a small diameter is required such as in bronchoscopy or choledochoscopy. They are no longer commonly used in standard GI endoscopy.

Video Endoscopy

Video endoscopy applies video technology to the endoscope. The video endoscope has replaced many of the flexible fiber optic endoscopes because it brings significant improvements in image quality and endoscope durability.

In a modern video system, light is transmitted to the tip of the endoscope through a fiber optic bundle, similar to the direct-viewing fiber optic system described earlier. However, the viewing fiber optic bundle is replaced with a charge-coupled device (CCD) chip-based camera placed at the tip of the endoscope. This chip sends a digital image back to a video processor, which displays an image on a color monitor.

The CCD chip camera uses a dense grid of photocell receptors, each generating a single pixel on the monitor. Image resolution depends on the density of receptor packing on the chip. Some video-endoscopes use a single-color CCD chip and create color images by rapidly cycling through a color wheel. However, most recent video-endoscopes use three-color CCD chips and provide the most accurate color resolution and depiction. Most video endoscopes also incorporate an automatic iris in the system to decrease the problem of glare from tissue reflection.

Having the image transmitted to the monitor allows the entire endoscopic team to observe the field. The CCD chip technology also allows for higher image quality with smaller scope diameters.

Image Capture

Illumination is provided by an external source: either by a xenon arc, or a halogen-filled tungsten filament lamp.

Modern endoscopes also include electronic systems to capture still images and record video.

Channels

Flexible endoscopes provide one or more instrument channels (2 to 4.2 mm in diameter) for passage of diagnostic and therapeutic instruments as well as for suctioning and auxiliary irrigation. When not in use, the channels are kept capped to prevent loss of insufflation and splashing of fluids.

Air and water insufflation channels permit distention of the bowel and cleaning of the lens. The positions of these channels are important to note when performing tasks.

Tip Control

The endoscopist controls tip deflection by rotating the two wheels on the headpiece.

- The larger wheel moves the tip up and down
- The smaller wheel moves the tip right and left

Although most scopes have locks, the wheels should be allowed to move freely for most procedures.

The shaft of the scope may also be torqued in a clockwise or counterclockwise manner to change the direction in which the scope is pointing. Torquing of the scope is more commonly employed when performing lower endoscopy than in upper endoscopy.

Equipment Setup

The equipment for flexible endoscopy is generally arranged on a multi-level cart, which allows access to all the equipment and easy mobility.

The cart typically includes:

- A monitor
- Video processor
- Light source
- Water bottle
- Image printer and recorder

A keyboard is used to enter patient and physician names, patient medical record number, date, and any additional documentation.

Umbilical Cable

A fiberoptic cable connects the endoscope to the light source. This umbilical cable also contains connectors for suction, water, and air insufflation.

Air and water irrigation are introduced through a common channel by depression of a trumpet-like valve on the control head of the scope. Partial depression of this valve insufflates air to distend the lumen. Complete depression of the valve draws air backward into the attached water bottle forcing a stream of water to the tip of the instrument. This washes the lens.

Depression of an adjacent trumpet valve suctions air or fluid at the tip of the instrument. This valve controls suction through an opening at the tip of the endoscope most often located at the 7 o'clock position at the tip of the endoscope.

Insufflation, irrigation, and suction should be tested prior to each insertion of the endoscope.

Equipment Setup Steps

Equipment problems commonly occur because proper setup procedures are not followed. The steps that follow will often help prevent failures of the system.

First, choose the appropriate size (length and diameter) and type of endoscope for the intended purpose.

Endoscopes come in various diameters and lengths. They are chosen based on the portion of the alimentary system being evaluated, the diagnostic or therapeutic intervention to be provided, the patient's underlying anatomy, and the preference of the endoscopist.

Flexible scopes are designed to view the lumen either in a front or side viewing manner.

Both pediatric and adult upper gastrointestinal endoscopes are available and many scopes have additional features that make the procedure easier to perform (scope stiffeners or pedal driven irrigators, for example).

Umbilical Cable

Connect the umbilical cable of the endoscope to the light source.

Electrical Equipment

Turn on all electronic equipment on the cart, even if you are not planning to use a particular item during the procedure (for example, a digital recorder). The connections of the various pieces of equipment may require that all be on for any one to work properly.

Water Bottle

Ensure that the water bottle is filled with sterile water (do not use saline as this may crystallize in the channel).

Connect the hose from the water bottle to the side of the umbilical cable. Typically components are fitted with mating connectors, so that the hose can only connect to one place.

Suction

Connect suction to the remaining site on the umbilical cable.

Equipment Testing

Obtain a cup or basin of water and test the following functions:

- Insufflation (by insufflation of air under water and observing bubbles)
- Water irrigation (with the tip of the endoscope out of the water)
- Suction (by aspirating the water from the cup)

If any of these functions is sluggish or nonfunctional, first check the connections.

Image Quality

Take the light source off standby and aim the tip of the endoscope toward a white background. The endoscope should then be white balanced by pushing the white balance button on the camera box. This will ensure proper color balance in the image.

To test the quality of the image, point the tip of the endoscope into the cupped fingers of one hand. You should see a sharp image of the fingers on the monitor.

Tip Deflection Controls

Check the tip deflection controls and verify that there is good one-to-one correlation between the movement of the deflection wheel and the movement of the tip of the endoscope.

In addition, ensure that all locking devices are in the desired position.

Additional Items

Verify that any additional items that may be required (such as biopsy forceps, polypectomy snares, dilating balloons) are available, functioning, and of appropriate size.

Troubleshooting

All endoscopes are not constructed in the same manner. In order to avoid pitfalls during the procedure, the user should become well versed in the construction and function of the particular endoscopic system in use.

A systematic approach to identifying a problem, followed by standard or creative measures to circumvent or repair the difficulty, will usually permit satisfactory completion of the procedure.

Common problems that may be encountered include:

- No light at distal end of scope
- Image is out of focus
- No irrigation
- No insufflation
- Clogged valve or nozzle
- Unable to pass instrument in channel

Equipment Care

Maintenance/Protection

Flexible and video endoscopes are expensive and relatively fragile. Attention to care and maintenance is important for proper functioning and longevity of the equipment.

The outer coating of the endoscope is delicate, particularly in the region near the tip. A rubber sheath, designed to flex as the tip bends, covers this region of the endoscope.

Breaking the delicate light fibers can be avoided by coiling the endoscope into gentle curves, rather than folding it in acute angles.

Do not:

- Drop the endoscope
- Allow a wheeled cart to roll over it
- Allow the patient to bite down on it

Avoid extreme angulation of the tip wherever possible and do not force biopsy forceps or other instruments down the channel when the tip is sharply angled.

Ensure that polypectomy snares and sclerosing needles are fully withdrawn into the sheath before passing them through the channel. Lubricate instruments with a suitable lubricant to facilitate passage.

Cleaning

After each use, wash off any gross contamination and suction water through the endoscope. Disinfection does not work well when foreign matter is present. Therefore, do not allow blood, mucus, stool, or other foreign matter to dry on the endoscope or in the channels or valves.

Cleaning the scope with a chemical disinfectant such as gluteraldehyde should be routine.

Many endoscopy suites use automated cleaners that rapidly wash, disinfect, and rinse the endoscope. Cleaning in this manner achieves “high level” disinfection, which is acceptable for endoscopy in the GI tract. It does not sterilize the endoscope the way operative equipment is sterilized for the OR.

Another option is to use ethylene oxide gas for sterilization. This technique, however, requires an overnight cycle.

It is important that the manufacturer’s instructions for disinfection and sterilization be followed closely to avoid potentially severe damage to the endoscope.