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The Internist's Guide to Minimally Invasive Gastrointestinal Surgery

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The Internist's Guide to Minimally Invasive Gastrointestinal Surgery

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This text is dedicated to my wife Patrizia
and my daughter Elena, my golf partners.

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Chapter 1
Introduction

Kristen Donohue and Craig Rezac

This text sets out to describe the many indications for and benefits of minimally invasive surgery (MIS) for the GI tract. This is by no means an exhaustive reference but meant to serve as an informative guide to appropriate patient selection and referrals. Minimally invasive surgery is often requested by patients, and we hope that this text serves as a reference for which patients would be candidates, what type of recovery and limitations to expect, as well as contraindications for minimally invasive approaches. We will briefly discuss the history and evolution of minimally invasive techniques. The general benefits of minimally invasive approaches will be referenced, and we will delve into more detail within individual chapters with regard to specific procedure types. Finally, there are many new and exciting tools on the horizon, and we will touch upon the future of minimally invasive GI surgery.

A Brief History of Minimally Invasive Surgery

Minimally invasive surgery has come a long way from its origins. Hippocrates first mentioned a rectal speculum circa the year 400 BC; however, modern endoscopy was not used for patient care until the mid-1800s [1]. The first mention of entering full body cavities with a light source was by Jacobaeus in 1910. He coined the term "laparothorakoskopie" with examinations of both the thorax and abdomen [1]. Minimally invasive surgery as we see it today really began to take off in the 1980s, and there has been tremendous growth within the field in the last 30 years.

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The first laparoscopic appendectomy was performed by German gynecologist Dr. Kurt Semm in 1981 [2], and the first laparoscopic cholecystectomy was reported in 1987 by French surgeon Dr. Philippe Mouret [3]. This technique quickly spread from Europe to North America. In 1992 the US National Institutes of Health convened a Consensus Development Conference on Laparoscopic Cholecystectomy which estimated that about 80% of cholecystectomies were already being performed this way [4]. Today laparoscopy is used to treat innumerable intraabdominal pathologies of which appendicitis and gallstones are only the beginning.

Furthermore, robotic surgery is one of the more recent advancements in minimally invasive surgical technique. The first robot-assisted procedure was done in orthopedics in 1983 [5]. The use of robotics spread rapidly to urology and other pelvic procedures. The first FDA-approved use of robotics for general surgery was in 1993 by Yulin Wang [5]. Over time, different robotic platforms have been developed. Remote surgery is one additional potential benefit of robotics. Jacques Marescaux performed a robot-assisted cholecystectomy in 2001 on a patient in Strasbourg, France, 4000 km away from the surgeon in New York [5]. Today robotics is utilized by many different surgical subspecialties and has expanded from these initial uses to include thoracic and cardiac surgery and even ENT. This work will focus on GI surgery including hernias, gallbladder, liver, pancreas, and intestine.

Potential Benefits of MIS

One of the greatest factors in growth for minimally invasive surgery has been patient interest and request. There are numerous benefits of minimally invasive surgery over open approaches. These include smaller incisions, less postoperative pain, less narcotic use, and less postoperative ileus. Additionally due to much of the above, patients experience faster return to daily activities including work [6].

Relative and Absolute Contraindications

There are few absolute contraindications to minimally invasive GI surgery. Patients who cannot tolerate general anesthesia will not be able to undergo laparoscopic or robotic procedures. However, these are the exact patients that may benefit from advanced endoscopic interventions rather than large open surgical procedures if their disease process is amenable. Other contraindications include patients with multiple prior abdominal surgeries and significant scar tissue that prohibits sagely navigating the abdomen laparoscopically. Other potentially complicating factors include very large ventral hernias, inability to tolerate insufflation, and large liver obstructing the view of target anatomy.

Pregnancy, particularly first and third trimester, was traditionally viewed as relative contraindications to laparoscopy. However, the literature has more recently shown that laparoscopic surgery is safe during any trimester [7]. Both laparoscopic cholecystectomy and appendectomy have been done late in the third trimester without increased risk of preterm labor or death to the fetus [8].

Future Directions

As minimally invasive surgery continues to grow, more advanced techniques and technology continue to arise. There are currently multiple "single-site" platforms for both laparoscopy and robotics. This eliminates the need for multiple small laparoscopic incisions, and allows the surgeon to operate through one slightly larger port, generally at the level of the umbilicus. The skin incision for these single-site surgeries is often not much larger than the traditional laparoscopic port site and is easy to hide within the umbilicus. The fascial incision is slightly larger than traditional laparoscopy or robotics, and this is associated with slightly increased incisional hernia risk compared to standard laparoscopic ports.

The future of minimally invasive surgery is looking to remove surgical scars and incisions in the skin all together. Natural orifice transluminal endoscopic surgery (NOTES) is a new technique where abdominal operations can be performed by passing an endoscope through a natural orifice (mouth, anus). The endoscope can then enter the abdominal cavity by making an internal incision through the stomach, vagina, colon, etc. to access the abdomen with no external incisions or scars [9].

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Chapter 2
Endoscopic Interventions

Frank Senatore and Haroon Shahid

Introduction

Endoscopy is a procedure that allows the examiner to look inside a hollow organ or cavity in the body. It consists of a flexible tube with a light delivery system utilizing a lens to transmit an image to a camera. Gastroenterologists employ the use of many different types of endoscopes to aid in the diagnosis and management of many unique conditions of the digestive tract. The endoscope is maneuvered through the gastrointestinal tract under direct visualization on a projected monitor. They contain an air delivery system to insufflate the gastrointestinal tract lumens, as well as several channels for water and insertion of tools and devices used during endoscopy.

While a specific date is difficult to identify for the beginning of modern endoscopy, Philipp Bozzini is credited for achieving the first attempt to visualize the interior body and by most is considered the father of endoscopy. The first endoscope was made in Mainz, Germany, in 1806, and Antonin Jean Desormeaux is recognized for performing the first successful operative procedure using an endoscope.

Initially shunned, the endoscope grew in prominence following the advent of electricity, with its first commercial use coming in 1865 in Dublin, Ireland, by Francis Cruise. Three years later, Adolph Kussmaul became the first person to perform endoscopy in the stomach of a human. As the locations for the use of an endoscope increased, designs for specialized endoscopes tailored to different parts of the

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body were envisioned. In 1881, Johann von Mikulicz created the first gastroscope which was used to visualize the esophagus, stomach, and small intestine.

The twentieth century saw the focus shift to improving the quality and resourcefulness of endoscopes. In 1932, the first flexible endoscope was developed. In 1957, the first fiberoptic endoscope was built, and the ability to steer the end of the endoscope came shortly thereafter. The 1960s saw the advent of automatic air insufflation, paving the way for new therapeutic devices to be invented, including thermal coagulation devices. By the 1970s, millions of procedures were being performed with endoscopes in the USA alone.

As endoscopes continued to be refined, videoscopes which were electronic endoscopes with a built-in video camera allowing for conversion of an image to an electric signal that could be displayed on a TV monitor were introduced. Ultrasonic endoscopes followed, with a transducer at their tip to allow deeper levels of tissue to be evaluated. Finally, in 2002, high-definition systems were devised to improve image quality and assist in more accurate diagnosis. Today, there are dozens of different endoscopes used in gastroenterology alone to aid in the diagnosis and management of digestive diseases.

Some of the most common indications for endoscopy include symptoms such as abdominal pain, nausea, vomiting, difficulty swallowing, weight loss, and gastrointestinal bleeding. Endoscopy is also indicated for many common diagnoses including anemia, cancers of the digestive tract, malabsorption, and infections. Finally, there are many common therapeutic interventions for which endoscopy is indicated including removal of foreign bodies, control of bleeding, diagnosing and managing neoplasms, and feeding tube placement.

Overall, gastrointestinal endoscopy is a minimally invasive procedure associated with reduced risks when compared to surgery, allowing for safe implementation in most patient populations. The indications for endoscopy and possible diagnostic and management modalities continue to grow within the field. Herein, we will discuss multiple conditions and locations within the digestive tract in which different forms of endoscopy and endoscopic techniques are routinely performed.

GI Bleeding

Peptic Ulcer Disease

Bleeding from peptic ulcer disease is a common explanation for patient's presenting with hematemesis, melena, and anemia. While the majority of patients with peptic ulcers will stop bleeding spontaneously, a cohort of patients will require endoscopic therapy. During upper gastrointestinal endoscopy evaluation, ulcers are classified based on their gross appearance to determine the need to endoscopic therapy. This classification, known as the Forrest classification, includes ulcers with spurting or oozing hemorrhage, nonbleeding visible vessels, and adherent clots. These peptic ulcers all require endoscopic therapy, whereas ulcers with a flat pigmented spot or clean base do not require endoscopic therapy.

There are several types of endoscopic therapies for peptic ulcer disease. Consensus guidelines recommend dual therapy during endoscopic treatment, which always includes the injection of epinephrine. A small injection needle is inserted through the endoscope channel with an epinephrine-filled syringe on the opposite side. Then, the needle is inserted into the ulcer site, and a 1:10,000 solution of epinephrine is administered. Epinephrine injection is relatively simple to deliver and often makes the bleeding ulcer site cleaner for the subsequent application of additional therapies. Epinephrine causes vasoconstriction of the bleeding vessel and allows for mechanical compression. Epinephrine injection is a safe modality but does carry a risk of tachycardia and arrhythmias.

Following this, thermal therapy or hemoclips are applied to the ulcer site. For peptic ulcer disease bleeding, thermal therapy is used in the form of a bipolar cautery probe. This probe is inserted through the endoscope channel and applies a high-frequency electrical current to the peptic ulcer to coagulate the surrounding tissue. The probe is applied with direct contact on the peptic ulcer, and firm pressure is applied for approximately 10 s, while the current is delivered. Based on the size of the ulcer and the amount of bleeding, this therapy can be applied several times. The main risk associated with this treatment modality is perforation, although this is quite rare [1, 2].

Hemoclips, also called endoclips or hemostatic clips, are steel clips that are inserted through the endoscope channel with a control device on the opposite end to open, close, and release the clip. Tissue around the peptic ulcer is grasped on either side of the bleeding site, and the hemoclip is closed, compressing off the surrounding area of bleeding. The endoclip tightly opposes the tissue, and then it is released from the endoscope. Unlike thermal therapy, hemoclips do not damage the ulcer tissue. More than one hemoclip may need to be placed based on the size of the ulcer and degree of bleeding. Hemoclips may also serve a dual purpose in being a radiopaque marker, should endoscopic intervention be unsuccessful and surgical or angiographic treatment be necessary.

Angioectasias

Angioectasias, also known as arteriovenous malformations (AVM), angiodysplasias, and vascular ectasias, are aberrant blood vessels that have a fern or spider veinlike appearance within the gastrointestinal tract. They are the most common vascular condition found in the gastrointestinal tract, associated with advanced age and several genetic disorders. Angioectasias are also associated with several common medical conditions including end-stage renal disease, aortic stenosis (called Heyde's syndrome), and von Willebrand disease. Angioectasias can occur anywhere in the GI tract but tend to more commonly occur in the small intestine. Bleeding from angioectasias typically presents in the form of anemia or occult gastrointestinal bleeding.

Argon plasma coagulation (APC) is the most commonly used endoscopic modality to treat bleeding angioectasias. This technique employs an electrical current in a slightly different approach. A probe is inserted through the endoscope channel and directed at the angioectasia but kept at a short distance from the lesion.

Argon plasma is released from the probe and ionized by high-voltage discharge, resulting in an electrical current conducted through the argon plasma gas. This coagulates the lesion and surrounding tissue. It is generally considered to be a more superficial treatment approach than bipolar cautery, reducing the risk of perforation. Frequently, even if angioectasias are encountered without active hemorrhage, they are still treated as they can bleed in the future [3].

Variceal Bleeding

Varices are dilated submucosal veins that result from portal hypertension. They are commonly found in patients with cirrhosis and most commonly occur in the esophagus and stomach. Variceal hemorrhage is a severe and life-threatening form of gastrointestinal bleeding. Patients typically present with large volume hematemesis, melena, and sometimes hematochezia due to rapid transit bleeding. Frequently these patients are hemodynamically unstable and require emergent endoscopic intervention.

Endoscopic band ligation is the hallmark of treating esophageal varices. It involves placing small elastic bands around varices. The band ligator is placed around the end of the endoscope and advanced to the location of the esophageal varices. These dilated veins are suctioned into the band ligator device, and elastic bands are fired one at a time, effectively wrapping around the base of the esophageal varix. Once secured, the band ligates the tissue and causes necrosis. Eventually, the band and necrotic tissue fall off when the underlying tissue fibroses. This approach is not only used for patients with active variceal hemorrhage but is also used prophylactically in patients with large esophageal varices [4].

In patients with variceal bleeding refractory to endoscopic band ligation, balloon tamponade placement can be used. The Sengstaken–Blakemore tube and Minnesota tube are the most common balloon tamponade tubes. They have a deflated esophageal and gastric balloon. The tube is advanced into the stomach; the gastric balloon is inflated with air and pulled up to the gastroesophageal junction. The outer portion of the tube is fastened to a device to maintain traction. The esophageal balloon can also be inflated if the bleeding persists. This is intended to be used as a temporizing measure to control variceal bleeding, until more permanent interventions can be initiated.

Sclerotherapy is an alternative for the treatment of variceal bleeding that consists of the injection of a sclerosant solution into varices, causing the destruction of tissue. It is delivered using an injection needle that is inserted through the endoscope channel. Ethanolamine and sodium tetradecyl sulfate are two commonly used sclerosants.

Gastric varices are more difficult to control endoscopically. Cyanoacrylate glue injection has proven to be effective in treating gastric varices although rebleeding can occur in over 20% of patients. More recently, endoscopic ultrasound has been utilized to deploy stainless steel coils into the gastric varices for varix obliteration with complete obliteration of fundal varices in up to 93% of cases [5].