Pediatric Gastrointestinal Imaging

STRINGER

PEDIATRIC GASTROINTESTINAL IMAGING

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To Judy, Charles, Rosemary, Henry, and my parents

Preface

The burgeoning of new modalities has necessitated a reappraisal of the imaging required for every organ system, and the gastrointestinal tract is no exception in this regard. In this book, the gastrointestinal tract includes all intra-abdominal structures other than the genitourinary tract and adrenal glands. The purpose of this book is to review the clinical and radiological features for each clinical diagnosis affecting the gastrointestinal tract and consider the most appropriate imaging modality for each situation.

The gastrointestinal tract can be imaged by many radiological modalities and techniques, including sonography, plain films, fluoroscopy, CT, nuclear medicine, angiography, interventional studies, and, more recently, MR. In our hospital, all these imaging modalities are available, including modern fluoroscopic units with digital hard copy, three Acuson 128 ultrasound machines with color Doppler, two GE SPECT Nuclear Medicine Imaging Cameras, two GE 9800 Quick CT scanners, a 1.5 Tesla GE Signa MR scanner, and a digital angiographic unit. In the last 9 years, since I have been at The Hospital for Sick Children, we have performed over 25,000 contrast studies, 20,000 abdominal sonograms, and 3,000 abdominal CT scans. Nuclear medicine and angiography have been freely available for those patients who required them. More recently, MR and interventional studies have been used when indicated. The information in this book is a distillate of this experience.

The first chapter, kindly provided by Dr. Peter Durie, Staff Gastroenterologist, gives an introductory overview of the common clinical findings. In Chapter 2, I have provided a description of the different techniques of examination that I use. Many techniques are markedly different from those performed in adults, and this section should be particularly helpful to residents, fellows, and adult radiologists who perform examinations in children. Pediatric radiologists may also find it interesting to compare these techniques with their own.

In the other eight chapters, each region of the gastrointestinal tract, from esophagus to pancreas, is discussed in turn, with respect to normal and abnormal radiological findings. Common and rare abnormalities are illustrated by various modalities, and for each condition the modality of choice is discussed. Which modality to use will depend, of course, on the available equipment and expertise as well as the clinical problem.

For the purposes of this book, the ideal modality is that which I feel has been most helpful at The Hospital for Sick Children in rapidly providing sufficient information to ensure proper patient management with minimum patient discomfort, radiation exposure, and cost to those involved. This book should therefore be useful to residents, fellows, and adult and pediatric radiologists as well as of interest to many other physicians including pediatricians, gastroenterologists, hepatologists, pediatric surgeons, and pediatric oncologists. For those inclined to research, an extensive bibliography is included to act as a basis for further study.

The aim of this book is to assist a varied group of radiologists and physicians in making safe, accurate, and rapid diagnoses that result in expeditious management of pediatric patients.

David A. Stringer

Acknowledgments

I am grateful to the many colleagues and friends who supported me while this book was in progress.

I am grateful for the great assistance and friendship of Dr. Peter Durie, Staff Gastroenterologist, who contributed Chapter 1, read the manuscript, and made many valuable contributions. Without clinicians of his caliber, my job would be more difficult and much less interesting. Dr. Judy Ash kindly contributed the nuclear medicine section in Chapter 2, which deals with the techniques used in nuclear medicine. Dr. Richard Gardiner was instrumental in the idea and the early preparation of this book, and I am grateful to him for his encouragement and assistance.

Without the past and present members of the general division of radiology who performed many of the studies that have made up our total experience, this book would not have been possible. These radiologists include Drs. Doug Alton, Paul Babyn, Pat Burrows, Alan Daneman, Peter Liu, David Manson, Bernard Rielly, and Dan Wilmot. In particular, I am grateful to Alan Daneman and Peter Liu, with whom I have worked very closely over many years and many papers since being at the hospital. I value their friendship, helpful advice, and encouragement. In addition, Dr. Derek Harwood-Nash was always so encouraging to academic endeavor, and Dr. Paul Babyn kindly read the manuscript.

Many secretaries have been involved, and I am particularly grateful to Kerri Detz and, more recently, Cheryl Wattam. The visual education department, and in particular Lou Scaglione and Mary Casey, prepared the illustrations, and I am most grateful for their dedicated assistance. Ellen Charkot, Cathy Babiak, and Linda Gough, our supervisors, have helped me in many ways to complete my work as well as the manuscript.

A very special mention must go to Debbie Kerrigan, our contrast procedure nurse. Debbie helped organize and file my teaching collection, from which most of the illustrations have been taken. In addition, she labeled all the pictures and accompanying slides—a Herculean task, which she not only performed efficiently but with an excellent sense of humor. It is a real pleasure to know her and her husband Alasdair and to be their friend.

Finally, a message for my long suffering family, my wife Judy and our children, Charles, Rosemary, and Henry, who have had to live through the birth of this baby—"At last the albatross is no longer around our necks."

Contents

1

INTRODUCTION TO GASTROINTESTINAL IMAGING IN PEDIATRICS

Peter R. Durie, M.D.

The signs and symptoms of disease in children often differ greatly from those in adults (Grand et al, 1976; Silverman and Roy, 1983; Sleisenger and Fordtran, 1983; Walker-Smith et al, 1983). There is no substitute for a carefully performed history and physical examination in the clinical evaluation of any patient. When the patient is a child, however, the need to utilize a parent or guardian to obtain vital information may be a handicap because parents often misconstrue their children's symptoms according to their own personal experiences. Because a wide variety of symptoms and physical signs may suggest a gastrointestinal diagnosis, the ability of the clinician to evaluate "the whole patient" is essential. Systematic gathering of information will permit the physician to sort through the possible diagnoses that may be responsible for a specific complaint. With complete information at hand, indications for investigation can be determined in an informed and logical fashion.

SIGNS AND SYMPTOMS OF GASTROINTESTINAL DISEASE IN CHILDHOOD

DISORDERS OF INGESTION

The impact of disease and, occasionally, therapy on nutrition in childhood is often overlooked and, thus, has failed to attract the medical attention it deserves. Deficient caloric intake can result not simply from organic disease but from a wide variety of environmental, social, and psychiatric problems (FAO/WHO, 1973). Some diseases merely suppress the desire to eat; others cause deficient caloric intake by impeding swallowing or by inducing gastroesophageal reflux and regurgitation.

Coordinated sucking and swallowing are well developed at term (Grand et al, 1976); however, an infant must learn to burp and often encounters feeding difficulties when first presented with solid foods. A sense of taste usually develops by 4 months of age, when sweet and salty foods tend to be preferred. Eruption of primary dentition usually begins around 6 or 7 months. Although gastroesophageal reflux and regurgitation are common in the first year, studies have shown that the resting basal esophageal sphincter pressure in infants is higher than that in adults. Investigation of feeding problems usually entails a swallowing study, feeding study, or single- or double-contrast barium swallow examination (see Chaps. 2 and 3).

Transfer Dysphagia

Acute lesions that may prevent passage of food to the posterior pharynx via swallowing are rare (Haight, 1969; Swischuk et al, 1974). One severe disorder, bilateral choanal atresia, presents at birth and requires urgent treatment. Painful mucosal lesions such as herpesvirus stomatitis and

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acute epiglottitis, a severe, potentially fatal infection, are also important transient problems to consider. Severe facial or palatal deformities, or dental malocclusion in older children, may interfere with the flow of food into the esophagus. Uncoordinated pharyngeal function, which accompanies brain damage, may result in insufficient ingestion of food and tracheal aspiration.

True Dysphagia

True dysphagia is rare in children. Globus hystericus, or the sensation of food sticking in the throat or upper esophagus, occurs more commonly but is not dysphagia. It tends to occur in adolescents in association with anxiety. At birth, the most common structural cause of dysphagia is esophageal atresia. (Ein and Friedberg, 1981; Haight, 1969). In neonates, extrinsic obstruction from compression of the esophagus is rare, but anomalous vessels can impinge on both the esophagus and the trachea, causing stridor as a predominant symptom. Older infants may place foreign objects in their mouths that occasionally lodge in the upper esophagus and are likely to cause respiratory distress. Ingestion of corrosive substances such as lye can be devastating to the upper digestive tract (Ein and Friedberg, 1981). Esophageal perforation or trauma can also result from endoscopic instrumentation or therapeutic injections (sclerotherapy) of esophageal varices. Refusal to swallow shortly after esophagoscopy suggests serious difficulties, which can be investigated by plain-film radiography and possibly a contrast swallow.

Esophagitis

Esophagitis can result from exposure of the esophagus to gastric acid. It may result in dysphagia due to discomfort from inflammation or obstruction due to fibrous scars. In immunocompromised patients and occasionally in immunocompetent individuals, infectious agents such as *Candida* or herpesvirus can produce debilitating esophagitis. A double-contrast barium swallow is the radiologic procedure of choice in the investigation of suspected esophagitis (see Chapter 3). Achalasia is an idiopathic condition of disordered lower esophageal motility in which the lower esophageal sphincter fails to relax (Bernischke, 1981). It is a somewhat rare condition in childhood but is known to occur in children as young as 6 years of age. Achalasia is best demonstrated by a single-contrast barium swallow and esophageal motility studies.

Regurgitation

Generally, no identifiable pathologic process or functional defect can be identified to explain this common condition in infancy (Azizkhan et al, 1980). The problem usually resolves by the second year of life, when children assume a more upright posture. In some children, displacement of part of the stomach into the chest is clearly a factor; in others, pressure within the lower esophageal sphincter is well below normal. Delayed gastric emptying may contribute to the problem. Radiologic examination with such techniques as barium meal, sonography, or nuclear-medicine milk scan may be useful in assessing gastroesophageal reflux and gastric emptying, particularly in difficult cases, but it may miss clinically obvious cases (see Chapter 4). Complementary studies include esophageal pH monitoring (Euler and Byrne, 1981; Sondheimer, 1980), esophageal motility studies (Moroz et al, 1976), and endoscopic evaluation for evidence of esophagitis.

Anorexia

A variety of chronic diseases can produce chronic anorexia, which is a most serious clinical problem for a growing child. The intestinal disorders that occur most frequently in children are celiac disease and inflammatory bowel disease. In adolescents, particularly young women, one must consider anorexia nervosa. Iatrogenically induced anorexia occurs relatively frequently. It is caused by the use of unpalatable "elimination" diets in the treatment of suspected food allergy and the use of drugs that either disturb gut function or induce central nervous system depression.

ACUTE ABDOMINAL PAIN

Acute abdominal pain is often accompanied by symptoms such as vomiting or gastrointestinal bleeding. When evaluating a child with acute abdominal pain, it is important to decide whether the problem requires medical or surgical intervention (Drake, 1980). Causes of acute abdominal pain vary widely according to the age of the patient.

In patients younger than 2 years of age, problems that require surgical intervention are more likely. One must consider intestinal obstruction, which may be caused by intussusception (Ein

and Stephens, 1971), volvulus, and malrotation (Stewart et al, 1976), and may be demonstrated on contrast studies (see Chapter 6). Appendicitis is rare in the very young child and is often associated with complications. Plain-film radiography and sonography can be helpful in the diagnosis of appendicitis, but contrast studies are rarely, if ever, indicated. Medical conditions that cause abdominal pain in young patients are usually infectious, particularly gastrointestinal illnesses such as gastroenteritis. Extraintestinal causes, such as urinary and pulmonary infections, also must be considered.

In children who are older than 2 years of age, the most important cause of abdominal pain is acute appendicitis. When abdominal pain is associated with acute blood loss, one must consider a Meckel diverticulum, which is best visualized with a radioisotope scan (Martin et al, 1976). Abdominal trauma can damage a number of abdominal organs and lead to acute abdominal pain. Investigation depends on the type of injury, but it often includes plain-film radiography, sonography, liver-spleen sulfur colloid scans, and computed tomography. Medical conditions that produce abdominal pain in children older than 2 years of age include infections of abdominal organs, acute pancreatitis, and diabetic ketoacidosis. In older children, particularly those older than 8 years of age, one should consider inflammatory bowel disease, which necessitates the use of high-quality double-contrast studies (see Chapters 2, 6, and 7). Cholelithiasis, with or without hemolytic anemia or biliary tract anomalies, is another important cause of abdominal pain (Ariyan et al, 1976). Cholecystography has been rendered obsolete by sonography.

CHRONIC RECURRENT ABDOMINAL PAIN

As with acute pain, chronic or recurrent abdominal pain should be considered organic in children who are younger than 2 years of age unless proven otherwise (Apley, 1975; Bain, 1974). The one exception is infantile colic (Holmes, 1969). In younger children particular care must be taken to exclude intestinal anomalies, intussusception, urinary tract infections, and extra-abdominal disorders such as pneumonia. These diseases may also cause recurrent abdominal pain in the older child, but other important conditions must be considered (Apley, 1975; Bain, 1974), such as mechanical obstruction, postoperative adhesions, and lactose intolerance (Barr et al, 1979). In children with cystic fibrosis, the distal intestinal obstruction syndrome (meconium ileus equivalent) should be a consideration. Recurrent abdominal pain in the older child should also raise the possibility of inflammatory bowel disease. One must also consider Henoch-Schönlein purpura if the child is not an infant.

Chronic functional constipation is common and may be associated with vague discomfort, but it hardly ever elicits severe pain. Plain-film radiographs of the abdomen are helpful in the assessment of severity of constipation. Peptic ulcer disease is relatively uncommon in childhood. In infants and children up to 10 years of age, ulcer disease almost invaribly occurs secondary to stress or as a result of ulcerogenic drugs such as aspirin. In children who are older than 10 years of age, primary peptic ulcer disease is more likely (Drumm et al, 1988). It usually involves the duodenum and is associated with a strong family history. Symptoms of abdominal pain are usually associated with gastrointestinal bleeding, but abdominal pain may be absent in the young child. Endoscopy is the investigative procedure of choice if ulcer disease is suspected (Moroz et al, 1976). Single-contrast barium meals are unreliable, but double-contrast techniques may be of value (see Chapters 2 and 5).

In older children, particularly those between the ages of 7 and 12, an organic cause for chronic recurrent pain will not be found in about 90 to 95 percent of patients (Apley, 1975). A carefully performed clinical evaluation should focus on causes and mechanisms. Unless specifically indicated, investigations should be kept to a minimum. Assuming that no organic cause is found, clinicians should take the time to reassure the patient and family and to encourage regular school and extracurricular activities. Emotional disturbances may underlie recurrent abdominal pain, but stressful circumstances, such as difficulties in school or mental disorders, may be hard to identify.

VOMITING

Forceful extrusion of gastric content is never normal and usually occurs with complete or partial obstruction of the intestinal tract anywhere from the stomach to the cecum (Lumsden and Holden, 1969). In more distal obstruction, there is an increased likelihood of abdominal distention. Obstruction may be mechanical or due to defective

peristaltic action. Bile staining may be expected if obstruction lies distal to the second part of the duodenum, but bile reflux into the stomach occurs in cases of severe vomiting without obstruction. Initial evaluation of the problem by plain-film radiography is extremely useful. Severe, persistent vomiting can lacerate the mucosa at the cardioesophageal junction and cause hemorrhage. Vomiting also accompanies nonobstructing disorders of the gastrointestinal tract, particularly if the lesion is proximal. Peptic ulcer and diffuse mucosal diseases such as gastritis, infectious enteritis, or celiac disease are frequently associated with vomiting. Vomiting is also commonly associated with acute cholecystitis and pancreatitis. Because vomiting may also be caused by a serious cerebral disorder, especially with raised intracranial pressure, a careful neurologic examination is mandatory. Extraintestinal infections, particularly those of the urinary tract or meninges, may also cause vomiting and, in some cases, diarrhea. Metabolic disturbances such as diabetic ketoacidosis, uremia, and disorders of amino acid metabolism are important causes of severe vomiting. The onset of Reye syndrome is heralded by severe intractable vomiting after apparent recovery from a viral illness; vomiting is followed by combativeness and rapid neurologic deterioration (Reye, 1963).

In the young infant, forceful vomiting should raise the suspicion of gastric outlet obstruction. During the first months of life, hypertrophic pyloric stenosis is the most important cause of gastric outlet obstruction (Bell, 1968). A carefully performed abdominal examination usually makes the diagnosis, but occasionally barium swallow or sonography is useful (see Chapters 2 and 5). In older children, particularly those over 10 years of age, chronic duodenal ulcer may rarely progress to obstructive symptoms.

Mechanical problems that affect the patency of the digestive tract beyond the pylorus may be either congenital or acquired. Ideally, congenital defects are detected early in life with the use of plain-film radiography and single-contrast barium studies. Although some congenital defects, such as intestinal atresia or meconium ileus, are apparent in utero or soon after birth, other anomalies may cause partial intermittent obstruction later in life. The most common and serious of these defects is intestinal malrotation, which may cause midgut volvulus and strangulation (Stewart et al, 1976). Other causes of partial obstruction include a congenital web and intestinal duplication. Hollow viscus myopathy or intestinal pseudo-obstruction may also lead to functional obstruction and vomiting (Byrne et al, 1977). The newborn with this condition may also present with urinary retention and megaureter from defective bladder contraction (the megacystis-microcolon-intestinal hypoperistalsis syndrome) (Wiswell et al, 1979). In older children, blunt trauma to the abdomen rarely produces a subserosal hematoma in the duodenum that will cause partial or complete obstruction.

DIARRHEA

In childhood, acute diarrhea is usually due to acute gastroenteritis (Davidson, 1986; Gall and Hamilton, 1977; Gracey, 1986; Larcher et al, 1977), and radiology has little to contribute to its investigation or management. Diarrhea that persists for more than 2 weeks is usually regarded as chronic (Larcher et al, 1977). Such chronic diarrhea can develop because an acute disorder persists, but a wide range of diseases must be considered that do not cause an acute illness. The majority of healthy children with persistent loose stools have a self-limiting problem and do not have a significant malabsorptive state; these children may receive considerable diagnostic and therapeutic medical attention, but to no avail.

A complete history of abnormal stool patterns is needed. The onset of illness, its progression, associated weight change, response to treatment, and any other symptoms should be noted. Weight loss or poor weight gain suggests organic disease, provided that the child's food intake has not been restricted. The relationship between the onset of chronic diarrhea and diet is important. In the child with celiac disease, for example, exposure to gluten in infancy may produce chronic diarrhea and growth failure weeks to months later. Extraintestinal manifestations provide diagnostic clues in some diseases. In cystic fibrosis, for example, diagnostic clues include finger clubbing and abnormal chest findings. Mouth ulcers, perianal lesions, skin rashes, arthritis, and finger clubbing are diagnostic clues in inflammatory bowel disease (Sanderson, 1986).

Persistent diarrhea in the young infant may suggest a congenital lesion. One should consider structural abnormalities such as congenital short gut or ileal stenosis that is producing a blind-loop syndrome. Congenital anomalies such as failure of

pancreatic digestion (cystic fibrosis, Shwachman syndrome) or specific inherited intestinal absorptive defects such as congenital villus atrophy or sucrase-isomaltase deficiency result in chronic diarrhea. Chronic diarrhea commonly results from osmotic factors, the classic example being carbohydrate malabsorption. Feeding of excessively high osmolar solutions can often cause chronic diarrhea, even in children with normal intestinal function. Dietary food-protein intolerance or food-allergy syndromes may cause chronic diarrhea, but they are difficult to diagnose. Although widely reported, the use of barium meal and follow-through to diagnose malabsorption syndrome is, in our opinion, of little or no value in the diagnosis of patients with suspected defects of digestion (Weizman et al, 1984).

In the older child, Crohn disease affecting the distal small bowel may manifest as chronic diarrhea. In the older patient with chronic bloody diarrhea, one might consider chronic inflammatory bowel disease of the large intestine due to either Crohn colitis or idiopathic ulcerative colitis. Carefully performed single-contrast barium swallow with small bowel follow-through and double-contrast barium enema are of great value in the evaluation of patients suspected of inflammatory bowel disease. In the younger child, chronic diarrhea and failure to grow can be due to Hirschsprung disease. A single-contrast barium study with or without rectal manometry is indicated, with confirmatory rectal biopsy for the absence of ganglion cells.

CONSTIPATION

Constipation, which is defined as difficulty or delay in the passage of stool, should be a cause for concern in the young infant, but in most children, particularly those older than 2 years of age, the implications of constipation are relatively benign. (Clayden and Lawson, 1976; Fitzgerald, 1977). Nevertheless, the symptom is a frequent cause of anxiety for parents and may be associated with other behavioral disorders (Fitzgerald, 1977).

Passage of meconium usually occurs within 24 to 36 hours of birth. After meconium stools are passed, the consistency and frequency of bowel actions vary greatly. Infants fed exclusively on breast milk may defecate once every 10 days, whereas other infants may pass five to six bowel movements per day. Stools are not normally formed until after 2 years of age. Children with developmental delay or physical disabilities that interfere with defecation may be slow to develop bowel control. By the age of 2 years, most children have some awareness of defecation, but conscious control of bowel habits usually occurs 6 to 12 months later.

When constipation is caused by organic disease, the problem is usually apparent in early infancy. Lower bowel obstruction due to Hirschsprung disease is by far the most common. As stated earlier, the diagnosis may be suggested by single-contrast barium enema or rectal manometry, but it must be confirmed by rectal biopsy. In older children, functional constipation is extremely common. Less commonly, constipation is associated with severe chronic dehydrating conditions; idiopathic hypocalcemia, diabetes insipidus, and cystinosis are rare examples of renal tubular defects that cause polyuria and, in most cases, severe dehydration. Spinal cord lesions that disrupt the lower reflexes cause sphincter dysfunction and incontinence and are frequently associated with constipation. Children with chronic disabilities resulting from cerebral palsy, delayed development, cancer, or chronic malnutrition frequently are constipated. Constipation can be the presenting complaint of hypothyroidism.

Retention of stools often follows a relatively innocent event, such as a fissure in ano. Voluntary retention of stools may be a result of behavioral or school difficulties. Once stool accumulates, the rectum dilates, and the sensation to defecate is blunted. A vicious cycle ensues in which stools become larger and harder, creating a self-perpetuating problem. Soiling may develop that is often misinterpreted as diarrhea. Barium enema studies are of doubtful value in the assessment of patients with functional constipation unless an organic cause is suspected.

GASTROINTESTINAL HEMORRHAGE

There are two main forms of intestinal hemorrhage—hematemesis and melena, implicating hemorrhage of the upper gut, and fresh rectal bleeding, indicating hemorrhage of the lower gut. As in other disorders, the causes of gastrointestinal bleeding in childhood are related to age (Cox and Ament, 1979; Spencer, 1964). In the newborn infant, it is important to distinguish between true hematemesis and vomiting of swallowed maternal blood. At this age, intestinal bleeding is often due

to a generalized bleeding diathesis, but a localized lesion within the stomach or duodenum, such as a stress ulcer or hemorrhagic gastritis, may follow severe birth asphyxia or sepsis. Neonatal stress ulcers are associated with a high mortality because they may not be apparent until perforation or severe hemorrhage occurs. Congenital lesions such as hemangioma or duplication of the gut also present with hemorrhage. Rectal bleeding may be the only sign in the newborn infant of midgut volvulus or enterocolitis, which may be bacterial, milk induced, or necrotizing. Hirschsprung disease can present with bloody diarrhea due to severe enterocolitis, which is often fatal.

Beyond the neonatal period, hematemesis and melena are relatively uncommon. Acute gastrointestinal bleeding may be due to diffuse gastritis or to peptic ulcer disease, either gastric or duodenal. Ulcers may be due to a secondary stress of an underlying disease or to ulcerogenic drugs such as aspirin. After the age of 10, primary peptic ulcer disease, particularly disease located in the duodenum, is currently recognized with increasing frequency. Esophagitis resulting from gastroesophageal reflux or esophageal varices may present with hematemesis and melena. Bleeding disorders are unusual causes of gastrointestinal hemorrhage beyond the neonatal period, but a serious disorder of platelet number or function (for example, leukemia or other forms of thrombocytopenia) must be considered. Henoch-Schönlein purpura or hemolytic uremic syndrome, which is frequently a cause of abdominal pain, may present with intestinal hemorrhage.

The passage of fresh blood through the rectum is usually considered to have serious consequences in adulthood; in infancy, however, rectal bleeding is often benign and is usually caused by a simple anal fissure or milk-protein intolerance. In a high percentage of infants, it is a self-limiting problem, and a cause cannot be found. In the older child, symptoms of rectal bleeding are usually associated with colonic juvenile polyps, but profuse rectal bleeding may occur with a Meckel diverticulum. The passage of blood in association with acute abdominal pain may suggest intussusception and indicate a diagnostic and therapeutic air or single-contrast barium enema (see Chapters 2 and 6). If an obvious cause for fresh rectal bleeding is not found and intussusception is not suspected, double-contrast barium studies are of value (see Chapters 2 and 7), but one should also consider sigmoidoscopy or colonoscopy, particularly for suspected lesions in the sigmoid and rectum.

GASTROINTESTINAL ENDOSCOPY IN THE PEDIATRIC PATIENT

Almost two decades of experience in adults have established the accuracy and utility of fiberoptic gastrointestinal endoscopy as a therapeutic and diagnostic tool (Sleisenger and Fordtran, 1983). This technique is applicable to the pediatric population and is being used with increasing frequency by gastroenterologists caring for children (Ament, 1977; Gleason, 1974; Hargrove, 1984; Hassall, 1984). A number of studies have demonstrated that endoscopy can provide important diagnostic information and be performed safely in young children, even in those younger than 2 years of age. Direct visualization of the lumen of the gastrointestinal tract is invaluable for evaluating the appearance and integrity of the mucosa, detecting lesions, and providing a means of obtaining biopsy tissue for diagnostic purposes. Both upper and lower endoscopy should be considered as useful adjuncts to carefully performed radiologic contrast examinations, particularly because they permit demonstration of superficial lesions that do not have sufficient depth or contour to be detected on radiographic contrast studies.

ENDOSCOPY OF THE UPPER GASTROINTESTINAL TRACT

This procedure permits viewing of the esophagus, stomach, and proximal duodenum. For older children (older than 5 years of age), an adult endoscope or a pediatric endoscope of smaller diameter may be used. For infants and younger children, an endoscope of smaller diameter (outside diameter of 1.2 cm) is advised. Endoscopy should be performed in a quiet, relaxed environment, preferably in a well-equipped procedure suite, with trained nurses in attendance. Risks attendant with this procedure are heightened by the need to employ general anesthesia in the younger child. General anesthesia with endotracheal intubation has been recommended for neonates, young infants, and preschool children to obviate respiratory embarrassment during the procedure; however, a recent study suggests that endoscopy of the upper gastrointestinal

tract is safe and well tolerated in infants, even neonates, with little or no sedation, but the safety of this approach has not been clearly established (Hargrove, 1984). In older children, sedation can be accomplished with intravenous diazepam (Valium) and meperidine (Demerol). The oropharynx should be anesthetized locally before the instrument is passed.

There is no question that in infants, children, and adults endoscopy of the upper gastrointestinal tract is vastly superior to single-contrast radiologic techniques and also more accurate than double-contrast techniques for the identification of the source of bleeding in the upper gastrointestinal tract, acute esophagitis, or superficial gastric or duodenal lesions, such as peptic ulcer disease and diffuse inflammatory lesions. It also provides a means to remove foreign bodies from the proximal intestinal tract. Most foreign bodies will spontaneously pass through the gastrointestinal tract. Smooth, round objects, such as coins, that stick in the esophagus may be removed under fluoroscopy using a Foley catheter (see Chapter 2). Sharp objects, however, should be removed endoscopically if they do not promptly pass out of the stomach. Objects that cause symptomatic obstruction should be removed early. Endoscopy has little role to play in the evaluation of functional recurrent abdominal pain in a child who is otherwise well.

When performed by well-trained, experienced professionals, complications, which include perforation of the esophagus, stomach, or duodenum, or intestinal bleeding, are exceedingly rare events.

Endoscopy of the upper gastrointestinal tract has a variety of indications (Table 1–1). Inflammatory conditions of the stomach and duodenum can best be confirmed by endoscopy and biopsy. Because peptic ulcer disease is not easily diagnosed by single-contrast techniques, double-contrast techniques or, preferably, endoscopy should be considered the procedure of choice in suspected cases.

TABLE 1–1
Indications for Endoscopy of the Upper Gastrointestinal Tract

Diagnostic	*Therapeutic*
Unexplained upper intestinal bleeding	Sclerosis of varices
Esophageal	Removal of foreign bodies
Foreign bodies	Stopping bleeding
Esophagitis	
Strictures	
Varices	
Gastric	
Gastritis	
Crohn disease	
Ulcers	
Congenital lesions (webs, atresia, diverticula, etc.)	
Duodenal	
Duodenitis	
Ulcer	

COLONOSCOPY

This procedure permits visualization of the entire colon and cecum. Sedation, such as that used for endoscopy of the upper gastrointestinal tract, is recommended. If possible, general anesthesia should be avoided, because the risk of bowel perforation is greater in the patient who is asleep. In our experience, general anesthesia may be used for limited studies of the sigmoid and descending colon in younger patients who are unlikely to tolerate the procedure under sedation.

As with double-contrast barium enema, adequate cleansing of the colon is extremely important before colonoscopy. Traditionally, the patient has been instructed to consume clear fluids for 2 to 3 days, and purgatives or saline enemas have been used. Cleansing of the colon may also be achieved with the use of an intestinal lavage solution containing balanced electrolytes and polyethylene glycol (Golytely), but this approach has not been extensively evaluated in children. (Gleason, 1974). In our experience, intestinal lavage appears to provide adequate colonic cleansing without severe side effects and reduces the preparative time for the procedure. Patients with severe pancolitis should not be given purgatives or repeated enemas because the colon is often relatively clean.

Rectal sigmoidoscopy with a rigid proctoscope continues to have some role, particularly in the identification of distal lesions, but a short, flexible sigmoidoscope is better tolerated and allows for superior visualization of the distal mucosa. In the well-prepared patient, the lubricated fiberoptic colonoscope is inserted into the rectum with the patient in the left lateral supine position. The colonoscope is usually advanced under direct visual control. Insufflation of small amounts of air is helpful. Difficulties in advancing the colono-