THE REQUISITES

Gastrointestinal Imaging

Fourth Edition

Giles W. L. Boland

ELSEVIER
SAUNDERS

Gastrointestinal Imaging

THE REQUISITES

Gastrointestinal Imaging

Fourth Edition

Giles W. L. Boland, MD, FACR
Abdominal Imaging and Intervention
Department of Radiology
Massachusetts General Hospital
Professor of Radiology
Harvard Medical School
Boston, Massachusetts

ELSEVIER
SAUNDERS

ELSEVIER
SAUNDERS

1600 John F. Kennedy Blvd.
Ste 1800
Philadelphia, PA 19103-2899

GASTROINTESTINAL IMAGING: THE REQUISITES,
FOURTH EDITION ISBN: 978-0-323-10199-8

Library of Congress Cataloging-in-Publication Data

Boland, Giles W. L., author.
Gastrointestinal imaging : the requisites / Giles Walter Boland.-- Fourth edition.
p. ; cm.-- (Requisites) (Requisites in radiology)
Preceded by: Gastrointestinal imaging / Robert D. Halpert. 3rd ed. c2006.
Includes bibliographical references and index.
ISBN 978-0-323-10199-8 (hardcover : alk. paper)
I. Halpert, Robert D. (Radiologist) Gastrointestinal imaging. Preceded by (work): II. Title. III. Series: Requisites series. IV. Series: Requisites in radiology.
[DNLM: 1. Digestive System--radiography. 2. Digestive System Diseases--diagnosis. WI 100]
RC804.R6
616.3'07572--dc23

2013029451

Senior Content Strategist: Don Scholz
Content Development Specialist: Lucia Gunzel
Publishing Services Manager: Patricia Tannian
Senior Project Manager: Claire Kramer
Design Direction: Steven Stave

Printed in the United States of America

Last digit is the print number: 9 8 7 6 5 4 3 2 1

This book is dedicated to my immediate family (Judith, Sam, Holly, Heidi, and Lucy) for their patience in allowing me to spend the many absent hours necessary to complete this work.

–Giles

Preface to the First Edition

In August of 1879, while attending the Annual Meeting of the American Association for the Advancement of Science in Saratoga, New York, the renowned physician Sir William Osler chanced to meet the inventor, Thomas Edison. Edison, having a passing interest in the medical applications of his inventions, suggested to Osler that it might be possible to "illumine the interior of the body by passing a small electric burner into the stomach." Sir William's response is not recorded, but his account of the encounter suggests some degree of amusement at the prospect of passing a tube with a light on the end into the stomach.

Nevertheless, Edison's words were prophetic and 114 years later, endoscopic direct visualization of the mucosal surface has established itself as the standard of gastrointestinal (GI) diagnosis, following several decades of virtual domination of this field by radiologists. However, the expected demise of radiological imaging of the gastrointestinal tract has not occurred. Instead, a collaborative, complementary relationship between endoscopy and radiological imaging of the gut has evolved, spurred on and encouraged by the profound effect of cost constraint and the increasing diagnostic sensitivity and relatively low cost of the radiological procedures.

Barium studies have decreased but not disappeared since the advent of widely available endoscopy. Moreover, the technical refinement of low-cost barium examinations may, in all likelihood, carve out a well-defined niche as a screening examination for many patients.

In addition, the development of other imaging methods has tremendously enhanced the role of imaging in GI diagnosis. Without doubt, the use of helical computer-assisted tomography, real-time ultrasound, and to an increasing extent, magnetic resonance imaging has greatly impacted gastrointestinal imaging. Indeed, modern cross-sectional multiplanar imaging has opened the abdomen for radiological inspection in a way that had been hitherto unattainable. Enhanced liver diagnosis and evaluation of the spleen, pancreas, lymphatics, and the structures surrounding the gut are now possible and signal the beginning of yet a new era in abdominal imaging and diagnosis.

In recent decades, our clinical colleagues have developed what they refer to as the problem-oriented approach to patient care and patient records. This refers to an orderly approach to patient diagnosis and management wherein the problems of greatest concern are appropriately weighted, while diagnoses of lesser importance are not lost sight of or neglected in the process. The goal is to establish a global perspective of patient care. Moreover, it should also facilitate a more readable and organized medical record.

In a similar fashion, we have tried to view the "radiological terrain" through the eyes of a first-year resident, a resident preparing for boards, or possibly a radiologist desiring to acquire a concise and abbreviated review of the specialty of gastrointestinal imaging. It would seem appropriate, from our view, to develop a problem-oriented approach to radiology to best address all of these demands and to attempt to present radiological problem solving (diagnosis) in an organized prioritized fashion.

This is generally referred to in radiology as the pattern approach. However, in keeping with a patient-oriented perspective on the practice of radiology, I would prefer to call these radiological patterns of disease "problems." The irregular thickened gastric fold, from the referring physician's point of view (and especially the patient's perspective) is not a pattern, but a problem! For the attending radiologist, the issue is one of problem solving. Although some may see this as nothing more than hair splitting and semantics (and they may be correct), it is, nevertheless, an accurate reflection of a philosophical perspective on the practice of radiology, no doubt left over from my days as a family practitioner.

The advantage of this approach, as opposed to the disease-oriented method, is to allow a closer paralleling of the real day-to-day world of radiology, and as a result, be of more practical value. The disadvantage is in the complexities of presenting material. In terms of writing a textbook, it is easier to describe a disease and all its radiological presentations, than to start with the radiological problem and work backward toward a reasonable differential diagnosis. The former is the organizational basis of almost all reference texts, while the latter is the daily experience of most radiologists. However, in the problem-oriented clinical management of a patient, problems often overlap, or the same disease may result in several very different problems. In the same way, a disease may have several radiological presentations. Gastric carcinoma, for example, may present as a problem of gastric folds, gastric mass, or ulceration. Hence, the inherent weakness in such a presentation of material.

Accordingly, we have tried to avoid undue redundancy while at the same time overlapping wherever necessary. Usually, the more in depth discussion will be reserved for the most common radiological problem posed by the disease entity.

Robert D. Halpert, MD

Preface

Much has changed in gastrointestinal radiology (and medicine in general) since the last major new edition of this book in 1999, yet in many ways, much has not. Modern imaging tools are now producing images of exquisite anatomical, physiological, and molecular detail, raising the profile of the specialty and increasing the value of our contribution to medicine. Although radiologists (perhaps gastrointestinal radiologists more than most) have an array of modern, sophisticated tools in their arsenal, these may not benefit the patient unless they are used wisely and prudently. The ubiquity of imaging devices has made it too easy sometimes for physicians to recommend imaging to investigate the wide range of clinical presentations and for radiologists to recommend further imaging for the management of the incidentaloma, a common finding for the gastrointestinal radiologist. This larger role that radiologists now enjoy must include taking a commensurately larger responsibility for ensuring that imaging is indicated and will benefit the patient. In short, radiologists and referring physicians should recommend imaging only when the benefits outweigh the costs. The central tenet of the profession—"do no harm"—remains just as important in this era of modern medicine as it ever has been.

This book therefore attempts to discuss not only the range of modalities and the spectrum of imaging findings in gastrointestinal disease, but also the most appropriate imaging for a given clinical context. Furthermore, all available imaging modalities are discussed, not just the most modern. Oral contrast (mostly barium) evaluation of the gut has generally been supplanted by endoscopic or cross-sectional imaging techniques, and it has become difficult for the contemporary resident to become familiar with the art of fluoroscopic contrast gastrointestinal studies. These techniques, however, when performed correctly can still yield exquisite (sometimes unique) detail of gastrointestinal pathology and function and consequently are discussed in some detail alongside the newer, more expensive technologies. It is hoped therefore that the reader will gain a deeper knowledge of how and when best to use a specific imaging modality and technique, as well as appreciate the range of imaging findings in gastrointestinal disease.

I would especially like to thank those who contributed images for this book, Michael Zalis, Francis Scholz, Deborah Hall, Avinash Kambadikone, Dushyant Sahani, Joseph Simeone, Jack Wittenberg, Mukesh Harisinghani, Laura Avery, Michael Gee, Peter Hahn, Susanna Lee, Michael Blake, Sheela Agarwal, Edward Palmer, Damian Dupuy, Koenraad Mortele, Jorge Soto, Chandan Kakkar, Rajagopal Kadavigere, Mitchell Tublin, Kumaresan Sandrasegaran, Christine Menias, Perry Pickhardt, Claudio Cortez, Cheri Canon, Mark Lockhart, and Tracy Jaffe, and many others who offered suggestions for particular cases. A special thank you to Eleni Balasalle for all the help in preparing the figures for this book.

All drawings by Giles Boland.

Giles W. L. Boland

Contents

CHAPTER 1

Esophagus

The esophagus extends from the lower pharynx at the upper esophageal sphincter to the lower esophageal sphincter at the esophageal vestibule, or phrenic ampulla, just above the gastroesophageal (GE) junction. It consists of inner circular and outer longitudinal muscle layers. There is striated (voluntary) muscle for the upper third and smooth muscle for the lower two thirds, and the esophagus has no serosal covering at any point. It is lined by squamous columnar epithelium throughout. The course of the esophagus is normally indented by the aortic arch, left main bronchus, and left atrium.

The esophageal vestibule, or phrenic ampulla, is normally slightly distended (Fig. 1-1). At the upper end of the vestibule is a slight narrowing, or A-ring, caused by smooth muscle (internal esophageal sphincter), which can be normal or may cause slight dysphagia if hypertrophied. The B-ring is at the GE junction itself (at the lower end of the vestibule, also known as phrenic ampulla) and is not seen unless a hiatal hernia is present. The Z line may be seen as a slight narrowing at the lower end of the phrenic ampulla and represents the epithelial junction between the esophagus (squamous) and stomach (columnar) and will not be seen unless a hiatal hernia is present. Dysphagia will not occur unless the B ring in the lower esophagus is less than 12 to 13 mm, when it is known as a Schatzki* ring (see discussion later in chapter).

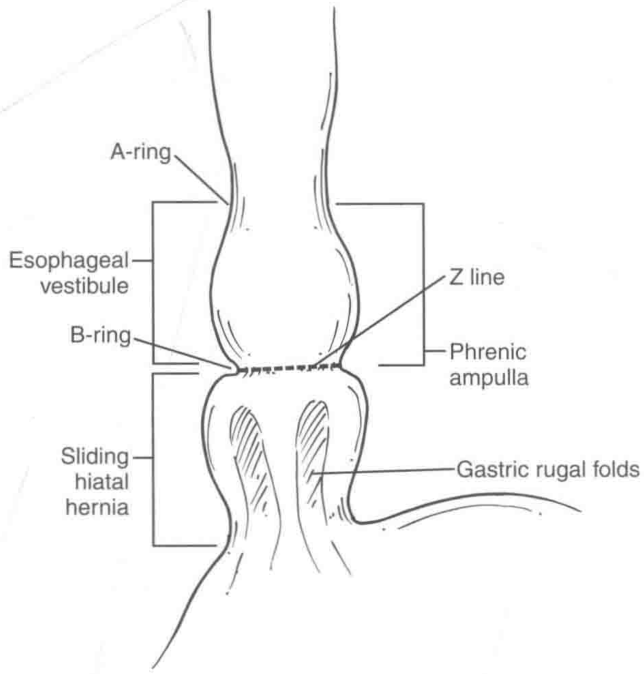

FIGURE 1-1. Schematic representation of lower esophageal anatomy (in the presence of a small hiatal hernia).

TECHNIQUES

Oral Contrast Studies

Although cross-sectional imaging techniques are critical for the evaluation of malignant esophageal disease for staging purposes, most esophageal abnormalities are too small and fine to be accurately evaluated by them. Contrast examination of the esophagus (usually with barium) is an appropriate tool for the evaluation of most esophageal disease, but the radiologist's role has been greatly diminished since the advent and routine use of direct optical endoscopy. However, given that the barium swallow and upper gastrointestinal (UGI) studies can be exquisite tools for the assessment of both morphological (gross appearance of the pharynx, esophagus, GE junction) and functional esophageal abnormalities (pharyngeal function, esophageal dysmotility, gastroesophageal reflux disease [GERD]), radiologists should still be familiar with their use and imaging findings.

A UGI swallow examination is best performed with both single- and double-contrast techniques. Before beginning the examination, the radiologist should further question the patient about his or her symptoms and history. The information gleaned from the patient can offer clues and greater specificity about what the radiologist might expect, and the radiologist might then modify or tailor the examination accordingly. At this point, the radiologist should explain the procedure to the patient because compliance is crucial to obtain an optimal examination. For instance, after the initial ingestion of effervescent gas granules, the patient should try as best as possible to refrain from eructation, which might defeat the purpose of performing a double-contrast examination. Maximal esophageal and gastric distention provides better images and therefore a greater ability to detect subtle disease. In the upright position, the patient then ingests the gas granules, followed by a small sip of water to aid rapid swallowing. The goal is to prevent the granules from "fizzing" in the mouth, which reduces their distensive effect in the esophagus and stomach. The patient then swallows a cup of high-density ("thick") barium, at which point images are taken of the gas-distended esophagus and small mucosal abnormalities can be identified. If any abnormality is identified at this point, multiple tangential views should be taken to allow the radiologist to evaluate the lesion in more detail once the examination is finished. Too often, inadequate oblique and tangential views are taken, resulting in the lesion being visible in a limited plane, which may make formal diagnosis difficult or even impossible. Frequently the examination is performed in conjunction with a UGI series with gastric and duodenal evaluation, and the radiologist will need to then concentrate on these organs while they are maximally distended with air. The radiologist should return later to a final evaluation of the esophagus using a single-contrast examination with low-density ("thin") barium, with the patient typically in the right anterior or prone oblique position. The patient takes several sips of barium, and esophageal motility and distensibility are evaluated as the radiologist observes the stripping waves of esophageal bolus propulsion. The lower esophagus is finally evaluated for hernias and the mucosal B-ring. GERD or a hiatal hernia may not initially be evident, and the patient should be asked to perform a Valsalva* maneuver as a provocative measure to increase intraabdominal

*Richard Schatzki (1901-1992), American radiologist.

*Antonio Maria Valsalva (1666-1723), Italian anatomist.

pressure. This action may elicit either the hiatal hernia or reflux and perhaps be the answer to the patient's symptoms. In this position, the normal longitudinal mucosal relief images are also observed, and this observation may permit variceal visualization. Finally, the stomach and duodenum should be briefly evaluated in case the patient's symptoms are due to disease in these organs.

If the patient's symptom is upper dysphagia, then anteroposterior (AP) and lateral views of the upper esophagus are taken immediately after the ingestion of the effervescent granules. While the patient drinks the barium, the radiologist both observes and performs rapid sequence images (3 to 4 per second) because the barium usually passes through the esophagus too fast for the radiologist to time the exposure correctly. Therefore functional information (i.e., a cricopharyngeus spasm) and morphological disease can be obtained at the same time.

The use of nonionic water-soluble contrast medium, instead of barium, is warranted when there is any risk of aspiration or esophageal leak. Although barium is inert and not toxic if inhaled, it may remain within bronchi for an extended period of time. Ionic contrast medium within the bronchi is hyperosmolar and can cause pulmonary edema and generally should not be used for esophageal examination. Barium is also toxic within the mediastinum and peritoneum, hence the use of nonionic contrast medium if esophageal perforation is suspected. Water-soluble contrast medium, which is less dense than barium, may not identify small leaks. If no initial leak or aspiration is identified, it is then prudent to follow the examination with denser barium, which may identify a small, contained leak. Even if there is some leakage of barium in these circumstances, it will likely be small, given that water-soluble contrast medium failed to identify any leakage.

Contrast studies of the esophagus (including any viscus) are often effective at characterizing the nature of the lesion or abnormality. Extrinsic (extraluminal) masses tend to displace the bowel because of their mass effect and demonstrate shallow, or obtuse, margins on contrast studies (Fig.1-2). Masses that originate in the submucosa (or have an intramural origin) tend to demonstrate sharper, less obtuse margins (Fig. 1-2). Mucosal masses tend to demonstrate acute margins, sometimes pedunculated and sometimes with a stalk. Furthermore, the intraluminal contrast appearances can suggest malignancy or benignity because malignant lesions tend to demonstrate abrupt, sharp margins that are usually irregular (sometimes termed *shouldering*) and are often short (Fig. 1-2). Benign lesions, on the other hand, demonstrate smoother borders with little irregularity, although some larger lesions may ulcerate as they outgrow their vascular supply. These rules of thumb generally apply to the entire gastrointestinal (GI) tract.

Computed Tomography

Computed tomography (CT), although still important in the evaluation of esophageal disease, is not the investigation technique of choice for most diseases unless the patient has esophageal malignancies for which it is used for staging purposes. CT can also be used to evaluate extraluminal or submucosal masses that may impinge on the esophagus because these cannot be observed directly by barium or endoscopic studies. It is also used to evaluate traumatic conditions of perforation, which are iatrogenic, traumatic, or spontaneous. Ideally the patient is asked to drink a cup of contrast material immediately before the CT to delineate the lumen.

Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) has even fewer applications in the esophagus given that respiratory motion artifacts are common when the chest is evaluated with MRI, although it may serve to evaluate mediastinal and paraesophageal abnormalities when CT is not indicated.

Endoscopic Ultrasound

Endoscopic ultrasound has a role in evaluation of submucosal esophageal masses but is rarely performed. Ultrasound has little use otherwise in the esophagus.

Nuclear Medicine

Nuclear medicine still has a role in the functional examination of esophageal motility and reflux disorder, particularly in children. The patient swallows technetium-99m (^{99m}Tc) sulfur colloid, and multiple dynamic views are taken to assess esophageal transit time, particularly in patients with lower esophageal sphincter abnormalities. This test may be used in patients who cannot tolerate manometric endoscopic studies. ^{99m}Tc pertechnetate is also used, particularly in children. After the patient swallows the radiolabelled liquid, multiple dynamic images are obtained for the evaluation of gastroesophageal reflux disease (GERD) or delayed gastric emptying. In an adult, however, the use of positron emission tomography (PET) or PET/CT has become more widespread. The use of PET or PET/CT in the evaluation of the esophagus itself is

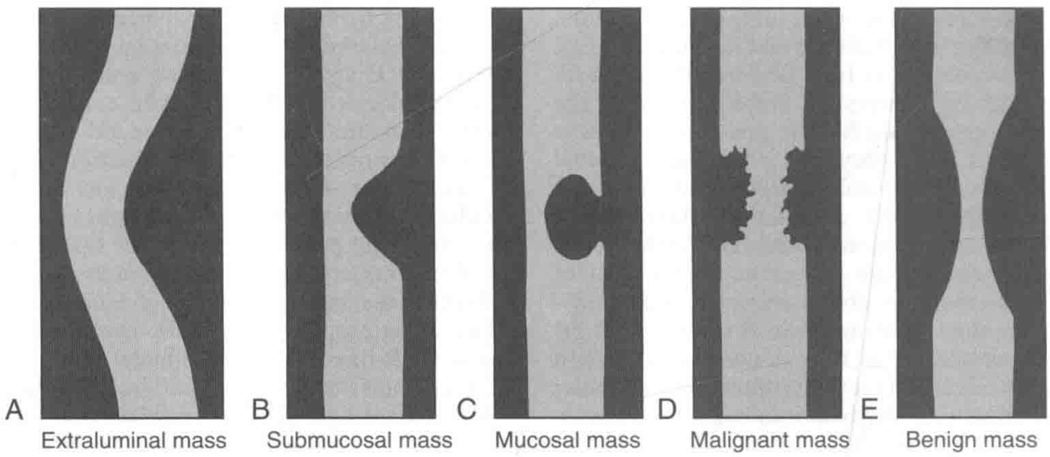

FIGURE 1-2. Schematic representation of extraluminal (**A**), submucosal (**B**), mucosal (**C**), malignant (**D**), and benign (**E**) mass features in contrast imaging of the GI tract.

limited because most primary malignancies can be evaluated directly with endoscopy or by CT. However, PET or PET/CT has proved to be particularly useful in the staging and follow-up assessment of extraesophageal disease, mainly regional lymphadenopathy, which endoscopy cannot see, and CT often cannot determine whether the node is metastatic or benign, particularly if it is small.

DIVERTICULA

Zenker Diverticulum

Zenker* diverticulum is a pulsion diverticulum, usually seen in the elderly, that is due to prolonged intraluminal pressure pushing the esophageal mucosa and submucosa through the medial defect (Killian dehiscence) between the horizontal and oblique fibers of the inferior constrictor muscle at the pharyngoesophageal junction. Patients usually have evidence of esophageal dysmotility and GERD. Patients usually present because of dysphagia, halitosis, and sometimes aspiration pneumonia as fetid food becomes trapped in the diverticulum and steadily enlarges it.

Zenker diverticulum is confirmed at barium swallow as a contrast-filled sac that is posterolateral to the esophagus just above C5-6 and the cricopharyngeus muscle. When it is small, Zenker diverticulum is usually detected best in the true lateral position as a small posterior outpouch, but as it enlarges, it is easy to identify as it extends laterally to avoid the cervical spine (Figs. 1-3 and 1-4). The larger the diverticulum, the greater the compression on the normal esophagus, which can become narrow.

There is an increased incidence of ulceration and carcinoma developing in the diverticulum. Perforation can also occur in patients because of the inadvertent placement of endoscopic instruments or nasogastric tubes.

*Friedrich Albert von Zenker (1825-1898), German pathologist.

Killian-Jamieson Diverticulum

Killian-Jamieson* diverticula are rare; they are observed below the level of the cricopharyngeus muscle, anterolateral to the cervical esophagus. They are also pulsion diverticula through the Killian-Jamieson space (similar to Zenker diverticula) but are much smaller than most Zenker diverticula and therefore produce symptoms and complications less commonly. They are seen as small, rounded, smooth outpouches of the lateral upper esophageal wall (Fig. 1-5). Rarely, they can be large and sometimes confused with Zenker diverticula and can even be observed with CT (Fig. 1-6).

Midesophageal Diverticulum

Midesophageal diverticula are usually anterior, occurring at the level of the carina. They either are due to traction from fibrotic disease in the mediastinum (i.e., healed granulomatous disease), which retracts the whole esophagus toward the fibrotic process, or, more commonly, are due to pulsion from increased intraesophageal pressure (Figs. 1-7 and 1-8). Traction diverticula in a UGI swallow are usually narrow or triangular with a pointed apex toward the mediastinal disease. Pulsion diverticula typically have a much wider neck, are larger, and fail to empty of barium easily because they have no muscular layer (Fig. 1-9). Most patients with pulsion diverticula have evidence of motility disorders.

Epiphrenic Diverticulum

Epiphrenic diverticula are pulsion diverticula (i.e., the result of increased intraluminal pressure), are found most commonly just cephalad to the GE junction, and are more common in elderly patients with esophageal dysmotility. Most are discovered

*Gustav Killian (1860-1921), German surgeon; Edward Bald Jamieson (1876-1956), Scottish anatomist.

FIGURE 1-3. Lateral UGI swallow in a 76-year-old woman with a small Zenker diverticulum (*arrow*) with a peanut lodged inside.

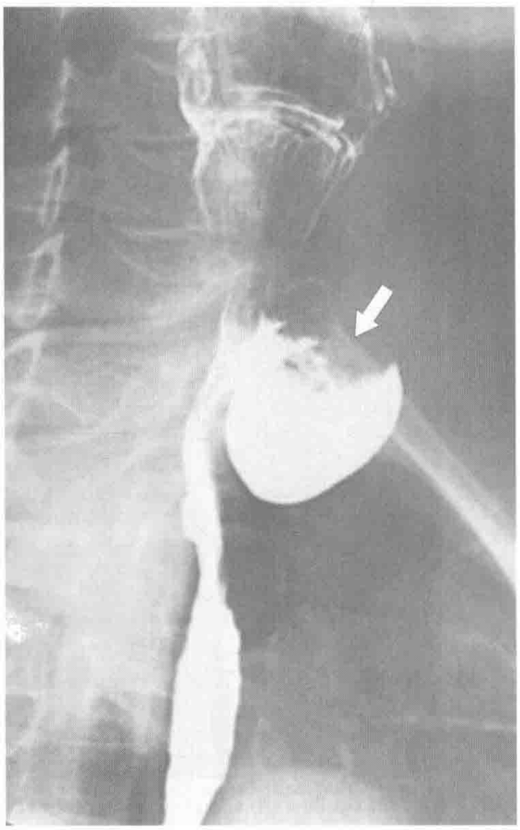

FIGURE 1-4. Left posterior oblique barium swallow in a 69-year-old man with a large outpouching (*arrow*) from the left esophagus due to a Zenker diverticulum.

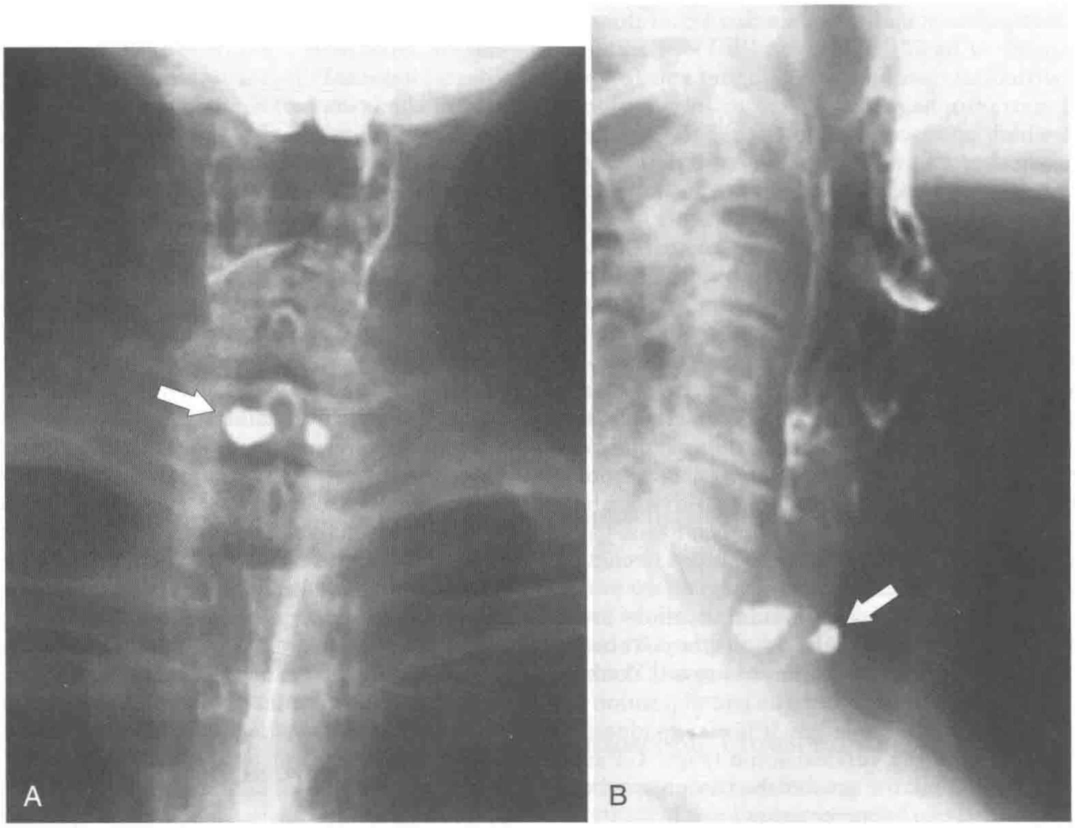

FIGURE 1-5. AP (**A**) and lateral (**B**) barium swallow in a 78-year-old woman with residual contrast on either side of the upper esophagus (*arrows*) due to a Killian-Jamieson diverticula.

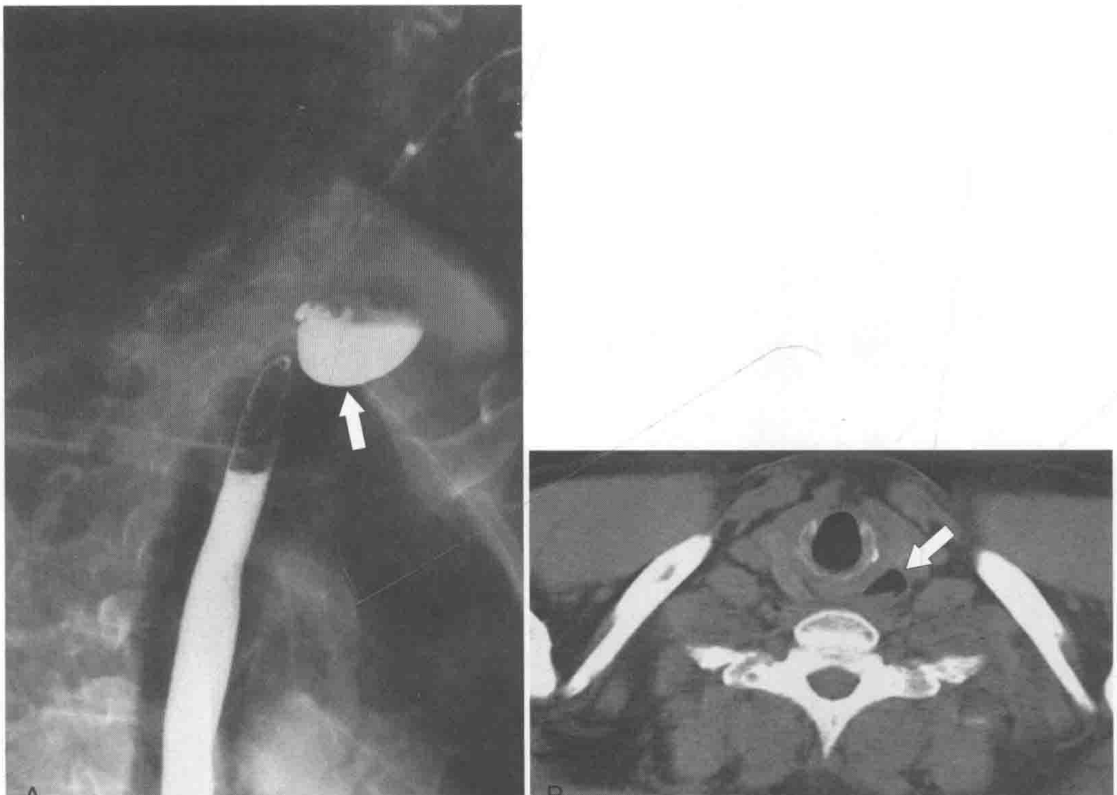

FIGURE 1-6. UGI swallow (**A**) and axial noncontrast (**B**) CT in a 71-year-old woman with a large Killian-Jamieson diverticulum (*arrows*).

FIGURE 1-7. UGI swallow in a 70-year-old man with a small midesophageal traction diverticulum (*large arrow*) from prior tuberculous mediastinal adenopathy. There is also a tracheoesophageal fistula (*small arrow*).

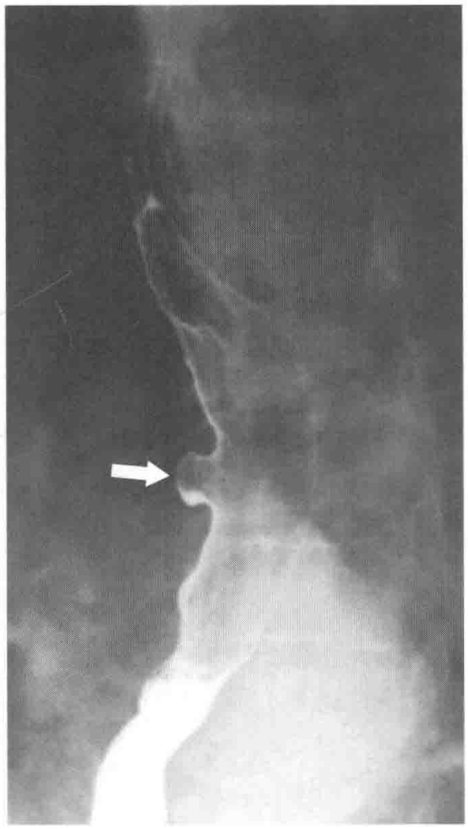

FIGURE 1-8. UGI swallow in a 66-year-old man with a small midesophageal pulsion diverticulum (*arrow*).

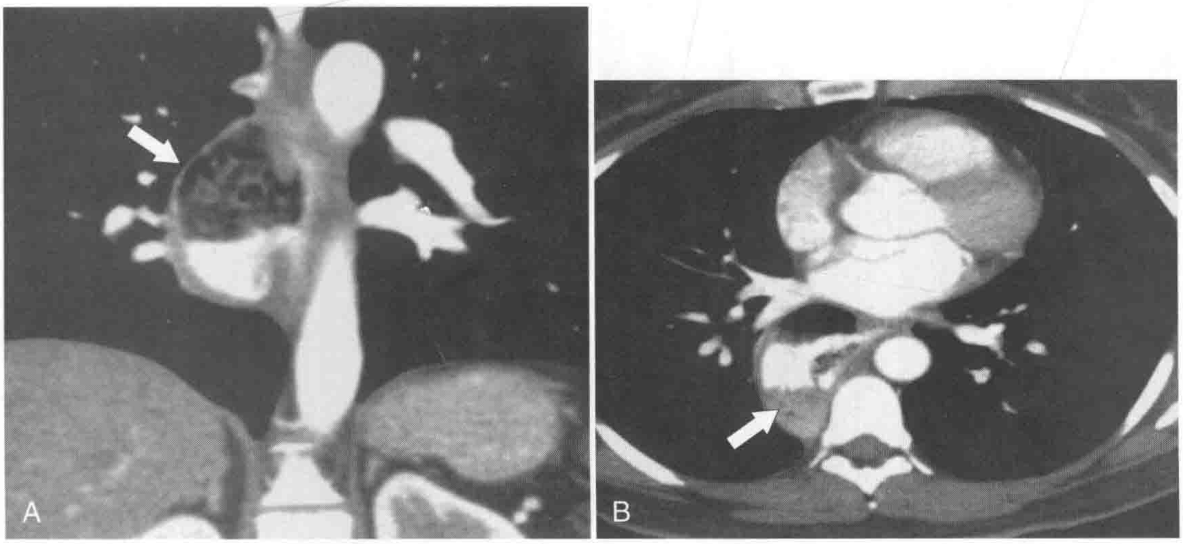

FIGURE 1-9. Coronal (**A**) and axial (**B**) contrast-enhanced CT in a 66-year-old man with a midesophageal pulsion diverticulum (*arrow*). Contrast freely refluxes through the wide-necked orifice (*arrow*).

incidentally, but symptoms include dysphagia, reflux, and aspiration. At a UGI examination, there are obvious wide-necked outpouches in the expected location, and they can be very large (Figs. 1-10 and 1-11).

Intramural Pseudodiverticula

Intramural pseudodiverticula are dilated mucous glands rather than true diverticula. These are seen as single, or more usually multiple, small, flask-like outpouchings from the esophageal lumen. They are associated with GERD and secondary stricture formation. They may be missed at esophagogastroduodenoscopy (EGD) and only observed at a UGI examination as numerous highly characteristic tiny outpouches from the esophageal lumen, typically at right angles (Fig. 1-12). When they are viewed en face, they can be mistaken for ulcer disease, but they are readily classified when viewed in the lateral plane.

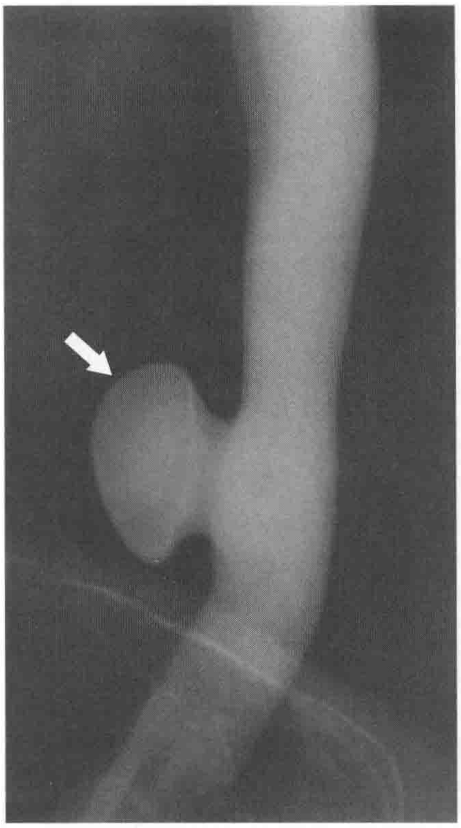

FIGURE 1-10. UGI swallow in a 59-year-old man with an epiphrenic diverticulum (*arrow*).

FIGURE 1-12. Esophageal barium swallow study in a 66-year-old man with multiple pseudodiverticula (*arrow*) and stricture due to chronic reflux esophagitis.

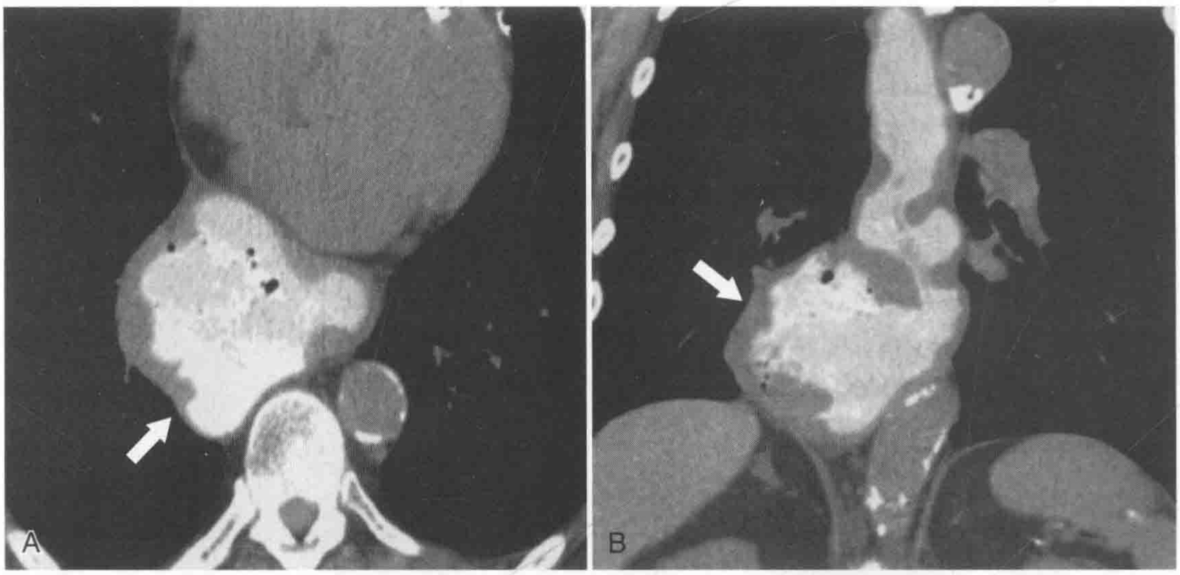

FIGURE 1-11. Axial (A) and coronal (B) CT in a 77-year-old man with a large, wide-mouthed (*arrow*) epiphrenic diverticulum.

ESOPHAGEAL WEBS AND RINGS

Esophageal webs and rings are usually located in the anterior upper esophagus and result from a variety of causes, which are either idiopathic or secondary to fibrosis from pemphigoid and epidermolysis bullosa, eosinophilic esophagitis, celiac disease, graft-versus-host disease, and Plummer-Vinson* syndrome (Figs. 1-13 and 1-14). The latter is associated with iron deficiency anemia, angular stomatitis, atrophic glossitis, and dysphagia. With lateral views with a UGI examination, these webs are seen as thin (web-like) defects at right angles to the direction of the esophageal lumen, which are usually shelf-like but can be circumferential (Fig. 1-15). Many webs are asymptomatic but can cause dysphagia. Sometimes an anterior web is combined with either posterior osteophyte impression or cricopharyngeal spasm (Fig. 1-16).

Webs can also be identified in the lower esophagus secondary to chronic GERD and are usually due to Schatzki ring. This is a relatively common finding seen in about 10% of the population

*Henry S. Plummer (1874-1936), American physician; Porter P. Vinson (1890-1959), American physician.

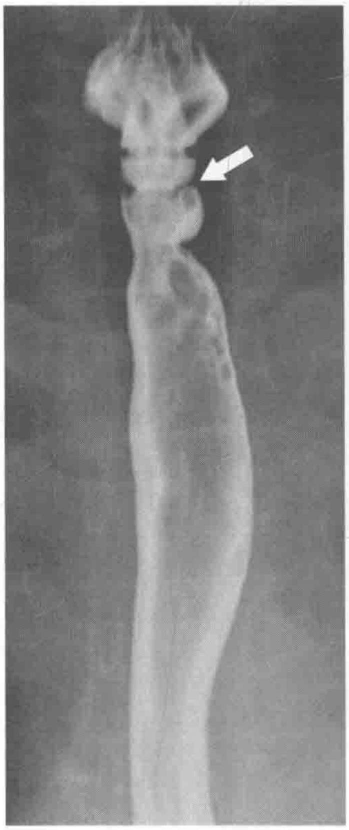

FIGURE 1-13. UGI swallow in a 39-year-old woman with epidermolysis bullosa and several circumferential esophageal webs (*arrow*).

FIGURE 1-14. Barium swallow of the cervical esophagus in a 44-year-old woman demonstrates an anterior esophageal web (*arrow*).

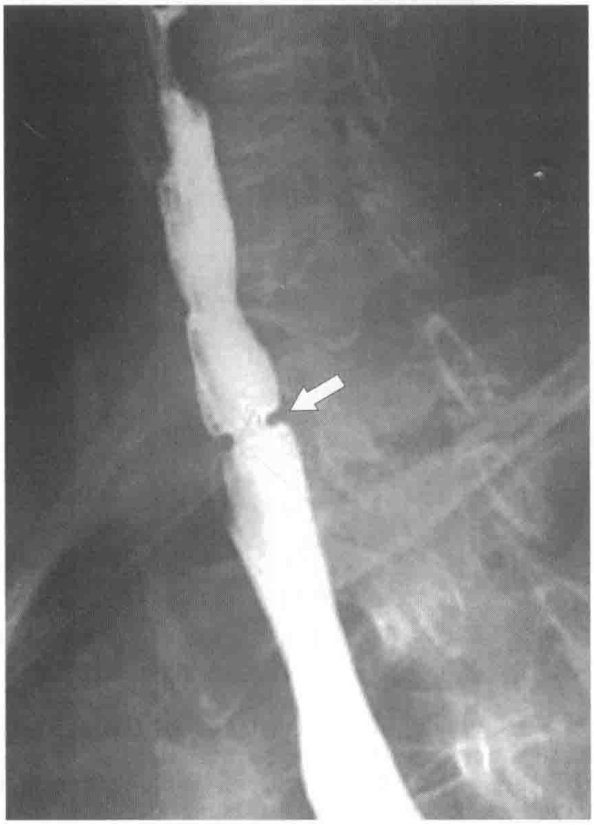

FIGURE 1-15. UGI swallow of the upper esophagus in an 84-year-old woman with a circumferential web (*arrow*).

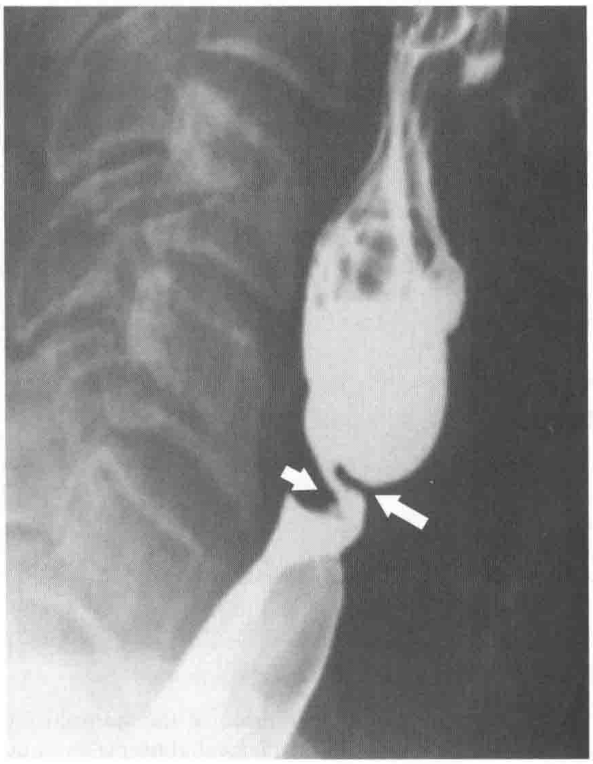

FIGURE 1-16. UGI of the cervical esophagus in a 60-year-old man demonstrating an anterior web (*large arrow*) and posterior impression (*small arrow*) due to cricopharyngeus spasm.

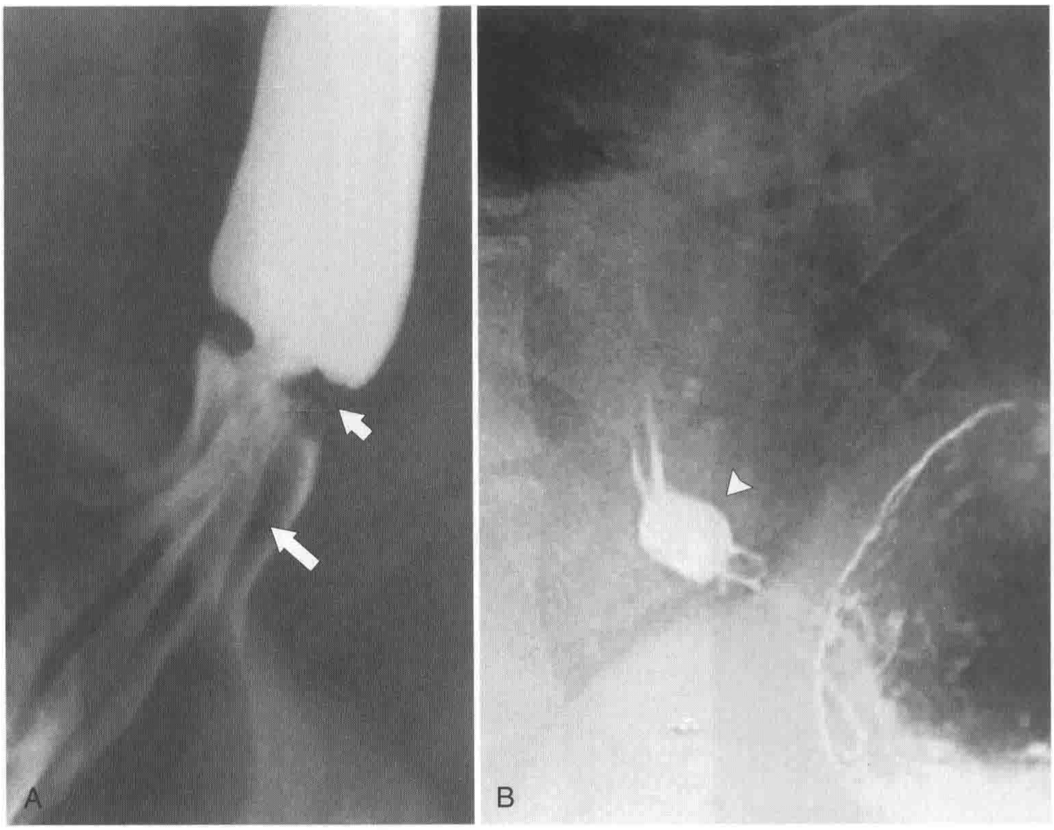

FIGURE 1-17. **A,** Barium swallow in a 64-year-old man with a Schatzki ring (*short arrow*). There is a small hiatal hernia with prominent gastric folds (*long arrow*). **B,** A 13-mm pill (*arrowhead*) failed to pass through the lower esophageal stricture.

and is usually asymptomatic, although about 30% of patients experience dyspeptic symptoms. It is caused by an inflammatory reaction from GERD to the esophageal B-ring, which develops a concentric narrowing resulting in luminal stricture formation, which if 13 mm or less, will likely produce symptoms. Wider rings may or may not be asymptomatic.

The rings are visualized as fixed and smooth associated with a small hiatal hernia below the rings during fluoroscopic observation after the patient swallows thin barium (Fig. 1-17). The rings can be missed on upright swallowing studies and are best elicited with the patient in the prone oblique position, the position most likely to distend the distal esophagus. The diameter of the rings can be confirmed by the patient's swallowing a 13-mm pill in the upright position. Narrowing to 13 mm or less is considered significant, at which point the pill will become stuck at the B-ring (Fig. 1-17).

INFLAMMATORY ESOPHAGOGASTRIC PSEUDOPOLYP OR FOLD

An inflammatory esophagogastric pseudopolyp or fold is an extension of a thickened gastric fold protruding up into the lower esophagus and mimics the appearance of a polyp (it is sometimes termed a *sentinel polyp*) (Fig. 1-18). GERD is usually associated. If the fold is excessively large, a biopsy is recommended to exclude adenocarcinoma at the GE junction.

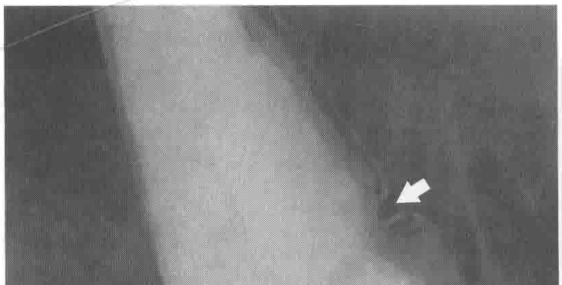

FIGURE 1-18. Barium swallow demonstrating mild B-ring (Schatzki) narrowing (*arrows*) and an inflammatory pseudopolyp (*arrowheads*).

HIATAL HERNIAS

Hiatal hernias are actually an extension of the stomach into the chest as opposed to a primary esophageal abnormality. They are differentiated into sliding (axial) or rolling (paraesophageal) types. In the former, which are far more common (up to 95% of all hiatal hernias), the upper gastric cardia and B-ring (lower esophageal mucosal ring) "slide" up through the diaphragmatic hiatus, typically more than 2 cm. The GE junction therefore lies above the diaphragm in the chest. Most sliding hernias are small and may not be observed at UGI contrast studies unless the patient is examined carefully (usually in the prone oblique position), and many are self-reducible in the erect position. Their significance, even when small, is that patients can have GERD with the resulting symptoms and potential complications. The typical sliding hernia at UGI study demonstrates several cardiac folds passing up into the chest, which may reduce back into the stomach when the patient is upright (Fig. 1-17). There may be a kink in the hiatal hernia because of compression by the adjacent diaphragm. Sliding hiatal hernias can be large with almost the whole stomach being in the chest, but the antrum pylorus remains within the abdomen (Fig. 1-19).

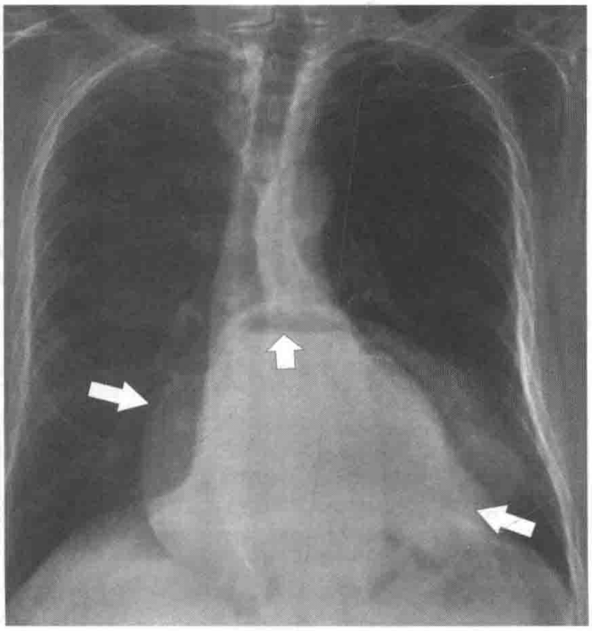

FIGURE 1-19. Chest radiograph in a 56-year-old man with a large hiatal hernia (*large arrows*) and gastric fluid level (*small arrow*). Most of the stomach resides in the chest.

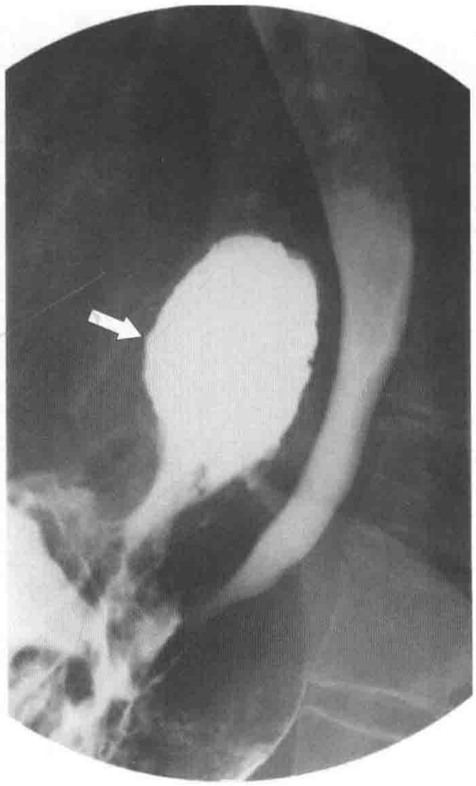

FIGURE 1-20. Barium swallow in a 48-year-old woman with a paraesophageal hernia (*arrow*).

FIGURE 1-21. UGI series (A) and coronal noncontrast CT (B) in a 52-year-old woman with a nonobstructing organoaxial volvulus resulting in an "upside down" stomach.

Far less common are paraesophageal hernias (rolling hernias) in which the GE junction remains within the abdomen, so reflux is much less likely to occur compared with sliding hiatal hernias. Rather, the gastric fundus passes up into the chest and lies to the left of the lower esophagus (Fig. 1-20). These are generally irreducible but are more likely to be asymptomatic compared with sliding hiatal hernia, due to GERD in the more common sliding hernias. On the other hand, a variant of the paraesophageal hernia occurs when the whole stomach lies "upside down" in the chest because of volvulus, which may be obstructing or nonobstructing (see "Gastric Volvulus" in Chapter 2) and which is at greater risk of strangulation and perforation (Fig. 1-21). This is also the case with the even rarer combination of a sliding hernia and paraesophageal hernia, whereby the GE junction lies in the