Computed Tomography of the Body

With Magnetic Resonance Imaging

Volume Three
Abdomen and Pelvis

COMPUTED TOMOGRAPHY OF THE BODY

With Magnetic Resonance Imaging

Second Edition

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Abdomen and Pelvis

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Computed Tomography of the Body

With Magnetic Resonance Imaging

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THE PANCREAS
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PREFACE

The second edition of *Computed Tomography of the Body* has been extensively updated and is presented as a comprehensive, state-of-the-art text on computed tomography (CT) of the body that now includes an integration of magnetic resonance (MR) imaging in all sections of the book. Since the first edition, there have been great advances in CT and its application to patient care. Although the impact of CT has been enormous, magnetic resonance imaging is undergoing explosive growth and is having an ever-increasing impact on body imaging.

As in the first edition, this text is organized so that basic anatomy and CT and MR techniques are discussed for each region of the body. The features of disease entities in these two imaging modalities are described and illustrated, and the relationship of CT to MR and other imaging techniques is discussed in depth. Recommendations are offered as to the role of each modality in specific clinical situations. The book presents an integrated approach, reflecting our current standard of practice. Knowledge of CT and MR imaging will continue to expand, and recommendations, techniques, and patterns of use will undoubtedly change in the future.

In writing this book, now expanded to three volumes, there have been many people without whose support, guidance, insight, and help this work could not have been completed. We thank our colleagues who contributed their time and case material, and we acknowledge the illustration departments at the University of California, San Francisco, and the University of Washington, as well as the secretarial and editorial support of Jan Taylor, Isabel Rosenthal, and Denice Nakano.

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INTRODUCTION TO VOLUME THREE

Owing to the rapid expansion of computed tomography and magnetic resonance imaging of the abdomen and pelvis, *Computed Tomography of the Body* has been expanded to three volumes, and magnetic resonance imaging has been completely integrated. Volume Three, Abdomen and Pelvis is designed as a comprehensive udpate and expansion of these topics in the first edition.

Since the first edition, high-resolution CT has become commonplace as has sub–3-second CT scanning. Magnetic resonance imaging has become a valuable procedure in the diagnosis of hepatic, adrenal, renal, prostate, and gynecologic abnormalities. Magnetic resonance imaging has been compared to computed tomography and where appropriate, recommendations are made as to the most rational use of each technology. Chapters on the physics of CT and MR imaging are included as are chapters on pediatric imagery and CT interventional procedures. The explosion of data on the use of CT and magnetic resonance imaging in the evaluation of liver and biliary tract abnormalities has necessitated expansion of the discussion of hepatobiliary tract disease into two new chapters, The Liver and The Biliary Tract.

I would like to thank the many who have helped to write this volume. In particular, I would like to thank my former colleagues at the University of California in San Francisco, my current colleagues at the University of Washington, and those from other institutions who have contributed their expertise. I would also like to thank the residents, fellows, and technicians at the University of Washington who have contributed so much to this volume. Finally, I would like to offer thanks to my secretary, Jan Taylor, for her secretarial and editorial support and to my former professors John Amberg, Richard Greenspan, Henry Goldberg, and Alexander R. Margulis.

ALBERT A. MOSS, M.D.

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Thorax and Neck

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CHAPTER 16

THE GASTROINTESTINAL TRACT

RUEDI F. THOENI ▪ ALBERT A. MOSS

Although barium radiography[1-3] and endoscopy[4] are safe and accurate initial diagnostic procedures for evaluating gastrointestinal abnormalities, neither assesses the extramucosal extent of disease. Angiography,[5] radionuclide scanning,[6] and ultrasonography[7,8] have been employed as additional diagnostic and staging modalities, but because of the limitations of these techniques, surgical exploration has remained the only accepted method of accurately assessing the true extent of disease. Computed tomography (CT) displays the gastrointestinal tract in cross section and thus images both the inner and outer surfaces of the alimentary tube. In addition, by imaging both adjacent and distant organs, CT is capable of evaluating both local and distant spread of disease.[8-10] Thus CT can provide the radiotherapist, surgeon, internist, and oncologist with a clearer understanding of the true extent of a gastrointestinal abnormality. More recently, magnetic resonance imaging (MRI) and cine- or ultrafast CT have been added to the diagnostic armamentarium of the radiologist but have not been widely used for the gastrointestinal tract. One of the major advantages of MRI imaging lies in the fact that direct coronal and sagittal images can be obtained in addition to the transaxial sections. Ultrafast CT using magnetic deflection of an electron beam to replace mechanical motion demonstrates the walls of the gastrointestinal tract more clearly than conventional CT because of the rapid acquisition time and resulting absence of image distortion related to peristalsis. Such rapid image acquisition facilitates accurate detection of bowel wall abnormalities.

COMPUTED TOMOGRAPHY OF THE GASTROINTESTINAL TRACT

Esophagus

Anatomy

The esophagus connects the pharynx with the stomach and consists of extrathoracic, mediastinal, and abdominal segments. Throughout its length, the

FIGURE 16–1 ■ Normal esophagus, cervical region. Cervical esophagus (E) at level of thyroid gland *(white arrows)* is positioned in the midline, just posterior to the trachea (T). The normal esophageal wall *(arrowheads)* is a thin, sharp structure outlined by air and mediastinal fat and measuring less than 3 mm in diameter. Longus colli muscles are indicated by black arrows.

esophagus is intimately related to a variety of vital vascular, pulmonary, cardiac, lymphatic, and neural structures. The esophagus is surrounded throughout most of its length by periesophageal fat that permits ready differentiation of the esophagus from adjacent structures.

The thickness of the normal esophageal wall as measured by CT in a well-distended esophagus is usually less than 3 mm (Fig. 16–1),[11, 12] and any measurement of more than 5 mm should be considered abnormal.[11, 13] Air in the esophagus is present in 40 to 60 per cent of patients examined by CT[11, 14, 15] and should not be considered an abnormal finding. Air, when present in the normal esophagus, is centrally positioned, and an eccentric position of gas within the esophagus should raise the possibility of an esophageal abnormality.[11, 14]

UPPER ESOPHAGUS

The cervical esophagus is a midline structure intimately related to the posterior tracheal wall, indenting it in approximately 40 per cent of cases (see Fig. 16–1). A smooth, rounded esophageal impression on the trachea should not be interpreted as evidence of tracheal invasion by an esophageal mass. Lateral and dorsal to the esophagus on either side are the long muscles (longus colli) of the neck. The thyroid gland is seen as a high-density structure lying anterior and lateral to the trachea and esophagus. Air is present within the cervical esophagus more frequently than in any other part of the esophagus.

MIDDLE ESOPHAGUS

At the level just below the sternal notch, the trachea deviates slightly to the right of the esophagus, with the esophagus remaining midline or shifting slightly to the left (Fig. 16–2).[11] The esophagus is closely applied to the thoracic spine, and no normal structure is found posterior to the esophagus at this level. A retrotracheal space of up to 4 mm can be present between the trachea and esophagus,[11] and a portion of lung can extend retrotracheally. The subclavian artery, common carotid artery, brachiocephalic artery, and brachiocephalic veins are also clearly identified at this level.

At the level of the aortic arch, the esophagus is closely related to the left posterolateral portion of the trachea (Fig. 16–3). The azygos vein is located to the

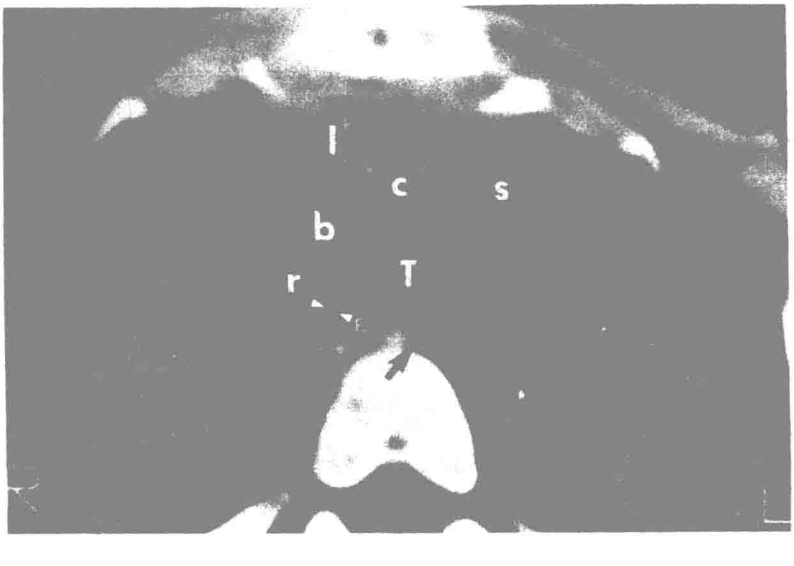

FIGURE 16–2 ■ Normal esophagus, level of sternal notch. In this patient the trachea (T) is slightly to the left of the esophagus (E). The retrotracheal extension of lung *(arrow)* is a normal finding. The left subclavian artery (s), common carotid artery (c), brachiocephalic artery (b), right (r) and left (l) brachiocephalic veins, and thin wall of the normal esophagus *(arrowheads)* are clearly identified.

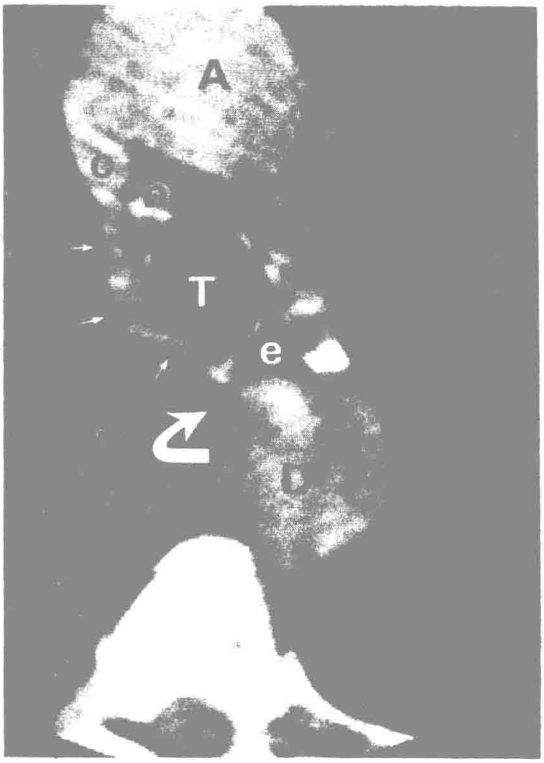

FIGURE 16–3 ■ Normal esophagus, level of aortic arch. The esophagus (e) is slightly to the right of the trachea (T), and the ascending (A) and descending (D) aorta, arch of the azygos vein *(straight arrows)* entering the superior vena cava (c) and azygoesophageal recess *(curved arrow)* are identified at this level. n = Normal-sized pretracheal lymph node.

right, posterior and lateral to the esophagus, and the arch of the azygos can be identified at this level (see Fig. 16–3). The lung is in direct contact with the right side of the esophagus, forming the azygoesophageal recess.[14] Just below the carina, the esophagus is closely related to the left main stem bronchus, separated only by a small amount of mediastinal fat (Fig. 16–4).[11, 14] At this level, a lung recess is present in 10 per cent to 20 per cent of patients between the esophagus and the left pulmonary artery.[14]

LOWER ESOPHAGUS

Below the left main stem bronchus, the esophagus comes in contact with the pericardium surrounding the posterior wall of the left atrium and is positioned near the left pulmonary vein as it enters into the left atrium. At this level the azygos vein is visible as a midline structure (Fig. 16–5). Below the level of the left atrium, the esophagus moves slightly to the left of midline just anterior to the descending aorta (Fig. 16–6), with only mediastinal fat separating the esophagus from the pericardium.

Just after the esophagus passes through the diaphragm, it turns left and courses in a horizontal plane to enter the gastric fundus (Fig. 16–7). On CT scans, the region of the gastroesophageal junction appears as a thickening along the medial cephalic aspect of the stomach in approximately one third of patients.[11, 16, 17] The apparent mass is produced as a result of the transverse plane's of axial CT sections passing through the horizontally directed normal esophagogastric junction (see Fig. 16–7).

Knowledge of the anatomy of the esophagogastric region usually permits a distinction of a true mass from a normal gastroesophageal junction. The gastrohepatic ligament courses between the lesser curvature of the stomach and liver, and the distal esophagus is enveloped by the cranialmost aspect of the ligament (Fig. 16–8).[16] The gastrohepatic ligament fuses with the fissure of the ligamentum venosum to pass anterior to the caudate lobe. Thus the cleft seen on transverse CT images separating the caudate lobe from the lateral segment of the left lobe points directly to the region of the esophagogastric junction (see Fig. 16–7).[16]

When a soft tissue mass is noted high along the lesser curvature of the stomach, its relation to the fissure plane anterior to the caudate lobe should be studied. If the mass and fissure plane are present on

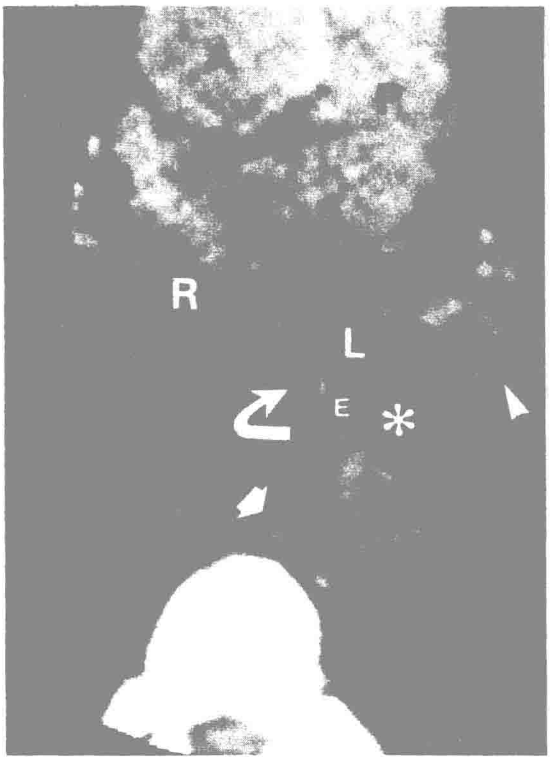

FIGURE 16–4 ■ Normal esophagus, level just below carina. A scan at this level demonstrates the relationships of the right (R) and left (L) main stem bronchi, esophagus (E), descending aorta (D), azygos vein *(straight arrow)*, pulmonary artery (P), ascending aorta (A), and azygoesophageal recess *(curved arrow)*. The left lung recess *(asterisk)* is shown abutting on the left main stem bronchus, esophagus, and left pulmonary artery *(arrowhead)*. V = Left pulmonary vein.

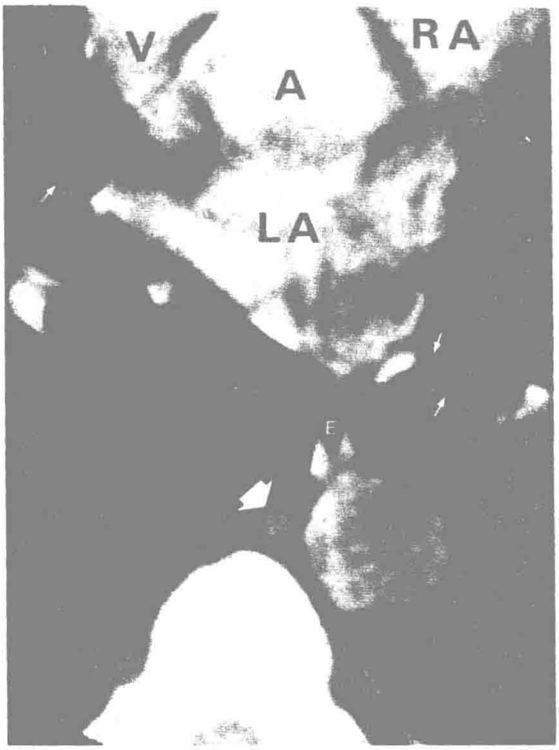

FIGURE 16–5 ■ Normal esophagus, level of left atrium. The esophagus (E) is in contact with pericardium surrounding the left atrium (LA). Pulmonary veins *(small arrows)*, right ventricle (V), right atrium (RA), ascending aorta (A), descending aorta (D), and azygos vein *(large arrow)* are also seen. At this level the esophagus is separated from lung by only the thickness of the esophageal wall and pleura.

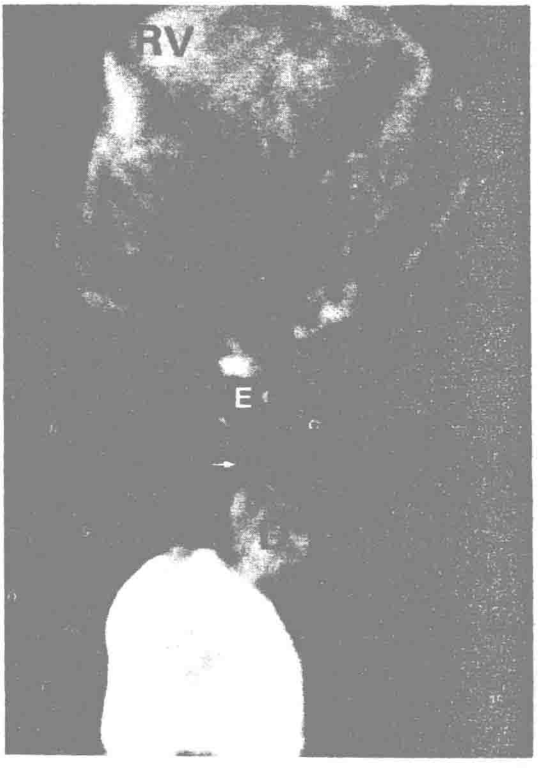

FIGURE 16–6 ■ Normal esophagus, level of left ventricle. The esophagus (E) is just to the left of midline, closely related to the left ventricle (LV) and separated from the descending aorta (D) by the posterior junction line *(arrow)*. RV = Right ventricle; V = inferior vena cava.

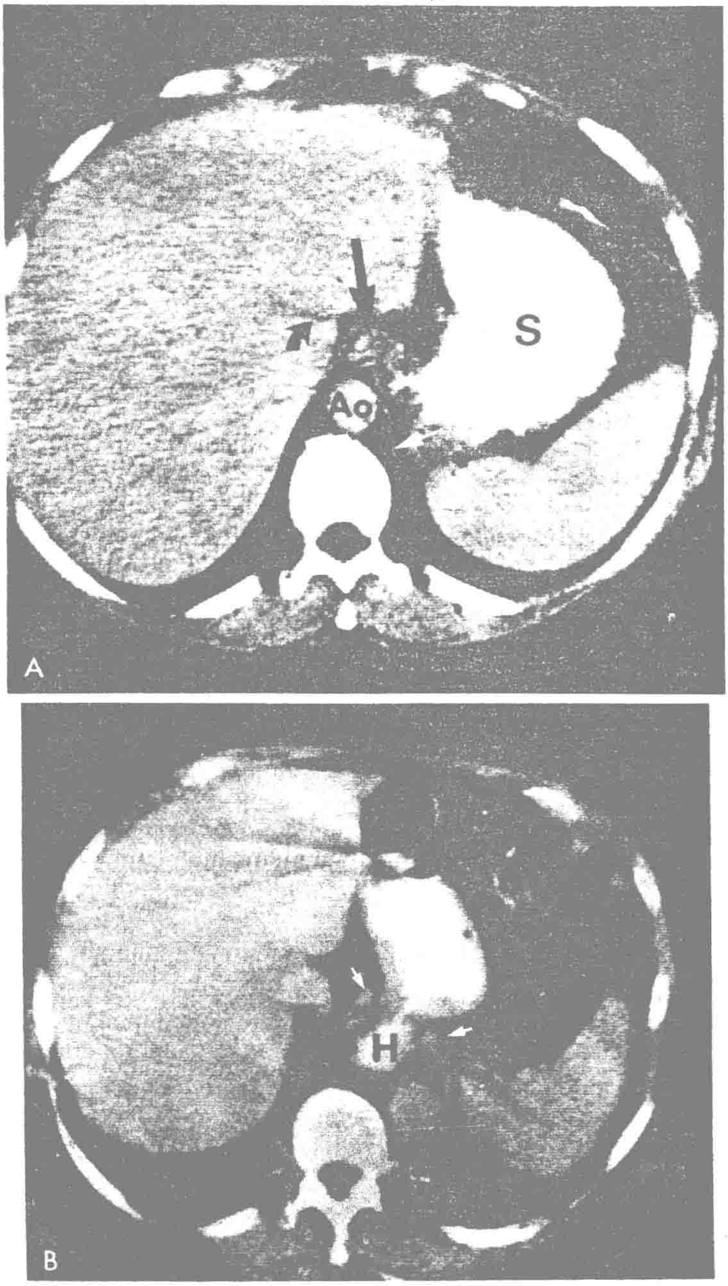

FIGURE 16–7 ■ Normal esophagus, level of gastroesophageal junction. *A*, The normal esophagus *(straight arrows)* courses in a horizontal plane to enter the fundus of the stomach (S). The cleft above the caudate lobe *(curved arrow)* points to gastroesophageal junction. Left diaphragmatic crus *(small arrow)* is closely applied to the abdominal aorta (Ao). *B*, Hiatus hernia (H) producing a mass in region of gastroesophageal junction. Note that the crura of the diaphragm *(arrows)* at the level of the esophageal hiatus are widely separated instead of tightly surrounding the descending aorta and esophagus. (*A* from Marks WM, Callen PW, Moss AA: AJR 136:359, 1981. © 1981, American Roentgen Ray Society. Reprinted by permission.)

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