MARSHAK AND LINDNER

Radiology of the Small Intestine

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Second Edition

W. B. SAUNDERS COMPANY / Philadelphia / London / Toronto

W. B. Saunders Company: West Washington Square
Philadelphia, Pa. 19105

1 St. Anne's Road
Eastbourne, East Sussex BN21 3UN, England

833 Oxford Street
Toronto, M8Z 5T9, Canada

Library of Congress Cataloging in Publication Data

Marshak, Richard H 1912–

Radiology of the small intestine.

Includes index.

1. Intestine, Small—Radiography. I. Lindner, Arthur E., 1928– joint author. II. Title.

RC804.R6M36 1976 616.3'4'07572 75–5053

ISBN 0-7216-6127-0

Radiology of the Small Intestine ISBN 0-7216-6127-0

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

Chapter on Angiography of the Small Bowel

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Chapter on Uncommon Lesions of the Small Intestine

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Chapter on Patterns of Spread of Malignancy to the Small Bowel

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Chapter on The Small Bowel in Infants and Children

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Foreword

This monograph needs no foreword but I have wanted to write one to state my belief that this volume will be a radiographic classic. Its virtues are clear: a readable text with superb pictures, an encylopedic coverage based on firsthand material. There is no hearsay here.

Two explicable factors have contributed greatly. First, this is a text on *clinical* radiology. As the authors have indicated in their own introduction, the experiences condensed in this volume arose in the midst of an active clinical setting: a day-to-day partnership with gastroenterology. Second, this text is based on close pathological correlation. One need only attend one of Dr. Richard Marshak's x-ray conferences to observe how tenaciously these correlations are pursued. The inexplicable factor is, of course, the senior author's talent for "pattern recognition." I do not believe that he himself could explain this gift, but it has enabled him to recognize and define toxic dilatation in ulcerative colitis, dilatation and intussusception in sprue, Crohn's disease of the colon, vascular insufficiency of the small bowel, and so forth.

If there is one section of the present volume I could call attention to, it is the area on malabsorption. The recent explosion of methods for studying small bowel absorptive function and columnar cell morphology has presented clinicians with techniques of considerable complexity. A careful reading of the section on malabsorption will show how far the differential diagnosis of malabsorptive syndromes can be carried on purely radiologic grounds.

While clinical entities involving the small bowel undoubtedly remain to be described, it is hard to see how small bowel radiology in the future can go beyond the morphologic basis of the present volume (although the future of vascular radiology of the gut remains to be explored). The authors' studies of the effect of anticholinergic drugs on the colon, and anticholinesterases on the small bowel, hint that the future of small bowel radiographic analysis will be in a functional direction. This foreword, however, is not intended to speculate about the future (whither radiology?) but to introduce this solid accomplishment of the present, which I confidently predict will have a great future.

HENRY D. JANOWITZ, M.D.

Preface to the Second Edition

Advances in radiological technique and interpretation as well as rapid progress in our understanding of the diseases that involve the small bowel have required a second edition of Radiology of the Small Intestine five years after the appearance of the first.

The text has been updated and three new chapters have been added. Doctor Morton Meyers, of Cornell University Medical College, has contributed a chapter on the patterns of metastatic cancer seen in the small bowel. Doctor Stanley Baum, of the University of Pennsylvania School of Medicine, has provided a thorough discussion of the applications of angiography to the study of the small bowel and its diseases. Finally, with the assistance of Dr. Charles Hazzi, of New York University School of Medicine, we have added a chapter on the small bowel in the immunoglobulin deficiency syndromes. Immunoglobulin disorders have proved to have important relationships to malabsorption and to malignancy. Increasing knowledge of immunological mechanisms will undoubtedly expand our understanding of other small bowel diseases in the years to come.

In the preparation of this second edition we have been aided by our colleague, Dr. Daniel Maklansky, to whom we are most grateful. We want also to thank our editor, Mr. John Hanley, and the W. B. Saunders Company for their cooperation, their suggestions, and their support.

RICHARD H. MARSHAK
ARTHUR E. LINDNER

Preface to the First Edition

The origins of this book can be traced to the early association of the senior author with Dr. Burrill Crohn. At a time when little was known about the small bowel and its diseases, large numbers of patients were referred to Dr. Crohn for diagnosis and management of regional enteritis. Not all of these patients proved to have regional enteritis, and in the course of studying them some of the differential roentgen features of lymphosarcoma and sprue, in particular, became better understood. From these beginnings the authors extended their interest in the radiologic aspects of the small bowel by studying both well established diseases, such as benign tumors and carcinoma, and new entities as they were described, such as the Zollinger-Ellison syndrome and vasculitis.

The upper gastrointestinal series and the barium enema became routine studies because the examinations could be done easily and disease was often discovered. The small bowel, however, was neglected, probably because so much time was necessary for its examination and there seemed to be a low incidence of disease. In recent years there has been new interest in the small bowel and an awareness that many diseases involve this organ, diseases which can be diagnosed quite accurately by careful attention to their roentgen features.

We have tried to present a systematic study of the diseases of the small bowel from a radiologic point of view. Some unevenness was inevitable, since we have emphasized the diseases with which we are most familiar. The chapters on regional enteritis, lymphosarcoma, sprue, carcinoma, and vascular disease are detailed, for example, while sections on tuberculosis and some of the parasitic diseases are brief. A chapter on granulomatous colitis, which might seem out of place in a volume on the small bowel, has been included because of the authors' special interest in this disease and because the small bowel is always of concern and is often involved in it.

We want to thank Dr. Bernard Wolf, Chairman of the Department of Radiology, Mount Sinai School of Medicine, and the other members of the Department who collaborated on several of the articles which form the basis of this volume; Dr. Burrill Crohn, who provided much of the initial material; and Dr. Henry Janowitz, who supplied more recent cases and offered many helpful and stimulating suggestions.

We believe the illustrations in this book are of unusually fine quality and we are grateful to Mr. Robert Carlin for his excellent photography. The careful typing of the manuscript was the work of Miss Linda Dubester, to whom we express our thanks. Finally we want to note our sincere appreciation to the W. B. Saunders Company for their enthusiasm and encouragement at each step in the preparation of this book. We found that with their help, work that might have been just a chore became a challenging project.

RICHARD H. MARSHAK
ARTHUR E. LINDNER

Contents

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Roentgen Examination of the Small Bowel

It is impractical to perform a complete small bowel examination on every patient with abdominal complaints; however, at least one small bowel film should be obtained as part of the routine upper gastrointestinal series. This can readily be accomplished as a delayed film at the conclusion of the examination. This film not only permits visualization of part of the small bowel but also provides an emptying film of the stomach. The chance that this single film may reveal a previously unsuspected lesion in the visualized small intestine is great enough to warrant its inclusion in the routine upper gastrointestinal series.

The *indications* for a complete small bowel examination include the following:

1. Gastrointestinal bleeding which cannot be localized to the esophagus, stomach, duodenal bulb, or colon.
2. Diarrhea or steatorrhea.
3. Unexplained abdominal pain.
4. Fever of unknown origin.
5. Retardation of growth and development.
6. Findings of ulcerative or granulomatous colitis on barium enema examination.

It is important to remember that an abnormality discovered in an upper gastrointestinal series or barium enema examination does not necessarily explain a patient's clinical findings and does not rule out a small bowel lesion. Clinical judgment and an awareness of the diseases that involve the small bowel provide additional indications for a small bowel examination.

TECHNIQUE

Patients are examined after an overnight fast, and whenever possible all medications are discontinued the day before the examination. Anticholinergics

and ganglionic blocking agents tend to cause dilatation and mimic the sprue pattern, and narcotics affect both the motility and the appearance of the folds of the small bowel.

The most important characteristic of a proper contrast material for the small bowel study is a barium which suspends easily and does not flocculate, precipitate, or settle in the presence of intestinal secretions. These aims can be accomplished by micropulverization of the barium sulfate and addition of a suspending agent. Most modern barium preparations, fortunately, contain adequate suspending agents and are sufficiently micropulverized for small bowel studies. Thus there is no longer need, in describing contrast media, to specify such terms as "flocculating" or "nonflocculating" barium. Plain USP barium, which may flocculate in the small bowel, should not be used for this examination.

A preliminary film of the abdomen prior to the administration of barium is often helpful. In adults the small bowel may contain scattered amounts of gas, but visualization of an entire segment or a loop is an abnormal finding. Large amounts indicate an ileus or obstruction. Gas can serve as a contrast medium on a plain film and demonstrate very effectively an area of pathology within the small bowel. The total absence of gas in the small bowel is abnormal.

The esophagus and stomach should be examined whenever a small bowel series is performed. Since considerable amounts of barium are used in a small bowel series, the examination of the upper gastrointestinal tract does not interfere with the small bowel study.

The small bowel is examined following administration of a mixture which is half barium sulfate, by volume, and half water. At least 16 oz. of the mixture is used, and at times 20 oz. or more may be required. Use of smaller amounts of barium may cause incomplete filling of loops and simulate a small bowel abnormality. The large volume of barium is especially valuable in the interpretation of diffuse lesions in the small bowel. Many intestinal loops may be visualized in continuity at the same time and the relationship of one segment to another is better evaluated (Figs. 1-1 to 1-3).

Compression studies are used whenever necessary for better delineation of a lesion, and they are routinely employed in demonstrating the terminal ileum. There is a tendency for barium to flood ileal loops in the pelvis, but compression studies and appropriate timing of films will usually permit visualization of all segments (Fig. 1-4).

The patient is initially examined fluoroscopically in 15 minutes, and if the barium meal has progressed sufficiently a film is taken. It is desirable to see the entire jejunum on the first film. This initial film may be taken in the supine position if adequate visualization of the ligament of Treitz has not previously been obtained during the upper gastrointestinal series. Subsequent films are all taken in the prone position. Further filming depends upon the rate of passage of the barium meal and usually consists of a film every 30 to 60 minutes until the barium has reached the colon. The later exposures provide evacuation films of the proximal loops of bowel and may better delineate tumors or ulcers of this area. Evacuation films, in fact, often serve the same purpose as compression films.

There is wide variation among subjects in the time of transit of barium through the small bowel. In normal persons the head of the barium column may take from 2 hours to as long as 5 to 6 hours to reach the colon. The range is so

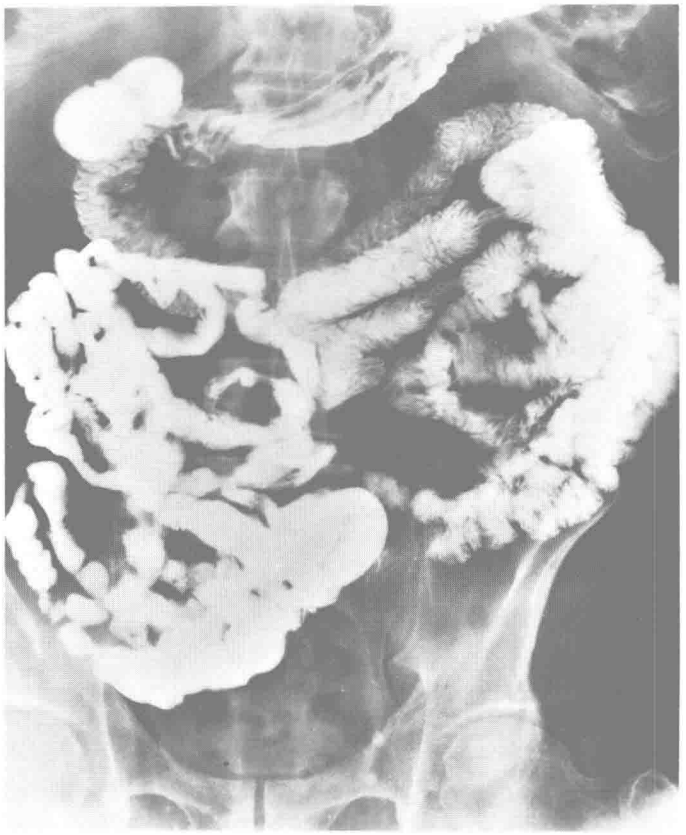

Figure 1-1 *Normal small intestine.* This film was taken thirty minutes after the ingestion of 20 fluid ounces of a barium mixture.

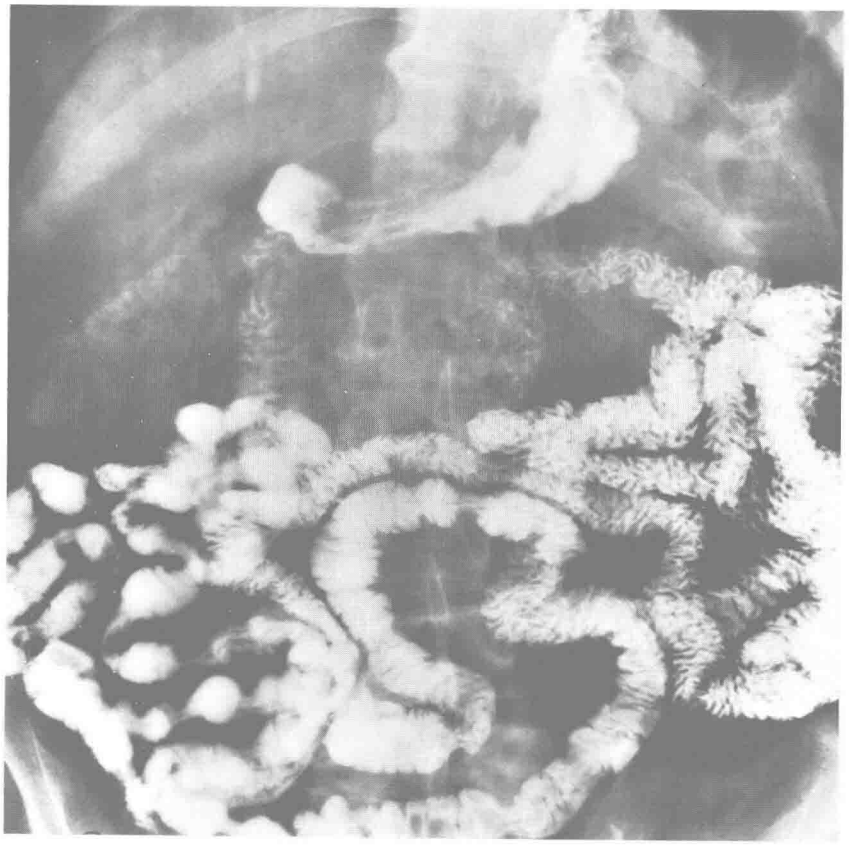

Figure 1-2 *Normal small intestine.* Note that the column of barium is continuous and that the loops have an undulating, serpentine configuration.

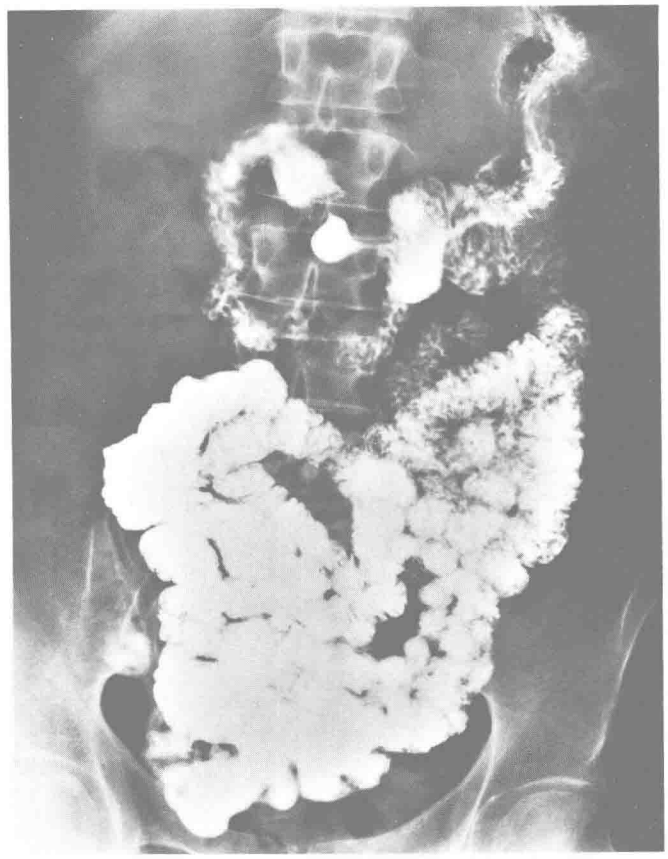

Figure 1-3 *Normal small intestine.* This film was made immediately after the upper gastrointestinal study was completed. The barium column has reached the distal ileum with visualization of most of the small bowel.

great that it is difficult to make a definite statement about transit time in a given patient. Moreover, the type of barium influences transit time. The examiner should be familiar with the motility pattern of the barium he employs. In general, appearance of barium in the colon less than an hour after the start of the examination suggests rapid transit and may warrant appropriate diagnostic studies for such systemic diseases as hyperthyroidism and carcinoid syndrome.

Often it is worthwhile to extend the small bowel examination to include the entire colon. This procedure is especially indicated in patients with inflammatory bowel disease, for films of the colon visualized from above may detect areas of inflammation not seen after distention of the colon with barium or air during the barium enema study. Conversely, especially in the presence of small bowel obstruction, the terminal ileum may be better visualized by reflux during a barium enema examination than by a small bowel series.

In some instances, when transit is slow, the patient is allowed to eat a small meal to stimulate motility and hasten the barium through the distal bowel. Feeding is permitted only when the proximal loops have been adequately studied.

Neostigmine is helpful in increasing motility and shortening the time of the small bowel examination (Fig. 1-5). A subcutaneous or intramuscular injection of 0.5 mg. will speed the passage of barium through the small bowel, and

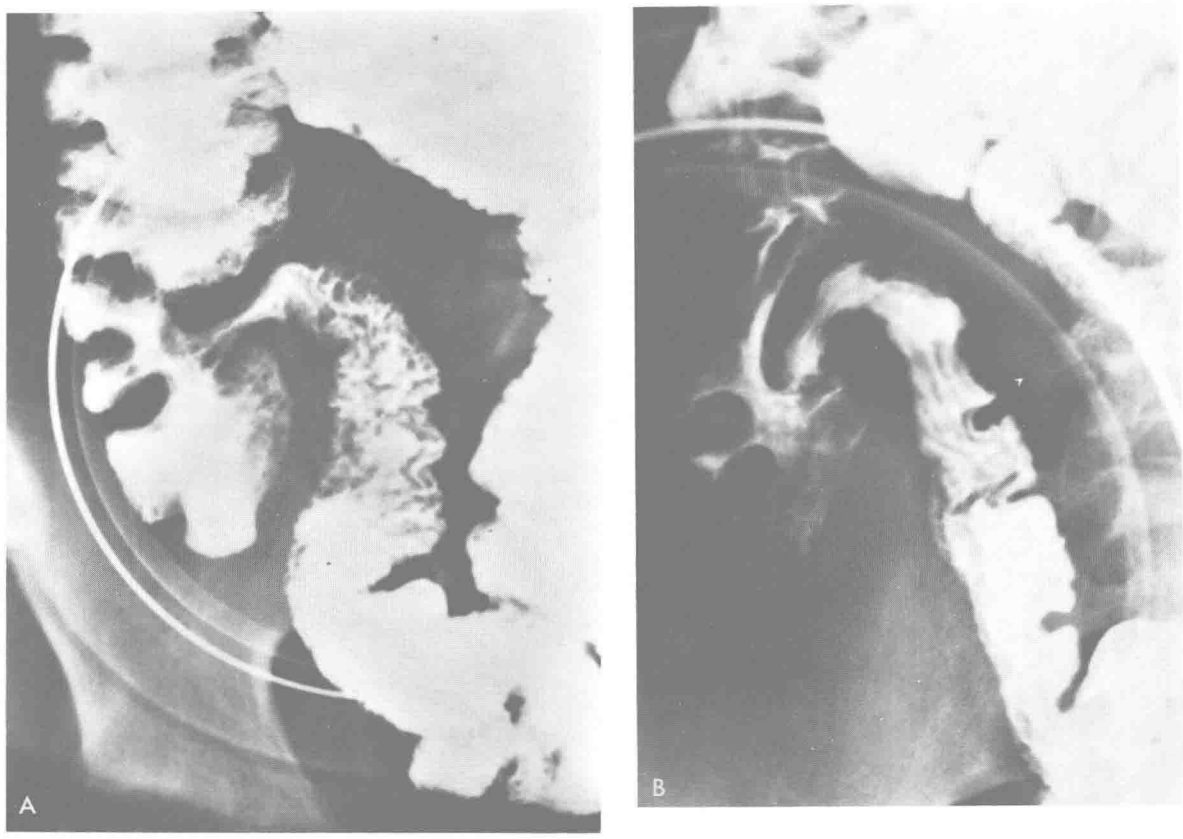

Figure 1-4 *Spot film of a normal terminal ileum.* This is readily accomplished in most cases by the use of an inflated rubber balloon or by compression with a cone.

in most cases the barium column will reach the colon in 30 to 45 minutes. Although use of the drug in this dosage is generally quite safe, it should not be employed in the elderly or in patients with heart disease, asthma, or complete mechanical intestinal or urinary tract obstruction. Atropine should be readily available in case a reaction occurs. It should be noted that neostigmine does not significantly alter the small bowel pattern, although the intestinal hurry may produce areas of narrowing which on occasion can be confusing.

In patients with incomplete small bowel obstruction, prostigmine may be a useful and safe adjuvant. In regional enteritis, for example, prostigmine frequently aids in visualization of stenotic segments of bowel by propelling barium into those areas.

Cholecystokinin (cholecystokinin-pancreozymin; CCK-PZ) is a hormone derived from the duodenal mucosa. Among its other actions is stimulation of propulsive activity in the mesenteric small bowel. Investigators have taken advantage of this property by using commercially prepared CCK-PZ to shorten the duration of the small bowel roentgen study. With this method, 40 units of CCK-PZ is injected intravenously one-half hour after ingestion of the barium suspension (to allow time for gastric emptying). Films are routinely exposed 1,3,5,7 and 10 minutes after the drug has been given. In most patients barium reaches the cecum in less than 15 minutes. Although adequate visualization of the small bowel may be obtained by this method, abdominal cramps and nausea occur as unpleasant side effects in many patients. The drug seems to us to offer