Ultrasound Diagnosis of Digestive Diseases

Francis S. Weill

Ultrasound Diagnosis of Digestive Diseases

Third Revised Edition

Foreword by F. Winsberg

With 942 Figures in 2591 Separate Illustrations

Springer-Verlag Berlin Heidelberg New York
London Paris Tokyo Hong Kong

Professor FRANCIS S. WEILL, M.D.
Chaire de Radiodiagnostic, Radiologie A
Hôpital Jean Minjoz, Avenue Fleming
F-25030 Besançon

Translator: FRED WINSBERG, M.D.
Department of Radiology
Mt. Sinai Medical Center
1 Gustave Levy Place
New York, NY 10029, USA

Title of the German Edition:
Ultraschalldiagnostik in der Gastroenterologie, zweite überarbeitete Auflage

Title of the French Edition:
L'ultrasonographie en pathologie digestive, 4e édition

ISBN 3-540-19059-7 3rd Edition Springer-Verlag Berlin Heidelberg New York Tokyo
ISBN 0-387-19059-7 3rd Edition Springer-Verlag New York Berlin Heidelberg Tokyo
ISBN 4-431-19059-7 3rd Edition Springer-Verlag Tokyo Berlin Heidelberg New York

Previous Editions:

Library of Congress Cataloging-in-Publication Data. Weill, Francis S., 1933- [Ultrasonographie en pathologie digestive. English] Ultrasound diagnosis of digestive diseases / Francis S. Weill ; with a foreword by F. Winsberg ; [translator, Fred Winsberg] - 3rd rev. ed. p. cm. Translation of: L'ultrasonographie en pathologie digestive. 3e éd. 1987. Includes bibliographies and index. ISBN 0-387-19059-7 (U.S.) 1. Digestive organs - Diseases - Diagnosis. 2. Diagnosis, Ultrasonic. 3. Digestive organs - Ultrasonic imaging. I. Title. [DNLM: 1. Gastrointestinal Diseases - diagnosis. 2. Ultrasonic Diagnosis. WI 141 W422u] RC804.U4W44 1989 616.3'607543 - dc 19 DNLM/DLC for Library of Congress 88-37421 CIP

Printed in Germany

Typesetting, printing, and bookbinding by Appl, Wemding
2121/3130-543210 - Printed on acid-free paper

The first edition of this work contained
the following dedication:

"To my everloving wife, who said that if I ever dared write another book, she would fly to Honolulu. That was a mistake: I will."

Alas! Neither of us will, or, as you might pun in English

"Oh, no, Lulu!"

Foreword

During the 1970s ultrasonography developed along different paths in continental Europe and the English-speaking world. Whereas static imaging dominated the United Kingdom and North America, real-time examination performed by physicians was the norm in the Federal Republic of Germany and France.

Francis Weill was uniquely able to bridge the gap between the two schools since he employed both techniques extensively. He made many important contributions to abdominal ultrasonography during that decade, including the first descriptions of peripancreatic vascular anatomy, the sonographic diagnostic features of obstructive jaundice, and the localization of intraperitoneal fluid collections.

During the past 20 years he has been working on an evolving textbook of gastrointestinal ultrasonography. This edition in English is the latest fruit of that effort.

There are many textbooks of ultrasonography but very few are the work of a single author with a systematic, consistent, and thoroughly organized approach. Moreover, a work that has been crafted and refined by 20 years of clinical experience is certainly unique in this field.

My relationship to this book began with the first English edition which I helped to translate from French. The current volume is a revised version of the most recent French edition, a book that we have found to be an invaluable reference in our department of radiological ultrasound for anyone who can manage a bit of French. I hope the English translation will make it accessible to the large audience of students, residents, fellows, and experienced sonologists that it deserves.

New York

FRED WINSBERG, M.D.

Preface

This book, now in its third edition, reflects twenty years of experience of ultrasonography. My aim is to make the training of new ultrasonographers easier. Their period of apprenticeship is always long, and they are never sure that they will have seen an adequate variety of pathologic conditions during the time available to them. I also hope to make ultrasound images more familiar to radiologists, internists, surgeons, and other interested specialists. Even if these physicians do not practice ultrasonography, they should be able to understand the information provided by this modality and to use it in their work. Finally, there are many ultrasonographers who have embarked on using real-time equipment but whose experience and training was with static techniques. They will find that this book provides them with a systematic description of ultrasound findings.

Ultrasonography has undergone several important technical developments: gray-scale imaging in 1975, the high speed digital scan converter in 1978 which allowed us to obtain real-time images of good quality, and now Doppler ultrasound combined with two-dimensional imaging with colour-coding. Ultrasonography is now a mature technique. It produces images that are faithful, and reproducible, approaching the theoretical limits imposed by the laws of physics. Computed tomography has not replaced ultrasonography but has in fact given new impetus to its development, since the signs employed by both methods are often the same. Study of these signs thus contributes to our understanding of both techniques. Nevertheless, however indispensable computed tomography may be, it remains a relatively expensive means of examination, delivers ionizing radiation to the patient, and suffers from its own physical limitations. Computed tomography cannot be used rationally in an environment devoid of ultrasound equipment and expertise, and the relative indications for the two techniques are discussed in detail. Magnetic resonance is the newcomer to tomographic imaging. It gives us such startlingly realistic anatomic images that we are fascinated by it. All the same, every time a sick patient is examined with ultrasound at the bedside or in the emergency room and a complex diagnostic problem is quickly resolved, we should realize that this method still has a long future. It is indeed an ideal radiologic-clinical method, and we must pay respectful tribute to the pioneers, Dr. Joseph Holmes of Denver and Dr. Ian Donald of Glasgow, both now deceased.

Besançon

FRANCIS S. WEILL

Contents

Part 6
Conclusion

Part 1 General Principles

Chapter 1 Principles of Ultrasonography and Types of Ultrasound Imaging

To understand ultrasonography it is necessary to appreciate salami. Normally one cuts a salami in transverse slices (Fig. 1.1 a); this is the same procedure that the ultrasonographer uses when confronted by an abdomen. However, salamis may also be cut in longitudinal slices (Fig. 1.1 b) or in oblique slices (Fig. 1.1 c). When one is capable of cutting in all directions and can recognize all the details of the slice (Figs. 1.2, 1.3), one has become a good ultrasonographer – or, as my friend George Leopold of San Diego said, when "slicing" by manual scanning was the daily routine, a member of the "salami club." For those who do not like salami or who are opposed to this gastronomic approach to digestive ultrasonography, another mental model is possible; the sadistic one (Fig. 1.4).

Principles of Ultrasound Laminagraphy

Since the technique illustrated in Fig. 1.4 risks malpractice suits, one must find something better. It is useful to recall certain principles of ultrasonographic scanning.

The basic tool is the transducer. It emits pulses of ultrasound, the pulses lasting approximately 1 ms and having 1-ms intervals between them. (In

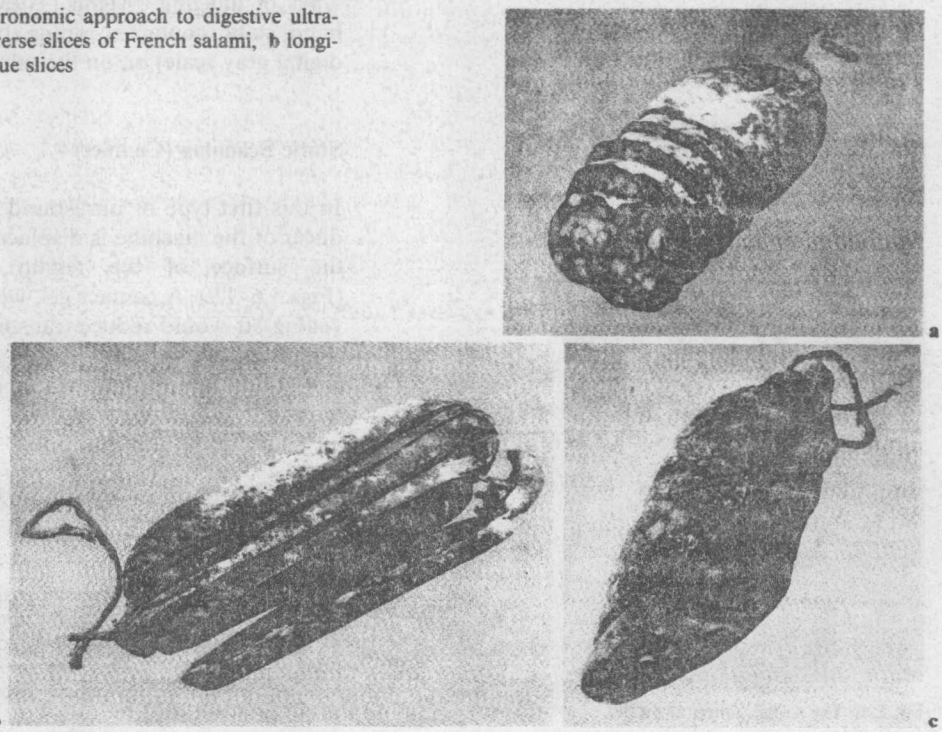

Fig. 1.1 a–c. The gastronomic approach to digestive ultrasonography. **a** Transverse slices of French salami, **b** longitudinal slices, **c** oblique slices

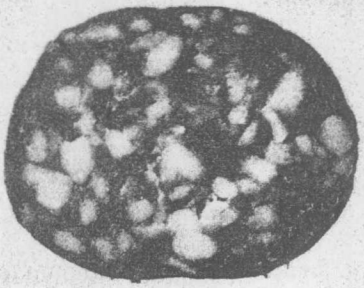

Fig. 1.2. Salami slice in close-up

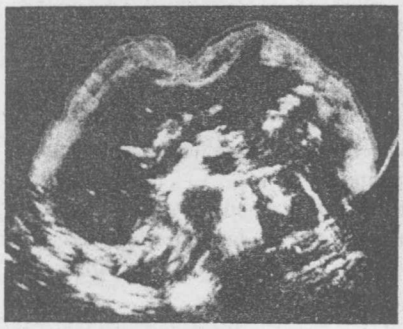

Fig. 1.3. Abdominal slice - same technique

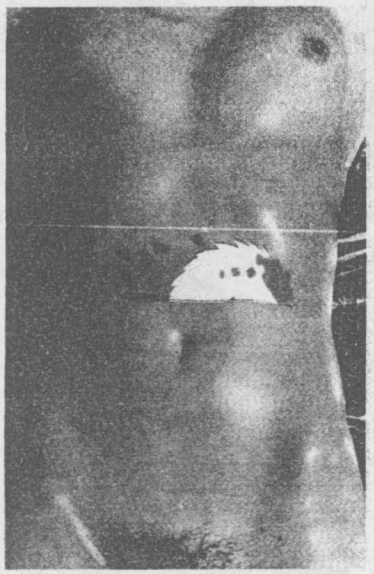

Fig. 1.4. The sadistic mental model

real-time imaging the pulse repetition time is determined by the depth of penetration and the frame rate. It varies from 100 to 250 μs.) These intervals permit the transducer to be used as both an emitter and a receiver. When a transducer is placed in contact with the abdomen and emits its ultrasound beam, which passes through the viscera, a certain number of echoes return from the acoustic interface zone (Fig. 1.5a). These echoes are then visualized on a cathode-ray tube, either in the form of deflections (A mode; Fig. 1.5b) or in the form of bright spots (B mode; Fig. 1.5c).

If the transducer is moved along the surface of the abdomen, a series of bright spots representing the interface zones will appear at each new position (Fig. 1.6). If one records the echoes from an infinite number of successive positions, their summation will enable an image of a transverse section of the abdomen to be constructed (Figs. 1.7, 1.8). Thus the construction of an ultrasonographic scan demands the following:

- Movement of the transducer along a fixed plane
- Display of the echoes on a scope, in the form of bright spots
- Summation of these spots

The different modes of displacement and summation have led to the development of different types of imaging systems. These are, on the one hand, static, contact scanning (bistable, analog, or digital gray scale) or, on the other hand, real-time.

Static Scanning (Contact)

In this first type of ultrasound system, the transducer of the machine is displaced manually along the surface of the region to be explored (Figs. 1.6-1.9). A contact gel, without which intervening air would reduce transmission to no more than 0.1%, is used. Obtaining a global tomographic section requires that the displacement be along

Fig. 1.6. a Successive positions of the transducer during a transverse scan of the abdomen. b The respective bright spots ▶

Fig. 1.7. a Much closer successive positions of the transducer during a transverse scan of the abdomen. b Summation of multiple bright spots belonging to the successive positions of the transducer. This summation builds up a sectional image of the various organs through which the ultrasound beam has passed ▶▶

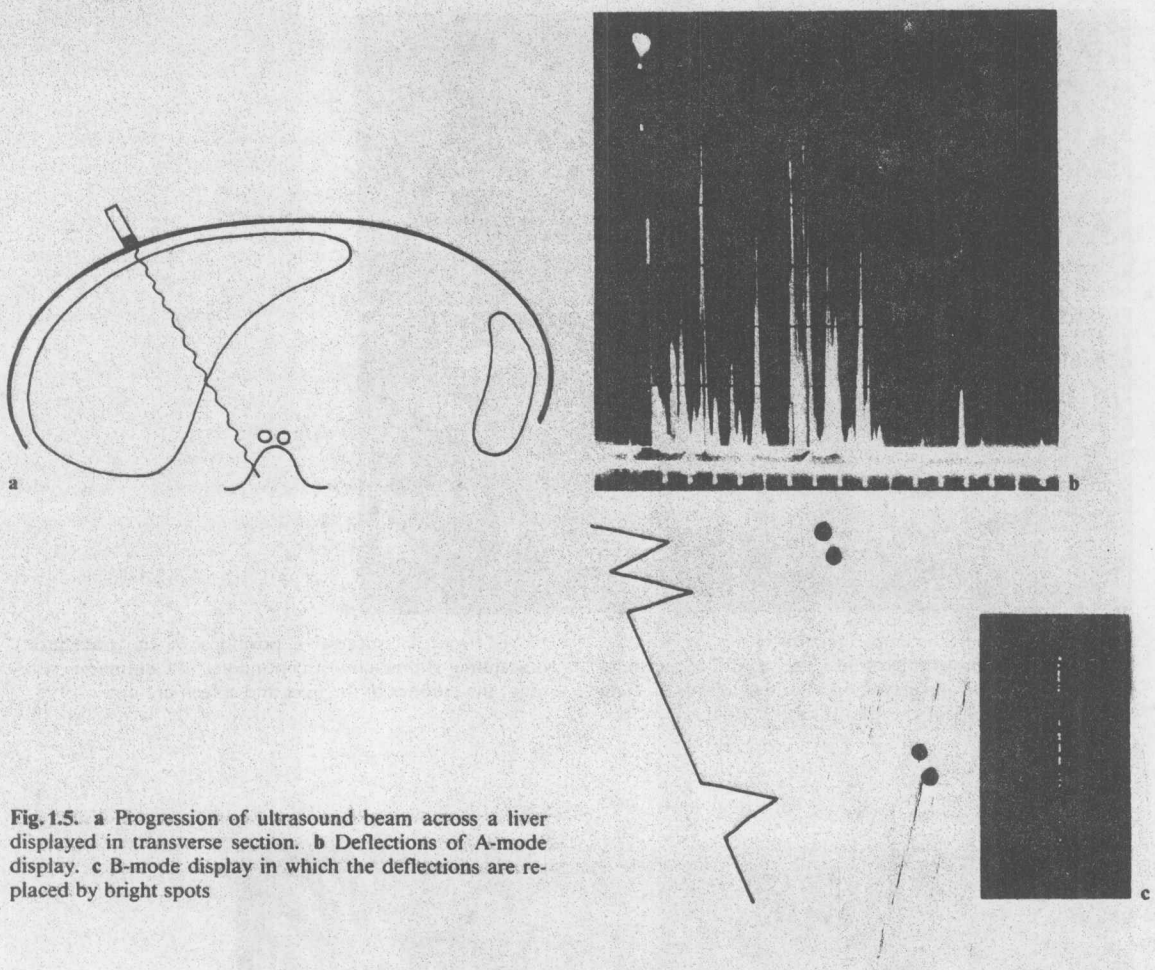

Fig. 1.5. **a** Progression of ultrasound beam across a liver displayed in transverse section. **b** Deflections of A-mode display. **c** B-mode display in which the deflections are replaced by bright spots

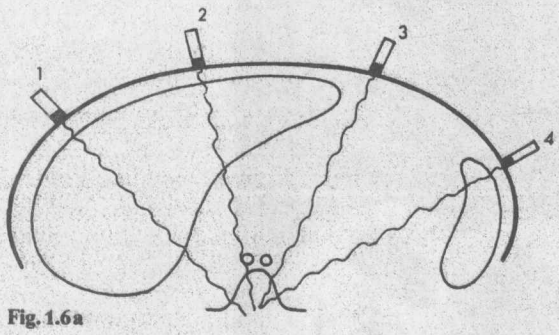

Fig. 1.6a

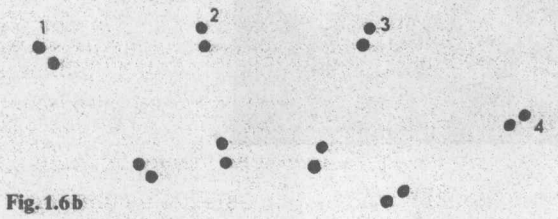

Fig. 1.6b

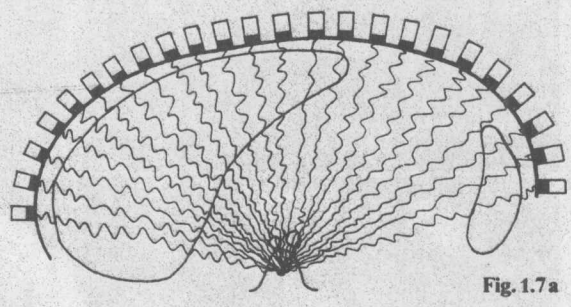

Fig. 1.7a

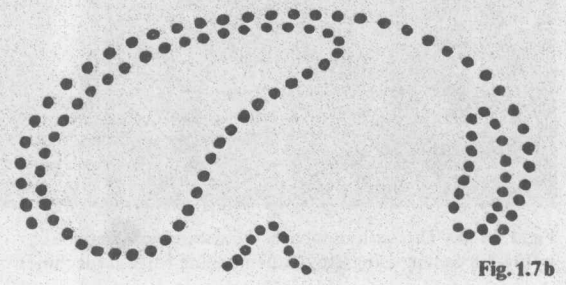

Fig. 1.7b