

英文原版

VOLUME Two

超声诊断学

Textbook of Diagnostic Ultrasonography

fifth edition

*Silver
Anniversary
Edition*

Sandra L.Hagen-Ansert



人民卫生出版社



HEALTH SCIENCE ASIA,
ELSEVIER SCIENCE

1568033

VOLUME TWO

Textbook *of* Diagnostic Ultrasonography

fifth edition

with 2538 illustrations

SANDRA L. HAGEN-ANSERT, M.S., RDMS, RDCS

Ultrasound Consultant and Educational Specialist
Former Program Director and Clinical Sonographer
Baptist College of Health Sciences, Memphis, Tennessee
University of California, San Diego Medical Center, San Diego, California

人 民 卫 生 出 版 社

Health Science Asia, Elsevier Science

人民卫生出版社

Health Science Asia, Elsevier Science

FIFTH EDITION

Original English Language Edition

Copyright © 2001 by Mosby, Inc.

Previous editions copyrighted 1978, 1983, 1989, 1995

All rights reserved.

Authorized English Reprints

Copyright © 2002 by Health Science Asia, Elsevier Science

图书在版编目 (CIP) 数据

超声诊断学(一、二卷)/(美)安塞特(Ansart, H. S. L.)
著. 影印版. —北京:人民卫生出版社, 2002

ISBN 7-117-04890-5

I. 超… II. ①安…②H… III. 超声波诊断—英文
IV. R445.1

中国版本图书馆 CIP 数据核字 (2002) 第 023088 号

图字: 01-2002-1968

超 声 诊 断 学(英文版)

(一、二卷)

编 著: SANDRA L. HAGEN-ANSERT, M. S., RDMS, RDCS

出版发行: 人民卫生出版社(中继线 67616688)

地 址: (100078)北京市丰台区方庄芳群园 3 区 3 号楼

网 址: <http://www.pmph.com>

E-mail: pmph@pmph.com

印 刷: 北京人卫印刷厂

经 销: 新华书店

开 本: 889×1194 1/16 印张: 73.75

字 数: 3084 千字

版 次: 2002 年 9 月第 1 版 2002 年 9 月第 1 版第 1 次印刷

标准书号: ISBN 7-117-04890-5/R·4891

定价(一、二卷): 341.00 元

著作权所有, 请勿擅自用本书制作各类出版物, 违者必究

(凡属质量问题请与本社发行部联系退换)

CONTRIBUTORS

FRANK CHERVENAK, MD

Professor of Obstetrics and Gynecology
Director of Obstetrics
Director, Maternal-Fetal Medicine
New York Hospital, Cornell Medical Center
New York, New York

DAWN GANGLOFF, BS, RDMS, RT(R)

Staff Sonographer, Ultrasound Department
St. Francis Hospital
Peoria, Illinois

M. ELIZABETH GLENN, MD

Women's Health Center at Baptist East
Memphis, Tennessee

CHARLOTTE HENNINGSSEN, MS, RDMS

Program Director, Diagnostic Medical Sonography
Florida College of Health Science
Orlando, Florida

MIRA L. KATZ, PhD, RVT

Research Technologist
Radiology Department
The Children's Hospital of Philadelphia
Philadelphia, Pennsylvania

LAURENCE B. McCULLOUGH, PhD

Professor of Medicine and Medical Ethics
Center for Medical Ethics and Health Policy
Baylor College of Medicine
Houston, Texas

TRACI PARKER, RDMS

Department of Radiology/Ultrasound
Boulder, Colorado

KERRY WEINBERG, MS, RDMS

Program Director, Diagnostic Medical Sonography
New York University
New York, New York

REVIEWERS

KEVIN P. BARRY, MED, RDMS, RDCS, RT(R)

Professor/Department Head
Diagnostic Medical Imaging
New Hampshire Technical Institute
Concord, New Hampshire

JAN D. BRYANT, MS, RDMS, RT(R)

Program Director
Diagnostic Medical Sonography Program
El Centro College
Dallas, Texas

CASEY CLARKE, BSRT, RT(R), RDMS, RDCS

Program Director
Diagnostic Medical Sonography
South Suburban College
South Holland, Illinois

JOAN CLASBY, BvE, RT, RDMS, RDCS

Director and Professor
Diagnostic Medical Sonographer
Orange Coast College
Costa Mesa, California

DALE E. COLLINS, MS, RT(R) (M) (QM), RDMS

Instructor
Medical Radiography
State University of New York–HSC–Syracuse
Syracuse, New York

STEVEN M. CURRIER, MS, RT, RDMS, RVT

Director
Medical Imaging
Lake Wales Medical Center
Lake Wales, Florida

JANICE D. DOLK, MA, RT(R), RDMS

Director
Diagnostic Medical Sonography Program
University of Maryland, Baltimore
Baltimore, Maryland

JANET M. FELDMEIER, BSRT, RDMS

Staff Ultrasonographer
Cardinal Glennon Children's Hospital
St. Louis, Missouri

KATHLEEN KURSHINSKY, RT(R)M, RDMS

Clinical Instructor
Chippewa Valley Technical College
Eau Claire, Wisconsin

THOMAS F. WALSH, MA, RDMS

Program Director
Middlesex Community College
Bedford, Massachusetts

KIMBERLEE B. WATTS

Director of Sonography
Caldwell Community College & Technical Institute
Hudson, North Carolina

CHERYL L. ZELINSKY, BA, RT(R), RDMS

Director
Diagnostic Medical Sonography Program
Oregon Institute of Technology
Klamath Falls, Oregon

FOREWORD

I am pleased to offer a foreword for this prestigious Silver Anniversary Edition of *Textbook of Diagnostic Ultrasonography*.

Continuing growth in the field of sonography certainly has warranted this new edition and Sandra Hagen-Ansert and her colleagues have proved more than equal to the task. New in this edition are chapters on the *foundations of sonography, scanning techniques and protocols, the vascular system, the liver, the genitourinary system, the retroperitoneal cavity, the scrotum, the breast, and the thyroid*, complementing existing chapters on general sonography. Special attention to neonates has resulted in specific chapters on cranial, abdominal, and renal sonography. Obstetric and gynecologic sonography have also been enhanced by revised offerings in normal anatomy and physiology, as well as embryosonology, congenital anomalies, and fetal echocardiography. The vascular chapters have been completely updated to include the latest techniques in vascular imaging. The cardiology section offers introductory material on anatomy and physiology, in addition to the normal echocardiographic protocol and images required to perform a complete examination. A brief overview of pathology the cardiac sonographer may encounter during an echocardiographic procedure is found in the echocardiographic pathology chapter. As with previous editions the quality of the text and illustrations remains very high. The authors are to be commended for their efforts in making a very readable textbook.

The focus of this text has always been on the sonographer actually performing studies. Those who assume this role have a unique relationship with physicians responsible for interpreting sonographic studies. Real-time sonography provides the sonogra-

pher with vast amounts of information, most of which is discarded. Final images reaching the physician are a distillation of this information. In a very real sense the sonographer performs diagnosis during the study. Nowhere else in medicine does this relationship exist. Perhaps the closest analogy is in gastrointestinal fluoroscopy, in which spot films are made of real-time images, often sacrificing functional information. Technologists perform these studies in virtually no institutions. Yet curiously, in these same institutions, sonographers daily churn out complex studies of the heart, abdomen, and pelvis—in my view a far more complex task.

This unique role as a physician's assistant clearly deserves recognition. It requires high-quality instruction, of which this book is an excellent example. It also requires outstanding and dedicated individuals, of which the book's principal author is an excellent example. She and her co-authors are to be congratulated on their success in advancing our knowledge in this discipline.

It is hard to overestimate the number of individuals who have benefited from previous editions of this text. Although this text was initially conceived for sonographers, I frequently see it used by sonologists as well. It is my belief that this usage typifies the close relationship between these groups, which is essential for top-quality sonography. In this edition, Sandra Hagen-Ansert and her colleagues have once again shown us that through prodigious effort it is still possible to produce a text benefiting all who labor in this vineyard.

George R. Leopold, MD

PREFACE

A LOOK BACK

Medicine has always been a fascinating field to me. I was introduced to it by Dr. Charles Henkelmann in 1963, who provided me with the opportunity to learn radiography. Although x-ray technology was interesting, it did not provide the opportunity to evaluate patient history or to follow through interesting cases, which seemed to be the most intriguing aspect of medicine and my primary concern.

Shortly after I finished my radiographic training in 1968, I was assigned to the radiation therapy department, where I was introduced to a very quiet, young, dedicated radiologist, whom I would later grow to admire and respect as one of the foremost authorities in diagnostic ultrasound. Convincing George Leopold that he needed another hand to assist him was difficult in the beginning, and it was through the efforts of his resident, Dan MacDonald, that I was able to learn what has eventually developed into a challenging and exciting new medical modality.

Using high-frequency sound waves, diagnostic ultrasound provides a unique method for visualization of soft tissue anatomic structures. Identifying such structures and correlating the results with clinical symptoms and patient data offers an ongoing challenge to the sonographer. The state of the art demands expertise in scanning techniques and maneuvers to demonstrate the internal structures; without quality scans, limited diagnostic sonographic information can be provided to the physician.

Our initial experience in ultrasound took us through the era of A-mode techniques, identifying aortic aneurysms through pulsatile reflections, trying to separate splenic reflections from upper-pole left renal masses, and, in general, attempting to echo every patient with a probable abdominal or pelvic mass. Of course, the one-dimensional A-mode techniques were difficult for me to conceptualize, let alone trust. However, with repeated successes and experience gained from mistakes, I began to believe in this method. The conviction that Dr. Leopold had about this technique was a strong indicator of its success in our laboratory.

In 1969, when our first two-dimensional ultrasound unit arrived in the laboratory, the "skeptics" started to believe a little more in this modality. I must admit that those early images looked like weather maps to me for several months. The repeated times I asked, "What is that?" were enough to try anyone's patience.

I can recall when Siemens installed our real-time unit and we saw our first obstetric case. It was such a thrill for us to see the fetus move, wave his hand, and show us fetal heart pulsations!

We scouted the clinics and various departments in the hospital for interesting cases to scan. With our success rate surpassing our failures, the case load increased, so that

soon we were involved in all aspects of ultrasound. There was not enough material for us to read to see the new developments. It was for this reason that excitement in clinical research soared, attracting young physicians throughout the country to develop techniques in diagnostic ultrasound.

Because Dr. Leopold was so intensely interested in ultrasound, it became the diagnostic method of choice for our patients. It was not long before conferences were incomplete without the mention of the technique. Later, local medical meetings and eventually national meetings grew to include discussion of this new modality. A number of visitors were attracted to our laboratory to learn the technique, and thus we became swamped with a continual flow of new physicians, some eager to work with ultrasound and others skeptical at first but believers in the end.

In 1970, the beginning of education progressed slowly, with many laboratories offering a one-on-one teaching experience. Commercial companies thought the only way to push the field was to develop their own national training programs, and thus several of the leading manufacturers were the first to put a dedicated effort into the development of ultrasound.

It was through the combined efforts of our laboratory and commercial interests that I became interested in furthering ultrasound education. Seminars, weekly sessions, local and national meetings, and consultations became a vital part of the growth of ultrasound.

Thus, as ultrasound grew in popularity, more intensified training was desperately needed to maintain the initial quality that the pioneers strived for. Through working with one of the commercial ultrasound companies conducting national short-term training programs, I became acquainted with Barry Goldberg and his enthusiasm for quality education in ultrasound. His organizational efforts and pioneer spirit led me to the east coast to further develop more intensive educational programs in ultrasound. The challenge grew of establishing new programs and continuing education in diagnostic medical sonography in the years to follow as we ventured across the United States and Canada.

INTRODUCING THE NEW FIFTH EDITION

Welcome to the Silver Anniversary Edition of the *Textbook of Diagnostic Ultrasonography*. This fifth edition continues the tradition of excellence begun when the first edition was published in the 1970s. Of course, the textbook has been vastly updated and reorganized over the

years. The field of diagnostic ultrasound has changed so dramatically in the past 40 years that the approach to many procedures has been altered significantly. Phenomenal strides in transducer design, instrumentation, and color flow Doppler have provided increased resolution in the ultrasound image. The introduction of contrast media is becoming more clinically accepted to image the gastrointestinal tract, the female reproductive system, and the multiple vascular pathways in the body. Three-dimensional imaging has provided additional information on the fetus to help the clinician obtain a clearer definition of fine detail.

The primary goal of this textbook continues: to provide an in depth resource for students studying sonography, as well as practitioners in hospitals, clinics, and private radiology, cardiology, and obstetric settings. This new, fifth edition strives to keep up with this fast-moving field, giving students and practitioners not only complete, but also up-to-date information in sonography.

ORGANIZATION

Textbook of Diagnostic Ultrasonography remains divided into two volumes to compensate for its expanded coverage and to make the book more convenient and easier to use. The content has been completely reorganized to provide better flow for the reader. The first volume covers general ultrasound applications, that is, abdominal and retroperitoneal cavities, superficial structures, and pediatrics. Also included in this volume are four chapters on cerebrovascular and peripheral vascular Doppler imaging, as well as two chapters focusing on an introduction to echocardiography with an overview of cardiac pathology. The second volume has been reorganized to primarily focus on obstetrics and gynecology.

Each chapter begins with a list of key terms and definitions to aid the reader. Sonographic concepts continue to be presented in a logical and consistent manner in each chapter. To help the student and the sonographer understand the patient's total clinical picture before the sonographic examination, discussions on anatomy, physiology, laboratory data, clinical signs and symptoms, pathology, and sonographic findings are found within each specific chapter. References cited in the text are listed at the end of each chapter. In addition, review questions are included at the end of each chapter to help the reader measure comprehension of the material.

ILLUSTRATIONS AND VISUALS

The reader will notice colorful illustrations throughout and color within the layout of the chapters. Focus charts highlight important areas throughout both volumes.

To keep up with the continually changing field of ultrasound, hundreds of new images have been incorporated, including many new color Doppler images. *Out of more than 3000 images, approximately 70% are new.* In addition, the multitude of anatomic illustrations have been completely redrawn in color to demonstrate many of the relevant landmarks the sonographer should look for when performing an ultrasound examination.

Ultrasound findings for particular pathologies and conditions are now preceded by the following special head:

Ultrasound findings.

This makes location of these sections easier for both the student and the practicing sonographer.

NEW TO THE FIFTH EDITION

This edition has been completely revised and expanded to offer a comprehensive textbook for the student in general ultrasound. The peripheral vascular chapters are appropriate for the student to understand vascular applications within a general ultrasound department. New chapters have been added on the foundations of sonography; the breast, thyroid, and scrotum and prostate; renal and retroperitoneal areas; high-risk pregnancy; congenital anomalies; fetal head and neural tube defects; and ethics and legal issues in obstetric ultrasound.

Particularly noteworthy is the section on obstetrics and gynecology, which has been completely updated from the excellent work of Kara Mayden Argo and her colleagues in the fourth edition, with several excellent new contributors. The pediatric ultrasound section written by Suzanne Devine and her colleagues from Children's Hospital in Chicago in the last edition has been updated as well. The cerebrovascular and peripheral vascular chapters have been completely revised by Mira Katz. Dr. Elizabeth Glenn has extensively rewritten the chapter on the breast from the focus of a sonographer working within a women's health center.

It is my hope that this textbook will not only introduce the reader to the field of ultrasound, but also go a step beyond to what I have found to be a very stimulating and challenging experience in diagnostic patient care.

Sandra Hagen-Ansert

ACKNOWLEDGMENTS

The author would like to recognize the work of the following individuals on the fourth edition, which allowed a building block to continue for this fifth edition: Kara Mayden Argo, BS, RDMS, RDCS, RTR (obstetrics); Kathleen Bauman, RDMS (neonatal head); Dale Cyr, BS, RDMS (first trimester); Suzanne Devine, RT, RDMS (pediatrics); Kate A. Feinstein, MD (pediatrics); Deborah Levine, MD (gynecologic pathology); Holly D. Lloyd, BS, RDMS (gynecology); Arnold Shkolnik, MD (pediatrics); Laura J. Zuidema, MD; and William J. Zwiebel, MD (liver physiology).

I would like to acknowledge the individual who contributed most to my early interest in diagnostic ultrasound, Dr. George R. Leopold, for his personal perseverance and instruction, as well as for his outstanding clinical research. My thanks also go to the following:

Dr. Sam Halpern, who encouraged me to publish

Dr. Barry Goldberg, for the opportunity to develop training programs in an independent fashion and for his encouragement to stay with it

Drs. Dolores Pretorius, Nancy Budorick, Wanda Miller-Hance, and David Sahn, for their encouragement throughout the years at the UCSD Medical Center

Dr. Daniel Yellon, for his early hour anatomy dissection and instruction in clinical cardiology

Dr. Carson Schneck, for his excellent instruction in gross anatomy and sections of "Geraldine"

Dr. Jacob Zatuchni, for the interest, enthusiasm, and understanding he showed me while at Episcopal Hospital

Dr. Fred Sample, whose quest for the anatomic ultrasound demonstration of the abdomen and pelvis was an inspiration to us all

Dr. Bill Sobotor, for his perseverance for quality and teamwork in the Allied Health curriculum at Baptist College of Health Science

Dr. Thomas Tabb, for his enthusiasm and quest for quality imaging in high-risk obstetrics

Darlene Bak, RDMS, for her support in supplying high-risk obstetric images

Cindy Owen, RDMS, for her support in supplying abdominal and vascular images

Phil Thompson, RDMS, for his support in supplying general ultrasound images

Dr. James Machin, for his support for education in the Diagnostic Medical Sonography program

GE Medical Systems for providing sonograms

For their support, I would like to thank the students I have taught in Diagnostic Ultrasound from the various medical institutions I have been involved with: Episcopal Hospital, Thomas Jefferson University Medical Center, University of Wisconsin, Madison Medical Center, UCSD Medical Center, Baptist College of Health Science, and Trident Technical College, who continually work toward the development of quality ultrasound techniques and instruction.

I would also like to acknowledge and thank the excellent staff at Harcourt Health Sciences, especially Carolyn Kruse, Linda Woodard, Jeanne Robertson, and Jeanne Wilke, all of whom were most patient and enduring for the entire preparation of the manuscript during tornados, multiple relocation moves, and reviewer comments. A special thank you to my production editor, Beth Hayes, whose eye for accuracy and detail has been outstanding in the production of this textbook.

Very special recognition goes to my patient and understanding family, Art, Rebecca, Alyssa, and Katrina, who were usually very tolerant of the hours upon hours of preparation and writing this edition bestowed upon all of our lives. The girls have grown up with these five editions and have volunteered their tiny hearts, and now abdominal vessels, for various illustrations throughout the book. They have vowed never to volunteer again.

CONTENTS

Volume One

Part I FOUNDATIONS OF SONOGRAPHY, 1

- 1** Foundations of Sonography, 3

Part II ABDOMEN, 23

- 2** Anatomic and Physiologic Relationships Within the Abdominal Cavity, 25
- 3** Introduction to Abdominal Scanning Techniques and Protocols, 42
- 4** The Vascular System, 70
- 5** The Liver, 110
- 6** The Gallbladder and the Biliary System, 164
- 7** The Pancreas, 194
- 8** The Gastrointestinal Tract, 225
- 9** The Urinary System, 245
- 10** The Spleen, 308
- 11** The Retroperitoneum, 327
- 12** The Peritoneal Cavity and Abdominal Wall, 347

Part III SMALL PARTS, 359

- 13** The Breast, 361
 - 14** The Thyroid and Parathyroid Glands, 395
 - 15** The Scrotum and Prostate, 408
-

Part IV PEDIATRICS, 429

- 16** Neonatal Echoencephalography, 431
- 17** The Pediatric Abdomen: Surgical Conditions, 460
- 18** The Neonatal Kidneys and Adrenal Gland, 469

Part V VASCULAR, 481

- 19** Extracranial Cerebrovascular Evaluation, 483
- 20** Intracranial Cerebrovascular Evaluation, 495
- 21** Peripheral Arterial Evaluation, 515
- 22** Peripheral Venous Evaluation, 531

Part VI CARDIOLOGY, 549

- 23** Anatomic and Physiologic Relationships Within the Thoracic Cavity, 551
- 24** Echocardiographic Evaluation and Techniques, 563

Volume Two

Part VII FOUNDATIONS OF OBSTETRIC SONOGRAPHY, 587

- 25** The Role of Ultrasound in Obstetrics, 589
- 26** The Normal First Trimester, 595
- 27** Sonography of the Abnormal First-Trimester Pregnancy, 609
- 28** Ultrasound of the Second and Third Semesters, 623

- 29** Obstetric Measurements and Gestational Age, 662
- 30** Fetal Growth Assessment by Ultrasound, 674
- 31** Ultrasound and High-Risk Pregnancy, 686
- 32** Prenatal Diagnosis of Congenital Anomalies, 708
- 33** Clinical Ethics for Obstetric Sonography, 726

Part VIII FETAL ANATOMY, 731

- 34** The Placenta, 733
- 35** The Umbilical Cord, 750
- 36** The Amniotic Fluid and Membranes, 762
- 37** The Fetal Head and Neural Tube Defects, 774
- 38** The Fetal Face and Neck, 797
- 39** The Fetal Thorax, 814
- 40** Fetal Echocardiography, 827
- 41** The Fetal Anterior Abdominal Wall, 869

- 42** The Fetal Abdomen, 882
- 43** The Fetal Genitourinary System, 897
- 44** The Fetal Skeleton, 918

Part IX GYNECOLOGY, 933


- 45** Normal Anatomy and Physiology of the Female Pelvis, 935
- 46** Embryogenesis and Pediatric and Congenital Anomalies, 948
- 47** The Sonographic Evaluation of the Female Pelvis, 953

Part X GYNECOLOGIC PATHOPHYSIOLOGY, 973

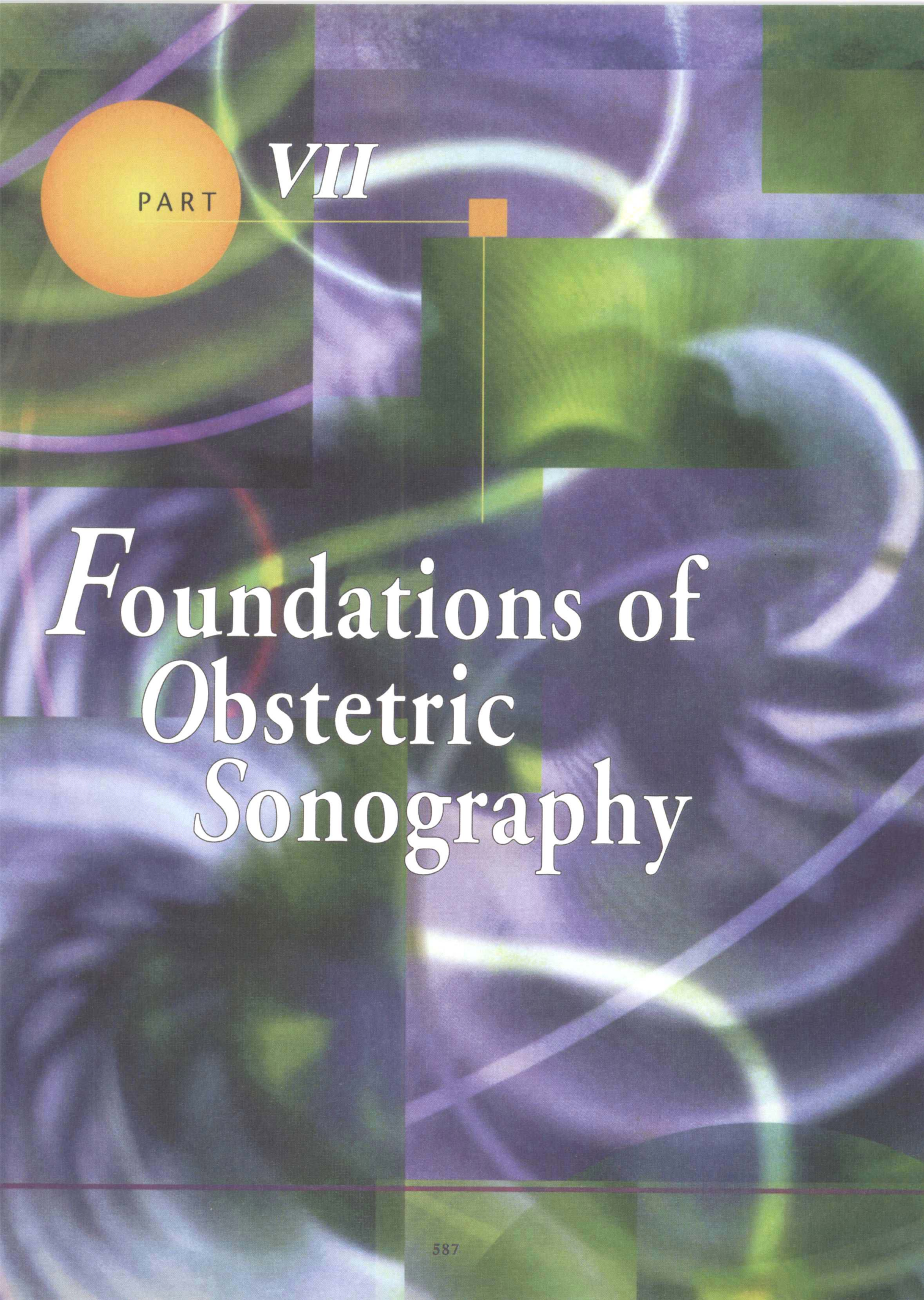
- 48** Pelvic Infections and Inflammatory Disease, 975
- 49** Uterine Anomalies, 984
- 50** Ovarian Anomalies, 998
- 51** Ultrasound Evaluation of Gestational Trophoblastic Disease, 1015

GLOSSARY, 1020

VOLUME TWO



*T*extbook *U*_{of} *D*iagnostic Ultrasonography



PART

VII

Foundations of Obstetric Sonography

The Role of Ultrasound in Obstetrics

Sandra L. Hagen-Ansert

OBJECTIVES

- List at least 10 indications for obstetric ultrasound examination
- List maternal risk factors that increase the chances of producing a fetus with congenital anomalies
- Recount four important questions to ask the patient before beginning the obstetric ultrasound examination
- Describe the biologic effects of ultrasonography
- Describe the four steps of the first-trimester sonography protocol
- Describe the six steps of the second- and third-trimester sonography protocol

RECOMMENDATIONS FOR OBSTETRICS AND GYNECOLOGIC ULTRASOUND

MATERNAL RISK FACTORS

PATIENT HISTORY

THE SAFETY OF ULTRASOUND

SAFETY OF DOPPLER IN THE OBSTETRIC PATIENT

GUIDELINES FOR ANTEPARTUM OBSTETRIC ULTRASOUND EXAMINATION

FIRST TRIMESTER

SECOND AND THIRD TRIMESTERS

REVIEW QUESTIONS

KEY TERMS

abruptio placenta - bleeding from a normally situated placenta causing its complete or partial detachment after the twentieth week of gestation

amniocentesis - aspiration of a sample of amniotic fluid through the mother's abdomen for diagnosis of fetal maturity and/or disease by assay of the constituents of the fluid

amnion - smooth membrane enclosing the fetus and amniotic fluid; it is loosely fused with the outer chorionic membrane

anencephaly - absence of the brain; the cerebellum and basal ganglia may be present

cervix - inferior segment of the uterus; more than 3.5 cm long during normal pregnancy, decreases in length during labor

chorion - cellular, outermost extraembryonic membrane, composed of trophoblast lined with mesoderm; it develops villi about 2 weeks after fertilization, is vascularized by allantoic vessels a week later, gives rise to the placenta, and persists until birth

corpus luteum - yellow body formed from the Graafian follicle after ovulation that produces estrogen and progesterone

ductus venosus - fetal vein that connects the umbilical vein to the inferior vena cava and runs at an oblique axis through the liver

embryo - conceptus to the end of the ninth week of gestation

gestational age - gestational age since the date of conception

gestational sac - structure that is normally within the uterus that contains the developing embryo

hydatidiform mole - condition in which there is partial or complete conversion of the chorionic villi into grapelike vesicles; villi are avascular and there is trophoblastic proliferation; condition may result in malignant trophoblastic disease

incompetent cervix - cervix dilates silently during the second trimester with the result that the membranes bulge and rupture and the fetus drops out

intrauterine growth restriction (IUGR) - abnormal growth pattern of the fetus; usually small abdomen compared with other growth parameters

lower uterine segment - thin expanded lower portion of the uterus that forms in the last trimester of pregnancy

macrosomia - exceptionally large infant with fat deposition in the subcutaneous tissues; seen in fetuses of diabetic mothers

oligohydramnios - insufficient amount of amniotic fluid

placenta - organ of communication (nutrition and products of metabolism) between the fetus and the mother; forms from the chorion frondosum with a maternal decidua contribution

placenta previa - placental implantation encroaches upon the lower uterine segment; the placenta comes first and bleeding is inevitable

polyhydramnios - excessive amount of amniotic fluid (>20 cm)

trimester - pregnancy is divided into three 13-week periods

umbilical cord - connecting lifeline between the fetus and placenta; it contains two umbilical arteries and one umbilical vein encased in Wharton's jelly

yolk sac - circular structure seen between 4 and 10 weeks that supplies nutrition to the fetal pole (the developing embryo); it lies within the chorion outside the amnion

Ultrasound has become one of the primary tools used by the obstetrician to evaluate the developing fetus during pregnancy. Obstetric ultrasound allows the clinician to assess the development, growth, and well-being of the fetus. When an abnormal condition is recognized prenatally, obstetric management may be altered to provide the best care for the fetus and child.

The sonographer performing fetal studies should understand both sonographic and obstetric principles. This allows the sonographer to accurately and thoroughly compile pertinent information to provide a complete assessment of the fetus. This profile includes anatomic and biometric analyses.

This chapter describes the medical indications for obstetric ultrasound examinations; reviews guidelines for scanning as outlined by the American College of Radiology (ACR), the American Institute of Ultrasound in Medicine (AIUM), and the American College of Obstetricians and Gynecologists (ACOG); and describes the risk factors associated with congenital fetal anomalies.*

RECOMMENDATIONS FOR OBSTETRIC AND GYNECOLOGIC ULTRASOUND

There are recommended indications for obstetric ultrasound examinations. The sonographer should be aware of the indications for ultrasound and should understand the medical complications associated with maternal disease states during pregnancy. This knowledge helps determine appropriate scanning techniques based on the specific in-

dication for the study and the clinical history of the mother.

The indications for obstetric and gynecologic studies as detailed by the National Institute of Child Health and Human Development and National Institutes of Health Consensus Report on Safety of Ultrasound are as follows⁶:

1. Estimation of **gestational age** for patients with uncertain clinical dates or verification of dates for patients who are to undergo scheduled elective repeat cesarean delivery, indicated induction of labor, or other elective termination of pregnancy. Ultrasonographic confirmation of dating permits proper timing of cesarean delivery or labor induction to avoid premature delivery.
2. Evaluation of fetal growth, for example, when the patient has an identified etiology for uteroplacental insufficiency, such as severe preeclampsia, chronic hypertension, chronic renal disease, or severe diabetes mellitus, or for other medical complications of pregnancy in which fetal malnutrition (e.g., **intrauterine growth restriction [IUGR]** or **macrosomia**) is suspected. Following fetal growth permits assessment of the impact of a complicating condition of the fetus and guides pregnancy management.
3. Vaginal bleeding of undetermined etiology in pregnancy. Ultrasound often allows determination of the source of bleeding and status of the fetus.
4. Determination of fetal presentation when the presenting part cannot be adequately determined in labor or the fetal presentation is variable in late pregnancy. Accurate knowledge of presentation guides management of delivery.
5. Suspected multiple gestation based on detection of more than one fetal heart beat pattern, fundal height larger than expected for dates, or prior use of fertility drugs. Pregnancy management may be altered in multiple gestation.
6. Adjunct to **amniocentesis**. Ultrasound permits guidance of the needle to avoid the **placenta** and fetus, to increase the chance of obtaining amniotic fluid and to decrease the chance of fetal loss.
7. Significant discrepancy between uterine size and clinical dates. Ultrasound permits accurate dating and detection of such conditions as oligohydramnios and polyhydramnios, as well as multiple gestation, IUGR, and anomalies.
8. Pelvic mass detected clinically. Ultrasound can detect the location and nature of the mass and aid in the diagnosis.
9. Suspected **hydatidiform mole** on the basis of clinical signs of hypertension, proteinuria, or the presence of ovarian cysts felt on pelvic examination or failure to detect fetal heart tones with a Doppler ultrasound device after 12 weeks. Ultrasound permits accurate diagnosis and differentiation of this neoplasm from fetal death.
10. Adjunct to cervical cerclage placement. Ultrasound aids in timing and proper placement of the cerclage for patients with **incompetent cervix**.
11. Suspected ectopic pregnancy or when pregnancy occurs after tuboplasty or prior ectopic gestation. Ultrasound is a valuable diagnostic aid for this complication.
12. Adjunct to special procedures such as cordocentesis, intrauterine transfusion, shunt placement, in vitro fertilization, embryo transfer, or chorionic villi sampling. Ultrasound aids instrument guidance that increases the safety of these procedures.

*ACR: www.ACR.org; AIUM: www.AIUM.org; ACOG: www.ACOG.org.