Diagnostic Radiology

An Anglo-American Textbook of Imaging

VOLUME THREE

EDITED BY
Ronald G. Grainger

David J. Allison

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Diagnostic Radiology

Preface

This completely new, authoritative, Anglo-American, integrated text of organ imaging is designed to help the radiologist throughout the various stages of his professional career. It is particularly orientated towards the radiological trainee, resident or registrar and to facilitate this purpose many of the contributing authors have had experience as examiners for the American Boards, Royal College of Radiologists and other examining bodies. For the trainee, a rather didactic style has been adopted, the examination syllabi have been covered and special attention has been paid to favourite examination topics. An additional Multiple Choice Question volume based on this textbook is in an advanced stage of preparation.

This book is also designed for the working bench in the reading (reporting) room and is well illustrated and indexed to facilitate rapid reference to the appropriate subject. Each chapter carries an extensive updated bibliography and a further list of classic papers and monographs to encourage further reading, should more detail be required. It is therefore hoped that these volumes will continue to serve as an illustrated text and as an entry to the literature, long after the early formal years of radiological training.

We believe that this is the first attempt at producing a comprehensive and integrated text of the several modalities of organ imaging, written by a large and distinguished international group of teachers, authors, practitioners and research workers. About one half of the contributors are from either side of the Atlantic, equal prominence being given to American and British practice.

Probably no field of medicine is advancing so rapidly at the present time as organ imaging. The last 10–15 years have seen the introduction and development of completely new technologies such as computer assisted tomography, digital imaging, isotope studies, ultrasound and magnetic resonance imaging. All of these and other techniques are discussed in this book, both in separate and specific technical chapters written by recognized authorities, and also by integration with conventional radiology in the general text where appropriate. Despite the great success of the alternative systems of organ imaging, conventional film radiology remains the major system in Departments of Radiology in the mid-1980s and this is reflected by the emphasis given in this text.

Radiology has become increasingly interventional and therapeutic as well as diagnostic, and good coverage of these procedures is presented by internationally acknowledged practising experts.

Imaging technology is developing so rapidly and so expensively that the major problems are those of providing the finances for the necessary technical and clinical developments, and in selecting the optimal imaging technique. As Dr Margulis points out in the opening chapter, the allocation of the necessary finance and resources is a matter for society in general, and for the medical profession in particular.

The editors wish to thank the Section and Advisory Editors and all of the many contributors to this work for their conscientious collaboration despite the many other demands on their valuable time and expertise.

We wish to thank Dr Anne Hemingway, Dr C. R. Merrill and Dr A. Adam for their major assistance in preparing the text for publication and in proof-reading, our secretaries Ms N. Moorcraft, Mrs V. Morris, Miss H. Pybus, Miss S. Smith and Mrs Y. Steel for typing and organisational assistance, and the photographic and illustration departments of our hospitals for their ever-willing and high-quality contributions.

Sheffield and London
1986

R.G.G.
D.J.A.

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Anyone who has participated in writing or publishing a book will know that the project is not viable without the co-operation and contributions of very many people.

To publish a completely new integrated textbook of a rapidly changing subject in which major technological advances are being made every year, with over 100 authors, writing in two different languages (American English and British English), with over 2000 pages and several thousand illustrations is absolutely impossible without the help, support, co-operation and advice of an army of several hundred people involved in the writing, illustrating, typing, editing, designing, typesetting, proofreading, printing, etc., etc.

It is obviously impossible to thank individually in print everyone who has endeavoured to secure the success of this book. The editors and publishers wish most sincerely to thank them collectively for the magnificent co-operation which we have received throughout this major project over its 5-year gestation.

The editors are particularly grateful to the Fleischner Society for permission to publish, at the end of Section Two, the 'Glossary of "Chest" Radiological Terms' suggested by their Terminology Committee.

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This work is dedicated
with our love
to

our dear wives

Ruth *Deirdre*

and
our dear children

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SECTION

8

The Female Reproductive System

Editor: Ronald G. Grainger

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80 Obstetrics

A. C. Fleischer, F. H. Boehm, A. C. Winfield, J. Millis, M. I. Shaff, A. E. James and J. Gibbs

Obstetric sonography

Sonographic imaging has, and will continue to have, one of its most significant impacts in medicine in the field of obstetrics (see suggestions for further reading). This chapter will emphasize the most common applications of diagnostic sonography in obstetrical disorders (Table 80.1). Other less frequently employed radiographic procedures such as amniography and pelvimetry will also be mentioned.

Table 80.1 Indications for obstetric sonography

A. *General*
1. Estimate gestational duration (menstrual age)
2. Confirm presence of intrauterine pregnancy and viability
3. Localization and textural evaluation of placenta
4. Detection of multiple gestation
5. Evaluation of pelvic masses occurring during pregnancy
6. Detection of certain anatomical and functional anomalies of the fetus

B. *First trimester*
1. Evaluation of uterine bleeding occurring in first trimester
2. Evaluation for suspected blighted ovum, threatened, incomplete or missed abortion
3. Distinguish intrauterine from ectopic pregnancy (combined with laboratory determinations)
4. Evaluation for suspected molar pregnancy
5. Confirm pregnancy associated with intrauterine contraceptive device

C. *Second trimester*
1. Localization and evaluation of the placenta prior to amniocentesis
2. Evaluation of fetal growth
3. Detection and differentiation of disorders associated with abnormal amounts of amniotic fluid

D. *Third trimester*
1. Confirm or exclude presence of placenta praevia
2. Determination of optimal time and mode of delivery

E. *Maternal disorders occurring during pregnancy*
1. Evaluation for suspected calculus cholecystitis
2. Evaluate for suspected pancreatitis
3. Evaluate for suspected hydro- or pyonephrosis of pregnancy
4. Evaluate for suspected ascites
5. Screening for large vascular aneurysms

F. *Postpartum*
1. Evaluation for retained products of conception

Scanning methods and patient preparation

Two general types of scanning devices are available for the obstetric patient; (a) scanners that have the transducer mounted on an articulated arm that produce '*static*' images, and (b) those scanning devices, that by their immediate processing of data, allow dynamic depiction of structures, called '*real-time*' scanners. Articulated arm scanners are valuable in that a series of tomographic images allows for a global depiction of the area of interest. The images obtained with a real-time scanner depict only a relatively limited region of interest at any one time. Real-time imaging allows for flexible imaging of structures within the body, due to its dynamic portrayal of regions of interest and its capability to alter the scanning plane.

A series of static images may augment the real-time examination when an overall appreciation of a large area of interest or structure is desired. For example, precise localization of the placenta may require serial tomographic static images. Because the field of view is limited in some real-time scanners, an articulated arm scanner is usually needed for an assessment of uterine size, e.g. for total intrauterine volume calculation. Static scanning is also helpful in evaluation of possible fetal anomalies since it can 'map out' regions of the fetus in a tomographic manner.

There are several types of transducer configurations for real-time scanners. *Linear array transducers* allow depiction of a large region of interest but have limited manipulative flexibility due to the relatively large size of the transducer head. The smaller scanning surface of the *mechanical sector real-time devices* allows more flexibility and is the preferred method of real-time examination in the first trimester, for pelvic masses that are present during pregnancy, and for some congenital anomalies.

Real-time scanning can be documented by multiple still frames with recording of selected views on a multi-image format camera, or by videotape recording. We prefer recording of certain routine 'views' on transparent film and only use videotaping in difficult and/or unusual cases. Videotaping is usually necessary when a moving structure such as the heart is being studied, or to document lack of fetal heart motion in intrauterine fetal demise.

Distension of the urinary bladder is most important in evaluating the patient in the first trimester and those patients who are suspected of having a placenta praevia. This is best accomplished by having the patient drink 250 to 350 ml of water or tea approximately 45 minutes prior to the examination. If the patient is under fluid intake restriction, distension of the urinary bladder can be achieved by intravenous administration of fluid or by introduction of a Foley catheter into the bladder, but the latter involves a slight risk of ascending infection. Distension of the urinary bladder displaces gas containing bowel out of the pelvis and, most important, brings the anteflexed uterus perpendicular to the incident beam which allows better depiction of the uterine texture by utilizing the axial resolution properties of the scanning device.

After the second trimester, and if a placenta praevia is not suspected clinically, we do not require the patient to be scanned with a fully distended bladder. If a low lying placenta is encountered on the initial scans, additional examinations can be performed utilizing the full bladder technique.

GENERAL APPLICATIONS THROUGHOUT PREGNANCY

Date-size discrepancy or unknown dates

One of the most frequent indications for sonography in obstetrics is to estimate gestational age, which is usually expressed from the first day of the last menstrual cycle (menstrual age). This problem is most frequently encountered in the patient who cannot accurately recollect her last menstrual period, has recently discontinued ovulation suppression contraception, who may have not had a regular menstrual cycle or may not have been menstruating, (such as patients who were breast feeding). Estimation of gestational duration during the first trimester of pregnancy can be achieved by sonography (Fig. 80.1) by recognition and/or measurement of certain anatomic structures and features characteristic of an early pregnancy (Table 80.2).

Table 80.2 Sonographic developmental features in pregnancy

Weeks (± 2 weeks)	Feature
3–4 weeks	Rim of choriodecidual tissue surrounding gestational sac
4–5 weeks	Chorion frondosum develops
5–6 weeks	Embryo, umbilical stalk, yolk sac identifiable
6–8 weeks	Fetal heart motion discernible by real-time scanning
10 weeks to term	Biparietal diameter measurable
12–27 weeks	Placental growth maximal
25–36 weeks	Uterine growth maximal
20 weeks to term	Major fetal viscera discernible

These features are discussed and illustrated in more detail in the section concerning normal sonographic features of the first trimester. Since differentiation and development of the major fetal organs occur between 9 and 15 weeks, we recommend restricting scan time to the minimum [1]. Although there is little evidence, it is possible that ultrasound may harm the developing fetus.

The choriodecidua forms an echogenic ring around the gestational sac at 3 to 4 weeks of pregnancy (Fig. 80.1B). At about 5 weeks of pregnancy, the choriodecidua becomes localized, forming the chorion frondosum (Fig. 80.1C) which appears as a localized echogenic region around the gestational sac. At approximately 6 to 7 weeks, the developing embryo as well as the umbilical stalk and yolk sac may be identified within the gestational sac adjacent to the chorion frondosum (Fig. 80.1D). From 8 to 12 weeks, an estimation of the length of the fetus (crown to rump length) can be used to assess accurately gestation duration (Table 80.3 & Fig. 80.1E). Estimation of gestational age by fetal length is accurate to within plus or minus 1 week. This anatomical method of 'dating' the pregnancy is preferable to measurement of gestational sac size alone since that par-