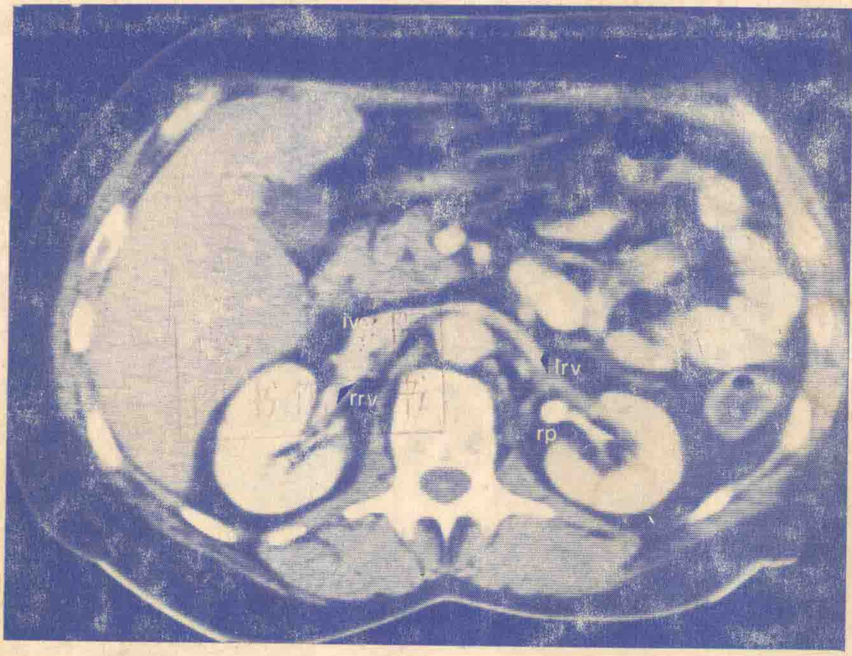
ABDOMINAL C. T.

A Source for Resident and Clinician



RICHARD A. SORGEN, M.D.

ROBERT D. RUSSO, JR., M.D.

ABDOMINAL C.T.

A Source for Resident and Clinician

By

RICHARD A. SORGEN, M.D.

Fellow in CT
Department of Radiology
St. Vincent's Medical Center
Bridgeport, Connecticut

and

ROBERT D. RUSSO, JR., M.D.

Director, CT Scan Division
Department of Radiology
St. Vincent's Medical Center
Bridgeport, Connecticut

WARREN H. GREEN, INC.

St. Louis, Missouri, U.S.A.

Published by

WARREN H. GREEN, INC.
8356 Olive Boulevard
St. Louis, Missouri 63132, U.S.A.

ISBN No. 87527-289-4

Printed in the United States of America

ABDOMINAL C.T.

To the memory of

Esther Lorraine Sorgen

INTRODUCTION

Revolution, whether well-planned or surprised, has a powerfully unsettling effect on the parties involved. Computerized axial tomography has settled upon the field of Radiology with such force that the everyday practice of Radiology has been changed significantly. Often quoted as the "revolutionary diagnostic tool of this century" or the "greatest radiological invention since the discovery of x-ray by Roentgen and Curie," the scanner has constantly been in controversy, not only from a medical standpoint, but from a health-planning arena, as well. Medical efficacy and the changes in practice algorithms have been argued and debated for the seven short years that CT has been in clinical operation. With the award of the Nobel Medicine Prize, certain aspects have calmed.

The introduction of CT scanning into a general Radiology practice has greatly enlarged the diagnostic scope of the practice of Radiology. Images are now obtained in an axial plane, and the difficulties with contrast solution have been greatly overcome. In the past, it has been difficult to separate contrast densities on conventional radiographs. The computer programs involved in CT have now brought contrast resolution into clinical application. Although CT scanning does not match the spatial resolution of conventional radiography, the compromise is more than acceptable due to the increases in contrast resolution. Difficult areas to study in the past have been elucidated by CT. Such areas as the pancreas, retroperitoneum, portis of the liver, and splenic hilar structures are now readily studied.

We all wish that the expense of purchasing CT scanners can be decreased, as they are invaluable to patient management. We find the discussions of cost controls, which have unfortunately been centered around these instruments, a compromising of patient care. The everyday practice of Radiology now involves the intimate use of CT scanning, and many centers have found great difficulty without accessibility to CT scanning. We look forward to further developments in scanning, such as dynamic flow studies and gated imaging. The horizon of providing physiological as well as anatomical data is rapidly approaching. The blending in of CT examinations in the overall diagnostic work-up is increasing on a daily basis. We have not advocated set algorithms yet, in CT scanning, as the evolution in clinical application is ever-changing. The displacement and even replacement of other images by CT have been gradual, and efficacy studies are needed in controlled environments.

Our intent in writing this book has been to illustrate, through our own case material, the variety of pathologic conditions of the abdomen that may be portrayed by computerized tomography. An historical review of the development of CT is followed by an explanation of its physical principles. We then outline our technique for performing an abdominal CT scan.

We have chosen to divide our book by organ system, rather than clinical problem (i.e., "mass," "jaundice," "pain in right upper quadrant"). Each chapter reviews normal CT anatomy, then discusses the spectrum of clinical entities CT may portray. The final portion of each section is a mini-atlas of cases pertaining to that organ system.

We hope that our effort will be instructive to both medical students and residents as a review of normal anatomy and pathologic states in the abdomen. We also hope that the clinician will gain a broader understanding of CT's capability in abdominal disease. The scans that are illustrated in the text are taken on a CT/T 8800 General Electric Whole Body Scanner.

ACKNOWLEDGMENTS

The authors are grateful to Mrs. Eileen Roberts, Mrs. Maria Dell'Olio Roberts and Ms. Christine Scianna for their splendid secretarial efforts.

The high quality of the scans reflects the fine work of the members of our CT Department, including Mrs. Pam Buckingham, Mrs. Sue Jamroz, Mr. James Lukacsy, Ms. Janice Mooney and Mr. Michael Stevko.

To Mr. Harry Hirsch, we extend our thanks for the excellence of his photography.

We would like to acknowledge three special people whose influence pervades these pages: Dr. Robert D. Russo, Sr., Chairman of the Department of Radiology at St. Vincent's Medical Center, Bridgeport, Connecticut—for his support and inspiration; Dr. Joel S. Albert—for his kind guidance; and Susan Sorgen—for her love and companionship.

R.A.S.
R.D.R.

CONTENTS

ABDOMINAL C.T.

HISTORICAL REVIEW

Since the early days of Drs. Cormack and Hounsfield in the 1960's, CT scanning has become a dramatic and now a dynamic tool in imaging. Computerized tomography itself is an x-ray system using a computer to refine an image through a tomographic plane. The reconstruction of the image by the computer allows for finer detail in an axial projection, which has not previously been available with the resolution otherwise obtained. The image itself is a checkerboard matrix based on the absorption and attenuation coefficient of a gamma x-ray beam. The original units were constructed at EMI, Ltd. Research Labs in England and used in their first clinical application. These more primitive units were head scanners and were soon followed in this country by body scanning, developed by Dr. Ledley of Georgetown Medical Center. The early works of body scanning were published in the mid 1970's. Drs. Hounsfield and Cormack shared the Nobel Prize for Medicine in 1979 because of their outstanding achievements in this line of work.

EQUIPMENT

Computerized tomography (CT, or computerized axial tomography, CAT) is an x-ray source technology using a transmission tube and a computer analog system to provide a digital image. There are newer fields of research in emission CT scanning; however, they are not fully developed enough at this time to be included in this edition.

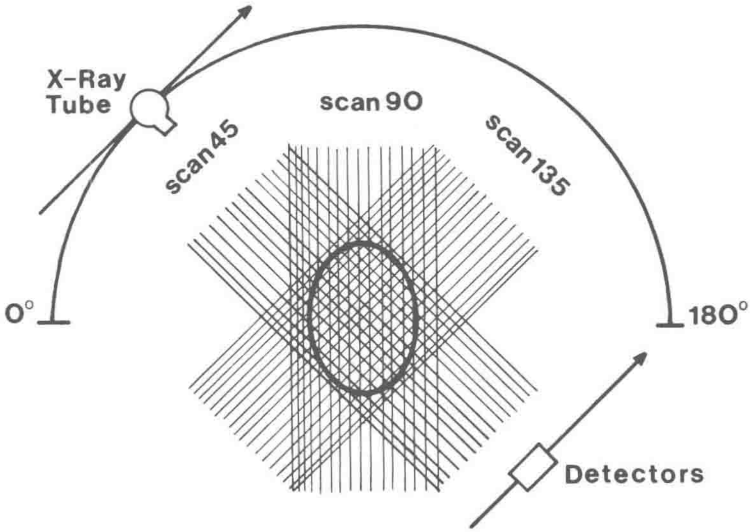
The basic components of a scanner are divided into the patient care area, computerized system, and viewing station. The patient sees a gantry and motorized table upon which he/she is placed. The gantry has a central portal through which the patient passes on the motorized table. It is easily determined what increments the patient will take going through the table with various scanning equipment going anywhere from 1½ mm to 30 mm. Most gantries are now capable of taking a digital rough x-ray, which allows for more formal localizations than the previous models were able to obtain. This digital x-ray acts as a matrix for guidance in determining the starting and ending point of a particular procedure. It also allows for gantry angulation in order to conform with the anatomical planes for such procedures, as scanning through a disc space. Disc spaces do not always lie perpendicular to the table, and the gantry can be angled in such a fashion to match the angle of the disc space. The computer systems themselves are basic digital "number crunching" systems, which allow massive amounts of data collected through the gantry detector system to be displayed and understood by a viewing physician. The information put into the computers comes from a detecting system enclosed within the gantry, and is simple digital material. The third basic component is a viewing system which has both a display module and computer software programs, which allow for manipulation of the collected data and processing the desired images. Most viewing consoles also have some sort of data storage and retrieval systems.

THE GANTRY

All CT scanners use an x-ray tube source, which is filtered and collimated to provide uniformity to the gamma x-ray beam. The beam is directly opposite the detectors, which may lie either in a semicircle, flat projection, or singularly on the opposite side of the portal. The detectors themselves can be solid state, such as sodium iodide crystals, or in the gaseous state, such as xenon tubes. The different configurations and rotations of the detectors and the tubes are used in the judgement of generations of equipment. Although in the past this was a simple procedure, the amount of sophistication in alignment and detecting units has made the simple breakdown into four generations somewhat difficult. A rough outline is offered.

FIRST GENERATION

Fig. I is a schematic to show the simple pencil beam and single detector system used on the first generation scanners. The source and detector are moved across the patient while readings of attenuation and absorption are obtained. The x-ray tube and the detector unit are moved as one and rotated slowly through angular increments. The united unit is then moved rotationally, and the process repeated. The major drawback is the four to six minutes it takes for the completed process and the image distortion that follow.

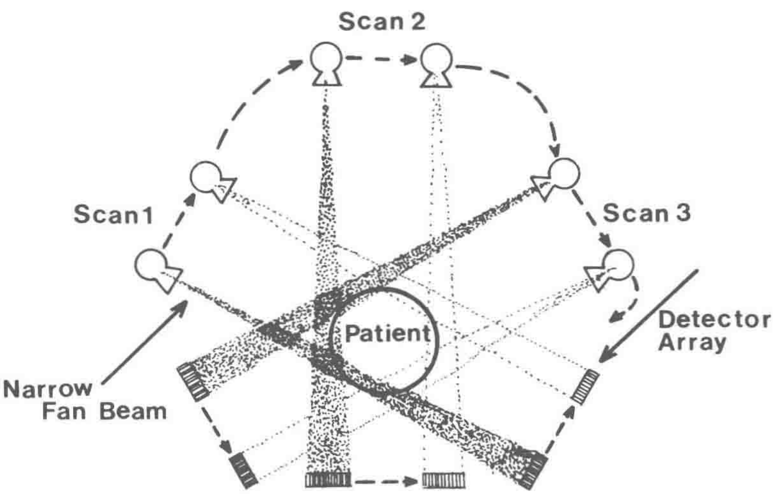


First Generation Scanner
Original EMI Unit

FIGURE I: © *An Introduction to the Physics of Diagnostic Radiology.* Christensen, Edward E. *et al.*, 1978

SECOND GENERATION

Fig. II shows the tube and detector system of a second generation scanner in schematic form. The original models were updated with several pencil beams, which were generated from a single x-ray source and now, rather than being directed into a single detector, are directed into a row of detectors. This combination of pencil beams and detectors are then rotated about the object to be scanned. As in the previous generation, the x-ray tube and detectors move in a fixed unit and rotate with successive translation. Although this cuts down on the amount of time by decreasing the number of increment steps, it is still time-consuming and dependent upon the number of detectors. Its greatest drawback is the fact that the spatial resolution remains the same as the first generation. The decreased time from four to six minutes, on the average, to 20 seconds does eliminate several physiological motions.



Second Generation Scanner

FIGURE II: © *An Introduction to the Physics of Diagnostic Radiology.* Christensen, Edward E. *et al.*, 1978