英文原版

Bragg Rubin Hricak

肿瘤影像学

Oncologic Imaging

SECOND EDITION

人民卫生出版社

Health Science Asia, Elsevier Science

Oncologic Imaging

Second Edition

David G. Bragg, M.D.
Emeritus Professor of Radiology
University of Utah School of Medicine
Salt Lake City, Utah

Philip Rubin, M.D.
Professor, Department of Radiation Oncology
University of Rochester Cancer Center
School of Medicine and Dentistry
Rochester, New York

Hedvig Hricak, M.D., Ph.D.
Chairman, Department of Radiology,
Carroll and Milton Petrie Chair
Memorial Sloan-Kettering Cancer Center
Professor of Radiology
Cornell University
New York, New York

Ann Muhs, Technical Editor

人民卫生出版社
Health Science Asia, Elsevier Science

人民卫生出版社
Health Science Asia, Elsevier Science

Oncologic Imaging
Original English Language Edition, 2002

图书在版编目(CIP)数据

肿瘤影像学 /(美)布拉格著．—影印本．—北京：人民卫生出版社，2002

ISBN 7-117-04920-0

Ⅰ.肿… Ⅱ.布… Ⅲ.肿瘤－影像诊断－英文
Ⅳ.R730.4

中国版本图书馆 CIP 数据核字（2002）第 024019 号

图字：01-2002-1964

肿 瘤 影 像 学（英文版）

原　　著：David G.Bragg, M.D.
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：三河市宏达印刷有限公司
经　　销：新华书店
开　　本：889×1194 1/16　**印张**：62.5　**插页**：12
字　　数：2749 千字
版　　次：2002年8月第1版　2002年8月第1版第1次印刷
标准书号：ISBN 7-117-04920-0/R · 4921
定　　价：191.00元

Oncologic Imaging

Contributors

Carol L. Andrews, M.D.
Assistant Professor in Residence, University of California; Los Angeles, School of Medicine, Los Angeles, California
Metastatic Bone Disease

Susan M. Ascher, Ph.D.
Professor, Georgetown University Medical Center; Director, Abdominal Imaging, Georgetown University Medical Center, Washington, DC
Cancer of the Adnexal Organs

N. Cem Balci, M.D.
Head, Department of Abdominal Imaging, Florence Nightingale Hospital, Istanbul, Turkey
Tumors of the Bladder and Urethra

Minerva Becker, M.D.
Division of Diagnostic Radiology, University Hospital Geneva, Geneva, Switzerland
Carcinoma of the Larynx

George S. Bisset III, M.D.
Professor of Radiology and Pediatrics, Vice Chairman, Department of Radiology, and Director, Section of Pediatric Radiology, Duke University Medical Center and Health System, Durham, North Carolina
Section Editor—Pediatrics

Scott M. Boles, M.D.
San Diego Diagnostic Radiology, San Diego, California
Carcinoma of the Cervix and Endometrium

David G. Bragg, M.D.
Emeritus Professor of Radiology, University of Utah School of Medicine, Salt Lake City, Utah
Imaging Strategies for Oncologic Staging, Diagnosis, and Multidisciplinary Treatment; Primary Malignancies of the Thorax; Chest Wall; Lymphomas and the Lymphoproliferative Disorders
Senior Editor and Section Editor—The Thorax and Lymphoproliferative Neoplasms

R. James Brenner, M.D., J.D.
Clinical Professor of Radiology, University of California, Los Angeles, School of Medicine, Los Angeles; Director, Breast Imaging, John Wayne Cancer Institute, Joyce Eisenberg Keefer Breast Center, Saint Johns Health Center, Santa Monica, California
Interventional Procedures of the Breast

Chandra M. Burman, Ph.D.
Associate Attending Physicist, Department of Medical Physics, Memorial Sloan-Kettering Cancer Center, New York, New York
Three-Dimensional and Conformal Treatment Planning

Susan Chang, M.D.
Associate Professor in Residence, University of California, San Francisco, School of Medicine, San Francisco, California
Brain and Spinal Cord Tumors

Chusilp Charnsangavej, M.D.
Professor of Radiology, Radiologist, and Deputy Division Head for Research, University of Texas M. D. Anderson Cancer Center, Houston, Texas
Cancer of the Liver, the Biliary Tree, and the Pancreas

George T. Y. Chen, Ph.D.
Professor, Department of Radiation Oncology, Harvard Medical School; Director of Radiation Biophysics Division, Department of Radiation Oncology, Massachusetts General Hospital, Boston, Massachusetts
Image Processing and Integration in Oncologic Imaging

Gang Cheng, Ph.D.
Research Associate, Department of Radiation Oncology, University of Rochester, Rochester, New York
Image-Guided Brachytherapy

Cynthia T. Chin, M.D.
Assistant Clinical Professor of Radiology, Neuroradiology Section, University of California, San Francisco, School of Medicine, San Francisco, California
Brain and Spinal Cord Tumors

Vincent F. H. Chong, M.D.
Senior Consultant, Department of Diagnostic Radiology, Singapore General Hospital, Singapore
Malignancies of the Nasopharynx and Skull Base; Malignancies of the Oral Cavity, Oropharynx, and Hypopharynx

Chen-Shou Chui, Ph.D.
Associate Professor, Department of Radiology, Cornell University Medical School; Associate Attending Physicist, Department of Medical Physics, Memorial Sloan-Kettering Cancer Center, New York, New York
Three-Dimensional and Conformal Treatment Planning

D. David Dershaw, M.D.
Professor of Radiology, Weill College of Medicine of Cornell University; Director, Breast Imaging Section, Department of Radiology, Memorial Sloan-Kettering Cancer, New York, New York
Breast Cancer

William P. Dillon, M.D.
Professor of Radiology, Neurology, and Neurosurgery and Chief, Section of Neuroradiology, University of California, San Francisco, Medical Center, San Francisco, California
Brain and Spinal Cord Tumors
Section Editor—Brain, Spinal Cord, Head and Neck

Lane F. Donnelly, M.D.
Associate Professor of Radiology and Pediatrics, University of Cincinnati College of Medicine; Staff Radiologist, Department of Radiology, Children's Hospital Medical Center, Cincinnati, Ohio
Tumors of the Pediatric Gastrointestinal Tract

N. Reed Dunnick, M.D.
Fred Jenner Hodges Professor and Chair, Department of Radiology, University of Michigan Health System, University of Michigan, Ann Arbor, Michigan
Tumors of the Adrenal Gland and Kidney

Steven C. Eberhardt, M.D.
Clinical Assistant Radiologist, Memorial Sloan-Kettering Cancer Center, New York, New York
Cancer of the Prostate

Gregory K. Edmundson, M.Sc.
Staff Physicist, William Beaumont Hospital, Department of Radiation Oncology, Royal Oak, Michigan
Interventional Techniques in Radiation Oncology to Optimize the Delivery of Therapy

John C. Egelhoff, D.O.
Associate Professor of Radiology and Pediatrics, University of Cincinnati College of Medicine; Staff Neuroradiologist, Children's Hospital Medical Center, Department of Radiology, Cincinnati, Ohio
Pediatric Central Nervous System Tumors

Y. F. Fan, M.D.
Senior Consultant, Department of Diagnostic Radiology, Singapore General Hospital, Singapore
Malignancies of the Nasopharynx and Skull Base

Girish Fatterpekar, M.D.
Staff, Mount Sinai Medical Center, New York, New York
Malignancies of the Oral Cavity, Oropharynx, and Hypopharynx

Zvi Y. Fuks, M.D.
Professor, Radiation Oncology, Department of Medicine, Cornell University Medical College; Attending Physician, and Deputy Physician-in-Chief for Planning, Department of Radiation Oncology, Memorial Sloan-Kettering Cancer Center, New York, New York
Three-Dimensional and Conformal Treatment Planning

Richard M. Gore, M.D.
Professor of Radiology, Northwestern University Medical School; Chief, Gastrointestinal Radiology, Evanston Northwestern Healthcare, Evanston, Illinois
Esophageal Cancer; Stomach Cancer
Section Editor—Gastrointestinal System

Michael B. Gotway, M.D.
Assistant Professor in Residence, Department of Radiology, San Francisco General Hospital, University of California, San Francisco, School of Medicine, San Francisco, California
AIDS-Related Malignancies

Simone K. Griff, M.D.
Radiologist, Boca Community Hospital, Boca Raton, Florida
Breast Cancer

Gary D. Grossfeld, M.D.
Assistant Professor of Urology, Program in Urologic Oncology, Mount Zion Comprehensive Cancer Center, University of California, San Francisco, San Francisco, California
Tumors of the Scrotum

Russell J. Hamilton, Ph.D.
Assistant Professor, Department of Radiation and Cellular Oncology, University of Chicago Medical School, Chicago, Illinois
Image Processing and Integration in Oncologic Imaging

Anil Hari, M.D.
Clinical Instructor, University of California, San Francisco, San Francisco, California
Tumors of the Scrotum

Samuel Hellman, M.D.
Professor of Radiation Oncology, University of Chicago Center for Advanced Medicine, Chicago, Illinois
Preface

William R. Hendee, Ph.D.
Professor and Vice Chair, Radiology, and Professor of Bioethics, Biophysics, and Radiation Oncology, Medical College of Wisconsin; Professor of Biomedical Engineering, Marquette University, Milwaukee, Wisconsin
New Imaging Techniques

Hedvig Hricak, M.D.
Chairman, Department of Radiology, Carroll and Milton Petrie Chair, Professor of Radiology, Cornell University; Memorial Sloan-Kettering Cancer Center, New York, New York
Introduction; Imaging Strategies for Oncologic Staging, Diagnosis, and Multidisciplinary Treatment; Carcinoma of the Cervix and Endometrium; Cancer of the Prostate; Late Effects
Editor and Section Editor—Genitourinary and Gynecologic Cancer

Margie A. Hunt, M.S.
Technical Director, External Beam Treatment Planning, Memorial Sloan-Kettering Cancer Center, New York, New York
Three-Dimensional and Conformal Treatment Planning

Patricia E. Hynes, M.D.
Diagnostic Radiologist, Minneapolis Radiology Associates, Minneapolis, Minnesota
Metastatic Bone Disease

Izumi Imaoka, M.D.
Clinical Fellow, Department of Radiology, Magnetic Resonance Division, Tenri Hospital, Tenri, Nara, Japan
Cancer of the Adnexal Organs

David A. Jaffray, Ph.D.
Staff Physicist, William Beaumont Hospital, Department of Radiation Oncology, Royal Oak, Michigan
Interventional Techniques in Radiation Oncology to Optimize the Delivery of Therapy

Reena C. Jha, M.D.
Assistant Professor and Director, Magnetic Resonance Imaging Center, Georgetown University Medical Center, Washington, District of Columbia
Cancer of the Adnexal Organs

Ferenc A. Jolesz, M.D.
Professor of Radiology, Harvard Medical School; Director, Division of Magnetic Resonance Imaging and Image-Guided Therapy Program, Brigham and Women's Hospital, Boston, Massachusetts
Image-Guided Tumor Targeting for Diagnosis and Therapy in Oncology

Frederick M. Kelvin, M.D.
Radiologic Specialists of Indiana, Inc., Indianapolis, Indiana
Colorectal Cancer

John C. Lappas, M.D.
Professor of Radiology, Indiana University School of Medicine; Diagnostic Radiologist, Indiana University Hospitals, Indianapolis, Indiana
Gastrointestinal Malignancies

Jean S. Lee, M.D.
Department of Radiation Oncology, University of California, San Francisco, Medical School, San Francisco, California
Image Processing and Integration in Oncologic Imaging

Steven A. Leibel, M.D.
Chairman, Department of Radiation Oncology, Memorial Sloan-Kettering Cancer Center, New York, New York
Three-Dimensional and Conformal Treatment Planning

Lydia Liao, M.D., Ph.D., M.P.H.
Radiologist, Department of Radiology, University of Rochester Medical Center, Rochester, New York
Image-Guided Brachytherapy

C. Clifton Ling, Ph.D.
Professor of Radiology (Physics), Weill Medical College, Cornell University; Enid Haupt Chairman, Department of Medical Physics, Memorial Sloan-Kettering Cancer Center, New York, New York
Three-Dimensional and Conformal Treatment Planning

Haisong Liu, Ph.D.
Postdoctoral Research Associate, University of Rochester, Rochester, New York
Image-Guided Brachytherapy

Laurie A. Loevner, M.D.
Associate Professor of Radiology and Otorhinolaryngology: Head and Neck Surgery, University of Pennsylvania Medical Center, Philadelphia, Pennsylvania
Paranasal Sinus Malignant Neoplasms

Thomas J. LoSasso, Ph.D.
Assistant Professor of Radiology, Cornell University; Associate Attending Physicist, Memorial Sloan-Kettering Cancer Center, New York, New York
Three-Dimensional and Conformal Treatment Planning

Gikas S. Mageras, Ph.D.
Associate Attending Physicist, Memorial Sloan-Kettering Cancer Center, New York, New York
Three-Dimensional and Conformal Treatment Planning

Dean D. T. Maglinte, M.D.
Professor of Radiology, Indiana University School of Medicine; Diagnostic Radiologist, Indiana University Hospitals, Indianapolis, Indiana
Gastrointestinal Malignancies; Colorectal Cancer

B. J. Manaster, M.D., Ph.D.
Professor and Vice Chairman, Department of Radiology, University of Colorado Health Sciences Center, Denver, Colorado
Soft Tissue Tumors of the Musculoskeletal System
Section Editor—Musculoskeletal System

Alvaro A. Martinez, M.D.
Chairman of Radiation Oncology, William Beaumont Hospital, Royal Oak, Michigan
Interventional Techniques in Radiation Oncology to Optimize the Delivery of Therapy

Maya D. Meux, M.D.
Clinical Assistant Professor, Department of Radiology, University of California, San Francisco, School of Medicine, San Francisco, California
AIDS-Related Malignancies

Frank H. Miller, M.D.
Associate Professor, Northwestern University Medical School; Chief, Gastrointestinal Radiology, and Director, Body Imaging Fellowship, Northwestern Memorial Hospital, Northwestern University, Chicago, Illinois
Stomach Cancer

William A. Mize, M.D.
Department of Radiology, University of Minnesota Hospital and Clinics, Minneapolis, Minnesota; Department of Radiology, Children's Hospital and Clinics
Tumors of the Pediatric Musculoskeletal System

Suresh K. Mukherji, M.D.
Head and Program Director, Neuroradiology, and Department of Radiology, University of Michigan; Division Director, Department of Radiology, University of Michigan Health System, Ann Arbor, Michigan
Malignancies of the Nasopharynx and Skull Base; Malignancies of the Oral Cavity, Oropharynx, and Hypopharynx; Carcinoma of the Larynx

Reginald F. Munden, D.M.D., M.D.
Associate Professor and Section Chief, Thoracic Imaging, Division of Diagnostic Imaging, University of Texas M. D. Anderson Cancer Center, Houston, Texas
Primary Malignancies of the Thorax

Kathleen A. Murray, M.D.
Adjunct Associate Professor, Department of Radiology, University of Utah Health Sciences Center, Salt Lake City, Utah
Chest Wall

Sara M. O'Hara, M.D.
Associate Professor of Radiology and Pediatrics, Department of Radiology, Children's Hospital Medical Center, and Staff, University of Cincinnati Hospital, Cincinnati, Ohio
Tumors of the Pediatric Genitourinary System

William Okuno, M.D.
Director, Computed Tomography, Lutheran General Hospital, Park Ridge, Illinois
Lymphomas and the Lymphoproliferative Disorders

Charles A. Pelizzari, Ph.D.
Associate Professor, Department of Radiation and Cellular Oncology, University of Chicago Medical School; Director, Radiotherapy Physics, Department of Radiation and Cellular Oncology, University of Chicago Medical Center, Chicago, Illinois
Image Processing and Integration in Oncologic Imaging

Philip Rubin, M.D.
Professor, Department of Radiation Oncology, University of Rochester Cancer Center, School of Medicine and Dentistry, Rochester, New York
Introduction; Imaging Strategies for Oncologic Diagnosis and Multidisciplinary Treatment; Imaging for Radiation Oncology Treatment Process; Carcinoma of the Cervix and Endometrium; Late Effects
Editor–Section Editor—Late Effects

Richard C. Semelka, M.D.
Professor and Vice Chair of Clinical Research, and Director of Magnetic Resonance Services, Department of Radiology, University of North Carolina, Chapel Hill, North Carolina
Tumors of the Bladder and Urethra

Michael B. Sharpe, Ph.D.
Staff Physicist, William Beaumont Hospital, Department of Radiation Oncology, Royal Oak, Michigan
Interventional Techniques in Radiation Oncology to Optimize the Delivery of Therapy

Edward A. Sickles, M.D.
Professor of Radiology and Director of Breast Imaging, University of California San Francisco, School of Medicine, San Francisco, California
Section Editor—1

Evan S. Siegelman, M.D.
Associate Professor, Department of Radiology; Hospital of the University of Pennsylvania, Philadelphia, Pennsylvania
Tumors of the Bladder and Urethra

Frank T. Slovick, M.D.
Heartland Hematology-Oncology Associates, Kansas City, Missouri
Late Effects

Stephan M. Stockberger, M.D.
Subspecialty: Abdominal Imaging, Indianapolis, Indiana
Colorectal Cancer

Daniel C. Sullivan, M.D.
Associate Director, Biomedical Imaging Program, National Cancer Institute, National Institutes of Health, Bethesda, Maryland
Imaging at the Cellular and Molecular Levels

Murali Sundaram, M.D.
Professor of Radiology, Department of Radiology, St. Louis University Hospital, St. Louis, Missouri
Tumors of the Skeletal System

James L. Tatum, M.D.
Professor of Radiology and Medicine, Associate Vice President for Health Sciences, and Chairman, Department of Radiology, Virginia Commonwealth University, Medical College of Virginia, Richmond, Virginia; Special Assistant, Biomedical Imaging Program, National Cancer Institute, National Institutes of Health, Bethesda, Maryland
Imaging at the Cellular and Molecular Levels

Susan D. Wall, M.D.
Professor and Vice Chair, Radiology, and Associate Dean, Graduate Medical Education, University of California, San Francisco, School of Medicine, San Francisco, California
AIDS-Related Malignancies

Antje Wefer, M.D.
Department of Diagnostic Radiology I, Hannover Medical School, Hannover, Germany
Late Effects

Jacqueline P. Williams, Ph.D.
Associate Professor of Radiation Oncology, University of Rochester School of Medicine and Dentistry, Rochester, New York
Late Effects

John W. Wong, M.Sc., Ph.D.
Director, Clinical Physics, William Beaumont Hospital, Department of Radiation Oncology, Royal Oak, Michigan
Interventional Techniques in Radiation Oncology to Optimize the Delivery of Therapy

Vahid Yaghmai, M.D.
Clinical Assistant Professor, Northwestern University Medical School, Chicago; Director of Body Computed Tomography, Evanston Northwestern Healthcare, Evanston, Illinois
Esophageal Cancer

Di Yan, M.Sc., D.Sc.
Associate Director, Clinical Physics, William Beaumont Hospital, Department of Radiation Oncology, Royal Oak, Michigan
Interventional Techniques in Radiation Oncology to Optimize the Delivery of Therapy

Fang-Fang Yin, Ph.D.
Division Head, Medical Physics, and Staff, Department of Radiation Oncology, Henry Ford Health System, Detroit, Michigan
Imaging for Radiation Oncology Treatment Process

Kyle K. Yu, M.D.
Residency Program Director, Department of Diagnostic Imaging, Santa Clara Valley Medical Center, San Jose, California
Cancer of the Prostate

Yan Yu, Ph.D.
Associate Professor, Department of Radiation Oncology, University of Rochester Medical Center, Rochester, New York
Image-Guided Brachytherapy

Michael J. Zelefsky, M.D.
Associate Professor, Cornell University Medical College; Associate Professor and Chief of Brachytherapy, Memorial Sloan-Kettering Cancer Center, New York, New York
Three-Dimensional and Conformal Treatment Planning

Preface

This second edition of *Oncologic Imaging* is especially important to clinical oncologists. The imaging techniques available and the clinical assessments required are rapidly changing during the ongoing biologic and technical revolution occurring in medicine. The oncologist—whether surgical, radiologic, or medical—requires four classes of information from diagnostic imaging: tumor detection, extent of malignant progression, anatomic location and relationship to normal tissues, and tumor physiology.

Neoplasm detection begins with screening. The RCO curve must be as rectilinear as possible. The screening images should indicate the general location of the putative tumor but need not be anatomically detailed. There should be a quantitative estimate of the numeric likelihood of malignancy rather than a descriptive comment subject to interpretive confusion.

In contrast to oncologic diagnosis, for optimal treatment, the evaluation of the primary tumor must be performed with minimal uncertainty regarding both extent of tumor and anatomic position of dose-limiting normal tissues. Under ideal circumstances, all tumor cells should be located, including microscopic infiltrations, but until this is possible, location of the tumor cell "density" within the gross tumor volume is desirable. By density, I mean the number of tumor cells per unit volume of tissue. It is essential that the understanding of the relationship of the tumor to normal tissues be as detailed as possible; this is the result of a precise fusion of variously acquired parts of imaging information. In addition, tumor physiology both before and during treatment is important for planning appropriately and carrying out surgical, radiotherapeutic, or medical systemic intervention.

The most vital determination for prognosis and treatment of cancer is whether metastases have occurred. Detection of metastases must be as anatomically informative as that used for primary tumors, with the additional requirement of establishing the number of metastases. In the past, patients were classified by whether they had metastases. However, metastases differ in number, location, and extent of malignant progression. Within the metastatic group there is a significant number of patients with oligometastases, that is, a more localized form of metastatic involvement restricted by number and organ site and therefore amenable to curative regional therapies. These metastases must be identified; their anatomic detail should be revealed, and this group of patients should be separated from those with extensive disseminated spread for whom systemic agents are the primary treatment. The better the determination of the nature, volume, and location of tumor, the more specific the therapeutic plan can be. Ideally, more intensive systemic therapy can be applied if it can be restricted to patients requiring such treatment because, in such cases, there is no longer concern with the unnecessary prophylactic treatment of patients who are free from widespread metastases. This means that tumor imaging must be extended to the detection of microscopic disease. Finally, to effect appropriate salvage treatment, the oncologist also must detect tumor recurrence as early as possible.

The book begins with introductory chapters providing an overview of cancer incidence and survival rates, a concise statement of the new molecular oncology of carcinogenesis, and the principles of multidisciplinary treatments. These important chapters offer promise for achieving some of the goals of the oncologist mentioned earlier. There follows a chapter on cancer classification and staging. The next chapters are devoted to updates of the rapid advances in diagnostic radiologic imaging, including cost-effectiveness, a description of the innovations in functional and metabolic imaging, the new frontiers of molecular imaging, and expanding interventional techniques. These are followed by discussion of the specific needs of an ever-changing radiation oncology treatment planning field, with the challenges of more dynamic and precise delivery of radiation—both photon and electron—designed to improve therapeutic ratios. The body of the book is organized by tumor type and site.

In short, we desire nonhazardous, noninvasive integrated techniques that diagnose disease, predict outcome, design treatment, and evaluate results of treatment. This second edition of *Oncologic Imaging* describes the current status and begins showing us the way to achieve these goals in the future.

SAM HELLMAN

NOTICE

Medicine is an ever-changing field. Standard safety precautions must be followed, but as new research and clinical experience broaden our knowledge, changes in treatment and drug therapy may become necessary or appropriate. Readers are advised to check the most current product information provided by the manufacturer of each drug to be administered to verify the recommended dose, the method and duration of administration, and contraindications. It is the responsibility of the treating physician, relying on experience and knowledge of the patient, to determine dosages and the best treatment for each individual patient. Neither the Publisher nor the editor assumes any liability for any injury and/or damage to persons or property arising from this publication.

THE PUBLISHER

Introduction

The second edition of the text *Oncologic Imaging* is designed to catalyze both interest in and appropriate application of sophisticated diagnostic imaging tools used in the process of detection, diagnosis, staging, treatment planning, and post-treatment follow-up surveillance of cancer. Advances in oncologic imaging have contributed to the cure of cancer by improving the therapeutic application of surgeons, radiation oncologists, and medical oncologists through the accurate and serial definition of target cancer volumes and foci in this multidisciplinary area of cancer care.

The societal burden of cancer is enormous. The American Cancer Society estimated that 1,228,600 diagnoses of new cases and 564,800 cancer-related deaths would occur in 2001.[1] The societal costs are equally staggering, having been estimated by the National Cancer Institute to exceed $110 billion in 2000. Although the relative 5-year survival rates for cancer have continued to increase, from an estimated 49% in the 1960s to approximately 60% in 2001,[2] the incidence rate has continued to increase as a reflection, in large measure, of the aging population.[1, 2] Although the improvements in certain cancer site survival rates have been impressive (e.g., pediatric, breast, testis, and cervical cancers), other types of cancer (e.g., male and female lung cancer, brain tumors) have been frustratingly difficult to manage. An incremental improvement in cancer survival will require the coordination of both investigational and clinical researchers and clinicians.

The progress in the understanding of cancers and their complex metabolic, genetic, and environmental dynamics has been dramatic since the last decade of the 20th century and promises that there will be continued incremental gains in the control of these complex neoplasms. It is the collective stimulus and future goal of diagnostic imaging, radiation oncology, and medical/surgical oncology, that with advances in the molecular biologic, genetic, and biomedical engineering communities we will be able to define more specifically the intrinsic environment and behavioral characteristics of cancer, thereby improving control and cure.

The establishment of the National Institute of Biomedical Imaging and Bioengineering will create the platform within the National Institutes of Health for the future directions of the imaging sciences. This new Institute will facilitate the translation of research and foster basic science and will enable the development of prospective interdisciplinary clinical trials.

The centerpiece of this second edition of *Oncologic Imaging* is the theme of catalyzing practical clinical interactions and research collaborations. Oncologists and radiologists alike are indeed fortunate to be practicing at a time when the past accomplishments of medical imaging are rich and its future bright. In 1985, when the first edition of this book was published, there had already been significant advances in imaging technology, and their marked impact on the diagnosis and management of cancer was a central motif of the text. Now, more than a decade and a half later, on the threshold of yet another imaging revolution, the challenge is to integrate the evolving understanding of metabolic, functional, genetic, and behavioral attributes of tumors with their anatomic characteristics and to elucidate the impact of this newly emerging information on the care of cancer patients.

To help readers meet this challenge, this second edition of *Oncologic Imaging* has been entirely rewritten. Each chapter is a new presentation, with greatly expanded content and a rich assortment of imaging illustrations (particularly computed tomography, magnetic resonance imaging, ultrasonography, single photon emission computed tomography, and positron emission tomography) to enable both the radiologist and the clinical oncologist to better appreciate and manage the challenge of multimodal tumor imaging. The text is organized according to the major organs and systems that are sites of cancer in both adult and child. For each site, both the state of the art and the current science of imaging, as well as the promise for the future, are discussed by nationally and internationally renowned contributing authors. The text is designed to serve practicing clinicians in both the clinical and imaging sciences, providing the information needed to allow integration of the ever more sophisticated operational tools of the disciplines of radiation oncology, medical and surgical oncology, and diagnostic radiology.

Some of the changes to the second edition include:

- Reorganization of the section on the brain and spinal cord and inclusion of it in the section on head and neck cancers
- Expansion of coverage of breast cancer to include a discussion of interventional techniques
- Expansion of coverage of the thorax to two chapters and of the gastrointestinal tract from three to five chapters
- Expansion of gynecologic cancers from one to two chapters and of musculoskeletal cancers from two to three chapters
- Expansion of the section on pediatric tumors from just one chapter in the first edition to four chapters, in an effort to cover more comprehensively the complexities of cancer imaging in the child

In an attempt to set the theme for imaging in oncology, the organization of organ site chapters begins with a brief review of tumor pathology and behavior, followed by cancer classification and staging, with most of the chapter devoted to imaging strategies for detection, diagnosis, staging, and treatment. The expanding field of minimally invasive diagnosis and multidisciplinary treatment of cancers is presented. No discussion of cancer imaging would

be complete without its application to treatment planning, enhanced by the new imaging technology that allows greater latitude and flexibility in conforming the treatment beam to a specific cancer site. Five new special chapters in the section entitled "Treatment Planning" are devoted to the critical role of imaging in radiation treatment planning and delivery. As metabolic and molecular imaging become available, biologically based dose distributions can be developed. Further enhancements will be realized as the use of image fusion (amplification of information derived from multiple procedures combined to create "real-time" three-dimensional image displays) becomes more widespread. In this edition, the treatment planning aspects of each type of cancer are presented in the radiation treatment planning section rather than at each anatomic site. A multidisciplinary treatment decision table, based on cancer stage, is concisely organized and facilitates interaction and coordination among imager, surgical oncologist, medical oncologist, and radiation oncologist in arriving at individualized approaches to cancer care by anatomic site, determined most often by the anatomic stage, the histopathologic tumor type and grade, or all three.

As the field of diagnostic radiology enters its second century, new challenges emerge that will shape its future. The first quarter century of progress, which began just before the previous century, reflected excitement about the discovery of the mysterious energy of the x-ray beam, with properties and abilities that facilitated viewing the human body through fluoroscopic screens and radiographs. At the beginning of the 20th century, the development of contrast materials enabled visualization of the gastrointestinal tract, biliary tree, and urinary tract. Later technologic explosions in midcentury—such as the advent of computed tomography, magnetic resonance imaging, ultrasonography, nuclear imaging, angiography, and minimally invasive procedures—drove the field rapidly into areas of exploration never before believed possible. This technologic "push" of increasingly sophisticated equipment and imaging procedures has transformed the medical horizon and opened the field of radiology to new challenges and opportunities as well as inherent risks. Image-guided diagnosis, treatment, and follow-up of cancer patients promises to dramatically increase the potential for curing cancer in the new millennium by more effective and accurate delivery of image-guided multimodal therapy. Therapeutic imaging is a logical extension and integration of diagnostic imaging, which initiates the process of treating and caring for oncologic patients. The imaging future promises new avenues of exploration of molecular, microscopic, genetic, and biologic events in the human body, performed noninvasively and in real time. It is with this excitement and promise that we present the second edition of *Oncologic Imaging*, and we dedicate it to the undiscovered vistas of the imaging sciences and their specific challenges in the field of oncology.

David G. Bragg
Philip Rubin
Hedvig Hricak

Bibliography

1. American Cancer Society: Facts and Figures—1998, Atlanta, GA, 1998, p 1.
2. Rubin P, Okunieff P, Rosenblatt J, Williams JP: Statement of the clinical oncologic problem. In Rubin P (ed): Clinical Oncology, 8th ed. Philadelphia, WB Saunders, 2001.

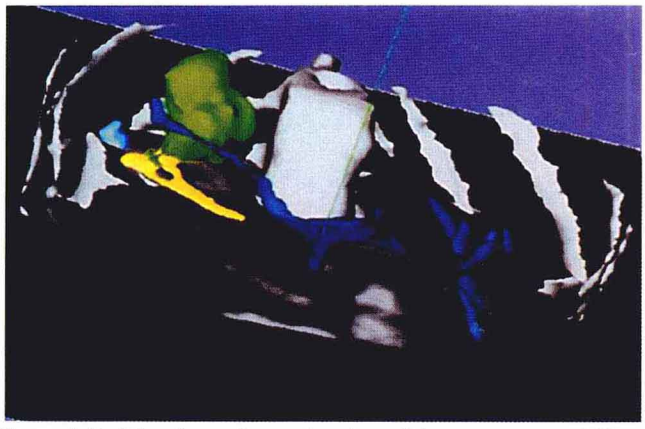

Figure 4–3. The three-dimensional model reconstructs a kidney myelolipoma (*green*) derived from a computed tomography scan. Bones are seen in white, kidney calices in yellow, and vessels in blue. In such models, the organs and various tissue components can be individually manipulated to facilitate surgical simulation and planning.

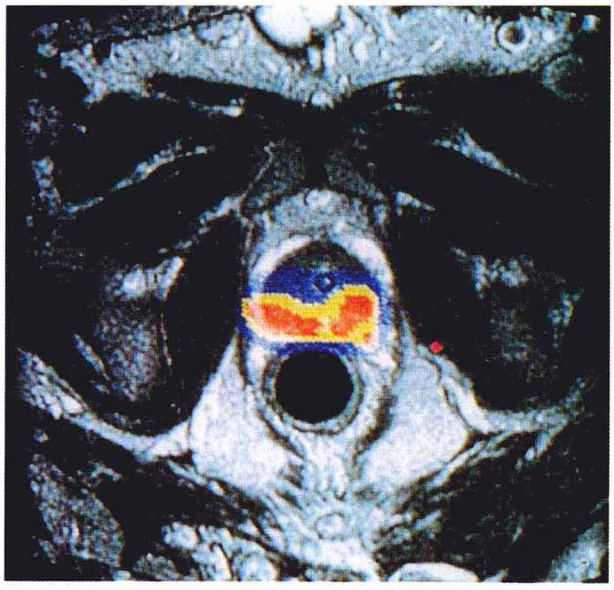

Figure 4–4. Axial magnetic resonance image (MRI) of a patient in the lithotomy position in an open MRI scanner. During treatment planning for brachytherapy of the prostate (which is central in the gray-scale image), dosimetry is superimposed on the image. Seen here as colorized fields on the posterior region of the gland before seed placement.

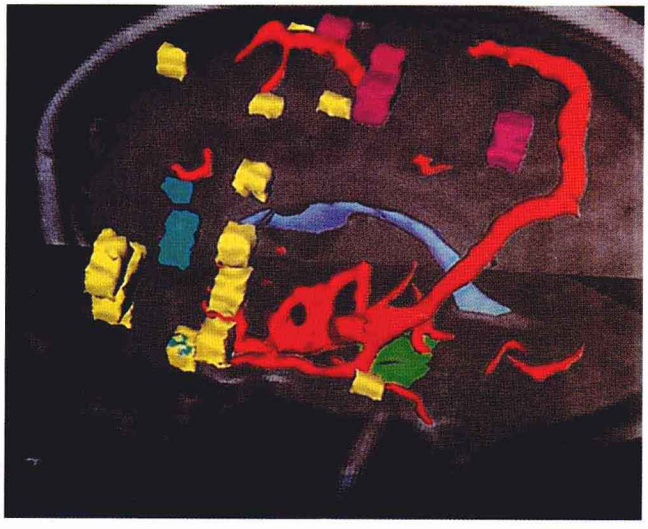

Figure 4–7. Multimodality data combined for intraoperative use in the interventional environment. An intraoperatively acquired axial magnetic resonance image (*obliquely perpendicular to the page*) and preoperative image data merge to assist in surgery. The preoperative data are shown as colorized overlay models: The lesion is in green; the vessels are in red; and magnetic resonance data for speech and motor functions are in blue, magenta, and yellow. In the intraoperative image, a hand-held probe appears from below, pointing toward the lesion.

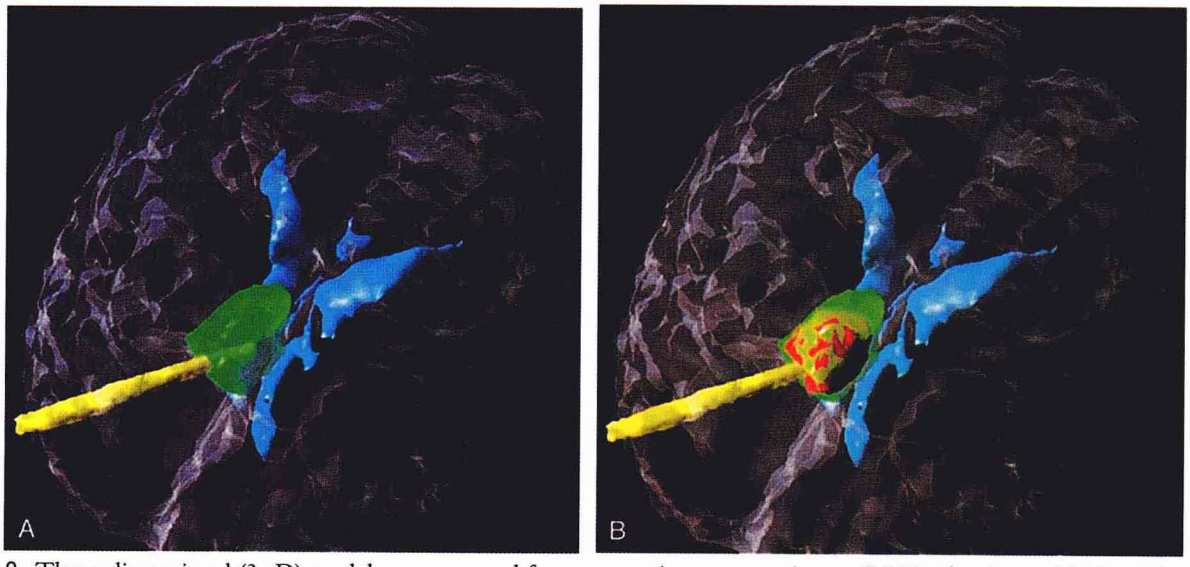

Figure 4–9. Three-dimensional (3–D) model reconstructed from magnetic resonance image (MRI) of an interstitial laser therapy of a low-grade astrocytoma performed under MRI guidance. The first image (*A*) shows the tumor (*green*) before treatment (*ventricles in blue and laser fiber in yellow*). The second image (*B*) shows the 3–D representation (*red*) of the treatment effect.

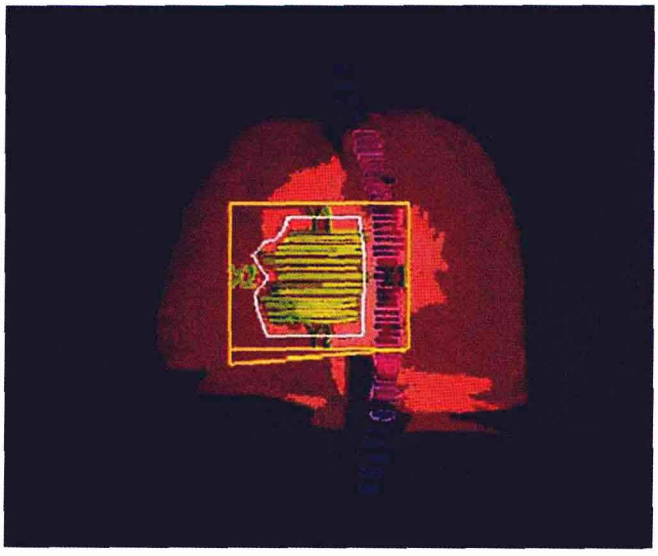

Figure 6–1. Beam's-eye view for a lung patient. Along with the outer skin, the lungs (*red*), spinal cord (*blue*), and planning treatment volume (*green*) are displayed. The treatment aperture (*white*) and the collimators (*yellow*) are also projected.

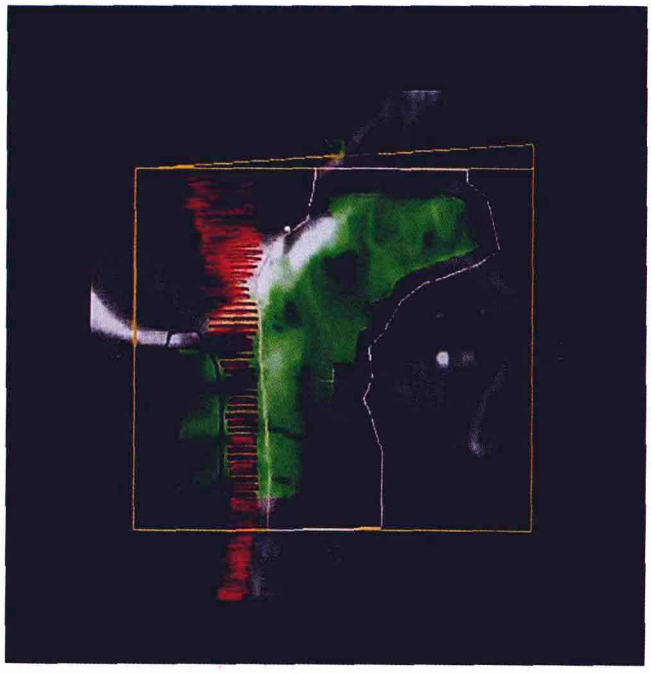

Figure 6–2. Digitally reconstructed radiograph of a lateral head and neck field showing the planning treatment volume (*green*), spinal cord and brainstem (*red*). The field apertures are shown (*pink and blue*) as well as the direction of the wedge.

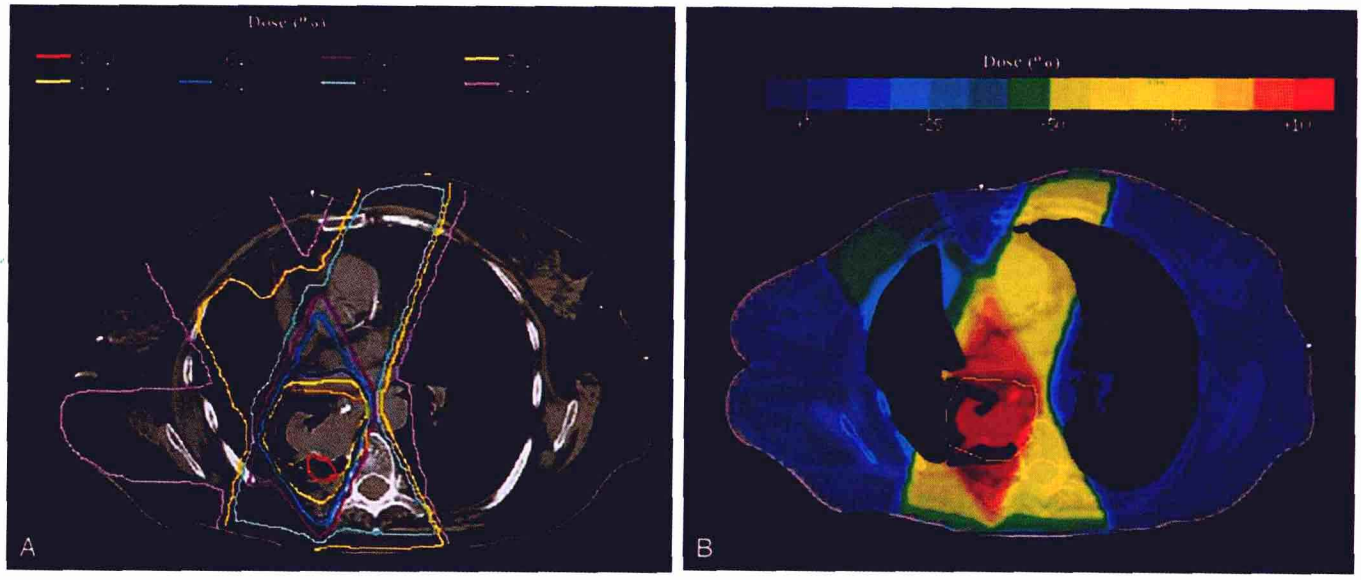

Figure 6–3. *A*, Isodose distribution for a lung patient in a transverse computed tomography plane. *B*, The outline of the planning treatment volume (*yellow*) is also shown with the same dose distribution as a color wash.

Figure 6–4. A three-dimensional dose display showing the planning treatment volume (*yellow*), parotid glands (*green*), and spinal cord (*red*) superimposed with the 95% isodose surface (*blue*).

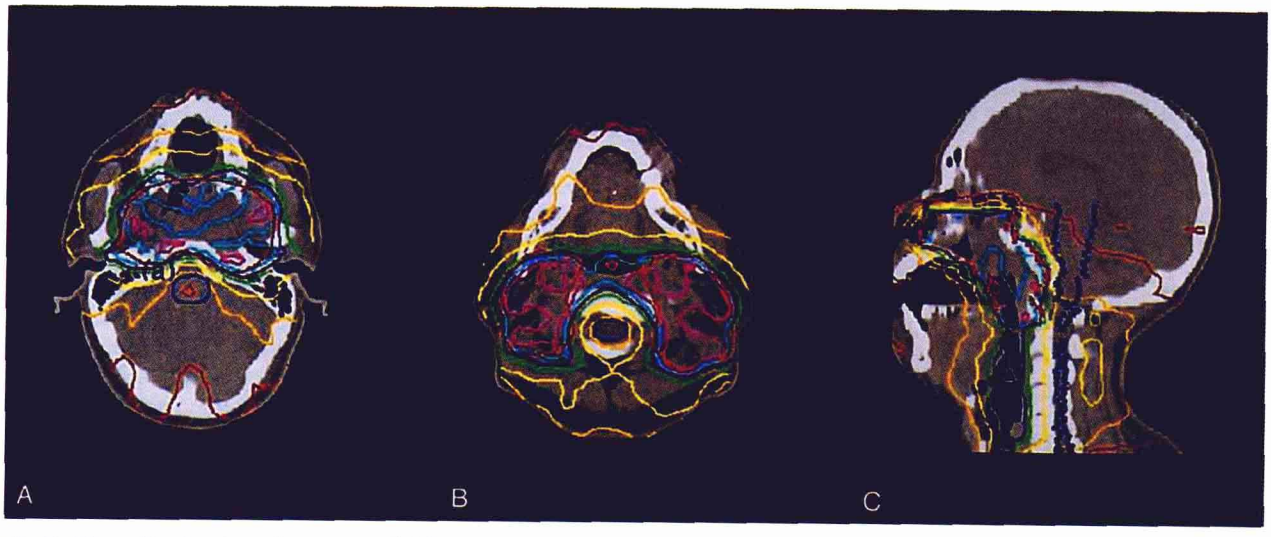

Figure 6–8. Dose distributions for a seven-field, intensity-modulated radiotherapy nasopharynx plan. The planning treatment volume is outlined in red and the spinal cord and brainstem are in blue. *A*, Axial distribution through the central axis. *B*, Axial distribution 4 cm inferior to the central axis. *C*, Sagittal distribution through the central axis.

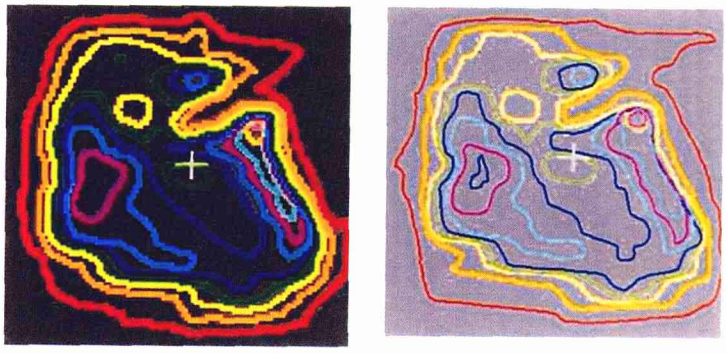

Figure 6–10. Dose distribution for a left lateral intensity-modulated radiotherapy head and neck field as calculated by the treatment planning system and measured using film dosimetry.

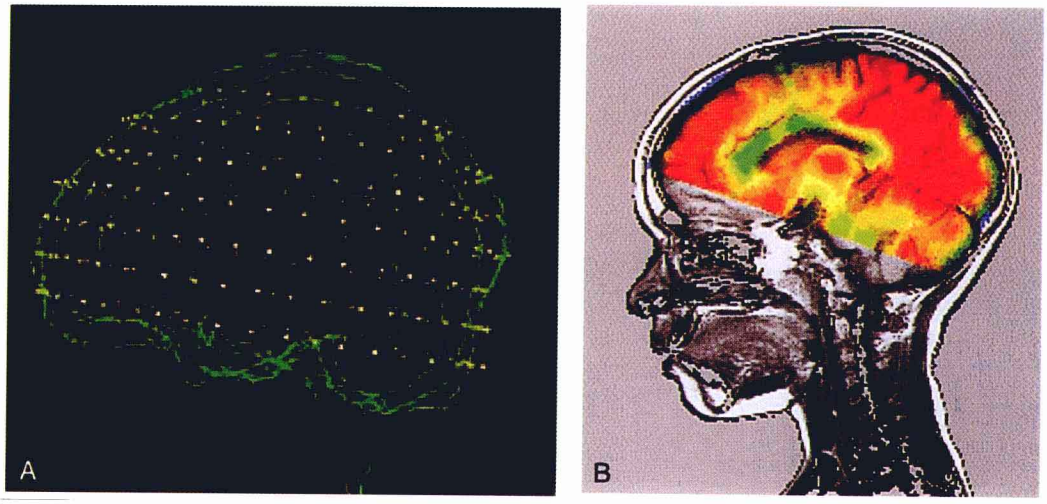

Figure 7–1. Screen display from a surface-fitting program. The sagittal contours represent the brain surface extracted from an MRI study. The dots are brain surface contours from axial images of positron emission tomography data. After initially positioning the two data sets interactively, the surfaces are fit to each other to minimize the volume between them.

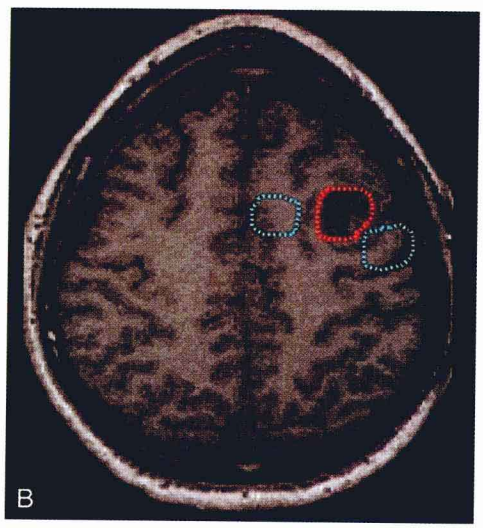

Figure 7–3. *B*, An axial image with a red contour indicating the tumor region and two blue regions lateral to the tumor, corresponding to right-hand tactile function. *C*, A dose distribution from conventional planning that produces a spherical high dose region. *D*, A dose distribution shaped to avoid the functional regions.