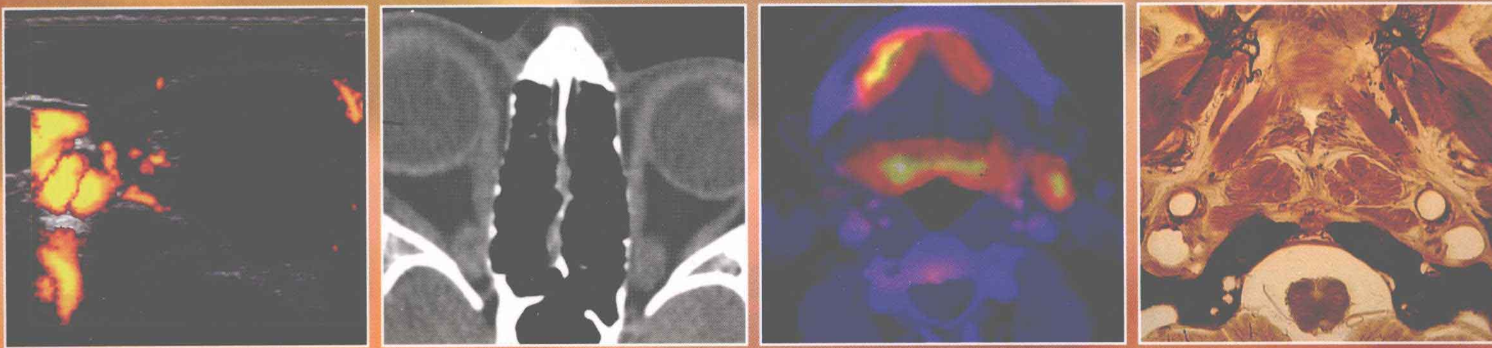
VOLUME I

INCLUDES ONLINE ACCESS TO FULLY SEARCHABLE TEXT

HEAD AND NECK RADIOLOGY



ANTHONY A. MANCUSO

WILLIAM N. HANAFEE

With contributions from:

Berit M. Verbist

Robert Hermans

Wolters Kluwer Health | Lippincott Williams & Wilkins

Head and Neck Radiology

VOLUME I

Anthony A. Mancuso, MD
Professor and Chairman, Department of Radiology
Professor of Otolaryngology
University of Florida College of Medicine
Gainesville, Florida

William N. Hanafee, MD (In Memoriam)
Professor of Radiology
University of California at Los Angeles Center for Health Sciences
Los Angeles, California

With contributions from:

Berit M. Verbist, MD, PhD
Leiden University Medical Center
Leiden, The Netherlands

Robert Hermans, MD, PhD
Professor
University Hospitals Leuven
Department of Radiology
Leuven, Belgium

Wolters Kluwer | Lippincott Williams & Wilkins
Health
Philadelphia • Baltimore • New York • London
Buenos Aires • Hong Kong • Sydney • Tokyo

Acquisitions Editor: Charles W. Mitchell
Product Manager: Ryan Shaw
Vendor Manager: Alicia Jackson
Senior Manufacturing Manager: Benjamin Rivera
Senior Marketing Manager: Angela Panetta
Design Coordinator: Holly McLaughlin
Production Service: Aptara, Inc.

© 2011 by LIPPINCOTT WILLIAMS & WILKINS, a WOLTERS KLUWER business

Two Commerce Square
2001 Market Street
Philadelphia, PA 19103

All rights reserved. This book is protected by copyright. No part of this book may be reproduced in any form by any means, including photocopying, or utilized by any information storage and retrieval system without written permission from the copyright owner, except for brief quotations embodied in critical articles and reviews. Materials appearing in this book prepared by individuals as part of their official duties as U.S. government employees are not covered by the above-mentioned copyright.

Printed in China

Library of Congress Cataloging-in-Publication Data
Mancuso, Anthony A.
Head and neck radiology / Anthony A. Mancuso, William N. Hanafee ;
with contributions from Berit M. Verbist, Robert Hermans.
p. ; cm.
Includes bibliographical references and index.
ISBN 978-1-60547-715-2 (hardback)
1. Head–Radiography. 2. Neck–Radiography. I. Hanafee, William N.,
1926- II. Title.
[DNLM: 1. Head—radiography. 2. Diagnostic Imaging.
3. Neck–radiography. WE 705 M269h 2011]
RC936.M339 2011
617.5′107572–dc22

2010024858

Care has been taken to confirm the accuracy of the information presented and to describe generally accepted practices. However, the authors, editors, and publisher are not responsible for errors or omissions or for any consequences from application of the information in this book and make no warranty, expressed or implied, with respect to the currency, completeness, or accuracy of the contents of the publication. Application of the information in a particular situation remains the professional responsibility of the practitioner.

The authors, editors, and publisher have exerted every effort to ensure that drug selection and dosage set forth in this text are in accordance with current recommendations and practice at the time of publication. However, in view of ongoing research, changes in government regulations, and the constant flow of information relating to drug therapy and drug reactions, the reader is urged to check the package insert for each drug for any change in indications and dosage and for added warnings and precautions. This is particularly important when the recommended agent is a new or infrequently employed drug.

Some drugs and medical devices presented in the publication have Food and Drug Administration (FDA) clearance for limited use in restricted research settings. It is the responsibility of the health care provider to ascertain the FDA status of each drug or device planned for use in their clinical practice.

To purchase additional copies of this book, call our customer service department at (800) 638-3030 or fax orders to (301) 223-2320. International customers should call (301) 223-2300.

Visit Lippincott Williams & Wilkins on the Internet: at LWW.com. Lippincott Williams & Wilkins customer service representatives are available from 8:30 am to 6 pm, EST.

10 9 8 7 6 5 4 3 2 1

Head and Neck Radiology

VOLUME I

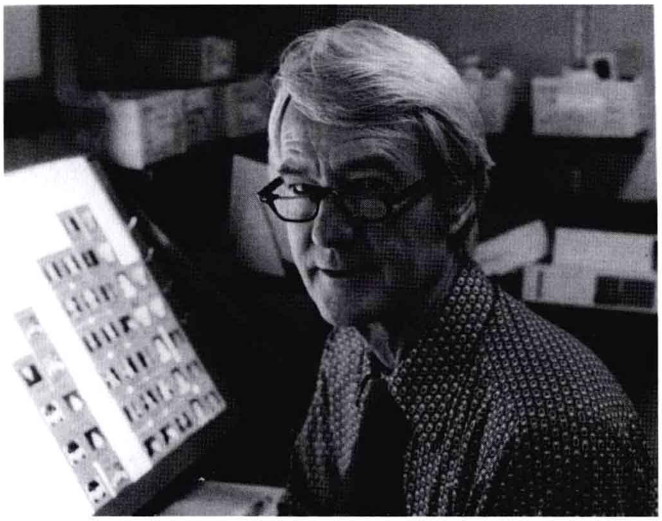
To Bill Hanafee, for all of his wisdom, leadership, and kindness,
and Paul Ward . . . who together created a model of what can be accomplished for
interdisciplinary patient care with a spirit of
mutual respect and everlasting friendship

AAM

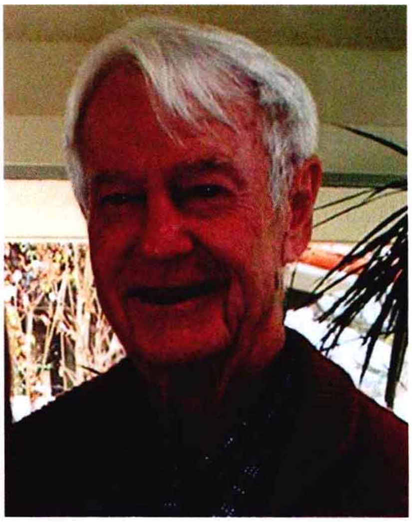
To our patients whose suffering is reflected in the images on these
pages . . . may we all learn from them and with the utmost
compassion improve daily our ability to find the best possible outcomes for those
afflicted with often devastating diseases

AAM
RH
BMV

Bruin flag at UCLA Pauley Pavillion at half mast in Honor of Bill's service–summer 2010.



Bill in his office at UCLA circa 1970s, preparing teaching material



Bill in retirement in north San Diego County, likely getting ready to shoot a round of golf with his longtime friend and colleague Paul Ward

CONTRIBUTORS/REVIEWERS

Robert T. Adelson, MD
Assistant Professor
Division Chief, Facial Plastic and Reconstructive Surgery
University of Florida College of Medicine
Department of Otolaryngology
Gainesville, Florida

Robert J. Amdur, MD
Professor
University of Florida College of Medicine
Department of Radiation Oncology
Gainesville, Florida

Patrick J. Antonelli, MD
George T. Singleton Professor and Chairman
Department of Otolaryngology
University of Florida College of Medicine
Gainesville, Florida

Manuel Arreola, PhD
University of Florida College of Medicine
Department of Radiology
Gainesville, Florida

Jeffrey A. Bennett, MD
Assistant Professor
University of Florida College of Medicine
Department of Radiology
Gainesville, Florida

Deepak Bhatt
UBM Institute
Dadar, Mumbai
India

M. Tariq Bhatti, MD
Associate Professor
Neuro-Ophthalmology and Orbital Disease
Duke Eye Center and Duke University Medical Center
Departments of Ophthalmology and Medicine
Durham, North Carolina

William O. Collins, MD
Assistant Professor
University of Florida College of Medicine
Department of Otolaryngology
Gainesville, Florida

Walter E. Drane, MD, FACR
Professor, Radiology
Director, Nuclear Medicine/Advanced GI Imaging
University of Florida College of Medicine
Department of Radiology
Gainesville, Florida

Robert Hermans, MD, PhD (Co-Author)
Professor
University Hospitals Leuven
Department of Radiology
Leuven, Belgium

Carol J. Langdoc, MD
Comprehensive ENT
Littleton, Colorado

Alan M. Lessner, MD
Associate Professor of Ophthalmology
Director of the Oculoplastic and Orbital Service
University of Florida College of Medicine
Department of Ophthalmology
Gainesville, Florida

Emma L. Lewis, BDS, MBBS, FRACDS(OMS)
Assistant Professor
College of Dentistry
Health Sciences Center
Department of Oral and Maxillofacial Surgery
Gainsville, Florida

William M. Mendenhall, MD
Professor
University of Florida College of Medicine
Department of Radiation Oncology
Gainesville, Florida

Suresh K. Mukherji, MD, FACR
Professor and Chief of Neuroradiology and Head and Neck Radiology
Professor of Radiology and Otolaryngology Head Neck Surgery, Radiation Oncology, Periodontics and Oral Medicine
University of Michigan Health System
Department of Radiology
Ann Arbor, Michigan

Madhu K. Nair, DMD, MS, PhD (C)
Chairman, Department of Oral and Maxillofacial Diagnostic Sciences
Associate Professor, Colleges of Dentistry and Medicine
University of Florida
Gainesville, Florida

James C. Pettigrew, Jr., DMD
Associate Professor, Colleges of Dentistry and Medicine
Director, Oral and Maxillofacial Radiology
University of Florida
Gainesville, Florida

James D. Ruskin, DMD, MD, FACS
Professor
Director, Center for Implant Dentistry
Department of Oral and Maxillofacial Surgery
Gainesville, Florida

Ilona M. Schmalfuss, MD
Adjunct Assistant Professor
University of Florida College of Medicine
Staff Radiologist/Malcolm Randall VA Medical Center
Gainesville, Florida

Mary Fran Smith, MD
Associate Professor of Ophthalmology
University of Florida College of Medicine
Department of Ophthalmology
Gainesville, Florida

Mikhail Vaysberg, DO
Assistant Professor
University of Florida College of Medicine
Department of Otolaryngology
Gainesville, Florida

Berit M. Verbist, MD, PhD (Co-Author)
Leiden University Medical Center
Leiden, The Netherlands

John W. Werning, MD
Associate Professor
University of Florida College of Medicine
Department of Otolaryngology
Gainesville, Florida

The Concept and Suggested Use of this Hybrid Text

General Concepts

This book is a hybrid print/electronic product. The goal of the entire resource is to transfer not only information but also wisdom and judgment based on over 30 years of the practice of modern head and neck diagnostic imaging initiated with the arrival of computed tomography and gray-scale ultrasound in the early to mid 1970s. The seminal knowledge base for those 30 years, however, was created by work done over many previous decades and, in the case of anatomy, centuries. That work established the anatomic basis as well as foundational experience in the pathoanatomic and clinical behavior of the often devastating diseases that afflict the head and neck region. The intended result of applying this continuum of knowledge and wisdom would be to produce the best possible diagnostic imaging process from acquisition to consulting and reporting. This would include assuring optimal resource utilization, which in turn leads to uniformly high-quality images—with those images eventually facilitating the best possible timely consultations and written reports.

Realizing these goals requires access to the entire scope of core knowledge needed to plan, perform, and interpret an imaging examination. This includes applied physics, anatomy, and pathophysiology. Such core knowledge must then be expanded within the known specific clinical context. Core knowledge might also be applied to a clinical situation never before encountered and, with good reasoning skills, result in the correct decision making in what might otherwise be a confounding situation.

Presenting the core and applied knowledge and illustrations in print would require about three volumes; this is impractical and unnecessary in this period of the publishing industry's transition. Therefore, the book is partly electronic and partially print in the following manner.

For the Electronic-Only Portion

The electronic portion of this text contains the following core material:

Part I: Applied Imaging Fundamentals—Chapters 1 through 6

This core material promotes an understanding of the physical principles used to design optimal image acquisition protocols (presented in Appendixes A and B and in searchable and continuously updated form at http://xray.ufl.edu), recognize the fundamental strengths and weaknesses of a given imaging modality relative to others, how to anticipate and correct artifacts, and the physical basis for what is seen on the image.

Part II: General Pathology, Pathophysiology, Patterns of Disease, and Natural History of Head and Neck Disorders Correlated with Imaging Appearance—Chapters 6 through 43

This core material establishes a knowledge base of how pathologic states develop and spread as well as how their microenvironment is expressed as pathologic alterations on imaging studies. These mechanisms and morphology of disease states such as cancer, inflammation, and tumor types typically occur in more than one anatomic site in the head and neck region. Once understood as core knowledge, this information does not have to be presented in a discussion of that pathologic process at each potential site of involvement. This leaves the user free to consider the unique clinical issues that these conditions have at each site.

For the Print Portion

The print portion of this text contains the core anatomic knowledge as a framework for clinically integrated material. This could stand alone as a text on the full range of head and neck problems.

Part III: Clinical Applications—Sections 3 through 16 (Chapters 44–223)

The clinical/diagnostic process, as presented in the 180 chapters in these sections is organized anatomically and then grouped by common pathologic and clinical conditions. The lead chapter in each section contains applicable core anatomy and techniques of examination. In subsequent chapters, disease extent and morphology are factored together with relevant clinical issues. Each chapter considers technical considerations and discreet applied anatomy based on core knowledge as needed. The user, depending on his or her knowledge base and goals, can search the electronic core for a more fundamental knowledge of the diagnostic process.

These chapters also consider the impact of the information on patient care and attempts to establish reasonable professional goals with regard to report content and communication appropriate for the acuity of the clinical situation. The intent of these chapters is to impart the wisdom and judgment based on the core knowledge and 33 years of practice in this challenging subspecialty.

CONTENTS

Contributors/Reviewers *vi*

Acknowledgments *viii*

VOLUME I

SECTION I ■ APPLIED IMAGING FUNDAMENTALS

1 Head and Neck Image Acquisition and Display: Introduction and General Principles
Anthony A. Mancuso, Manuel Arreola, and Suresh K. Mukherji

2 Computed Tomography: Introduction and General Principles
Anthony A. Mancuso, Manuel Arreola, and Suresh K. Mukherji

3 Magnetic Resonance Imaging: Introduction and General Principles
Anthony A. Mancuso, Manuel Arreola, and Suresh K. Mukherji

4 Diagnostic Ultrasound: Techniques and General Principles
Anthony A. Mancuso

5 Nuclear Medicine: Introduction and General Principles
Walter E. Drane, Anthony A. Mancuso, and Suresh K. Mukherji

6 Imaging Guided Biopsy
Anthony A. Mancuso

SECTION II ■ GENERAL PATHOLOGY, PATHOPHYSIOLOGY, PATTERNS OF DISEASE, AND NATURAL HISTORY OF HEAD AND NECK DISORDERS CORRELATED WITH IMAGING APPEARANCE

7 Integrating Imaging and Pathologic Diagnosis
Anthony A. Mancuso

8 Developmental Lesions: Epidermoid, Dermoid, Teratomas, Hamartomas and Aberrant Tissue
Anthony A. Mancuso

9 Proliferative Hemangiomas, Vascular Malformations and Vascular Compression Syndromes
Anthony A. Mancuso

10 Fluid Collections, Cysts and Hematomas
Anthony A. Mancuso

11 Naturally Occurring Paramagnetic Substances Including Blood Products
Anthony A. Mancuso

12 Calcification, Ossifications, Matrices, Radiodense Foreign Bodies and Their Mimics
Anthony A. Mancuso

13 Infections and Noninfectious Inflammatory Disorders: General Morphology, Cellulitis, Abscess and Suppurative Adenitis
Anthony A. Mancuso

14 Infectious and Noninfectious Inflammatory Disorders: Reactive Bony Changes, Osteitis, Osteonecrosis and Osteomyelitis
Anthony A. Mancuso

15 Infectious and Noninfectious Inflammatory Disorders: Vasculitis Including Arteritis, Thrombophlebitis and Vascular Thrombosis
Anthony A. Mancuso

16 Infectious and Noninfectious Inflammatory Disease: Chronic Infections Including Fungal
Anthony A. Mancuso

17 Infectious and Non Infectious Inflammatory Diseases: Wegener's Granulomatosis (WG)
Anthony A. Mancuso

18 Infectious and Non Infectious Inflammatory Disorders: Sarcoidosis and Inflammatory Pseudotumor
Anthony A. Mancuso

19 Infectious and Noninfectious Inflammatory Diseases: Langerhans Cell Histiocytosis (LCH)
Anthony A. Mancuso

20 Infectious and Non Infectious Inflammatory Diseases: Autoimmune Diseases and Amyloidosis
Anthony A. Mancuso

21 Benign and Malignant Tumors: General Issues and Growth Patterns and Treatment Related Changes
Anthony A. Mancuso

22 Benign and Malignant Epithelial Tumors: Lesions of Glandular Origin
Anthony A. Mancuso

23 Benign and Malignant Epithelial Tumors: Lesions of Mucosal Origin
Anthony A. Mancuso

Web-only Chapters available at *www.headneckradiology.com.*

24 Benign and Malignant Epithelial Tumors: Lesions of Cutaneous (Skin) Origin
Anthony A. Mancuso

25 Malignant and Other Aggressive Tumors of Vascular Origin
Anthony A. Mancuso

26 Benign Lymphoid and Other Reactive and Proliferative Processes Including PTLD
Anthony A. Mancuso

27 Lymphoma
Anthony A. Mancuso

28 Leukemia and Plasma Cell Neoplasms
Anthony A. Mancuso

29 Benign and Malignant Peripheral Nerve Sheath Tumors
Anthony A. Mancuso

30 Benign and Malignant Neuroectodermal and Other Neurogenic Tumors
Anthony A. Mancuso

31 Benign and Malignant Meningeal Tumors
Anthony A. Mancuso

32 Pituitary Tumors That Present as Skull Base and Extracranial Head and Neck Masses
Anthony A. Mancuso

33 Paragangliomas (Chemodectomas)
Anthony A. Mancuso

34 Chordoma
Anthony A. Mancuso

35 Benign and Malignant Mesenchymal Tumors: Muscle and Other Cell Line Origins
Anthony A. Mancuso

36 Benign and Malignant Lipogenic Tumors
Anthony A. Mancuso

37 Benign and Malignant Tumors of Fibrous Origin and the Fibromatoses
Anthony A. Mancuso

38 Benign and Malignant Osteogenic Tumors of Bone
Anthony A. Mancuso

39 Benign and Malignant Chondrogenic Tumors of Bone
Anthony A. Mancuso

40 Fibrous Dysplasia and other Fibroosseous Lesions of Bone
Anthony A. Mancuso

41 Cystic Lesions of Bone
Anthony A. Mancuso

42 Bone and Other Metastatic Disease to the Head and Neck
Anthony A. Mancuso

43 Systemic, Metabolic and Miscellaneous Diseases Affecting Bone
Anthony A. Mancuso

SECTION III ■ THE EYE, ORBIT AND VISUAL PATHWAYS INCLUDING CRANIAL NERVES III, IV AND VI

44 Eye, Orbit, Visual Pathways and Cranial Nerves III, IV and VI: Introduction and General Principles 1
Berit M. Verbist, Anthony A. Mancuso, and M. Tariq Bhatti

45 Eye: Retinal, Choroidal, and Hyaloid Detachments 34
Anthony A. Mancuso, M. Tariq Bhatti, Deepak Bhatt, and Berit M. Verbist

46 Eye: Developmental Abnormalities and Acquired Alteration in the Size and Shape of the Eye 43
Anthony A. Mancuso, Mary Fran Smith, Deepak Bhatt, and Berit M. Verbist

47 Eye: Degenerative Conditions 57
Anthony A. Mancuso, Mary Fran Smith, Deepak Bhatt, and Berit M. Verbist

48 Tension Orbit and Its Acute Threat to Vision 62
Anthony A. Mancuso and Berit M. Verbist

49 Eye: Acute and Chronic Infections 66
Anthony A. Mancuso, Mary Fran Smith, Deepak Bhatt, and Berit M. Verbist

50 Eye: Noninfectious Inflammatory Diseases 73
Anthony A. Mancuso, Mary Fran Smith, Deepak Bhatt, and Berit M. Verbist

51 Eye: Trauma 79
Anthony A. Mancuso, Mary Fran Smith, Deepak Bhatt, and Berit M. Verbist

52 Eye: Intraocular Neoplastic Masses and Vascular Malformations 90
Anthony A. Mancuso, Mary Fran Smith, Deepak Bhatt, and Berit M. Verbist

53 Optic Nerve and Sheath: Developmental Abnormalities 104
Anthony A. Mancuso and Mary Fran Smith

54 Optic Nerve and Sheath: Trauma 110
Anthony A. Mancuso and Mary Fran Smith

55 Optic Nerve and Sheath: Acute and Chronic Infections and Noninfectious Inflammatory Conditions 117
Anthony A. Mancuso and Mary Fran Smith

56 Optic Nerve and Sheath: Benign and Malignant Tumors 125
Anthony A. Mancuso, Mary Fran Smith, and Berit M. Verbist

57 Intraconal Orbit: Orbital Pseudotumor and Acute and Chronic Infections and Noninfectious Inflammatory Conditions 138
Anthony A. Mancuso, Deepak Bhatt, Alan M. Lessner, and Berit M. Verbist

58 Graves Dysthyroid Ophthalmopathy (Orbitopathy) 148
Anthony A. Mancuso, Mary Fran Smith, and Deepak Bhatt

59 Intraconal Orbit: Vascular Malformations 154
Anthony A. Mancuso, Mary Fran Smith, and Berit M. Verbist

60 Intraconal Orbit: Tumors 166
Anthony A. Mancuso, Mary Fran Smith, and Berit M. Verbist

61 Bony Orbit and Extraconal Compartment: Developmental Lesions 175
Anthony A. Mancuso, Mary Fran Smith, and Berit M. Verbist

62 Extraconal Orbit: Orbital Pseudotumor, Noninfectious Inflammatory Conditions, and Acute and Chronic Infections 183
Anthony A. Mancuso and Mary Fran Smith

63 Orbit: Blunt Force, Fractures, and Penetrating Injuries 190
Anthony A. Mancuso and Mary Fran Smith

64 Bony Orbit and Extraconal Compartment: Tumors 207
Anthony A. Mancuso, Alan D. Lessner, and Berit M. Verbist

65 Lacrimal Gland: Orbital Pseudotumor and Acute and Chronic Infections and Noninfectious Inflammatory Conditions 215
Anthony A. Mancuso, Mary Fran Smith, and Berit M. Verbist

66 Lacrimal Gland: Benign and Malignant Tumors 224
Anthony A. Mancuso, Mary Fran Smith, and Berit M. Verbist

67 Nasolacrimal Apparatus: Developmental Conditions 233
Anthony A. Mancuso, Mary Fran Smith, and Berit M. Verbist

68 Nasolacrimal Apparatus: Acute and Chronic Infections and Noninfectious Inflammatory Conditions 236
Anthony A. Mancuso, Mary Fran Smith, and Berit M. Verbist

69 Nasolacrimal Apparatus: Benign and Malignant Tumors 245
Anthony A. Mancuso, Mary Fran Smith, and Berit M. Verbist

70 Preseptal Compartment: Acute and Chronic Infections and Noninfectious Inflammatory Conditions 250
Anthony A. Mancuso, Alan D. Lessner, and Berit M. Verbist

71 Preseptal Compartment: Benign and Malignant Tumors 255
Anthony A. Mancuso, Alan D. Lessner, and Berit M. Verbist

72 Cavernous Sinus: Noninfectious Inflammatory Conditions and Acute and Chronic Infections 260
Anthony A. Mancuso, Mary Fran Smith, and Berit M. Verbist

73 Cavernous Sinus: Benign Tumors and Developmental Masses 270
Anthony A. Mancuso, Mary Fran Smith, and Berit M. Verbist

74 Cavernous Sinus: Malignant Tumors 283
Anthony A. Mancuso, Mary Fran Smith, and Berit M. Verbist

75 Cavernous Sinus: Vascular Abnormalities 291
Anthony A. Mancuso and Mary Fran Smith

76 Disorders of Conjugate Gaze: Cranial Nerve III, IV, and VI Neuropathies 299
Anthony A. Mancuso and Mary Fran Smith

77 Posterior Visual Pathways: Chiasm to Visual Cortex 307
Anthony A. Mancuso and Mary Fran Smith

SECTION IV ■ SINONASAL AND CRANIOFACIAL REGION INCLUDING CRANIAL NERVE V

78 Sinonasal and Craniofacial Region and Cranial Nerve V: Introduction and General Principles 311
Anthony A. Mancuso

79 Developmental Craniofacial Anomalies: Syndromic, Clefts, Encephaloceles (Brain Heterotopias), and Nasal Dermoids 334
Anthony A. Mancuso and William O. Collins

80 Cerebrospinal Fluid Leaks: Rhinorrhea and Otorrhea 345
Anthony A. Mancuso and William O. Collins

81 Choanal Atresia and Nasal Pyriform Aperture Stenosis and Infantile Upper Airway Obstruction 357
Anthony A. Mancuso and William O. Collins

82 Facial and Sinonasal Vascular Malformations and Proliferative Hemangiomas 366
Anthony A. Mancuso and William O. Collins

83 Functional Endoscopic Sinus Surgery 372
Anthony A. Mancuso, William O. Collins, and Carol J. Langdoc

84 Acute and Subacute Sinusitis 386
Anthony A. Mancuso, William O. Collins, and Carol J. Langdoc

85 Chronic Sinusitis and Nasal Polyposis 398
Anthony A. Mancuso, William O. Collins, and Carol J. Langdoc

86 Acute and Subacute Fungal Sinusitis 413
Anthony A. Mancuso and Carol J. Langdoc

87 Chronic Noninfectious Inflammatory Conditions: Granulomatoses and Histiocytoses 424
Anthony A. Mancuso and William O. Collins

88 Maxillofacial Trauma: Blunt-Force Fractures and Penetrating Injuries 430
Anthony A. Mancuso and Robert T. Adelson

89 Sinuses, Nasal Cavity, and Central Skull Base: Solid Malignant Tumors 452
Anthony A. Mancuso, William M. Mendenhall, and John W. Werning

90 Sinonasal Primary Bone Origin Tumors 476
Anthony A. Mancuso and John W. Werning

91 Fibrous Dysplasia and other Fibro-osseous Lesions of the Craniofacial Skeleton 479
Anthony A. Mancuso and William O. Collins

92 Sinonasal Systemic Malignancies 484
Anthony A. Mancuso, William M. Mendenhall, and John W. Werning

93 Primary Bony and Metabolic Disorders of the Craniofacial Skeleton 493
Anthony A. Mancuso

94 Disorders of Olfaction 496
Anthony A. Mancuso and Carol J. Langdoc

95 Trigeminal Neuralgia and other Trigeminal Neuropathies 502
Anthony A. Mancuso and Berit M. Verbist

96 Mandible: Introduction and General Principles 508
Anthony A. Mancuso, James C. Pettigrew, and Madhu K. Nair

97 Acute and Subacute Mandibular and Dental Infections and Noninfectious Inflammatory Conditions 519
Anthony A. Mancuso, James C. Pettigrew, and Madhu K. Nair

98 Mandibular Trauma: Blunt-Force Fractures and Penetrating Injuries 533
Anthony A. Mancuso, James C. Pettigrew, Madhu K. Nair, and James D. Ruskin

99 Mandible and Maxilla: Odontogenic Tumors and Cysts 547
Anthony A. Mancuso, James C. Pettigrew, Madhu K. Nair, and Emma L. Lewis

100 Mandible and Maxilla: Nonodontogenic Tumors and Cysts 558
Anthony A. Mancuso, James C. Pettigrew, Madhu K. Nair, and Emma L. Lewis

101 Temporomandibular Joint: Introduction, General Principles, and Internal Derangements 567
Anthony A. Mancuso, James C. Pettigrew, Madhu K. Nair, and James D. Ruskin

102 Temporomandibular Joint: Inflammatory, Degenerative, and Traumatic Conditions 578
Anthony A. Mancuso, James C. Pettigrew, Madhu K. Nair, and James D. Ruskin

103 Temporomandibular Joint Tumors 590
Anthony A. Mancuso, James C. Pettigrew, Madhu K. Nair, and James D. Ruskin

SECTION V ■ TEMPORAL BONE, POSTERIOR SKULL BASE, POSTERIOR FOSSA, AND CRANIAL NERVES

104 Temporal Bone, Posterior Skull Base, Posterior Fossa, and Cranial Nerves 596
Anthony A. Mancuso, Berit M. Verbist, and Patrick J. Antonelli

105 Developmental Abnormalities of the External and Middle Ear (Aural Atresias) and Cranial Nerve VII 669
Berit M. Verbist, Anthony A. Mancuso, and Patrick J. Antonelli

106 Developmental Abnormalities of the Inner Ear and Cranial Nerve VIII 690
Berit M. Verbist, Anthony A. Mancuso, and Patrick J. Antonelli

107 Genetic Causes of Hearing Loss: Syndromic and Nonsyndromic 718
Berit M. Verbist, Anthony A. Mancuso, and Patrick J. Antonelli

108 Vascular Variations, Anomalies, and Conditions of the Temporal Bone 724
Berit M. Verbist, Anthony A. Mancuso, and Patrick J. Antonelli

109 Pulse Synchronous (Pulsatile) Tinnitus 735
Berit M. Verbist, Anthony A. Mancuso, and Patrick J. Antonelli

110 Acute Otomastoiditis and Its Complications 742
Berit M. Verbist, Anthony A. Mancuso, and Patrick J. Antonelli

111 Chronic Otomastoiditis and Acquired Cholesteatoma 756
Berit M. Verbist, Anthony A. Mancuso, and Patrick J. Antonelli

112 Petrous Apex Mucosal Disease Including Petrous Apicitis 777
Berit M. Verbist, Anthony A. Mancuso, and Patrick J. Antonelli

113 Petrous Apex Cholesterol Granuloma/Cholesterolosis, Mucocele, and Epidermoid Cysts 784
Berit M. Verbist, Anthony A. Mancuso, and Patrick J. Antonelli

114 Necrotizing ("Malignant") Otitis Externa 796
Berit M. Verbist, Anthony A. Mancuso, and Patrick J. Antonelli

115 Temporal Bone and Skull Base Osteomyelitis other than Necrotizing Otitis Externa 805
Berit M. Verbist, Anthony A. Mancuso, and Patrick J. Antonelli

116 Temporal Bone: Noninfectious Inflammatory Diseases 813
Berit M.Verbist, Anthony A. Mancuso, and Patrick J. Antonelli

117 Labyrinthitis 817
Berit M. Verbist, Anthony A. Mancuso, and Patrick J. Antonelli

118 Otosclerosis 833
Berit M. Verbist, Anthony A. Mancuso, and Patrick J. Antonelli

119 Primary Bony Disorders of the Temporal Bone 853
Berit M. Verbist, Anthony A. Mancuso, and Patrick J. Antonelli

120 Temporal Bone Trauma 863
Berit M. Verbist, Anthony A. Mancuso, and Patrick J. Antonelli

121 Benign Masses of the Middle Ear, and Mastoid 875
Berit M. Verbist, Anthony A. Mancuso, and Patrick J. Antonelli

122 Malignant Tumors of the External and Middle Ear and Mastoid 887
Berit M. Verbist, Anthony A. Mancuso, William M. Mendenhall, and Patrick J. Antonelli

123 Temporal Bone Paragangliomas (Chemodectomas) 900
Berit M. Verbist, Anthony A. Mancuso, William M. Mendenhall, and Patrick J. Antonelli

124 Petrous Apex Benign Neoplasms and Slow-Flow Vascular Malformations 915
Berit M. Verbist, Anthony A. Mancuso, and Patrick J. Antonelli

125 Petrous Apex Chondrosarcoma 924
Berit M. Verbist, Anthony A. Mancuso, and Patrick J. Antonelli

126 Petrous Apex Malignant Tumors 929
Berit M. Verbist, Anthony A. Mancuso, and Patrick J. Antonelli

127 Bell Palsy: Acute Onset Peripheral Facial Nerve Palsy with No Apparent Cause 937
Berit M. Verbist, Anthony A. Mancuso, and Patrick J. Antonelli

128 Facial Nerve: Developmental Conditions 942
Berit M. Verbist, Anthony A. Mancuso, and Patrick J. Antonelli

129 Facial Nerve: Infectious and Noninfectious Inflammatory Conditions 951
Berit M. Verbist, Anthony A. Mancuso, and Patrick J. Antonelli

130 Facial Nerve: Benign Tumors 958
Berit M. Verbist, Anthony A. Mancuso, and Patrick J. Antonelli

131 Facial Nerve: Malignant Conditions 971
Berit M. Verbist, Anthony A. Mancuso, and Patrick J. Antonelli

132 Facial Nerve: Vascular Conditions 978
Berit M. Verbist, Anthony A. Mancuso, and Patrick J. Antonelli

133 Cochleovestibular Nerve and Cerebellopontine Angle Infections and Noninfectious Inflammatory Conditions 987
Berit M. Verbist, Anthony A. Mancuso, and Patrick J. Antonelli

134 Cochleovestibular Nerve and Cerebellopontine Angle Tumors and Cysts 994
Berit M. Verbist, Anthony A. Mancuso, and Patrick J. Antonelli

135 Cochleovestibular Nerve: Vascular Conditions 1018
Berit M. Verbist, Anthony A. Mancuso, and Patrick J. Antonelli

136 Cochlear and Auditory Brain Stem Implants 1026
Berit M. Verbist, Anthony A. Mancuso, and Patrick J. Antonelli

137 Glossopharyngeal Neuropathy and Referred Otalgia 1040
Berit M. Verbist, Anthony A. Mancuso, and Patrick J. Antonelli

138 Vagal Neuropathy, Vocal Cord Weakness, and Referred Otalgia 1054
Berit M. Verbist, Anthony A. Mancuso, and Patrick J. Antonelli

139 Spinal Accessory Neuropathy 1067
Berit M. Verbist, Anthony A. Mancuso, and Patrick J. Antonelli

140 Hypoglossal Nerve Neuropathy and Dysarthria 1075
Berit M. Verbist, Anthony A. Mancuso, Patrick J. Antonelli

141 Horner Syndrome: Cervical Sympathetic/Oculosympathetic Neuropathy 1085
Berit M. Verbist, Anthony A. Mancuso, and Patrick J. Antonelli

VOLUME II

SECTION VI ■ THE SUPRAHYOID NECK

142 Suprahyoid Neck and Related Spaces: Introduction and General Principles 1098
Anthony A. Mancuso

143 Prestyloid Parapharyngeal Space Masses 1110
Anthony A. Mancuso

144 Retrostyloid Parapharyngeal Space Masses 1124
Anthony A. Mancuso

145 Masticator Space, Buccal Space, and Infratemporal Fossa Masses 1141
Anthony A. Mancuso

146 Masticator Space, Buccal Space, and Infratemporal Fossa Infections and Other Inflammatory Conditions 1157
Anthony A. Mancuso

147 Retropharyngeal and Prevertebral Space Masses 1164
Anthony A. Mancuso

148 Retropharyngeal and Prevertebral Space Inflammatory Conditions 1173
Anthony A. Mancuso

SECTION VII ■ INFRAHYOID NECK AND CERVICO-THORACIC JUNCTION (THORACIC INLET)

149 Infrahyoid Neck, Head and Neck Lymphatic System, and Thoracic Inlet: Introduction and General Principles 1189
Anthony A. Mancuso

150 Infrahyoid Neck: Visceral Compartment and Retropharyngeal Conditions Presenting as a Neck Mass 1218
Anthony A. Mancuso

151 Retropharyngeal and Visceral Compartment Inflammatory Conditions 1227
Anthony A. Mancuso

152 Retropharyngeal and Prevertebral Space Masses 1237
Anthony A. Mancuso

153 Branchial Apparatus Developmental Anomalies 1242
Anthony A. Mancuso

154 Lateral Compartment: Vascular Conditions Including Penetrating and Iatrogenic Injuries 1261
Anthony A. Mancuso

155 Lateral Compartment: Nonnodal Infectious and Inflammatory Conditions 1276
Anthony A. Mancuso

156 Lateral Compartment: Nonnodal Masses 1284
Anthony A. Mancuso

157 Cervical Metastatic Disease and the "Unknown" Primary 1294
Anthony A. Mancuso, William M. Mendenhall, John W. Werning, and Ilona M. Schmalfuss

158 Cervical Adenopathy: Reactive and Infectious 1335
Anthony A. Mancuso

159 Cervical Adenopathy Due to Benign and Malignant Systemic Diseases **1347**
Anthony A. Mancuso

160 Posterior Compartment: Prevertebral and Paravertebral Space Inflammatory Conditions **1360**
Anthony A. Mancuso

161 Posterior Compartment: Benign and Developmental Masses **1368**
Anthony A. Mancuso

162 Posterior Compartment: Malignant Masses **1376**
Anthony A. Mancuso

163 Cervicothoracic Junction and Brachial Plexus Conditions: General Diagnostic Approach **1382**
Anthony A. Mancuso

164 Cervicothoracic Junction and Brachial Plexus: Developmental Conditions **1394**
Anthony A. Mancuso

165 Cervicothoracic Junction: Brachial Plexus Vascular Conditions **1399**
Anthony A. Mancuso

166 Cervicothoracic Junction: Brachial Plexus Inflammatory Conditions **1404**
Anthony A. Mancuso

167 Cervicothoracic Junction: Brachial Plexus Benign and Malignant Tumors **1409**
Anthony A. Mancuso

168 Cervicothoracic Junction: Brachial Plexus Trauma **1420**
Anthony A. Mancuso

SECTION VIII ■ THYROID AND PARATHYROID GLANDS

169 Thyroid and Parathyroid Glands: Introduction **1428**
Anthony A. Mancuso

170 Thyroid Developmental Anomalies **1434**
Anthony A. Mancuso

171 Goiter: Nontoxic Thyroid Gland Enlargement **1449**
Anthony A. Mancuso and Mikhail Vaysberg

172 Thyroid: Nodules and Malignant Tumors **1457**
Anthony A. Mancuso, William M. Mendenhall, and Mikhail Vaysberg

173 Thyroid Gland Inflammatory Disease and Trauma **1482**
Anthony A. Mancuso

174 Parathyroid Glands: Hyperparathyroidism **1487**
Anthony A. Mancuso and Mikhail Vaysberg

SECTION IX ■ MAJOR SALIVARY GLANDS: PAROTID, SUBMANDIBULAR, SUBLINGUAL

175 Major Salivary Glands and Peripheral Facial Nerve: Parotid, Submandibular, and Sublingual and Related Spaces—Introduction and General Imaging Principles **1498**
Anthony A. Mancuso

176 Parotid Gland Developmental Anomalies **1522**
Anthony A. Mancuso

177 Parotid Infections **1530**
Anthony A. Mancuso and Mikhail Vaysberg

178 Parotid Noninfectious Inflammatory Conditions **1543**
Anthony A. Mancuso

179 Parotid Tumors and Tumorlike Conditions **1555**
Anthony A. Mancuso, Mikhail Vaysberg, and William M. Mendenhall

180 Submandibular Gland and Space Developmental Anomalies **1584**
Anthony A. Mancuso and Mikhail Vaysberg

181 Submandibular Gland and Space: Infectious and Noninfectious Inflammatory Diseases **1589**
Anthony A. Mancuso and Mikhail Vaysberg

182 Tumors of the Submandibular Gland and Space and Tumorlike Conditions **1605**
Anthony A. Mancuso, William M. Mendenhall, and Mikhail Vaysberg

183 Tumors of the Sublingual Gland and Space and Tumorlike and Inflammatory Conditions **1622**
Anthony A. Mancuso, Mikhail Vaysberg, and William M. Mendenhall

SECTION X ■ NASOPHARYNX

184 Nasopharynx: Introduction **1639**
Anthony A. Mancuso

185 Nasopharynx: Developmental Abnormalities **1660**
Anthony A. Mancuso

186 Nasopharynx: Infections **1669**
Anthony A. Mancuso

187 Nasopharynx: Noninfectious Inflammatory Conditions **1679**
Anthony A. Mancuso

188 Nasopharynx: Malignant Tumors **1684**
Anthony A. Mancuso and William M. Mendenhall

189 Nasopharynx: Juvenile Angiofibroma **1712**
Anthony A. Mancuso, William M. Mendenhall, and Mikhail Vaysberg

SECTION XI ■ OROPHARYNX

190 Oropharynx: Introduction **1728**
Anthony A. Mancuso and Robert Hermans

191 Oropharynx Developmental Abnormalities **1744**
Robert Hermans, Anthony A. Mancuso, and William O. Collins

192 Oropharynx: Infectious and Noninfectious Inflammatory Conditions **1752**
Robert Hermans, Anthony A. Mancuso, and William O. Collins

193 Oropharynx and Oral Cavity: Acute and Chronic Effects of Blunt and Penetrating and Iatrogenic Trauma **1767**
Robert Hermans, Anthony A. Mancuso, and William O. Collins

194 Oropharynx: Benign Noninflammatory Masses and Tumors **1773**
Robert Hermans, Anthony A. Mancuso, and William O. Collins

195 Oropharynx: Malignant Tumors 1780
Anthony A. Mancuso, William M. Mendenhall, and John W. Werning

SECTION XII ■ ORAL CAVITY AND FLOOR OF THE MOUTH

196 Oral Cavity and Floor of the Mouth: Introduction 1813
Anthony A. Mancuso and Robert Hermans

197 Oral Cavity: Developmental Abnormalities 1828
Robert Hermans, Anthony A. Mancuso, and William O. Collins

198 Oral Cavity: Infectious and Noninfectious Inflammatory Conditions 1836
Robert Hermans, Anthony A. Mancuso, and William O. Collins

199 Oral Cavity and Floor of the Mouth: Benign Tumors 1844
Robert Hermans, Anthony A. Mancuso, and William O. Collins

200 Oral Cavity and Floor of the Mouth: Malignant Tumors 1851
Anthony A. Mancuso, William N. Mendenhall, and John W. Werning

SECTION XIII ■ LARYNX, HYPOPHARYNX, AND CERVICAL ESOPHAGUS

201 Larynx: Introduction, Normal Anatomy, and Function 1893
Robert Hermans and Anthony A. Mancuso

202 Larynx: Developmental Abnormalities 1925
Robert Hermans, Anthony A. Mancuso, and William O. Collins

203 Laryngocele 1935
Robert Hermans, Anthony A. Mancuso, and William O. Collins

204 Larynx: Infectious and Noninfectious Inflammatory Diseases 1946
Robert Hermans, Anthony A. Mancuso, and William O. Collins

205 Larynx: Benign Noninflammatory Masses and Tumors 1964
Robert Hermans, Anthony A. Mancuso, and William O. Collins

206 Larynx: Malignant Tumors 1975
Robert Hermans, Anthony A. Mancuso, William N. Mendenhall, and John W. Werning

207 Larynx: Acute and Chronic Effects of Blunt and Penetrating Trauma 2022
Robert Hermans, Anthony A. Mancuso, and William O. Collins

208 Larynx: Iatrogenic Trauma and Subglottic Stenosis 2045
Robert Hermans, Anthony A. Mancuso, and William O. Collins

SECTION XIV ■ TRACHEA

209 Trachea: Introduction 2058
Anthony A. Mancuso

210 Trachea: Developmental Abnormalities 2065
Anthony A. Mancuso and William O. Collins

211 Trachea: Infectious and Noninfectious Inflammatory Diseases 2074
Anthony A. Mancuso and William O. Collins

212 Trachea: Benign and Malignant Tumors 2081
Anthony A. Mancuso, William O. Collins, and William M. Mendenhall

213 Trachea: Acute and Chronic Effects of Blunt and Penetrating Trauma and Mucosal Injury 2093
Anthony A. Mancuso and William O. Collins

214 Tracheal Stenosis, Tracheomalacia, and Iatrogenic Trauma 2100
Anthony A. Mancuso and William O. Collins

SECTION XV ■ HYPOPHARYNX

215 Hypopharynx: Introduction, Normal Anatomy, and Function 2114
Robert Hermans and Anthony A. Mancuso

216 Hypopharynx: Developmental Abnormalities 2125
Robert Hermans, Anthony A. Mancuso, and William O. Collins

217 Hypopharynx and Cervical Esophagus: Infectious and Noninfectious Inflammatory Diseases 2133
Robert Hermans, Anthony A. Mancuso, and William O. Collins

218 Hypopharynx: Benign Noninflammatory Masses and Tumors 2141
Robert Hermans, Anthony A. Mancuso, and William O. Collins

219 Hypopharynx: Malignant Tumors 2147
Robert Hermans, Anthony A. Mancuso, William M. Mendenhall, and John W. Werning

220 Hypopharynx and Cervical Esophagus: Acute and Chronic Effects of Blunt, Penetrating, and Iatrogenic Trauma 2173
Robert Hermans, Anthony A. Mancuso, and William O. Collins

SECTION XVI ■ CERVICAL ESOPHAGUS

221 Cervical Esophagus: Introduction 2186
Anthony A. Mancuso

222 Cervical Esophagus: Developmental Abnormalities 2191
Anthony A. Mancuso and William O. Collins

223 Cervical Esophagus: Benign and Malignant Tumors 2198
Anthony A. Mancuso, William M. Mendenhall, and John W. Werning

Appendix A: Computed Tomography Protocols for ENT 2211

Appendix B: Magnetic Resonance Protocols for Neuroradiology 2230

Appendix C: Spread of Patterns of Head and Neck Malignancies 2258

Index I-1

SECTION III ■ THE EYE, ORBIT AND VISUAL PATHWAYS INCLUDING CRANIAL NERVES III, IV AND VI

CHAPTER 44 ■ EYE, ORBIT, VISUAL PATHWAYS, AND CRANIAL NERVES III, IV, AND VI: INTRODUCTION AND GENERAL PRINCIPLES

BERIT M. VERBIST, ANTHONY A. MANCUSO, AND M. TARIQ BHATTI

TECHNICAL ASPECTS

Techniques and Relevant Aspects

Plain films should only be used infrequently for orbital problems. Standard film/screen, digital radiography, or computed radiology techniques are appropriate for the now very infrequent indications for plain radiography.

Ultrasound is generally performed with an 8- to 10-MHz transducer. Either A mode or B mode, color flow, and power Doppler techniques are used depending on specific indications. These examinations are usually performed by ophthalmologists. They are used to evaluate both intraocular and orbital pathology. Other imaging methods frequently used by ophthalmologists to evaluate ocular structures and pathology are autofluorescence, fluorescein angiography, and optical coherence tomography (OCT). Autofluorescence is based upon the naturally occurring fluorescent emission of ocular tissues and is used to evaluate retinal diseases and vascular abnormalities. To examine the circulation of the retina, fluorescein angiography is used: After injection of sodium fluorescein into the systemic circulation, the fluorescence emitted after illumination of the retina is recorded. By use of this method, diabetic retinopathy, vascular occlusions, edema of the optic disc, and tumors can be detected. OCT is a noninvasive imaging technique with millimeter penetration and submicron resolution producing high-resolution cross-sectional images of optical reflectivity. Topographic maps can be obtained. The images are displayed in a color scheme. OCT is particularly suitable to examine retinal thickness.

Specific computed tomography (CT) techniques by indications are detailed in Appendix A. In the past, gantry angulation may have been changed from the usual zero degrees to the infraorbital meatal line (IOML) to –10 degrees for emphasis on the course of the optic nerve toward and then through the optic canal. Such angling is really not necessary with ≥16 slice multidetector computed tomography (MDCT) and workstation viewing since slightly off-axial axis reformations done at the workstation from the axial data set are not significantly degraded. Acquisition slice thickness (SLT) should be ≤0.5 to 1.0 mm. Reformations will be of excellent quality with such data acquisition.

Intravenous contrast is used frequently. If calcifications are important to the detection of pathology and/or differential diagnosis, a noncontrast acquisition should be done. That decision should be made on a case-by-case basis to avoid a radiation dose to the lens. This is typically only done in practice for the initial evaluation of a child with possible retinoblastoma. Non–contrast enhanced CT is also done initially to rule out an intraorbital foreign body. Magnetic resonance imaging (MRI) can also be useful for foreign bodies if they are composed of plant or similar organic material.

Scanning with and without a Valsalva maneuver, with the orbit in different dependent positions, or with venous compression may be very useful in the rare cases of suspected orbital varices.[1]

Specific magnetic resonance (MR) protocols are outlined in Appendix B. MR examinations of the orbit are routinely done with a localized volume receiver coil that allows for visualization of both orbits and surrounding structures of interest such as the paranasal sinuses. A localized surface coil may be useful for higher-resolution studies of ocular or single orbit pathology that does not require visualization of more posterior structures. A standard volume head coil is used for studies of the visual pathways.

SLT should be ≤3 mm. A field of view of 8 to 10 cm with a localized receiver coil if only the eye is studied and 12 to 16 cm if the entire orbital area on both sides must be included as a region of interest.

All eye makeup, especially mascara and shadow, should be removed for MR studies. The head should be positioned so that the IOML is perpendicular to the tabletop; the head may be tilted back in a "chin up" position 10 degrees if the optic nerve and canal are of primary interest. Alternatively, a quick view can be done to choose the optimal plane. Oblique sagittal acquisitions in the plane of the optic nerve are occasionally useful for studying the optic nerve. Standard two-dimensional Fourier transform (2DFT), spin echo (SE) techniques are usually used; fast spin echo (FSE) sequences are used for T2-weighted images. Fat-nulling short TI inversion recovery (STIR) or true fat suppression pulse sequences are included to evaluate the orbit. Currently, frequency selective fat suppression is the most common fat suppression method employed. This suffers from sometimes critical susceptibility artifacts at the margins of the orbits and surrounding air-filled sinuses as well as along the course of the second through sixth cranial nerves as they lie along a well-aerated sphenoid sinus. This significant problem is discussed in Chapters 1 and 3 (Fig. 1.4).

This problem is magnified at 3 Tesla (T). Fat suppression is, however, uniformly superb in the midportion of the muscle cone for evaluation of pathologic changes involving the optic nerve and sheath and surrounding intraconal fat.

Another artifact encountered frequently in orbital MRI is chemical shift or water–fat shift (WFS). The artifact increases the higher the field strength. The WFS decreases with higher receiver bandwidth; however, this occurs at the expense of signal-to-noise ratio (Figs. 3.2 and 44.1). Although WFS will still be present, fat suppression techniques will render the WFS artifact invisible.

Imaging of the eye and orbit is also susceptible to motion artifacts, causing blurring and signal throughout the object and the background, most pronounced in the phase-encoding direction. Whereas a frequency-encoding step is acquired in the time of a single echo, this taking a few milliseconds, a phase-encoding step requires collection of all lines of k-space, each separated by repetition time that takes minutes. This explains why motion artifacts along the frequency-encoding direction are usually insignificant.

Intravenous paramagnetic contrast is used frequently. Magnetic resonance angiography (MRA) is used most frequently for lesions of the cavernous sinus region or suspected cases of intracranial aneurysms and those of the ophthalmic artery or posterior communicating artery aneurysms in particular. MRA is usually done with a time of flight technique optimized for spatial resolution and background suppression; the technical aspects of this were detailed in Chapters 1 and 3.

Much diagnostic angiography in this anatomic region area is done by computed tomographic angiography (CTA) or MRA. Such studies should be done with as high a resolution technique as possible. In general, CTA should be done with 0.5- to 1.0-mm–thick sections. Bone subtraction CTA for this area, which is so intimately related to the central skull base, may prove more definitive than standard postprocessing techniques segmenting out bone from vessels. MRA of definitive quality is usually not possible on units operating under 1 T, but lower field units may produce studies sufficient for gross screening in selected circumstances.

Catheter angiography is reserved as a prelude to endovascular therapy and in high flow lesions and or when the smaller vessel angioarchitecture is important in medical decision making.

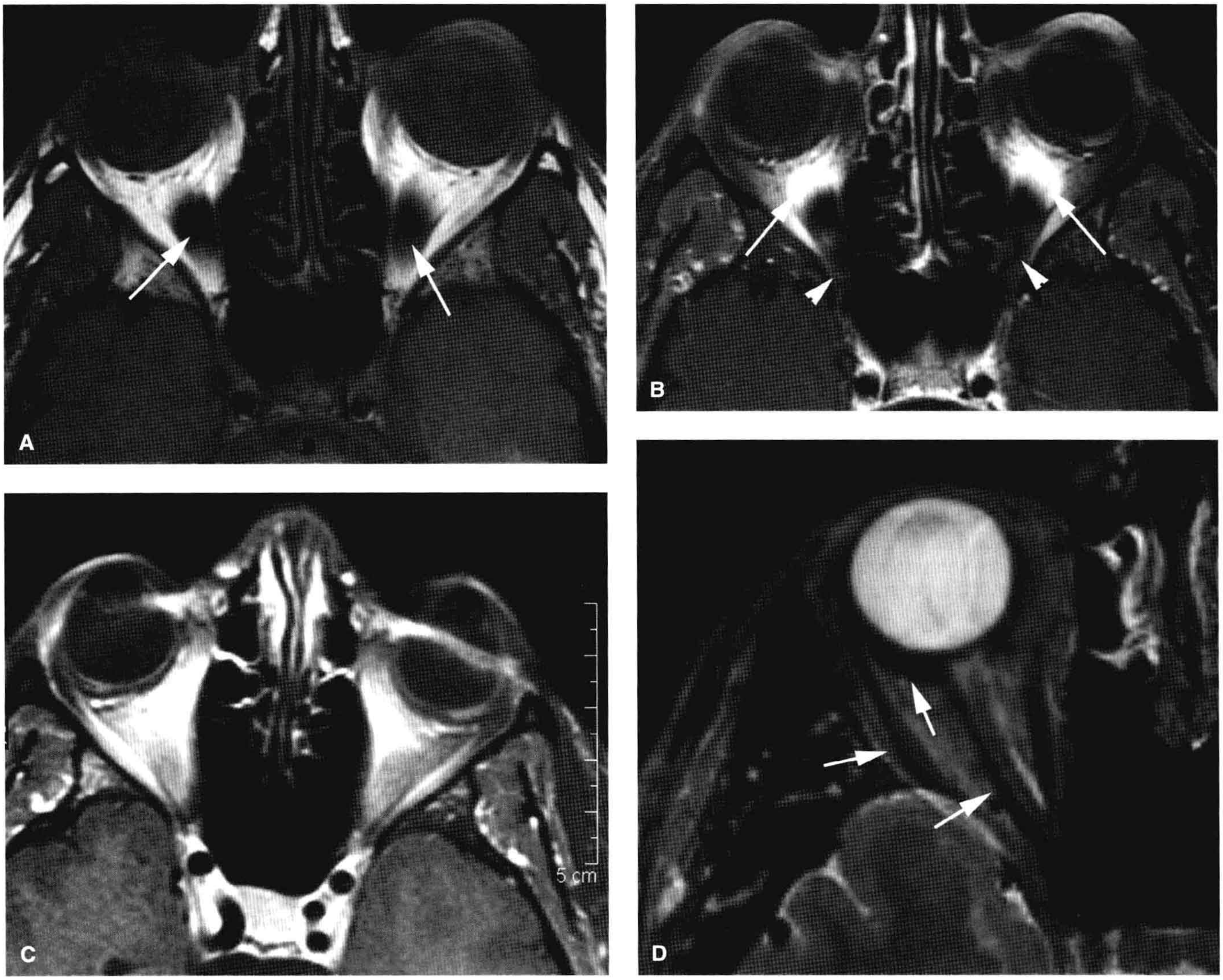


FIGURE 44.1. Artifacts as seen on magnetic resonance imaging of the orbit. **A, B:** The field distortion artifacts seen along the floor of the orbit (*arrows* in **A**) become much exaggerated in the fat suppression image (*arrows* in **B**). The field distortion artifacts that are much worse in (**B**) also obscure the anatomy at the orbital apex (*arrowheads*). **C:** Field distortion artifacts due to permanently placed eyeliner as a tattoo. **D:** Water–fat shift artifact (*arrows*).