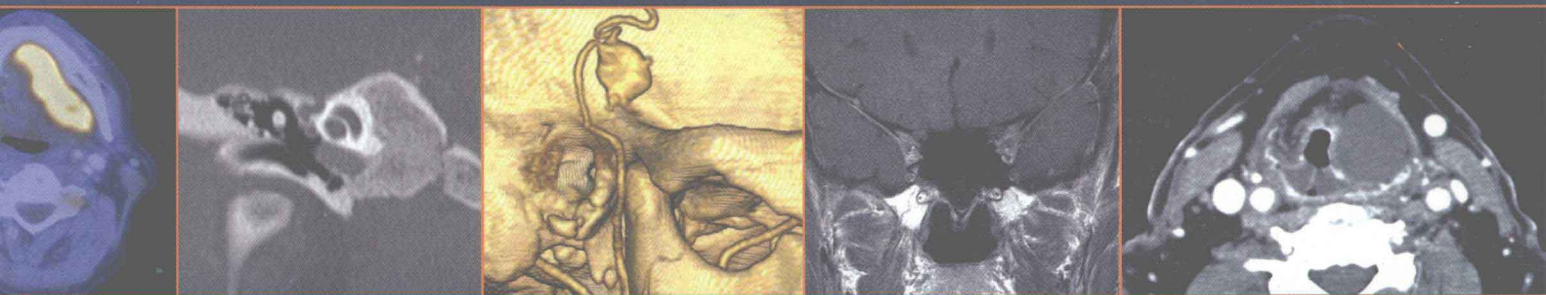


Peter M. Som • Hugh D. Curtin

HEAD and NECK IMAGING

Fifth Edition



Volume 2

UPPER AERODIGESTIVE TRACT

NECK

MOLECULAR-BASED DIAGNOSIS AND
NONSURGICAL TREATMENT OF CANCER

FIFTH EDITION

HEAD and NECK IMAGING

Volume 2

Peter M. Som, MD, FACR

Professor of Radiology, Otolaryngology—Head and Neck Surgery,
and Radiation Oncology

The Mount Sinai School of Medicine of New York University

Chief of Head and Neck Imaging Section

Mount Sinai Medical Center

New York, New York

Hugh D. Curtin, MD

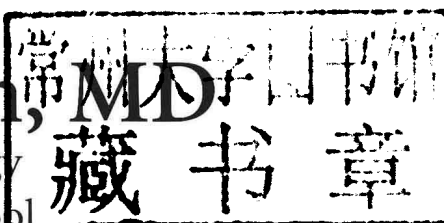
Professor of Radiology
Harvard Medical School

Chief of Radiology

Department of Radiology

Massachusetts Eye and Ear Infirmary

Boston, Massachusetts



MOSBY



ELSEVIER

No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording, or any information storage and retrieval system, without permission in writing from the publisher. Details on how to seek permission, further information about the Publisher's permissions policies, and our arrangements with organizations such as the Copyright Clearance Center and the Copyright Licensing Agency, can be found at our website: www.elsevier.com/permissions.

This book and the individual contributions contained in it are protected under copyright by the Publisher (other than as may be noted herein).

Notices

Knowledge and best practice in this field are constantly changing. As new research and experience broaden our understanding, changes in research methods, professional practices, or medical treatment may become necessary.

Practitioners and researchers must always rely on their own experience and knowledge in evaluating and using any information, methods, compounds, or experiments described herein. In using such information or methods they should be mindful of their own safety and the safety of others, including parties for whom they have a professional responsibility.

With respect to any drug or pharmaceutical products identified, readers are advised to check the most current information provided (i) on procedures featured or (ii) by the manufacturer of each product to be administered, to verify the recommended dose or formula, the method and duration of administration, and contraindications. It is the responsibility of practitioners, relying on their own experience and knowledge of their patients, to make diagnoses, to determine dosages and the best treatment for each individual patient, and to take all appropriate safety precautions.

To the fullest extent of the law, neither the Publisher nor the authors, contributors, or editors, assume any liability for any injury and/or damage to persons or property as a matter of products liability, negligence or otherwise, or from any use or operation of any methods, products, instructions, or ideas contained in the material herein.

Previous editions copyrighted 2003, 1996, 1991, 1984 by Mosby, Inc.

ISBN: 978-0-323-05355-6

Acquisitions Editor: Rebecca Gaertner
Developmental Editor: Lisa Barnes
Publishing Services Manager: Patricia Tannian
Senior Project Manager: John Casey
Designer: Steven Stave

Printed in China

Last digit is the print number: 9 8 7 6 5 4 3 2 1

Working together to grow
libraries in developing countries

www.elsevier.com | www.bookaid.org | www.sabre.org

ELSEVIER

BOOK AID
International

Sabre Foundation

HEAD and NECK IMAGING

Contributors

James J. Abrahams, MD

*Professor of Diagnostic (Neuroradiology) and Surgery
(Otolaryngology)*

Fellowship Program Director, Neuroradiology

Director of Medical Studies

Department of Diagnostic Radiology

Yale University School of Medicine

New Haven, Connecticut

Bruce S. Bauer, MD, FACS, FAAP

Department of Pediatric Plastic Surgery

North Shore University Health System

Highland Park Hospital

Highland Park, Illinois

Kristen L. Baugnon, MD

Assistant Professor

Department of Radiology, Division of Neuroradiology

Emory University School of Medicine

Atlanta, Georgia

Andrew D. Bergemann, MD

Assistant Professor

Department of Science Education

Hofstra University North Shore—LIJ School of Medicine

Hempstead, New York

R. Thomas Bergeron, MD

Professor, Department of Radiology

New York University Langone Medical Center

Tish Hospital

Attending Radiologist

Department of Radiology

Bellevue Hospital

New York, New York

Jorge Bianchi, DMD, MMSc

Invited Professor

Department of Oral Rehabilitation

Universidad Mayor

Radiologist, Department of Radiology

Oral and Maxillofacial Radiologist

Department of Dental Medicine

Clinica Santa Maria

Radiologist, Department of Radiology

Radix Radiologia Odontomaxilofacial

Santiago, Chile

Susan I. Blaser, MD

Staff Radiologist

Division of Neuroradiology

The Hospital for Sick Children

Associate Professor

Medical Imaging

University of Toronto

Toronto, Ontario, Canada

Margaret S. Brandwein-Gensler, MD

Professor of Pathology and Surgery

Section Head, Surgical Pathology

Department of Pathology

University of Alabama at Birmingham

Attending Physician

Department of Pathology and Surgery

University of Alabama Hospitals

Birmingham, Alabama

Ryan J. Burri, MD

Instructor of Clinical Radiation Oncology

Columbia University College of Physicians and Surgeons

Instructor of Clinical Radiation Oncology

Columbia University Medical Center

New York Presbyterian Hospital

New York, New York

Jan W. Casselman, MD, PhD

Academic Consultant

Department of Radiology

University Hospital—Gent

Gent, Belgium;

Chairman

Department of Radiology—Medical Imaging

AZ St. Jan Brugge-Oostende AV

Brugge, Belgium;

Consultant Radiologist

Department of Radiology

AZ St. Augustinus

Wilrijk Antwerpen, Belgium

J. A. Castelijns, MD, PhD

Department of Radiology

VU University Medical Center

Amsterdam, The Netherlands

Mary Elizabeth Cunnane, MD

*Instructor, Department of Radiology
Harvard Medical School
Staff Radiologist
Department of Radiology
Massachusetts Eye and Ear Infirmary
Boston, Massachusetts*

Hugh D. Curtin, MD

*Professor of Radiology
Harvard Medical School
Chief of Radiology
Department of Radiology
Massachusetts Eye and Ear Infirmary
Boston, Massachusetts*

John M. DelGaudio, MD

*Professor, Chief of Rhinology and Sinus Surgery
Emory University
Atlanta, Georgia*

Bradley N. Delman, MD

*Associate Professor of Radiology
The Mount Sinai School of Medicine of New York University
New York, New York*

Damian E. Dupuy, MD, FACP

*Professor of Diagnostic Imaging
The Warren Alpert Medical School of Brown University
Director of Tumor Ablation
Rhode Island Hospital
Providence, Rhode Island*

Girish M. Fatterpekar, MD

*Assistant Professor of Radiology
James J. Peters Veterans Administration Hospital
Mount Sinai Medical Center
New York, New York*

Reza Forghani, MD, PhD, FRCPC

*Assistant Professor
Department of Diagnostic Radiology
McGill University
Attending Radiologist
Department of Radiology
Sir Mortimer B. Davis—Jewish General Hospital
Montreal, Quebec, Canada*

Elliott R. Friedman, MD

*Assistant Professor
Department of Diagnostic and Interventional Imaging
University of Texas Medical School at Houston
Houston, Texas
Neuroradiology Fellow
Department of Radiology
Emory University
Atlanta, Georgia*

Matthew Gardiner, MD

*Instructor
Department of Ophthalmology
Harvard Medical School
Director, Emergency Ophthalmology Services
Massachusetts Eye and Ear Infirmary
Boston, Massachusetts*

Eric M. Genden, MD

*Professor and Chairman
Department of Otolaryngology—Head and Neck Surgery
The Mount Sinai School of Medicine of New York University
New York, New York*

Matthew David Gilman, MD

*Instructor, Department of Radiology
Harvard University
Associate Director
Division of Thoracic Imaging
Department of Radiology
Massachusetts General Hospital
Boston, Massachusetts*

Lawrence E. Ginsberg, MD

*Professor, Department of Diagnostic Radiology
Division of Diagnostic Imaging
The University of Texas MD Anderson Cancer Center
Adjunct Clinical Professor of Radiology
Baylor College of Medicine
Houston, Texas*

Tessa A. Goldsmith, MA, CCC-SLP, BRS-S

*Associate Director
Speech, Language and Swallowing Disorders
Massachusetts General Hospital
Boston, Massachusetts*

Rajiv Gupta, MD, PhD

*Instructor, Department of Radiology
Harvard Medical School
Assistant Radiologist
Director, Ultra High Resolution Volume CT
Department of Radiology
Massachusetts General Hospital
Massachusetts General Hospital Site Miner
Center for Integration of Medicine and Innovative Technology
Massachusetts General Hospital
Boston, Massachusetts*

Mari Hagiwara, MD

*Assistant Professor, Department of Radiology
New York University School of Medicine
Assistant Professor, Department of Radiology
New York University Langone Medical Center
Assistant Professor, Department of Radiology
Bellevue Hospital
New York, New York*

Anton N. Hasso, MD

*Professor, Department of Radiological Sciences
 Director, Neuroimaging Research and Development
 College of Medicine
 Professor of Radiological Science
 Professor of Otolaryngology—Head and Neck Surgery
 University of California at Irvine
 Orange, California*

Michael W. Hayt, MD

*Medical Director and Director of Neuroradiology
 Central Florida Center for Diagnostic Imaging
 Winter Park, Florida*

Allison S. Holman, MS, CCC-SLP

*Speech Language Pathologist
 Department of Speech, Language and Swallowing Disorders
 Massachusetts General Hospital
 Boston, Massachusetts*

Patricia A. Hudgins, MD

*Professor of Radiology/Otolaryngology
 Department of Radiology
 Emory University School of Medicine
 Director of Head and Neck Radiology
 Department of Radiology
 Emory University Hospital
 Atlanta, Georgia*

Jason D. Iannuccilli, MD

*Department of Radiology
 Alpert Medical School of Brown University
 Department of Radiology
 Rhode Island Hospital
 Providence, Rhode Island*

Amy F. Tsang Juliano, MD

*Instructor, Department of Radiology
 Harvard Medical School
 Staff Radiologist
 Department of Radiology
 Massachusetts Eye and Ear Infirmary
 Staff Radiologist
 Department of Neuroradiology
 Brigham and Women's Hospital
 Boston, Massachusetts*

Takashi Kaneda, DDS, PhD

*Chief and Professor
 Department of Radiology
 Nihon University School of Dentistry at Matsudo
 Chief and Professor
 Department of Radiology
 Nihon University Hospital at Matsudo
 Matsudo, Chiba, Japan*

Melissa D. Kang, MD

*Assistant Professor
 Department of Neuroradiology
 Thomas Jefferson University Hospital
 Philadelphia, Pennsylvania*

Johnny Kao, MD

*Assistant Professor of Radiation Oncology
 The William Harris Research Fellow
 The Mount Sinai School of Medicine of New York University
 New York, New York*

Edward E. Kassel, MD, DDS, FRCPC, FACR

*Associate Professor
 Departments of Medical Imaging, Otolaryngology, and
 Ophthalmology
 University of Toronto
 Head, Division of Head and Neck Radiology
 Joint Department of Medical Imaging
 Mount Sinai Medical Center University Health Network
 Toronto, Ontario, Canada*

Lale Kostakoglu, MD

*Professor of Radiology
 The Mount Sinai School of Medicine of New York University
 Director of PET/CT Oncology and Research
 Mount Sinai Medical Center
 New York, New York*

Ilhami Kovanlikaya, MD

*Professor of Radiology
 Associate Research Professor of Radiology
 Department of Radiology
 Weill Cornell Medical College, Cornell University
 New York, New York*

Saulo Lacerda, MD

*Department of Radiology
 Image Memorial—Dasa
 Salvador, Bahia, Brazil*

Jeffrey T. Laitman, PhD

*Professor and Director of Anatomy and Functional Morphology
 Director of Gross Anatomy
 Professor of Otolaryngology
 The Mount Sinai School of Medicine of New York University
 Professor of Anthropology
 City University of New York
 Research Associate in Anthropology
 American Museum of Natural History
 New York, New York*

J. S. Lameris, PhD, MD

*Professor, Department of Radiology
 University of Amsterdam
 Professor, Department of Radiology
 Academic Medical Center of Amsterdam
 Amsterdam, The Netherlands*

Meng Law, MD, MBBS, FRACR

*Professor of Radiology and Neurological Surgery
Director of Neuroradiology
Keck School of Medicine
University of Southern California
Los Angeles, California*

William Lawson, MD, DDS

*Professor and Vice Chairman
Department of Otolaryngology—Head and Neck Surgery
The Mount Sinai School of Medicine of New York University
New York, New York*

Ruby J. Lien, MD

*Resident, Department of Radiology
St. Luke's—Roosevelt Hospital Center
Columbia University College of Physicians and Surgeons
New York, New York*

William W. M. Lo, MD

*St. Vincent Medical Center
Clinical Professor of Radiology
University of Southern California
Los Angeles, California*

Laurie A. Loevner, MD

*Professor, Department of Radiology
University of Pennsylvania Hospital
Philadelphia, Pennsylvania*

Neel Madan, MD

*Assistant Professor of Radiology
Tufts University School of Medicine
Assistant Professor of Radiology
Tufts Medical Center
Boston, Massachusetts*

Mahmood F. Mafee, FACR

*Clinical Professor
Department of Radiology
University of California, San Diego
Clinical Professor
Department of Radiology
University of California, San Diego Medical Center
San Diego, California*

M. Marcel Maya, MD

*Neuroradiologist
Department of Imaging
Cedars Sinai Medical Center
Los Angeles, California*

David G. McLone, MD, PhD

*Professor of Neurosurgery
The Childrens Memorial Hospital and Feinberg School
of Medicine
Northwestern University
Chicago, Illinois*

Gul Moonis, MD

*Assistant Professor of Radiology
Staff Neuroradiologist
Department of Radiology
Beth Israel Deaconess Medical Center
Assistant in Radiology
Department of Radiology
Massachusetts Eye and Ear Infirmary
Boston, Massachusetts*

Suresh K. Mukherji, MD, FACR

*Professor and Chief of Neuroradiology and Head and Neck
Radiology
Professor of Radiology, Otolaryngology—Head and Neck
Surgery, Radiation Oncology, Periodontics, and Oral
Medicine
Department of Radiology
University of Michigan Health System
Ann Arbor, Michigan*

Thomas P. Naidich, MD

*Director of Neuroradiology
Vice Chair of Radiology for Academic Affairs/Research
Professor of Radiology and Neurosurgery
Irving and Dorothy Regenstreif Research Professor of
Neuroscience (Neuroimaging)
Department of Radiology
The Mount Sinai School of Medicine of New York University
New York, New York*

Shyamala C. Navada, MD

*Assistant Professor of Medicine
Division of Hematology/Oncology Tisch Cancer Institute
The Mount Sinai School of Medicine of New York University
New York, New York*

Danny Nunn, MS, CCC-SLP

*Speech Pathologist
Department of Speech, Language and Swallowing Disorders
Massachusetts General Hospital
Boston, Massachusetts*

Tomohiro Okano, DDS, PhD

*Professor and Chairman
Department of Radiology
Showa University School of Dentistry
Tokyo, Japan*

Mika Otonari-Yamamoto, DDS, PhD

*Department of Oral and Maxillofacial Surgery
Tokyo Dental College
Chiba, Japan*

Stuart Packer, MD

*Assistant Professor of Medicine, Hematology, and Medical
Oncology
The Mount Sinai School of Medicine of New York University
New York, New York*

Colin S. Poon, MD, PhD, FRCPC

*Assistant Professor of Radiology
Director of Head and Neck Imaging
Director of Neuroradiology Fellowship Program
Department of Radiology
University of Chicago
Chicago, Illinois*

Joy S. Reidenberg, PhD

*Professor of Anatomy
The Mount Sinai School of Medicine of New York University
New York, New York*

Caroline D. Robson, MB, ChB

*Associate Radiologist in Chief
Vice Chair Division Chief, Neuroradiology
Staff Neuroradiologist
Director, MR and Head and Neck Imaging
Department of Radiology
Children's Hospital Boston and Harvard Medical School
Boston, Massachusetts*

Laura V. Romo, MD

*Assistant Professor, Department of Radiology
Harvard Medical School
Radiologist, Department of Radiology
Massachusetts Eye and Ear Infirmary
Radiologist, Department of Radiology
Brigham and Women's Hospital
Boston, Massachusetts*

Lorne Rosenbloom, MDCM, FRCPC

*Assistant Professor
Department of Diagnostic Radiology
McGill University
Assistant Professor, Department of Radiology
Sir Mortimer B. Davis-Jewish General Hospital
Montreal, Quebec, Canada*

Osamu Sakai, MD, PhD

*Professor of Radiology
Boston University School of Medicine
Chief of Neuroradiology
Department of Radiology
Boston Medical Center
Boston, Massachusetts*

Tsukasa Sano, MD

*Professor and Chairman
Department of Oral and Maxillofacial Radiology
Tokyo Dental College
Chiba, Japan*

J. Pierre Sasson, MD

*Clinical Instructor
Department of Radiology
Harvard Medical School
Boston, Massachusetts;
Vice Chair, Radiology, Residency Program Director
Department of Radiology
Mount Auburn Hospital
Cambridge, Massachusetts*

Charles J. Schatz, MD

*Director of Head and Neck Imaging
Beverly Tower Wilshire Advanced Imaging
Beverly Hills, California;
Clinical Professor of Radiology and Otolaryngology
University of Southern California School of Medicine
Los Angeles, California*

Steven J. Scrivani, DDS, DMed. Sc

*Professor
The Craniofacial Pain and Headache Center
Tufts University School of Dental Medicine
Department of Public Health and Family Medicine
Tufts University School of Medicine
Research Associate
The Pain and Analgesia Imaging and Neuroscience
(P.A.I.N.) Group
McLean Hospital
Boston, Massachusetts*

Ali R. Sepahadari, MD

*Assistant Professor
Department of Health Sciences
Assistant Professor
Department of Radiological Sciences
University of California, Los Angeles
Los Angeles, California*

Wendy R. K. Smoker, MS, MD, FACP

*Professor of Radiology, Neurology and Neurosurgery
Director of Neuroradiology
Director of Neuroradiology Fellowship Program
Co-Director, MRI
The University of Iowa Hospitals and Clinics
Iowa City, Iowa*

Peter M. Som, MD, FACP

*Professor of Radiology, Otolaryngology—Head and Neck
Surgery, and Radiation Oncology
The Mount Sinai School of Medicine of New York University
Chief of Head and Neck Imaging Section
Mount Sinai Medical Center
New York, New York*

Joel D. Swartz, MD

*President
Germantown Imaging Associates
Gladwyne, Pennsylvania*

Michiel W.M. van den Brekel, MD, PhD

*Otolaryngologist, Head and Neck Surgeon
Department of Otorhinolaryngology
Academic Medical Center
University of Amsterdam
Chairman
Head and Neck Surgery and Oncology
Netherlands Cancer Institute
Antoni van Leeuwenhoek Hospital
Amsterdam, The Netherlands*

Beverly Y. Wang, MD

*Professor of Pathology and Otolaryngology
Department of Pathology
New York University School of Medicine
Director of Surgical Pathology
Department of Surgical Pathology
New York University Langone Medical Center
New York, New York*

Alfred L. Weber, MD, FACP

*Professor, Department of Radiology
Harvard Medical School
Chief of Radiology, Emeritus
Department of Radiology
Massachusetts Eye and Ear Infirmary
Boston, Massachusetts;
Clinical Professor of Radiology
University of Missouri, Kansas City
Kansas City, Missouri*

Jane L. Weissman, MD, FACP

*Professor of Radiology and Otolaryngology
Director of Head and Neck Imaging
Oregon Health and Science University
Portland, Oregon*

Jeffrey R. Wesolowski, MD

*Assistant Professor
Department of Radiology
University of Michigan
Ann Arbor, Michigan*

P. L. Westesson, MD, PhD, DDS

*Chief of Diagnostic and Interventional Neuroradiology
Department of Imaging Sciences
University of Rochester Medical Center
Professor of Radiology and Clinical Dentistry
Department of Imaging Sciences
University of Rochester Medical Center
Strong Memorial Hospital
Rochester, New York;
Professor of Oral Diagnostic Sciences
State University of New York at Buffalo
Buffalo, New York;
Associate Professor of Oral Radiology
Department of Imaging Sciences
University of Lund
Lund, Sweden*

Robert A. Zimmerman, MD

*Chief, Neuroradiology Division/MRI
Children's Hospital of Philadelphia
Professor of Radiology
University of Pennsylvania School of Medicine
Philadelphia, Pennsylvania*

S. James Zinreich, MD

*Professor of Radiology and Otorhinolaryngology—Head
and Neck Surgery
The Johns Hopkins Medical Institutions
Baltimore, Maryland*

To Judy and Carole, again

Each new edition of our book seems to take more effort and consume more time to complete than any of the previous editions. Through the years that we have invested in this project, you have given us love, support, and inspiration while showing continued exceptional patience.

For just being there, we dedicate this fifth edition of Head and Neck Imaging to the both of you with our love and thanks.

PMS and HDC

Preface

Since the fourth edition of our book, technology has continued to advance, leading to better lesion conspicuity and diagnosis. In addition, new insights have been gained into embryology, physiology, and pathology that better allow us to understand the diseases we encounter. Taking all of this new information into account, we have attempted to make this fifth edition as complete a reference on the topics of head and neck imaging as possible. The new edition is a thorough updating of the prior edition. It has been reorganized, new topics have been added, and the book is now in full color.

Specifically, the embryology, physiology, and anatomy sections have been expanded. These are now complemented by numerous color drawings to illustrate specific points. We are pleased to have been able to include drawings from Frank Netter, *Sobotta's Anatomy*, *Gray's Anatomy*, and pictures from other sources along with numerous original works. These beautiful drawings help clarify the anatomy and complement the rest of the text, and we thank Elsevier for helping make their inclusion in the book possible. We also want to specifically thank the Netter family for helping us include Frank Netter's beautiful drawings.

The imaging atlases were also greatly expanded with more detail and anatomic variants being addressed in each area. Some chapters were greatly expanded and updated. This can be seen in the treatment of PET/CT imaging. New chapters were also added, such as Nonsurgical Treatment of Head and

Neck Cancer and Imaging-Based Intervention: Biopsy and Treatment. However, due to concerns about the overall size of this edition, almost all plain radiographs have been removed. Since these films are rarely used today in everyday practice, we thought the space would be better used to cover more fully the current topics of head and neck imaging. The fourth edition will remain available for those who want analysis of plain radiographs of the paranasal sinuses, for example.

As always, any multi-authored text is only as good as the contributions from the contributors, and we again thank all of them for the thorough treatments of their topics, especially in this current era of limited academic time. We also want to thank the dedicated people at Elsevier who worked so hard with us to produce this edition. Our readers have said that they use our text in several distinct ways. They use it as an anatomic reference to aid their interpretation skills, as a resource to look up a particular entity with which they are not familiar, and as a pictorial reference to compare to a case they are currently reading. In response to these uses, we have made this fifth edition as comprehensive as possible, and we hope that our readership will find this edition to be the complete resource that they expect and that they will use it to learn and review head and neck imaging, as well as an aid in the daily diagnosis of current cases. We also hope that they enjoy the field of head and neck imaging as much we do.

Peter M. Som
Hugh D. Curtin

Contents

Volume I FACIAL REGION AND ANTERIOR SKULL BASE

MIDFACE AND SINONASAL CAVITIES

Chapter 1 – Embryology and Congenital Lesions of the Midface	3
<i>Thomas P. Naidich, Susan I. Blaser, Ruby J. Lien, David G. McLone, Girish M. Fatterpekar, and Bruce S. Bauer</i>	

Chapter 2 – Embryology, Anatomy, Physiology, and Imaging of the Sinonasal Cavities	99
<i>Peter M. Som, William Lawson, Girish M. Fatterpekar, and S. James Zinreich</i>	

<i>Atlas of Normal Anatomy of the Paranasal Sinuses</i>	141
---	------------

Chapter 3 – Inflammatory Diseases of the Sinonasal Cavities	167
<i>Peter M. Som, Margaret S. Brandwein-Gensler, and Beverly Y. Wang</i>	

Chapter 4 – Tumors and Tumor-Like Conditions of the Sinonasal Cavities	253
<i>Peter M. Som, Margaret S. Brandwein-Gensler, Edward E. Kassel, and Eric M. Genden</i>	

Chapter 5 – Functional Endoscopic Sinus Surgery: Postoperative Findings and Complications	411
<i>Kristen L. Baugnon, John M. Del Gaudio, and Patricia A. Hudgins</i>	

Chapter 6 – Classic Sinus Surgery for Inflammatory Diseases, Tumors, and Tumor-like Conditions	439
<i>Peter M. Som, William Lawson, and Margaret S. Brandwein-Gensler</i>	

Chapter 7 – Facial Fractures	491
<i>Lorne Rosenbloom, Bradley N. Delman, and Peter M. Som</i>	

Section II ORBIT AND VISUAL PATHWAYS

Chapter 8 – Embryology, Anatomy, and Imaging of the Eye and Orbit	527
<i>Mahmood F. Mafee and Peter M. Som</i>	

<i>Atlas of the Orbit</i>	573
---------------------------	------------

Chapter 9 – Pathology of the Eye and Orbit	591
<i>Mary Elizabeth Cunnane, Ali R. Sepahadari, Matthew Gardiner, and Mahmood F. Mafee</i>	

Chapter 10 – Anatomy, Imaging, and Pathology of the Lacrimal Apparatus	757
<i>Edward E. Kassel and Charles J. Schatz</i>	

Chapter 11 – Anatomy, Imaging, and Pathology of the Visual Pathways	855
<i>Meng Law, Saulo Lacerda, and Robert A. Zimmerman</i>	

CENTRAL SKULL BASE

Chapter 12 – Embryology, Anatomy, and Imaging of the Central Skull Base	927
<i>Hugh D. Curtin and Mari Hagiwara</i>	

Chapter 13 – Pathology of the Central Skull Base	947
<i>Hugh D. Curtin, Mari Hagiwara, and Peter M. Som</i>	

Chapter 14 – Perineural Tumor Spread Associated with Head and Neck Malignancies	1021
<i>Lawrence E. Ginsberg</i>	

TEMPORAL BONE

Chapter 15 – Embryology, Anatomy, and Imaging of the Temporal Bone	1053
<i>Hugh D. Curtin, Raj Gupta, and R. Thomas Bergeron</i>	

Chapter 16 – Congenital Anomalies of the Temporal Bone	1097
<i>Laura V. Romo, Jan W. Casselman, and Caroline D. Robson</i>	

Chapter 17 – Trauma to the Temporal Bone	1167
<i>Joel D. Swartz and Melissa D. Kang</i>	

Chapter 18 – Inflammatory Disease of the Temporal Bone	1183
<i>Joel D. Swartz and Mari Hagiwara</i>	

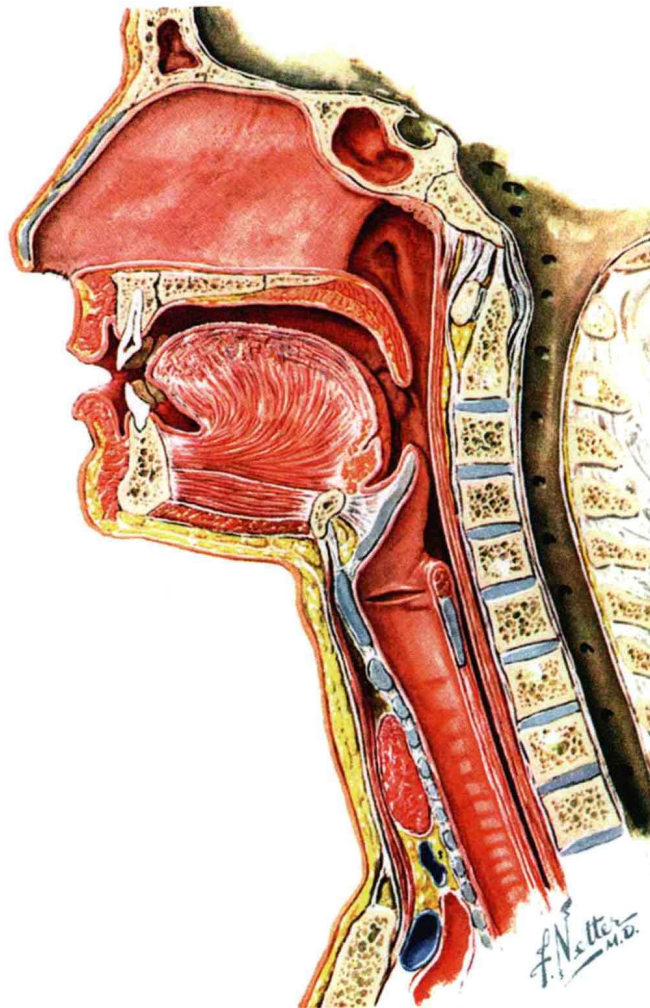
Chapter 19 – Otosclerosis and Dysplasias of the Temporal Bone	1231
<i>Osamu Sakai, Hugh D. Curtin, Anton N. Hasso, and Joel D. Swartz</i>	

Chapter 20 – Temporal Bone Tumors and Cerebellopontine Angle Lesions	1263
<i>Amy F. Tsang Juliano, M. Marcel Maya, William W. M. Lo, and Ilhami Kovanlikaya</i>	

Chapter 21 – Vascular Tinnitus of the Temporal Bone 1409*Gul Moonis, William W. M. Lo, and M. Marcel Maya***JAWS AND TEMPOROMANDIBULAR JOINTS****Chapter 22 – Embryology and Anatomy of the Jaw and Dentition 1425***James J. Abrahams, Colin S. Poon, and Michael W. Hayt***Chapter 23 – Dental CT Reformatting Programs and Dental Imaging 1443***James J. Abrahams, Colin S. Poon, and Michael W. Hayt***Chapter 24 – Dental Implants and Related Pathology 1459***James J. Abrahams and Colin S. Poon***Chapter 25 – Cysts, Tumors, and Nontumorous Lesions of the Jaw 1469***Takashi Kaneda, Alfred L. Weber, Steven J. Scrivani, Jorge Bianchi, and Hugh D. Curtin***Chapter 26 – Anatomy, Pathology, and Imaging of the Temporomandibular Joints 1547***P.L. Westesson, Mika Otonari-Yamamoto, Tsukasa Sano, and Tomohiro Okano***Volume II
UPPER AERODIGESTIVE TRACT AND NECK****Section VI
UPPER AERODIGESTIVE TRACT****Chapter 27 – Anatomy and Imaging of the Oral Cavity and Pharynx 1617***Wendy R. K. Smoker and Peter M. Som***Chapter 28 – Pathology of the Oral Region 1643***Reza Forghani, Wendy R. K. Smoker, and Hugh D. Curtin***Chapter 29 – Pathology of the Pharynx 1749***Jeffrey R. Wesolowski and Suresh K. Mukherji***Chapter 30 – Pediatric Airway Disease 1811***Elliott R. Friedman, Caroline D. Robson, and Patricia A. Hudgins***Chapter 31 – Anatomy, Imaging, and Pathology of the Larynx 1905***Hugh D. Curtin***Chapter 32 – Anatomy, Imaging, and Pathology of the Trachea 2041***J. Pierre Sasson, Neel Madan, Matthew David Gilman, and Peter M. Som***Chapter 33 – Videofluoroscopic Evaluation of Oropharyngeal Swallowing 2085***Tessa A. Goldsmith, Allison S. Holman, and Danny Nunn***NECK****Chapter 34 – Embryology and Anatomy of the Neck 2117***Peter M. Som, Wendy R. K. Smoker, Joy S. Reidenberg, Andrew D. Bergemann, Patricia A. Hudgins, and Jeffrey T. Laitman***Atlas of Anatomy of the Neck 2164****Chapter 35 – Ultrasound of the Neck 2181***J.A. Castelijns, Michiel W. M. van den Brekel, Suresh K. Mukherji, and J. S. Lameris***Chapter 36 – Fascia and Spaces of the Neck 2203***Peter M. Som and Hugh D. Curtin***Chapter 37 – Congenital Lesions of the Neck 2235***Peter M. Som, Wendy R.K. Smoker, Hugh D. Curtin, Joy S. Reidenberg, and Jeffrey T. Laitman***Chapter 38 – Lymph Nodes of the Neck 2287***Peter M. Som and Margaret S. Brandwein-Gensler***Chapter 39 – Parapharyngeal and Masticator Space Lesions 2385***Peter M. Som and Hugh D. Curtin***Chapter 40 – Anatomy and Pathology of the Salivary Glands 2449***Peter M. Som and Margaret S. Brandwein-Gensler***Chapter 41 – Anatomy and Pathology of the Thyroid and Parathyroid Glands 2611***Laurie A. Loevner***Chapter 42 – Skin and Soft-Tissue Lesions 2679***Bradley N. Delman, Jane L. Weissman, and Peter M. Som***Chapter 43 – Imaging of the Brachial Plexus 2743***Bradley N. Delman and Peter M. Som***Chapter 44 – The Posttreatment Neck: Clinical and Imaging Considerations 2771***Peter M. Som and Eric M. Genden***MOLECULAR-BASED DIAGNOSIS AND NONSURGICAL TREATMENT OF CANCER****Chapter 45 – PET/CT Imaging 2825***Lale Kostakoglu***Chapter 46 – Nonsurgical Treatment of Head and Neck Cancer 2893***Ryan J. Burri, Johnny Kao, Shyamala C. Navada, and Stuart Packer***Chapter 47 – Imaging-Based Intervention: Biopsy and Treatment 2915***Jason D. Iannuccilli and Damian E. Dupuy***Index I-1**

SECTION VI

UPPER AERODIGESTIVE TRACT



Anatomy and Imaging of the Oral Cavity and Pharynx

Wendy R.K. Smoker and Peter M. Som

OVERVIEW

It is logical to discuss the anatomy of the oral cavity and pharynx together, as they represent one continuous aerodigestive tract, which is also in direct communication with the back of the sinonasal cavities (see Chapter 2). The oral cavity, or mouth, extends from the lips anteriorly to an anatomically described posterior ring consisting of the line of the circumvallate papillae in the posterior portion of the mobile tongue, the anterior tonsillar pillars, and a line connecting the upper margins of these pillars in the palate (Fig. 27-1).

The approximation of this oropharyngeal isthmus is accomplished by the palatoglossus muscles that form the basis of the anterior tonsillar pillars and this is essential to deglutition (see Chapter 33). While awake, the pharyngeal airway patency is maintained by the combined dilating actions of the genioglossus, geniohyoid, stylohyoid, and tensor veli palatini muscles (Fig. 27-2). Together they counteract the negative pressure generated within the pharynx during inspiration. If during sleep, the tone of these muscles is decreased, the function of the dilator muscles may not be sufficient to maintain pharyngeal patency. If the walls of the pharynx become apposed, intermittent pharyngeal obstruction may cause snoring, sleep apnea, hypoxia, and hypercarbia, which, in turn, may lead to awakening and sleep disturbances. Such muscle weakening can be caused by alcohol, sedatives, hypothyroidism, and a variety of neurological diseases.¹

The oral cavity is subdivided into the vestibule and oral cavity proper. The vestibule is the space between the external surface of the teeth and gums and the lateral walls of the mouth (see Fig. 27-1). This space contains the gingivobuccal sulcus, which marks the junction of the gingival mucosa with the buccal mucosa. The lateral walls of the oral cavity are formed by the cheeks (buccomasseteric regions) and the retromolar trigone areas. The floor of the mouth is formed by the mylohyoid muscle. Thus, the oral cavity includes the oral tongue (anterior two-thirds of the tongue), the floor of the mouth, lips, gingivobuccal and buccomasseteric regions, and the adjacent portions of the maxilla and mandible. Opening into the mouth are the salivary secretions of the sublingual, submandibular and parotid glands, as well as the secretions of the mucosal minor salivary glands (see Chapter 40 for a discussion of the major salivary glands) (Fig. 27-3).¹ Table 27-1 summarizes the muscles of the oral cavity.

The mouth is primarily concerned with the ingestion and the mastication of food, the latter being primarily

accomplished by the teeth. Although the sinonasal cavities function as the primary airways in adults, the mouth serves as a secondary airway and it is essential for phonation. From a clinical prospective, the separation of the oral cavity and oropharynx is also useful as malignancies, especially squamous cell carcinomas in these two regions differ in their presentations, prognoses, and histologic grades.^{2,3}

With regard to the lips, their range of mobility is critical to functions such as speech, whistling, singing, playing wind instruments, and expectoration. They are also critical in human expressions such as smiling, smirking, pouting, or grinning. The vermilion border is the line of transition from the skin to lip mucosa.⁴ In addition, the inclination of the maxillary incisor teeth is in part controlled by the competence of the lips. Normally, the tips of the maxillary incisor teeth lie below the upper border of the lower lip. If the lips are incompetent, the maxillary incisor teeth may not be correctly positioned and the lower lip may even lie behind these teeth. Conversely, too tight or overactive lip musculature may cause retroclined maxillary incisor teeth.¹

Behind, the oral cavity is continuous with the oropharynx. The pharynx is a 12- to 14-cm long musculomembranous tube-shaped structure that runs from the skull base to the lower border of the cricoid cartilage, at the level of the sixth cervical vertebra.^{2,3} The superior pharyngeal constrictor muscle attaches to the skull base posteriorly at the pharyngeal tubercle (Fig. 27-4B). The pharynx is subdivided into three sections: (1) the nasopharynx, which extends from the skull base to the level of the hard palate (upper surface of the soft palate); (2) the oropharynx, which extends from the palate to the level of the valleculae or top of the body of the hyoid bone; and (3) the hypopharynx or laryngopharynx, which extends caudally to the lower border of the cricoid cartilage and the upper margin of the cricopharyngeus muscle (Fig. 27-4). The hypopharynx is continuous below with the cervical esophagus (Fig. 27-5A). Projecting into the anterior wall of the hypopharynx is the larynx and thus the hypopharyngeal airway is also continuous with the laryngeal airway and the tracheal and bronchial airways caudal to the larynx (Fig. 27-5B).¹ The larynx is discussed in Chapter 31 and the trachea in Chapter 32.

The pharynx plays a role in breathing, swallowing, and speech. Because of these multifunctional roles, safeguards are present to prevent laryngeal penetration or aspiration, nasal regurgitation, and pharyngonasal reflux; these are discussed in Chapter 33. During swallowing when a bolus reaches the posterior mouth, there is stimulation of the glossopharyngeal