Christopher C. Chang
Gary A. Incaudo
M. Eric Gershwin
Editors

Diseases of the Sinuses

A Comprehensive Textbook of Diagnosis and Treatment

Second Edition

Springer

Diseases of the Sinuses

Christopher C. Chang • Gary A. Incaudo • M. Eric Gershwin
Editors

Diseases of the Sinuses

A Comprehensive Textbook of Diagnosis and Treatment

Second Edition

Springer

Editors
Christopher C. Chang, MD, PhD, MBA, FAAAAI, FACAAI
Division of Allergy and Immunology
Department of Pediatrics
Thomas Jefferson University
Wilmington, DE
USA

Gary A. Incaudo, MD, FAAAAI, FACAAI
Division of Rheumatology, Allergy and Clinical Immunology
University of California School of Medicine
Davis, CA
USA

M. Eric Gershwin, MD, MACP, MACR, FAAAAI
The Jack and Donald Chia Distinguished Professor of Medicine
Division of Rheumatology, Allergy and Clinical Immunology
University of California School of Medicine
Davis, CA
USA

ISBN 978-1-4939-0264-4 ISBN 978-1-4939-0265-1 (eBook)
DOI 10.1007/978-1-4939-0265-1
Springer New York Heidelberg Dordrecht London

Library of Congress Control Number: 2014940551

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Even a single drop of water will eventually hollow out a stone. We hope this text will be such a drop for sufferers of disease and especially victims of upper airway pathology.

CC, GI, and MEG

Preface

The study of sinus diseases crosses the boundaries of many specialties, but it is primarily the domain of allergists and otolaryngologists. Other disciplines that care for patients with sinus disease include pulmonology, infectious disease, and rheumatology. Since the publication of our first edition, our understanding of sinus disease has changed dramatically, mainly as a result of recent developments and new discoveries in the field of immunology. New immunologic concepts relating to both the innate and adaptive immune systems have helped us to recognize that sinus disease may be more of an inflammatory rather than an infectious process. Since the first edition, pathogen-associated molecular patterns (PAMPs), danger-associated molecular patterns (DAMPs), and their receptors known as pattern recognition receptors (PRRs) have been discovered, and the signaling pathways that lead to chronic inflammation have been refined. New cytokines have been discovered, and the role of IL-17 in chronic inflammation is now being investigated for its role in sinusitis. Other ongoing research concerns the role of other cells including T regulatory cells, dendritic cells, and neutrophils and the pathways that lead to their proliferation, recruitment, and activity. New concepts such as biofilms and their role in chronic sinusitis have afforded us a greater understanding of the pathogenic mechanisms behind the disease. The concept of the unified airway has helped to direct new therapeutic strategies in the treatment of sinusitis, and the mechanism behind the activity of leukotriene and prostaglandin pathways in aspirin-exacerbated respiratory disease and the related sinus disease is of great interest to clinicians and scientists.

This textbook is divided into sections addressing separately the pathogenesis, clinical presentation, and medical and surgical management of acute and chronic rhinosinusitis. Special entities such as autoimmune-related sinusitis, allergy and sinusitis, and aspirin-exacerbated respiratory disease are discussed in separate chapters. The role of immunodeficiency is also addressed. The management section has been updated from the previous edition to incorporate new medical modalities and surgical procedures.

While sinus problems are extremely common, there is very little organized teaching in medical schools. It is the goal of this textbook to provide a comprehensive source of information regarding the basic science of the sinuses and the clinical approach to sinusitis. Sinusitis is not just one disease, and the etiologic factors are likely multifactorial. The authors of this textbook are experts in their field from all over the world and share their expertise and insights from years of collective experience in treating sinus diseases.

The book will appeal to anyone who has an interest in sinus disease, including both physicians and allied health professionals. Internists, pediatricians, allergists, otolaryngologists, and infectious disease specialists will find the book to be a comprehensive source of knowledge. Physician assistants and nurse practitioners who work with specialists who treat sinus disease would also benefit from the book.

We are hopeful that this comprehensive textbook on sinus disease from many experts in the field will provide the reader with different perspectives on how various medical professions or specialties approach the diverse array of sinus problems experienced by our patients.

Philadelphia, PA — Christopher C. Chang, MD, PhD, MBA, FAAAAI, FACAAI
Davis, CA — Gary A. Incaudo, MD, FAAAAI, FACAAI
Davis, CA — M. Eric Gershwin, MD, MACP, MACR

Acknowledgments

The editors of this book would like to thank all the authors for their tireless contribution to their respective chapters. We would also like to thank our administrative coordinator, Dolores DiStefano, for her communications with all the authors during the preparation phase. The editors would also like to thank their families for their sacrifices in order that we may work on this book during weekends and holidays. Finally, we would like to thank our publisher, Richard Lansing, and his staff for their assistance in bringing this textbook to fruition.

Contents

Part I Anatomy and Physiology

1 Anatomy of the Nose and Paranasal Sinuses 3
Samuel Márquez, William Lawson, Steven D. Schaefer, Anthony S. Pagano, Michael Papaxanthos, Bradley N. Delman, and Jeffrey T. Laitman

2 Physiology and Host Immune Responses of the Nose and Sinuses 45
Jonathan A. Bernstein and Andrew M. Smith

3 Immunobiology of Chronic Rhinosinusitis 57
Gary A. Incaudo and Christopher C. Chang

4 Structural Anomalies of the Nose and Sinuses in Patients with Rhinosinusitis 73
Vijay R. Ramakrishnan, Todd T. Kingdom, and Richard R. Orlandi

Part II Microbiology

5 Microbiology of Acute, Subacute, and Chronic Rhinosinusitis in Children 89
Gregory P. DeMuri and Ellen R. Wald

6 Microbiology of Acute, Subacute, and Chronic Rhinosinusitis in Adults 99
Michael S. Benninger and Troy D. Woodard

7 Biofilms in Chronic Rhinosinusitis 109
Nithin D. Adappa and James N. Palmer

8 Fungus in Sinus Disease 119
Matthew W. Ryan, Ng Yuk Hui, and Mohammad O. Aloulah

Part III The Clinical Spectrum of Sinus Disease

9 Differential Diagnosis of Rhinitis and Rhinosinusitis 133
Jonathan Romeo and Mark S. Dykewicz

10 Diagnosis and Classification of Chronic Rhinosinusitis with and Without Polyposis in Adults and Children 153
Daniel L. Hamilos

11 Sinusitis, Rhinitis, Asthma, and the Single Airway Hypothesis 173
Christopher C. Chang

12 Nonsteroidal Anti-inflammatory Drug Hypersensitivity and Sinus Disease . . . 195
Jinny E. Chang, Andrew A. White, and Ronald A. Simon

13 Headache and Sinonasal Disease . . . 209
Michael J. Marmura and Stephen D. Silberstein

14 Immunodeficiency and Sinus Disease . . . 223
Stephen J. McGeady and Gary A. Incaudo

15 Autoimmunity and Sinus Disease . . . 247
Stanley M. Naguwa, Christopher C. Chang, and Gary A. Incaudo

Part IV Diagnostic Modalities

16 Anterior Rhinoscopy and Nasal Endoscopy in the Diagnosis of Sinonasal Disease . . . 277
Douglas R. Johnston and Marc R. Rosen

17 Imaging of the Paranasal Sinuses: Plain-Film Radiography, Computed Tomography, and Magnetic Resonance Imaging . . . 295
Mahmood F. Mafee, Nikdokht Farid, and Wei Yen Lim

18 Direct or Objective Evaluation of Nasal Function: Nasal Mucosal Microscopy, Mucociliary Transport, Flow Rhinometry, Acoustic Rhinometry and Olfactory Assessment . . . 323
Anton R. Dotson and Gary A. Incaudo

Part V Medical and Surgical Management

19 Medical Management of Acute Rhinosinusitis in Children and Adults . . . 359
Nathan Richards, Shannon Doyle Tiedeken, and Christopher C. Chang

20 Medical Management of Chronic Rhinosinusitis in Children and Adults . . . 373
Samuel L. Friedlander

21 Sinus Surgical Techniques from Caldwell-Luc to MIST . . . 389
Peter J. Catalano, Rahul C. Gupta, Meir Warman, and Rohan C. Wijewickrama

22 Surgical Management of Rhinosinusitis in Children and Adolescents . . . 411
Jessica R. Levi and Richard Schmidt

23 Surgical Management of Rhinosinusitis with and Without Polyps in Adults . . . 425
Marcelo B. Antunes and David W. Kennedy

24 Controversies in the Surgical Management of Chronic Rhinosinusitis . . . 449
Samuel Jayaraj and Peter James Andrews

25 Managing Complications of Endoscopic Sinus Surgery in Children and Adults . . . 465
Brendan C. Hanna and Peter-John Wormald

26 Chronic Frontal Sinusitis . . . 475
Murugappan Ramanathan Jr. and Andrew P. Lane

27 Orbital and Intracranial Complications of Acute and Chronic Rhinosinusitis 495
Jan Kastner, Daniel Simmen, David Netuka, Jan Kastner Sr., and Volker Gudziol

28 Surgical Management of Cysts and Papillomas of the Nose and Sinuses 517
Jamie L. Funamura, Jonathan Liang, and Craig W. Senders

29 Tumors of the Nose and Paranasal Sinuses 535
Aaron D. Robinson, Jonathan Liang, and Quang Luu

30 The Paranasal Sinuses in Facial Trauma 557
Carmine Taglialatela Scafati and Salvatore Taglialatela Scafati

Index 589

Contributors

Nithin D. Adappa, MD Division of Rhinology and Skull Base, Department of Otorhinolaryngology – Head and Neck Surgery, University of Pennsylvania, Philadelphia, PA, USA

Mohammad O. Aloulah, MBBS, KSUF Department of Otolaryngology, Head and Neck Surgery, King Abdulaziz University Hospital, King Saud University, Riyadh, Saudi Arabia

Peter James Andrews, MBBS, BSc (hons), FRCS (ORL-HNS) University College London Hospital, Royal National Throat Nose and Ear Hospital, London, UK

Marcelo B. Antunes, MD Department of Otorhinolaryngology: Head and Neck Surgery, Perelman School of Medicine of the University of Pennsylvania, University of Pennsylvania Medical Center, Philadelphia, PA, USA

Michael S. Benninger, MD Department of Head and Neck Institute, Cleveland Clinic Foundation, Cleveland, OH, USA

Jonathan A. Bernstein, MD Division of Immunology, Department of Internal Medicine, Allergy Section, University of Cincinnati, Cincinnati, OH, USA

Peter J. Catalano, MD, FACS, FARS Department of Otolaryngology, St. Elizabeth's Medical Center, Tufts University School of Medicine, Boston, MA, USA

Christopher C. Chang, MD, PhD, MBA, FAAAAI, FACAAI Division of Allergy and Immunology, Department of Pediatrics, Thomas Jefferson University, Wilmington, DE, USA

Jinny E. Chang, MD Department of Allergy, Asthma and Immunology, Sansum Clinic, Santa Barbara, CA, USA

Bradley N. Delman, MD Department of Radiology, Icahn School of Medicine at Mount Sinai, New York, NY, USA

Gregory P. DeMuri, MD Department of Pediatrics, American Family Children's Hospital/University of Wisconsin School of Medicine and Public Health, Madison, WI, USA

Anton R. Dotson, MD Allergy Associates, Chico, CA, USA

Mark S. Dykewicz, MD Department of Internal Medicine, Saint Louis University School of Medicine, St. Louis, MI, USA

Nikdokht Farid, MD Division of Neuroradiology, Division of Head and Neck Radiology, Department of Radiology, University of California San Diego, San Diego, CA, USA

Samuel L. Friedlander, MD Department of Allergy/Immunology and Sleep Medicine, University Hospitals of Cleveland, Solon, OH, USA

Jamie L. Funamura, MD Department of Otolaryngology – Head and Neck Surgery, University of California Davis Medical Center, Sacramento, CA, USA

Volker Gudziol, MD, PhD Department of Otorhinolaryngology and Head and Neck Surgery, University Hospital Carl Gustav Carus, Dresden, Germany

Rahul C. Gupta, MD Department of Otolaryngology, St. Elizabeth's Medical Center, Tufts University School of Medicine, Boston, MA, USA

Daniel L. Hamilos, MD Division of Rheumatology, Allergy and Immunology, Department of Medicine, Massachusetts General Hospital, Harvard Medical School, Boston, MA, USA

Brendan C. Hanna, MB, BCh, FRCSI, PhD Department of Surgery-Otolaryngology Head and Neck Surgery, University of Adelaide, Adelaide, Australia

Ng Yuk Hui, MBBS, FAMS Department of Otolaryngology, Singapore General Hospital, Singapore

Gary A. Incaudo, MD, FAAAAI, FACAAI Division of Rheumatology, Allergy and Clinical Immunology, University of California School of Medicine, Davis, CA, USA

Samuel Jayaraj, MBBS, FRCS(Eng), FRCS(ORL-HNS) Barts Health NHS Trust, Whipps Cross University Hospital, London, UK

Douglas R. Johnston, MD Department of Otolaryngology, A.I. duPont Hospital for Children, Thomas Jefferson University, Wilmington, DE, USA

Jan Kastner, MD Department of Otorhinolaryngology and Head and Neck Surgery, Motol Hospital, 1st Medical Faculty of Charles University, Prague, Czech Republic

Jan Kastner Sr., MD Department of Neuroradiology, Medical Faculty in Pilsen, Charles University, Prague, Czech Republic

David W. Kennedy, MD, FACS, FRCSI Department of Otorhinolaryngology: Head and Neck Surgery, Perelman School of Medicine of the University of Pennsylvania, University of Pennsylvania Medical Center, Philadelphia, PA, USA

Todd T. Kingdom, MD Departments of Otolaryngology-Head and Neck Surgery, University of Colorado, Aurora, CO, USA

Jeffrey T. Laitman, PhD, DMedSc(Hon), FAAAS, FAAA, FALA Center for Anatomy and Functional Morphology, Departments of Otolaryngology and Medical Education, Icahn School of Medicine at Mount Sinai, New York, NY, USA

Andrew P. Lane, MD Department of Otolaryngology – Head and Neck Surgery, Johns Hopkins Medical Institutions, Baltimore, MD, USA

William Lawson, MD, DDS, FACS Department of Otolaryngology, Icahn School of Medicine at Mount Sinai, New York, NY, USA

Jessica R. Levi, MD Department of Otolaryngology Head and Neck Surgery and the Department of Pediatrics, Boston University/Boston Medical Center, Boston, MA, USA

Jonathan Liang, MD Department of Otolaryngology – Head and Neck Surgery, Johns Hopkins School of Medicine, Baltimore, MD, USA

Wei Yen Lim, MBBS, Master of Radiology Department of Radiology, ANOC Neuroscience and Orthopaedic Center, Kuala Lumpur, Malaysia

Quang Luu, MD Department of Otolaryngology – Head and Neck Surgery, University of California Davis Medical Center, Sacramento, CA, USA

Mahmood F. Mafee, MD, FACR Division of Neuroradiology, Division of Head and Neck Radiology, Department of Radiology, University of California San Diego, San Diego, CA, USA

Michael J. Marmura, MD Department of Neurology, Jefferson Medical College, Thomas Jefferson University, Philadelphia, PA, USA

Samuel Márquez, PhD Departments of Cell Biology and Otolaryngology, SUNY Downstate Medical Center, Brooklyn, NY, USA

Stephen J. McGeady, MD Division of Allergy and Immunology, Department of Pediatrics, Thomas Jefferson University, Philadelphia, PA, USA

Stanley M. Naguwa, MD Division of Rheumatology, Allergy and Clinical Immunology, University of California, Davis School of Medicine, Davis, CA, USA

David Netuka, MD, PhD Department of Neurosurgery, Central Military Hospital, 1st Medical Faculty of Charles University, Prague, Czech Republic

Richard R. Orlandi, MD Department of Otolaryngology-Head and Neck Surgery, University of Utah School of Medicine, Salt Lake City, UT, USA

Anthony S. Pagano, MPhil Center for Anatomy and Functional Morphology, Icahn School of Medicine at Mount Sinai, New York, NY, USA

James N. Palmer, MD Department of Otorhinolaryngology – Head and Neck Surgery, University of Pennsylvania, Philadelphia, PA, USA

Michael Papaxanthos, MD, DEA Department of Ent and Face and Neck Surgery, Center of Palais Gallien/Clinique Tourny, Palais Ent and Face and Neck Surgery Center, Bordeaux, France

Murugappan Ramanathan Jr., MD Department of Otolaryngology-Head and Neck Surgery, Johns Hopkins Medical Institutions, Baltimore, MD, USA

Vijay R. Ramakrishnan, MD Department of Otolaryngology-Head and Neck Surgery, University of Colorado, Aurora, CO, USA

Nathan Richards, MD Division of Allergy and Immunology, Department of Pediatrics, Thomas Jefferson University, Philadelphia, PA, USA

Aaron D. Robinson, MD Department of Otolaryngology – Head and Neck Surgery, University of California Davis Medical Center, Sacramento, CA, USA

Jonathan Romeo, DO Section of Pulmonary, Critical Care, and Allergic and Immunologic Diseases, Wake Forest University School of Medicine, Winston-Salem, NC, USA

Marc R. Rosen, MD Department of Otolaryngology Head and Neck Surgery, Thomas Jefferson University Hospital, Philadelphia, PA, USA

Matthew W. Ryan, MD Department of Otolaryngology, University of Texas Southwestern Medical Center, Dallas, TX, USA

Carmine Taglialatela Scafati, MD, FEBOMFS Servizio di Chirurgia Maxillo-Facciale, Ospedale Santa Maria delle Grazie, Pozzuoli, Naples, Italy

Salvatore Taglialatela Scafati, MD Servizio di Chirurgia Maxillo-Facciale, Ospedale Santa Maria delle Grazie, Pozzuoli, Naples, Italy

Steven D. Schaefer, MD, FACS Department of Otolaryngology, Lenox Hill Hospital, New York, NY, USA

Richard Schmidt, MD Department of Surgery, Nemours duPont Hospital for Children, Wilmington, DE, USA

Craig W. Senders, MD, FACS Department of Otolaryngology – Head and Neck Surgery, University of California Davis Medical Center, Sacramento, CA, USA

Stephen D. Silberstein, MD Department of Neurology, Jefferson Medical College, Thomas Jefferson University, Philadelphia, PA, USA

Daniel Simmen, MD, PhD ORL-Zentrum, Center for Rhinology, Skull Base Surgery and Facial Plastic Surgery, The Hirslanden Clinic, Zurich, Switzerland

Ronald A. Simon, MD Division of Allergy, Asthma and Immunology, Scripps Clinic, San Diego, CA, USA

Andrew M. Smith, MD, MS Division of Immunology, Allergy, and Rheumatology, Cincinnati VA Medical Center, University of Cincinnati, Cincinnati, OH, USA

Shannon Doyle Tiedeken, MD Department of Pediatrics, Alfred I. duPont Hospital for Children, Wilmington, DE, USA

Ellen R. Wald, MD Department of Pediatrics, American Family Children's Hospital/University of Wisconsin School of Medicine and Public Health, Madison, WI, USA

Meir Warman, MD Department of Otolaryngology, St. Elizabeth's Medical Center, Tufts University School of Medicine, Boston, MA, USA

Andrew A. White, MD Division of Allergy, Asthma and Immunology, Scripps Clinic, San Diego, CA, USA

Rohan C. Wijewickrama, MD Department of Otolaryngology, St. Elizabeth's Medical Center, Tufts University School of Medicine, Boston, MA, USA

Troy D. Woodard, MD Department of Head and Neck Institute, Cleveland Clinic Foundation, Cleveland, OH, USA

Peter-John Wormald, MD, FACS, FCS(SA), FRCS(ed), MBChB Department of Otolaryngology, Head and Neck Surgery, Queen Elizabeth Hospital, The University of Adelaide, Woodville South, SA, Australia

Part I
Anatomy and Physiology