

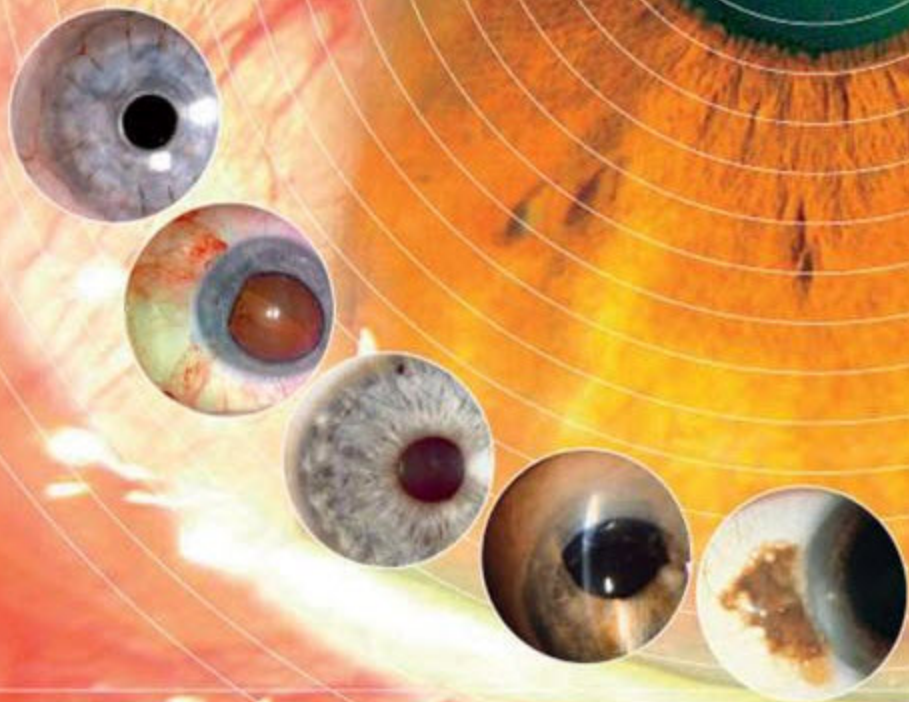
Copyrighted Material

FREDERICK S. BRIGHTBILL  
PETER J. McDONNELL | CHARLES N.J. MCGHEE  
AYAD A. FARJO | OLIVIA SERDAREVIC

FOURTH EDITION

# CORNEAL SURGERY

THEORY, TECHNIQUE AND TISSUE



MOSBY  
ELSEVIER

Copyrighted Material

MOSBY is an imprint of Elsevier Inc.

© 2009, Elsevier Inc. All rights reserved.

First edition 1986

Second edition 1993

Third edition 1999

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. Permissions may be sought directly from Elsevier's Rights Department: phone: (+1) 215 239 3804 (US) or (+44) 1865 843830 (UK); fax: (+44) 1865 853333; e-mail: [healthpermissions@elsevier.com](mailto:healthpermissions@elsevier.com). You may also complete your request on-line via the Elsevier website at <http://www.elsevier.com/permissions>.

ISBN-13: 978-0-323-04835-4

**British Library Cataloguing in Publication Data**

A catalogue record for this book is available from the British Library

**Library of Congress Cataloging in Publication Data**

A catalog record for this book is available from the Library of Congress

**Notice**

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

*The Publisher*

Working together to grow  
libraries in developing countries

[www.elsevier.com](http://www.elsevier.com) | [www.bookaid.org](http://www.bookaid.org) | [www.sabre.org](http://www.sabre.org)

ELSEVIER BOOK AID International Sabre Foundation

Printed in China

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

Commissioning Editor: *Russell Gabbedy*  
Development Editor: *Sharon Nash*  
Project Manager: *Gemma Lawson/Emma Riley*  
Design: *Charles Gray*  
Illustration Manager: *Merlyn Harvey*  
Illustrator: *Laurel Cook Howe*  
Marketing Manager(s) (UK/USA): *John Canelon/William Veltre*  
Multimedia Producer: *Fraser Johnston*

## PREFACE

The ‘face’ and ‘faces’ of this Fourth Edition text for 2008 have changed as the reader will note immediately on viewing our front cover. In the hope of appealing to a broader international readership, we are joined by Olivia Serdarevic (Paris and New York) and Charles McGhee (Auckland, New Zealand). Peter McDonnell (Baltimore) and Ayad Farjo (Ann Arbor) complement our editorship, which seemed an increasingly daunting task involving three continents and our book publisher across the Atlantic. Add in the mix of an older editor (FSB) trying to keep up with the world of multiple contributors, frequently changing e-mail addresses, along with on-line manuscript corrections, and the task seemed overwhelming.

This book arose 22 years ago from an Eye Bank Association of America meeting in San Diego when keratoplasty began to flourish and eye banks created more stringent standards and were led by fellowship-trained corneal surgeons. We trained and were mentored by outstanding corneal surgeons and influenced directly by the likes of Dohlman, Kaufman, Laibson, Fine, Peyton, Polack, Troutman, Maumenee, Castroviejo and indirectly by Paufigue and Rycroft among others.

The publication of Krachmer, Mannis and Holland’s first and second editions of *Cornea* stands as a monument to absolutely the best of our current generation of corneal specialists with much to tell us about both the medical and surgical aspects of the diagnosis and treatment of corneal disease. Our mutual publishing company Elsevier suggested that this text should accentuate the surgical aspects of the cornea, and we have achieved this. In doing so we have strived to retain appropriate research chapters which aide our understanding of corneal anatomy and physiology.

This Fourth Edition again utilizes marvelous additional illustrations of Laurel Cook Lhowe to emphasize surgical technique and there is a return to color figures throughout the text. The refractive surgery portion of *Cornea Surgery* has been extensively revised and lengthened with Section Four reviewing ‘Endothelial keratoplasty’ and Part Six providing in-depth coverage of ‘Surgical Correction of Refractive Errors’. The reader will note the retention of previous edition upgraded chapters such as ‘Penetrating Keratoplasty’ but the loss of all but one eye-banking chapter. Eye banks under the direction of the Eye Bank Association of America in fact have not disappeared—to the contrary we use them more than ever as they take on additional roles such as processing tissue for lamellar keratoplasty.

So as to not forget the lessons of the past; Peter Laibson, both in his lecture in Chicago two years ago, and in Chapter One of this text, has provided historical perspective on modern day corneal surgery.

Frederick S. Brightbill, MD  
Madison, Wisconsin, U.S.A.  
July, 2008

# LIST OF CONTRIBUTORS

**Juan C. Abad MD**

Cornea, Anterior Segment and Refractive Surgery  
Clinica Oftalmologica de Medellin (COM)  
Medellin  
Colombia

**Richard L. Abbott MD**

Thomas W Boyden Endowed Chair in Ophthalmology  
Health Sciences Professor  
Cornea and External Diseases  
UCSF Department of Ophthalmology  
Research Associate  
Francis I. Proctor Foundation  
San Francisco, California

**Omar Ahmad MD**

Ophthalmology, Resident Physician  
University of Michigan  
Ann Arbor, Michigan

**Tracy L. Aigner OD****Esen Karamürsel Akpek MD**

Associate Professor of Ophthalmology  
Director of Ocular Surface Diseases and Dry Eye Clinic  
Wilmer Eye Institute  
Johns Hopkins University  
Baltimore, Maryland

**Daniel M. Albert MD, MS**

Director of the UW Eye Research Institute  
F.A. Davis Professor and Lorenz E. Zimmerman Professor and Chair  
Emeritus  
Department of Ophthalmology & Visual Sciences  
University of Wisconsin School of Medicine and Public Health  
Madison, Wisconsin

**Dimitri T. Azar MD**

BA Field Endowed Chair in Ophthalmologic Research  
Professor and Head

Department of Ophthalmology and Visual Sciences  
Illinois Eye and Ear Infirmary  
University of Illinois at Chicago  
Chicago, Illinois

**Siamak Balali MD**

Visiting Scholar  
Department of Ophthalmology  
University of Illinois Eye and Ear Infirmary  
University of Illinois at Chicago  
Chicago, Illinois

**Neal P. Barney MD**

Associate Professor  
Department of Ophthalmology and Visual Sciences  
University of Wisconsin School of Medicine and Public Health  
Madison, Wisconsin

**Ashley Behrens MD**

Assistant Professor of Ophthalmology  
Cornea, Cataract and Refractive Surgery  
The Wilmer Eye Institute, The Johns Hopkins School of Medicine  
Baltimore, Maryland

**Marial D. Bernal MD**

Clinical Assistant Professor of Ophthalmology  
Cornea and External Diseases  
Louisiana State University Health Sciences Center  
New Orleans, Louisiana

**Robert E. Brass MD**

Private Practice  
Latham, New York  
Associate Clinical Professor  
Department of Ophthalmology  
Albany Medical College  
Albany, New York

**Erich H.P. Braun MD**

Cornea Fellow  
Department of Ophthalmology

University of California  
Irvine, California

**Geoffrey Brent MD****Frederick S. Brightbill MD**

Clinical Professor  
Department of Ophthalmology and Visual Sciences  
University of Wisconsin School of Medicine and Public Health  
Madison, Wisconsin  
Partner  
Brightbill/Ericson Eye Associates  
Rockford, Illinois

**Linda L. Burk MD**

Assistant Clinical Professor  
Department of Ophthalmology  
University of Texas – Southwest School of Medicine  
Dallas, Texas

**Cat N. Burkat MD**

Assistant Professor  
Department of Ophthalmology and Visual Sciences  
University of Wisconsin  
Madison, Wisconsin

**Timothy B. Cavanaugh MD**

Private Practice, Medical Director of Cavanaugh Eye Center  
And Laser Vision Center of  
Kansas City  
Overland Park, Kansas

**Daniel H. Chang MD**

Empire Eye and Laser Center  
Bakersfield, California

**Edwin S. Chen MD**

Fellow  
Corneal Services  
Devers Eye Institute  
Portland, Oregon

**Min Chen MD**

Visiting Researcher  
Johnson & Johnson Ocular Surface and  
Visual Optics Department  
Keio University School of Medicine  
Japan

**Jesse Chew MD FRCS(C)**

Adjunct Clinical Assistant Professor  
John A. Moran Eye Center  
University of Utah  
Clinical Instructor, Providence  
Health Care  
University of British Columbia  
Vancouver, British Columbia, Canada

**Christopher Y. Chow MD**

Michigan Cornea Consultants  
Southfield, Michigan

**Roy S. Chuck MD PhD**

Director of Refractive Surgery, Tom  
Clancy Professorship in  
Ophthalmology  
Johns Hopkins University, Wilmer Eye  
Institute at Greenspring Station  
Lutherville, Maryland

**Robert J. Cionni MD**

Cincinnati Eye Institute  
University of Cincinnati  
University of Utah  
The Eye Institute of Utah  
Salt Lake City, Utah

**Liane Clamen****Glenn C. Cockerham MD**

Clinical Associate Professor of  
Ophthalmology and Pathology  
Stanford University Medical Center  
Stanford, California

**Carole A. Cooke MB BCH BAO(Hons) FRCOphth**

Cornea and Anterior Segment Fellow  
University of Auckland  
Department of Ophthalmology and  
Visual Sciences  
Faculty of Medical & Health Sciences  
The University of Auckland  
Auckland  
New Zealand

**Douglas J. Coster FRANZCO**

Professor of Ophthalmology  
Department of Ophthalmology  
Flinders Medical Centre  
South Adelaide  
Australia

**Constance Cox MD****Marc R. Criden MD**

ASSOCIATE PROFESSOR  
UNIVERSITY OF TEXAS AT HOUSTON  
HOUSTON, TEXAS

**Matthew Alan Dahlgren MD**

Milwaukee Eye Care Associates  
Milwaukee, Wisconsin

**Daniel Dawson MD**

Clinical Cornea Fellow  
Bascom Palmer Eye Institute  
University of Miami-FL  
Miami, Florida

**Sheraz M. Daya MD FACP FACS FRCS(Ed)**

Director and Consultant Ophthalmic  
Surgeon  
Centre for Sight  
Corneoplasty Unit and Eye Bank  
Queen Victoria Hospital NHS Trust  
East Grinstead, UK

**Ali R. Djalilian MD**

Assistant Professor of Ophthalmology  
Associate Director, Ophthalmology  
Residency Program  
Director, Medical Student Education  
University of Illinois Eye and  
Ear Infirmary  
University of Illinois at Chicago  
Chicago, Illinois

**John F. Doane MD**

Corneal, Refractive and Anterior  
Segment Surgeon  
Discover Vision Centers  
Clinical Assistant Professor  
Department of Ophthalmology  
Kansas University Medical Center  
Kansas City  
Kansas, Missouri

**Murat Dogru MD**

Associate Professor of Ophthalmology  
Johnson & Johnson Ocular Surface and  
Visual Optics Department  
Keio University School of Medicine  
Japan

**Terence J. Doherty MD**

Private Practice  
Loden Vision Centers  
Nashville, Tennessee

**Claes H. Dohlman MD PhD**

Professor of Ophthalmology, Harvard  
Medical School  
Massachusetts Eye and Ear Infirmary  
Boston, Massachusetts

**Eric D. Donnenfeld MD**

Partner, Ophthalmic Consultants of  
Long Island  
Trustee, Dartmouth Medical School  
Ryan Medical Arts Building  
Rockville Centre, New York

**Peter C. Donshik MD**

Clinical Professor  
Health Center  
University of Connecticut  
Bloomfield, Connecticut

**Steven P. Dunn MD**

Director, Cornea Services  
Department of Ophthalmology

William Beaumont Hospital  
Royal Oak, Michigan

**William J. Dupps, Jr. MD PhD**

Associate Staff, Ophthalmology and  
Biomedical Engineering  
Cole Eye Institute  
Cleveland Clinic and Lerner Research  
Institute  
Cleveland, Ohio

**Henry Edelhauser PhD**

First Professor and Director of  
Ophthalmology Research  
Department of Ophthalmology  
Emory University Eye Center  
Atlanta, Georgia

**William Ehlers MD**

Assistant Clinical Professor  
Health Center  
University of Connecticut  
Storrs, Connecticut

**Marcela Espinosa-Lagana MD**

Consultant Ophthalmic Surgeon  
Centre for Sight  
Queen Victoria Hospital NHS Trust  
East Grinstead, UK

**Jason Evangelista MD**

Director of Corneal Service  
The Eye Depot  
Bradenton, Florida

**Ella G. Faktorovich MD**

Pacific Vision Institute  
San Francisco  
California

**Samir G. Farah MD**

Assistant Professor of Ophthalmology  
St George Medical Center  
University of Balamand  
Beirut, Lebanon

**Marjan Farid MD**

Assistant Professor of Ophthalmology  
Division of Cornea, Cataract, and Refractive  
Surgery  
Department of Ophthalmology, UC-Irvine  
Irvine, California

**Ayad A. Farjo MD**

Director  
Brighton Vision Center  
Brighton, Michigan  
Assistant Clinical Professor  
Department of Ophthalmology and  
Visual Sciences  
University of Wisconsin Hospitals  
and Clinics  
Wisconsin

**Qais Anastas Farjo MD**

Clinical Assistant Professor  
University of Toledo



Ann Arbor  
Michigan

**M. Elizabeth Fini PhD**

Professor of Cell & Neurobiology  
Vice Dean for Research Advancement  
Interim Director, Institute for  
Genetic Medicine  
Keck School of Medicine of the  
University of Southern California  
Los Angeles, California

**Jerry G. Ford MD**

Clinical Assistant Professor, Florida State  
University  
Eye Associates Of Tallahassee  
Tallahassee, Florida

**C. Stephen Foster MD**

Professor of Ophthalmology  
The Massachusetts Eye & Ear Infirmary  
Harvard Medical School  
Cambridge, Massachusetts

**Bradley Fouraker MD**

Director of Corneal Service  
Brandon Eye Clinic  
Brandon, Florida

**Pierre Fournié MD**

Cornea & External Disease Fellow  
Purpan Hospital  
Department of Ophthalmology  
Place Baylac  
Toulouse  
France

**Prashant Garg MD**

Consultant Cornea and Anterior Segment  
Services  
Director Education and G Chadra Sekhar  
Distinguished Chair of Education  
L V Prasad Eye Institute  
Hyderabad, India

**Dayle H. Geroski PhD**

Associate Professor of Ophthalmology  
Emory Eye Center  
Emory University  
Atlanta, Georgia

**Matthew Giegengack MD**

**Steven Paul Ginsberg BA MD MALS  
FACS FICS**

Private Practice  
Kensington, Maryland

**David B. Glasser MD**

Assistant Professor of Ophthalmology  
Johns Hopkins University School of Medicine  
Columbia, Maryland

**Michael Gordon MD**

President  
Gordon Binder Weiss Vision Institute  
San Diego, California

**Gabriel M. Gordon BS**

Doctoral Candidate in Cellular Biology  
and Anatomy  
Bascom Palmer Eye Institute  
Evelyn E. & William L. McKnight  
Vision Research Center  
Miami, Florida

**Mark S. Gorovoy MD**

Gorovoy Eye Specialists  
Fort Myers  
Florida

**John D. Gottsch MD**

Associate Professor of Ophthalmology  
Johns Hopkins University School of Medicine  
The Wilmer Eye Institute  
Baltimore, Maryland

**Colin R. Green PhD DSc**

W&B Hadden Chair of Ophthalmology &  
Translational Vision Research  
Department of Ophthalmology and  
Visual Sciences  
Faculty of Medical & Health Sciences  
University of Auckland  
New Zealand

**David H. Haight MD**

Clinical Professor of Ophthalmology  
NYU School of Medicine  
New York, New York  
Clinical Assistant Professor of  
Ophthalmology Weill Cornell College of  
Medicine  
New York, New York

**Julia A. Haller MD**

Ophthalmologist-in-Chief  
Wills Eye Institute  
Professor and Chair  
Department of Ophthalmology  
Jefferson Medical College, Thomas Jefferson  
University  
Philadelphia, Pennsylvania

**Samer Hamada MD MSc FRCS(Ed)**

Fellow in Cornea, Anterior Segment and  
Refractive Surgery  
Corneoplastic Unit & Eye Bank  
Queen Victoria Hospital NHS Trust  
West Sussex  
UK

**David R. Hardten MD**

Adjunct Associate Professor of Ophthalmology  
University of Minnesota  
Minnesota Eye Consultants  
Minneapolis, Minnesota

**Scott G. Hauswirth OD FFAO**

Consultative Optometrist  
Minnesota Eye Consultants  
Minneapolis, Minnesota

**David G. Heidemann MD**

Michigan Cornea Consultants  
Southfield, Michigan

**Lisa Herrygers MD**

Private Practice  
Medical Eye Specialists  
Bozeman, Montana

**Natasha L. Herz MD**

Clinical Instructor of Ophthalmology at  
Georgetown School of Medicine  
Rockville, Maryland

**Christopher Hodge BAppSc (Orth) DOBA**

Orthoptist  
The Eye Institute  
Chatswood  
New South Wales  
Australia

**Kenneth J. Hoffer MD**

Clinical Professor of Ophthalmology  
UCLA  
St Mary's Eye Center  
Santa Monica, California

**Edward J. Holland MD**

Director, Cornea Services  
Professor of Ophthalmology  
University of Cincinnati  
Cincinnati Eye Institute N.KY  
Edgewood, Kentucky

**Randolph T. Jackson MD**

Fellow in Cornea, Refractive and Anterior  
Segment Surgery  
Discover Vision Centers  
Kansas City, Missouri

**Frank M. Jakobs MD PhD**

Speciality, Cornea/External Disease  
Munich, Germany

**Thomas John MD**

Clinical Associate Professor  
Loyola University at Chicago  
Oak Lawn, Illinois

**Albert S. Jun MD, PhD**

Assistant Professor of Ophthalmology  
Cornea and Anterior Segment Service  
The Wilmer Eye Institute, The Johns Hopkins  
Medical Institutions  
Baltimore, Maryland

**Aion Kahana MD PhD**

Assistant Professor, Eye Plastics, Orbit and  
Facial Cosmetic Surgery  
Department of Ophthalmology and Visual  
Sciences  
Kellogg Eye Center  
Ann Arbor, Michigan

**Andrea Cotait Kara-Jose MD**

Cornea and Glaucoma Section  
Ophthalmologist  
Federal University of Sao Paulo, Brazil  
Cornea and Refractive Surgery Fellowship  
Northwestern University

Chicago, Illinois  
Evanston Northwestern Healthcare,  
Evanston, Illinois

**Steven E. Katz MD**

Associate Professor of Ophthalmology  
The Ohio State University  
Columbus, Ohio

**Stephen D. Klyce PhD**

Professor of Ophthalmology  
Louisiana State University School  
of Medicine  
New Orleans, Louisiana

**Douglas D. Koch MD**

Professor and the Allen, Mosbacher, and  
Law Chair in Ophthalmology  
Cullen Eye Institute  
Baylor College of Medicine  
Houston, Texas

**Ernest W. Kornmehl MD FACS**

Medical Director  
Kornmehl Laser Eye Associates  
Clinical Instructor  
Harvard Medical School  
Associate Clinical Professor  
Tufts School of Medicine  
Boston, Massachusetts

**Jay H. Krachmer MD**

Professor and Chairman  
Department of Ophthalmology at the  
University of Minnesota  
Minneapolis

**Amol D. Kulkarni MD**

Clinical Instructor  
Department of Ophthalmology and  
Visual Science  
University of Wisconsin  
School of Medicine and Public Health  
Madison, Wisconsin

**Peter R. Laibson MD**

Professor of Ophthalmology, Thomas  
Jefferson University School of Medicine  
Director Emeritus, Cornea Service,  
Wills Eye Institute  
Philadelphia, Pennsylvania

**Ronald A. Laing PhD**

CTO, Bio-optics International LLC  
Formerly Research Professor of  
Ophthalmology and Associate Professor  
of Physiology  
Department of Ophthalmology  
Boston University School of Medicine  
Florida

**Jeffrey Day Lanier MD**

Clinical Professor  
Department of Ophthalmology  
University of Texas Medical School at Houston  
Houston, Texas

**Jonathan H. Lass MD**

Charles I. Thomas Professor and Chairman  
Department of Ophthalmology and  
Visual Sciences

University Hospitals Case Medical Center  
Cleveland, Ohio

**Michael A. Lawless MB BS FRANZCO FRACS**

Medical Director Vision Group  
Chatswood, New South Wales  
Australia

**Dolena R. Ledee PhD**

Research Assistant Professor  
University of Miami Miller School  
of Medicine  
Miami, Florida

**James Lee MD**

Colorado Springs, Colorado

**Janet Lee MD**

Cornea and Refractive Surgery Fellow  
Department of Ophthalmology  
University of Illinois Eye and Ear Infirmary  
University of Illinois at Chicago  
Chicago, Illinois

**Yunhee Lee MD MPH**

Assistant Professor of Clinical  
Ophthalmology  
University of Miami-FL  
Bascom Palmer Eye Institute  
Miami, Florida

**Kaevalin Lekhanont MD**

Clinical Instructor of Ophthalmology  
Cornea & Refractive Surgery Service  
Department of Ophthalmology  
Ramathibodi Hospital, Mahidol University  
Bangkok, Thailand

**Richard G. Lembach MD**

Professor of Ophthalmology  
The Ohio State University  
Columbus, Ohio

**Jeremy E. Levenson MD**

Clinical Professor of Ophthalmology  
Jules Stein Eye Institute  
UCLA Medical Center  
Los Angeles, California

**Ilya M. Leyngold MD**

Ophthalmology Resident  
Johns Hopkins University Hospital  
Wilmer Eye Institute  
Baltimore, Maryland

**Thomas J. Liesegang MD**

Professor of Ophthalmology  
Mayo Clinic College of Medicine  
Jacksonville, Florida

**Thomas D. Lindquist MD PhD**

Medical Director, SightLife, Seattle, Washington  
Chief, Cornea and External Disease Service  
Group Health Cooperative, Bellevue,  
Washington  
Group Health Bellevue Medical Center  
Bellevue Eye Care  
Bellevue, Washington

**Richard L. Lindstrom MD**

Founder and Attending Surgeon: Minnesota  
Eye Consultants  
Adjunct Professor Emeritus: University of  
Minnesota  
Department of Ophthalmology  
Minnesota Eye Consultants  
Minneapolis, Minnesota

**Mark J. Lucarelli MD**

Associate Professor of Ophthalmology  
and Visual Sciences  
Oculoplastic Surgery Service  
Department of Ophthalmology and Visual  
Sciences  
University of Wisconsin  
Madison, Wisconsin

**Tina C. Lucas-Glass MD**

Chief of Surgery, Emory-Adventist Hospital  
Alpha Eye Associates, L.L.C  
Smyrna, Georgia

**Marian S. Macsai MD**

Chief, Division of Ophthalmology—  
Evanston Northwestern Healthcare  
Professor & Vice Chair, Department  
of Ophthalmology—Northwestern  
University Feinberg  
School of Medicine  
Evanston Northwestern Healthcare  
Glenview, Illinois

**Waleed Mahran MD**

Ophthalmology Research Fellow  
Department of Ophthalmology and Visual  
Sciences  
Illinois Eye and Ear Infirmary  
University of Illinois at Chicago  
Chicago, Illinois

**Fabrice Manns PhD**

Assistant Professor  
Department of Biomedical Engineering  
and Ophthalmology  
University of Miami-FL  
Bascom Palmer Eye Institute  
Miami, Florida

**Suy Anne R. Martins MD PhD**

Research Fellow in Cornea and  
Refractive Surgery  
The Wilmer Eye Institute, The Johns Hopkins  
University School of Medicine  
Baltimore, Maryland

**William D. Mathers MD**

Professor of Ophthalmology  
Department of Ophthalmology  
Casey Eye Institute  
Portland, Oregon

**Peter J. McDonnell MD**

Director  
William Holland Wilmer Professor of  
Ophthalmology  
Wilmer Eye Institute  
Johns Hopkins University  
Baltimore, Maryland



**Charles N. J. McGhee MB, BSc, PhD, FRCS, FRCOphth, FRANZCO, FRSA**

Maurice Paykel Professor and Chair of Ophthalmology  
Department of Ophthalmology and Visual Sciences  
Faculty of Medical and Health Sciences—  
University of Auckland  
Auckland  
New Zealand  
Director, New Zealand National Eye Centre

**David M. Meisler MD FACS**

Professor of Ophthalmology  
Cole Eye Institute  
Cleveland Clinic Lerner College of Medicine  
Cleveland, Ohio

**Shahzad Mian MD**

Assistant Professor  
Ophthalmology & Visual Sciences  
Department  
Kellogg Eye Institute  
University of Michigan  
Ann Arbor, Michigan

**H. L. Rick Milne MD**

The Eye Center  
Columbia, South Carolina

**Bartly J. Mondino MD**

Bradley R. Straatsma Professor of Ophthalmology  
Director, Jules Stein Institute  
Chair, UCLA Department of Ophthalmology  
Los Angeles, California

**W. Stanley Muenzler MD**

Clinical Professor of Ophthalmology  
The University of Oklahoma Health Science Center  
Oklahoma City, Oklahoma

**Nariman Nassiri MD**

Research Fellow  
Department of Ophthalmology  
University of Illinois Eye and Ear Infirmary  
University of Illinois at Chicago  
Chicago, Illinois

**Sarah Nehls MD**

Assistant Professor  
Department of Ophthalmology and Visual Sciences  
University of Wisconsin School of Medicine & Public Health  
Madison, Wisconsin

**Catherine Newton MD**

Associate Clinical Professor of Ophthalmology  
University of Louisville  
School of Medicine  
Louisville, Kentucky

**Guillermo E. Noguera MD**

Research Fellow in Cornea and Refractive Surgery  
The Wilmer Eye Institute, The Johns Hopkins University School of Medicine,  
Baltimore, Maryland

**Michael L. Nordlund MD PhD**

Assistant Professor of Ophthalmology  
University of Cincinnati  
Cincinnati Eye Institute  
Cincinnati, Ohio

**Yuri S. Oleynikov MD PhD**

Research Scientist  
Cedars-Sinai Medical Center  
Los Angeles, California

**Randall J. Olson MD**

The John A. Moran Presidential Professor and Chair of Ophthalmology and Visual Sciences  
Director, John A. Moran Eye Center  
John A. Moran Eye Center, University of Utah  
Salt Lake City, Utah

**Tania M. Onclinx MD**

Santa Monica, California

**Tatsuya Ongucci MD**

Ophthalmology Research Fellow  
Department of Ophthalmology and Visual Sciences  
Illinois Eye and Ear Infirmary  
University of Illinois at Chicago  
Chicago, Illinois

**Tetsuro Oshika MD PhD**

Professor and Chairman  
Department of Ophthalmology  
Institute of Clinical Medicine  
University of Tsukuba  
Japan

**Vasudha A. Panday MD**

Assistant Residency Program Director,  
Wilford Hall Medical Center  
Assistant Professor of Surgery, Uniformed Services University  
Of the Health Sciences  
Department of Ophthalmology  
Lackland, Texas

**Sanjay V. Patel MD**

Assistant Professor of Ophthalmology  
Mayo Clinic  
Rochester, Minnesota

**Jay S. Pepose MD PhD**

Professor of Clinical Ophthalmology & Visual Sciences  
Department of Ophthalmology & Visual Sciences  
Washington University School of Medicine  
Medical Director  
Pepose Vision Institute  
St. Louis, Missouri

**Daryl R. Pfister MD**

Southwestern Eye Center  
Mesa, Arizona

**Roswell R. Pfister MD**

Pfister Vision Correction Center  
Birmingham, Alabama

**Heather Anne Delong Potter MD**

Assistant Professor of Ophthalmology  
Department of Ophthalmology and Visual Sciences  
University of Wisconsin Madison  
Madison, Wisconsin

**Gaurav Prakash MD**

Senior Registrar  
Dr. Rajendra Prasad Centre for Ophthalmic Sciences  
All India Institute of Medical Sciences  
New Delhi  
India

**Marianne O. Price PhD**

Executive Director  
Cornea Research Foundation of America  
Indianapolis, Indiana

**Francis W. Price, Jr. MD**

President  
Price Vision Group  
Indianapolis, Indiana

**Louis E. Probst MD FRCS**

Assistant Professor  
University of Western Ontario  
London, Ontario  
Canada

**Mujtaba A. Qazi MD**

Clinical Instructor  
Department of Ophthalmology & Visual Sciences  
Washington University School of Medicine  
Director, Clinical Studies  
Pepose Vision Institute  
St. Louis, Missouri

**Gullapalli N. Rao MD PhD**

Distinguished Chair of Eye Health  
L V Prasad Eye Institute  
India

**Christopher J. Rapuano MD**

Professor of Ophthalmology  
Jefferson Medical College of Thomas Jefferson University  
Co-Director  
Cornea Service  
Wills Eye Institute  
Philadelphia, Pennsylvania

**Satya V. Reddy MD**

Clinical Assistant Professor of Ophthalmology  
University of Illinois at Chicago Eye and Ear Infirmary  
Chicago, Illinois

**John William Reed MD**

Professor Emeritus, Surgical Sciences  
Department of Ophthalmology  
Wake Forest University Eye Center  
Winston-Salem, North Carolina

**William J. Reinhart MD**

Professor of Ophthalmology  
Case Western Reserve University School  
of Medicine  
Department of Ophthalmology  
University Hospitals of Cleveland  
Cleveland, Ohio

**Cynthia J. Roberts PhD**

Martha G. and Milton Staub Chair for  
Research in Ophthalmology  
Professor  
The Department of Ophthalmology  
Biomedical Engineering Centre  
The Ohio State University  
Columbus, Ohio

**Linda Rose MD PhD**

Assistant Professor of Ophthalmology  
Director, Corneal and External Diseases  
University of New Mexico  
Albuquerque, New Mexico

**Steven Rosenfeld MD FACS**

Voluntary Associate Professor  
Bascom Palmer Eye Institute  
University of Miami Miller School of Medicine  
Miami, Florida  
Private Practice  
Delray Eye Associates  
Delray Beach, Florida

**Jason S. Rothman MD**

Ophthalmic Consultants of Boston  
Private Practice  
Boston, Massachusetts

**James Rowsey MD**

Director of Corneal Service  
Saint Luke's Cataract and Laser Institute  
Tarpon Springs, Florida

**Roy Scott Rubinfeld MD**

Washington Eye Physicians and Surgeons  
Chevy Chase, Maryland  
Clinical Associate  
Professor of Ophthalmology  
Georgetown University Medical Center  
Washington, DC

**David J. Schanzlin MD**

Professor of Ophthalmology  
Department of Ophthalmology  
Director, Refractive Surgery  
Shiley Eye Center  
University of California, San Diego  
La Jolla, California

**Olivia N. Serdarevic MD**

Professor of Ophthalmology  
University of Paris VI  
Paris, France  
Cornell University Weill Medical College  
New York Presbyterian Medical Center  
Lenox Hill Hospital  
Beth Israel Medical Center  
New York, New York

**Neda Shamie MD**

Corneal Services  
Devers Eye Institute  
Portland, Oregon

**Namrata Sharma MD**

Associate Professor of Ophthalmology  
Dr. Rajendra Prasad Centre for Ophthalmic  
Sciences  
All India Institute of Medical Sciences  
New Delhi  
India

**Edward Shaw**

Formerly Chairman, Department  
of Ophthalmology  
Saint Luke's Medical Center  
Phoenix, Arizona

**Trevor Sherwin BSc PhD**

Senior Lecturer  
Department of Ophthalmology and  
Visual Sciences  
Department of Ophthalmology  
University of Auckland  
Auckland  
New Zealand

**Shigeto Shimmura MD**

Associate Professor  
Department of Ophthalmology  
Keio University School of Medicine  
Japan

**Christine Sindt OD**

Clinical Associate Professor  
Director, Contact Lens Service  
Department of Ophthalmology  
Pomerantz Family Pavilion  
Iowa City, Iowa

**Stephen Slade MD FACS**

Surgeon, Private Practice  
Slade & Baker Vision  
Houston, Texas

**Renée Solomon MD**

Private Practice  
New York, New York

**Kaz Soong MD**

Professor of Ophthalmology and Visual  
Sciences  
Division of Cornea, External Disease &  
Refractive Surgery  
WK Kellogg Eye Center  
University of Michigan  
Ann Arbor, Michigan

**Walter J. Stark MD**

Boone Pickens  
Professor of Ophthalmology  
The Wilmer Eye Institute  
The Johns Hopkins Hospital  
Baltimore, Maryland

**Roger F. Steinert MD**

Professor of Ophthalmology  
Professor of Biomedical Engineering

Director of Cornea, Refractive and Cataract  
Surgery  
Vice Chair of Clinical Ophthalmology  
Director, Gavin Herbert Eye Institute  
University of California  
Irvine, California

**Joel Sugar MD**

Professor of Ophthalmology  
Department of Ophthalmology &  
Visual Sciences  
University of Illinois at Chicago  
Chicago, Illinois

**Alan Sugar MD**

Professor of Ophthalmology and Visual  
Sciences  
Kellogg Eye Center  
University of Michigan  
Ann Arbor, Michigan

**Leejee H. Suh MD**

Assistant Professor of Ophthalmology  
Bascom Palmer Eye Institute  
Department of Cornea and External  
Diseases  
Miami, Florida

**John E. Sutphin MD**

Professor and Chair  
Department of Ophthalmology  
The University of Kansas Medical Center  
Kansas City, Kansas

**Mark A. Terry MD**

Director, Corneal Services  
Devers Eye Institute  
Portland, Oregon

**Matthew Joseph Thompson MD**

Cornea and External Disease  
Springfield, Clinic  
Springfield, Illinois

**Kazuo Tsubota MD**

Professor and Chairman  
Department of Ophthalmology  
Keio University School of Medicine  
Japan

**Elmer Y. Tu MD**

Associate Professor of Clinical  
Ophthalmology, Director of the Cornea  
and External Disease Service  
Department of Ophthalmology  
University of Illinois at Chicago  
Chicago, Illinois

**Rasik B. Vajpayee MS, FRCSEd FRANZCO**

Professor of Ophthalmology  
Centre for Eye Research Australia  
Department of Ophthalmology  
University of Melbourne  
Victoria  
Australia