Orbit, Eyelids, and Lacrimal System

Last major revision 2015–2016
The American Academy of Ophthalmology is accredited by the Accreditation Council for Continuing Medical Education (ACCME) to provide continuing medical education for physicians. The American Academy of Ophthalmology designates this enduring material for a maximum of 10 AMA PRA Category 1 Credits™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

CME expiration date: June 1, 2018. AMA PRA Category 1 Credits™ may be claimed only once between June 1, 2015, and the expiration date.

BCSC® volumes are designed to increase the physician’s ophthalmic knowledge through study and review. Users of this activity are encouraged to read the text and then answer the study questions provided at the back of the book.

To claim AMA PRA Category 1 Credits™ upon completion of this activity, learners must demonstrate appropriate knowledge and participation in the activity by taking the posttest for Section 7 and achieving a score of 80% or higher. For further details, please see the instructions for requesting CME credit at the back of the book.

The Academy provides this material for educational purposes only. It is not intended to represent the only or best method or procedure in every case, nor to replace a physician's own judgment or give specific advice for case management. Including all indications, contraindications, side effects, and alternative agents for each drug or treatment is beyond the scope of this material. All information and recommendations should be verified, prior to use, with current information included in the manufacturers’ package inserts or other independent sources, and considered in light of the patient's condition and history. Reference to certain drugs, instruments, and other products in this course is made for illustrative purposes only and is not intended to constitute an endorsement of such. Some material may include information on applications that are not considered community standard, that reflect indications not included in approved FDA labeling, or that are approved for use only in restricted research settings. The FDA has stated that it is the responsibility of the physician to determine the FDA status of each drug or device he or she wishes to use, and to use them with appropriate, informed patient consent in compliance with applicable law. The Academy specifically disclaims any and all liability for injury or other damages of any kind, from negligence or otherwise, for any and all claims that may arise from the use of any recommendations or other information contained herein.

AAO, AAOE, American Academy of Ophthalmology, Basic and Clinical Science Course, BCSC, EyeCare America, EyeNet, EyeSmart, EyeWiki, Focal Points, IRIS, ISRS, OKAP, ONE, Ophthalmic Technology Assessments, Ophthalmology, Preferred Practice Pattern, ProVision, SmartSight, The Ophthalmic News & Education Network, and the AAO logo (shown on cover) and tagline (Protecting Sight. Empowering Lives.) are, among other marks, the registered trademarks and trademarks of the American Academy of Ophthalmology.

Cover image: From BCSC Section 5, Neuro-Ophthalmology. Fundus photograph showing an arteriovenous malformation (racemose angioma) of the retina in a patient with Wyburn-Mason syndrome. (Courtesy of Mark J. Greenwald, MD.)

Copyright © 2017 American Academy of Ophthalmology. All rights reserved. No part of this publication may be reproduced without written permission.

Printed in the United States of America.
Basic and Clinical Science Course

Louis B. Cantor, MD, Indianapolis, Indiana, Senior Secretary for Clinical Education
Christopher J. Rapuano, MD, Philadelphia, Pennsylvania, Secretary for Lifelong Learning and Assessment
George A. Cioffi, MD, New York, New York, BCSC Course Chair

Section 7

Faculty
Jill Annette Foster, MD, Chair, Columbus, Ohio
Keith D. Carter, MD, Iowa City, Iowa
Vikram D. Durairaj, MD, Austin, Texas
Marsha C. Kavanagh, MD, Portsmouth, New Hampshire
Bobby S. Korn, MD, PhD, La Jolla, California
Christine C. Nelson, MD, Ann Arbor, Michigan
Morris E. Hartstein, MD, Consultant, Raanana, Israel

The Academy wishes to acknowledge the American Society of Ophthalmic Plastic and Reconstructive Surgery (ASOPRS) for recommending faculty members to the BCSC Section 7 committee.

The Academy also wishes to acknowledge the following committees for review of this edition:

Committee on Aging: Paul N. Rosenberg, MD, Webster, New York
Vision Rehabilitation Committee: Richard A. Harper, MD, Little Rock, Arkansas

Practicing Ophthalmologists Advisory Committee for Education: Robert G. Fante, MD, Primary Reviewer, Denver, Colorado; Edward K. Isbey III, MD, Chair, Asheville, North Carolina; Alice Bashinsky, MD, Asheville, North Carolina; David J. Browning, MD, PhD, Charlotte, North Carolina; Bradley Fouraker, MD, Tampa, Florida; Dasa Gangadhar, MD, Wichita, Kansas; Steven J. Grosser, MD, Golden Valley, Minnesota; James A. Savage, MD, Memphis, Tennessee

European Board of Ophthalmology: Peter Raus, MD, Chair, Brussels, Belgium; Artur Klett, MD, FEBO, Liaison, Tallinn, Estonia; Maria Borrelli, MD, PhD, Düsseldorf, Germany; Gerd Geerling, MD, PhD, FEBO, Düsseldorf, Germany
Financial Disclosures

Academy staff members who contributed to the development of this product state that within the past 12 months, they have had no financial interest in or other relationship with any entity discussed in this course that produces, markets, resells, or distributes ophthalmic health care goods or services consumed by or used in patients, or with any competing commercial product or service.

The authors and reviewers state that within the past 12 months, they have had the following financial relationships.*

Dr Browning: Aerpio (S), Alimera Sciences (C), Diabetic Retinopathy Clinical Research (S), Genentech (S), Novartis Pharmaceuticals (S), Pfizer (S), Regeneron Pharmaceuticals (S)

Dr Durairaj: KLS Martin (L), Stryker Corporation/Medical Division (L)

Dr Fante: Ophthalmic Mutual Insurance Company (C, L)

Dr Foster: Allergan (C, L), Merz (C, L)

Dr Fouraker: Addition Technology (C), Alcon Laboratories (C), Keravision (C), Ophthalmic Mutual Insurance Company (C)

Dr Geerling: Allergan (C, L), Bausch + Lomb (C, L), TearLab (C, L, O), TearScience (C, L), Théa Pharma (C, L)

Dr Grosser: Ivantis (O)

Dr Isbey: Alcon Laboratories (S), Allscripts (C), Bausch + Lomb (S), Medflow (C)

Dr Korn: Elsevier (P)

Dr Raus: Allergan (L)

Dr Savage: Allergan (L)

The other authors and reviewers state that within the past 12 months, they have had no financial interest in or other relationship with any entity discussed in this course that produces, markets, resells, or distributes ophthalmic health care goods or services consumed by or used in patients, or with any competing commercial product or service.

*C = consultant fees, paid advisory boards, or fees for attending a meeting; L = lecture fees (honoraria), travel fees, or reimbursements when speaking at the invitation of a commercial sponsor; O = equity ownership/stock options of publicly or privately traded firms (excluding mutual funds) with manufacturers of commercial ophthalmic products or commercial ophthalmic services; P = patents and/or royalties that might be viewed as creating a potential conflict of interest; S = grant support for the past year (all sources) and all sources used for a specific talk or manuscript with no time limitation

Recent Past Faculty

Warren J. Chang, MD
Roberta E. Gausas, MD
Andrew R. Harrison, MD
John Bryan Holds, MD
In addition, the Academy gratefully acknowledges the contributions of numerous past faculty and advisory committee members who have played an important role in the development of previous editions of the Basic and Clinical Science Course.

**American Academy of Ophthalmology Staff**

Dale E. Fajardo, *Vice President, Education*
Beth Wilson, *Director, Continuing Professional Development*
Ann McGuire, *Acquisitions and Development Manager*
Stephanie Tanaka, *Publications Manager*
D. Jean Ray, *Production Manager*
Kimberly Torgerson, *Publications Editor*
Beth Collins, *Medical Editor*
Naomi Ruiz, *Editorial Assistant*
## Contents

General Introduction ........................................... xv

Objectives ....................................................... 1

### PART I  Orbit ................................................. 3

1 Orbital Anatomy ............................................. 5
   Dimensions .................................................. 5
   Topographic Relationships ................................. 5
      Roof of the Orbit ....................................... 6
      Lateral Wall of the Orbit ............................... 7
      Medial Wall of the Orbit ............................... 8
      Floor of the Orbit ...................................... 8
   Apertures .................................................... 9
      Ethmoidal Foramina ..................................... 9
      Superior Orbital Fissure ............................... 9
      Inferior Orbital Fissure .............................. 9
      Zygomaticofacial and Zygomaticotemporal Canals .... 9
      Nasolacrimal Canal .................................... 10
      Optic Canal ........................................... 10
   Soft Tissues ............................................... 11
      Periorbita .............................................. 11
      Intraorbital Optic Nerve .............................. 11
      Extraocular Muscles and Orbital Fat ................... 11
      Annulus of Zinn ....................................... 12
      Vasculature of the Orbit .............................. 13
      Nerves ................................................ 16
      Lacrimal Gland ....................................... 18
   Periorbital Structures ................................... 18
      Nose and Paranasal Sinuses ........................... 18

2 Evaluation of Orbital Disorders .............................. 21
   History .................................................... 21
   Pain ....................................................... 21
   Progression ............................................... 21
   Periorbital Changes ..................................... 22
   Physical Examination ................................... 23
      Inspection ............................................ 23
      Palpation ............................................ 25
      Auscultation ......................................... 26
vi CONTENTS

Primary Studies .......................................................... 26
  Computed Tomography ............................................. 26
  Magnetic Resonance Imaging ..................................... 28
  Comparison of CT and MRI ....................................... 29
  Ultrasonography ....................................................... 31
Secondary Studies .......................................................... 32
  Venography .............................................................. 32
  Arteriography .......................................................... 32
  CT and MR Angiography ........................................... 32
Pathology ......................................................................... 32
Laboratory Studies .......................................................... 33

3 Congenital Orbital Anomalies ........................................... 35
  Anophthalmia ............................................................. 35
  Microphthalmia .......................................................... 35
  Treatment of Anophthalmia/Microphthalmia .................... 36
Craniofacial Clefting and Syndromic Congenital
  Craniofacial Anomalies .............................................. 36
  Congenital Orbital Tumors ......................................... 39
    Hamartomas and Choristomas .................................. 39

4 Orbital Inflammatory and Infectious Disorders .................... 43
  Infectious Inflammation ............................................. 44
    Cellulitis .............................................................. 44
    Necrotizing Fasciitis ............................................. 48
    Orbital Tuberculosis .............................................. 49
    Zygomycosis .......................................................... 50
    Aspergillosis .......................................................... 50
    Parasitic Diseases .................................................. 51
  Noninfectious Inflammation ........................................ 51
    Thyroid Eye Disease .............................................. 51
    IgG4 Disease .......................................................... 60
    Vasculitis ............................................................. 60
    Sarcoidosis ............................................................ 63
    Nonspecific Orbital Inflammation ............................. 63

5 Orbital Neoplasms and Malformations ................................. 67
  Vascular Tumors, Malformations, and Fistulas .................. 67
    Infantile (Capillary) Hemangioma ............................ 67
    Cavernous Hemangioma .......................................... 68
    Hemangiopericytoma .............................................. 69
    Lymphatic Malformation ........................................ 69
    Venous Malformation ............................................. 71
    Arteriovenous Malformation .................................... 72
    Arteriovenous Fistula ............................................. 72
    Orbital Hemorrhage ............................................... 74
Neural Tumors .......................................................... 74
  Optic Nerve Glioma ................................................. 74
  Neurofibroma ......................................................... 77
  Meningioma .......................................................... 78
  Schwannoma .......................................................... 82
Mesenchymal Tumors .................................................. 82
  Rhabdomyosarcoma .................................................. 82
  Miscellaneous Mesenchymal Tumors ............................. 84
Lymphoproliferative Disorders .................................... 85
  Lymphoid Hyperplasia and Lymphoma ......................... 85
  Plasma Cell Tumors ................................................. 89
  Histiocytic Disorders ............................................. 90
  Xanthogranuloma .................................................... 90
Lacrimal Gland Tumors ............................................... 91
  Epithelial Tumors of the Lacrimal Gland ...................... 91
  Nonepithelial Tumors of the Lacrimal Gland .................. 94
Secondary Orbital Conditions ...................................... 94
  Globe and Eyelid Origin .......................................... 94
  Sinus Disease Affecting the Orbit ............................. 95
Metastatic Tumors .................................................... 98
  Metastatic Tumors in Children .................................. 98
  Metastatic Tumors in Adults .................................... 99
  Management of Orbital Metastases ............................... 101

6 Orbital Trauma ..................................................... 103
  Midfacial (Le Fort) Fractures .................................. 103
  Orbital Fractures .................................................. 103
    Zygomatic Fractures ............................................ 103
    Orbital Apex Fractures ....................................... 106
    Orbital Roof Fractures ....................................... 106
    Medial Orbital Fractures .................................... 106
    Orbital Floor Fractures ...................................... 108
  Intraorbital Foreign Bodies .................................... 112
  Orbital Hemorrhage .............................................. 112
  Traumatic Vision Loss With Clear Media ..................... 112

7 Orbital Surgery .......................................................... 115
  Surgical Spaces ...................................................... 115
  Orbitotomy ........................................................... 116
    Superior Approach ............................................ 116
    Inferior Approach ............................................. 118
    Medial Approach ............................................... 118
    Lateral Approach .............................................. 120
  Orbital Decompression .......................................... 121
  Postoperative Care for Orbital Surgery ....................... 124
  Special Surgical Techniques in the Orbit ..................... 124
  Complications of Orbital Surgery .............................. 124
## Part II Periocular Soft Tissues

### 9 Facial and Eyelid Anatomy

- **Face** 141
- **Eyelids** 145
  - Skin and Subcutaneous Tissue 146
  - Protractors 147
  - Orbital Septum 149
  - Orbital Fat 149
  - Retractors 149
  - Tarsus 151
  - Conjunctiva 152
- Additional Anatomical Considerations 152

### 10 Classification and Management of Eyelid Disorders

- **Congenital Anomalies** 155
  - Blepharophimosis–Ptosis–Epicanthus Inversus Syndrome 155
  - Congenital Ptosis of the Upper Eyelid 156
  - Congenital Ectropion 156
  - Euryblepharon 156
  - Ankyloblepharon 158
  - Epicanthus 158
  - Epiblepharon 159
  - Congenital Entropion 159
  - Congenital Distichiasis 160
  - Congenital Coloboma 160

---

### 8 The Anophthalmic Socket

- Enucleation and Evisceration 128
  - Enucleation 128
  - Evisceration 129
- Intraoperative Complications of Enucleation and Evisceration 130
- Orbital Implants 131
- Prostheses 132
- Anophthalmic Socket Complications and Treatment 132
  - Deep Superior Sulcus 132
  - Contracture of Fornices 133
  - Exposure and Extrusion of the Implant 133
  - Contracted Sockets 134
  - Anophthalmic Ectropion 135
  - Anophthalmic Ptosis 135
  - Lash Margin Entropion 136
  - Cosmetic Optics 136
- Exenteration 136
  - Considerations for Exenteration 136
  - Types of Exenteration 137
Cryptophthalmos ........................................... 161
Congenital Eyelid Lesions: Infantile (Capillary) Hemangioma ........ 161
Acquired Eyelid Disorders .................................. 162
Chalazion ...................................................... 162
Hordeolum ...................................................... 163
Eyelid Edema .................................................. 164
Floppy Eyelid Syndrome ...................................... 164
Trichotillomania ............................................... 165
Eyeid Neoplasms .............................................. 165
Clinical Evaluation of Eyelid Tumors ......................... 165
Benign Eyelid Lesions ......................................... 166
Benign Adnexal Lesions ...................................... 169
Benign Melanocytic Lesions ................................ 172
Premalignant Epidermal Lesions: Actinic Keratosis ............. 175
In Situ Epithelial Malignancies ............................. 176
Premalignant Melanocytic Lesions: Lentigo Maligna .......... 177
Malignant Eyelid Tumors .................................... 177
Eyelid Trauma ................................................ 187
Blunt Trauma ................................................. 187
Penetrating Trauma .......................................... 187
Secondary Repair ............................................ 189
Dog and Human Bites ....................................... 190
Burns .............................................................. 190
Eyelid and Canthal Reconstruction ............................. 191
Eyelid Defects Not Involving the Eyelid Margin ................. 191
Eyelid Defects Involving the Eyelid Margin .................... 192
Lateral Canthal Defects ...................................... 195
Medial Canthal Defects ..................................... 195

11 Periocular Malpositions and Involutional Changes ............. 197
History and Examination .................................... 197
Ectropion ....................................................... 197
Involutional Ectropion ....................................... 199
Paralytic Ectropion .......................................... 201
Cicatricial Ectropion ........................................ 201
Mechanical Ectropion ....................................... 201
Entropion ....................................................... 202
Congenital Entropion ....................................... 202
Involutional Entropion ...................................... 202
Acute Spastic Entropion ..................................... 205
Cicatricial Entropion ........................................ 206
Symblepharon ................................................ 208
Trichiasis ....................................................... 208
Management ................................................... 208
Blepharoptosis ............................................... 209
Evaluation ...................................................... 209
PART III Lacrimal System

12 Anatomy, Development, and Physiology of the Lacrimal Secretory and Drainage Systems

251

Normal Anatomy

251

Secretary System

251

Drainage System

252

Development

255

Secretary System

255

Drainage System

255

Physiology

255
13 Abnormalities of the Lacrimal Secretory and Drainage Systems

Developmental Abnormalities .............................................. 257
  Lacrimal Secretory System .............................................. 257
  Lacrimal Drainage System .............................................. 257
Congenital Lacrimal Drainage Obstruction .......................... 259
  Evaluation ................................................................. 259
  Punctal and Canalicular Agenesis and Dysgenesis ............... 259
Congenital Nasolacrimal Duct Obstruction ......................... 260
Dacryocystocele ........................................................... 265
Acquired Lacrimal Drainage Obstruction ............................. 267
  Evaluation ................................................................. 267
  Punctal Disorders ........................................................ 272
  Canalicular Obstruction ............................................... 273
  Acquired Nasolacrimal Duct Obstruction ......................... 276
Therapeutic Closure of the Lacrimal Drainage System .......... 281
Trauma ............................................................................. 282
  Canaliculus ..................................................................... 282
  Lacrimal Sac and Nasolacrimal Duct ............................... 284
Infection ............................................................................ 284
  Dacryoadenitis ............................................................. 284
  Canaliculitis .................................................................... 284
  Dacryocystitis .............................................................. 285
Neoplasm ............................................................................ 286
  Lacrimal Gland .............................................................. 286
  Lacrimal Drainage System .............................................. 287

Basic Texts ................................................................. 289
Related Academy Materials ............................................. 291
Requesting Continuing Medical Education Credit ............... 293
Study Questions ............................................................ 295
Answer Sheet for Section 7 Study Questions ..................... 301
Answers ................................................................. 303
Index ................................................................. 307
General Introduction

The Basic and Clinical Science Course (BCSC) is designed to meet the needs of residents and practitioners for a comprehensive yet concise curriculum of the field of ophthalmology. The BCSC has developed from its original brief outline format, which relied heavily on outside readings, to a more convenient and educationally useful self-contained text. The Academy updates and revises the course annually, with the goals of integrating the basic science and clinical practice of ophthalmology and of keeping ophthalmologists current with new developments in the various subspecialties.

The BCSC incorporates the effort and expertise of more than 90 ophthalmologists, organized into 13 Section faculties, working with Academy editorial staff. In addition, the course continues to benefit from many lasting contributions made by the faculties of previous editions. Members of the Academy Practicing Ophthalmologists Advisory Committee for Education, Committee on Aging, and Vision Rehabilitation Committee review every volume before major revisions. Members of the European Board of Ophthalmology, organized into Section faculties, also review each volume before major revisions, focusing primarily on differences between American and European ophthalmology practice.

Organization of the Course

The Basic and Clinical Science Course comprises 13 volumes, incorporating fundamental ophthalmic knowledge, subspecialty areas, and special topics:

1. Update on General Medicine
2. Fundamentals and Principles of Ophthalmology
3. Clinical Optics
4. Ophthalmic Pathology and Intraocular Tumors
5. Neuro-Ophthalmology
6. Pediatric Ophthalmology and Strabismus
7. Orbit, Eyelids, and Lacrimal System
8. External Disease and Cornea
9. Intraocular Inflammation and Uveitis
10. Glaucoma
11. Lens and Cataract
12. Retina and Vitreous
13. Refractive Surgery

In addition, a comprehensive Master Index allows the reader to easily locate subjects throughout the entire series.

References

Readers who wish to explore specific topics in greater detail may consult the references cited within each chapter and listed in the Basic Texts section at the back of the book.
These references are intended to be selective rather than exhaustive, chosen by the BCSC faculty as being important, current, and readily available to residents and practitioners.

**Videos**

This edition of Section 7, *Orbit, Eyelids, and Lacrimal System*, includes videos related to topics covered in the book. The videos were selected by members of the BCSC faculty and are available to readers of the print and electronic versions of Section 7. Mobile-device users can scan the QR code below (a QR-code reader must already be installed on the device) to access the video content.

**Study Questions and CME Credit**

Each volume of the BCSC is designed as an independent study activity for ophthalmology residents and practitioners. The learning objectives for this volume are given on page 1. The text, illustrations, and references provide the information necessary to achieve the objectives; the study questions allow readers to test their understanding of the material and their mastery of the objectives. Physicians who wish to claim CME credit for this educational activity may do so by following the instructions given at the end of the book.

**Conclusion**

The Basic and Clinical Science Course has expanded greatly over the years, with the addition of much new text, numerous illustrations, and video content. Recent editions have sought to place greater emphasis on clinical applicability while maintaining a solid foundation in basic science. As with any educational program, it reflects the experience of its authors. As its faculties change and medicine progresses, new viewpoints emerge on controversial subjects and techniques. Not all alternate approaches can be included in this series; as with any educational endeavor, the learner should seek additional sources, including Academy Preferred Practice Pattern Guidelines.

The BCSC faculty and staff continually strive to improve the educational usefulness of the course; you, the reader, can contribute to this ongoing process. If you have any suggestions or questions about the series, please do not hesitate to contact the faculty or the editors.

The authors, editors, and reviewers hope that your study of the BCSC will be of lasting value and that each Section will serve as a practical resource for quality patient care.
Objectives

Upon completion of BCSC Section 7, *Orbit, Eyelids, and Lacrimal System*, the reader should be able to

- describe the normal anatomy and function of orbital and periocular tissues
- identify general and specific pathophysiologic processes (including congenital, infectious, inflammatory, traumatic, neoplastic, and involutional) that affect the structure and function of these tissues
- select appropriate examination techniques and protocols for diagnosing disorders of the orbit, eyelids, and lacrimal system
- select from among the various imaging and ancillary studies available those that are most useful for the particular patient
- describe appropriate differential diagnoses for disorders of the orbital and periocular tissues
- state the indications for enucleation, evisceration, and exenteration
- describe functional and cosmetic indications in the surgical management of eyelid and periorbital conditions
- state the principles of medical and surgical management of conditions affecting the orbit, eyelids, and lacrimal system
- identify the major postoperative complications of orbital, eyelid, and lacrimal system surgery