

Contents

General Introduction	xix
Objectives	1
1 The Pediatric Eye Examination	3
Examination of Children in the Outpatient Setting	3
History and Examination: General Considerations and Strategies	3
Examination: Specific Elements.	5
Visual Acuity Assessment	5
Red Reflex Examination and the Brückner Test	9
Dynamic Retinoscopy	9
Visual Field Testing	10
Pupil Testing	10
Anterior Segment Examination	10
Intraocular Pressure Measurement	10
Cycloplegic Refraction	10
Fundus Examination	12
PART I Strabismus	13
2 Strabismus Terminology	15
Definitions.	15
Prefixes and Suffixes.	15
Strabismus Classification Terms.	16
Abbreviations for Types of Strabismus	17
3 Anatomy of the Extraocular Muscles	19
Origin, Course, Insertion, and Innervation of the Extraocular Muscles	19
Horizontal Rectus Muscles	20
Vertical Rectus Muscles	20
Oblique Muscles	20
Levator Palpebrae Superioris Muscle.	22
Relationship of the Rectus Muscle Insertions	22
Blood Supply of the Extraocular Muscles.	23
Arterial System	23
Venous System	23
Structure of the Extraocular Muscles	24
Orbital and Fascial Relationships	25
Adipose Tissue	25
Muscle Cone	26

Muscle Capsule	26
The Tenon Capsule	26
The Pulley System	28
Anatomical Considerations for Ophthalmic Procedures	28
4 Motor Physiology	31
Basic Principles and Terms	31
Ocular Rotations	31
Positions of Gaze	31
Extraocular Muscle Action	31
Eye Movements	32
Motor Units	32
Monocular Eye Movements	33
Binocular Eye Movements	37
Supranuclear Control Systems for Eye Movement	40
5 Sensory Physiology and Pathology	41
The Physiology of Normal Binocular Vision	41
Retinal Correspondence	41
Fusion	42
Selected Aspects of the Neurophysiology of Vision	43
Visual Development	44
Effects of Abnormal Visual Experience on the Retinogeniculocortical Pathway	44
Abnormalities of Binocular Vision	47
Visual Confusion	47
Diplopia	47
Sensory Adaptations in Strabismus	48
Suppression	48
Anomalous Retinal Correspondence	50
Monofixation Syndrome	51
6 Amblyopia	53
Epidemiology	53
Pathophysiology	53
Classification	54
Strabismic Amblyopia	54
Refractive Amblyopia	54
Visual Deprivation Amblyopia	55
Detection and Screening	56
Evaluation	56
Treatment	57
Cataract Removal	57
Refractive Correction	57
Occlusion Therapy	58
Pharmacologic or Optical Treatment	58
Binocular Treatment	59
Complications and Challenges of Therapy	59

7	Diagnostic Evaluation of Strabismus and Torticollis . . .	63
	Obtaining a History in Cases of Strabismus or Torticollis	63
	Assessment of Ocular Alignment	64
	Diagnostic Positions of Gaze	64
	Cover Tests	64
	Corneal Light Reflex and Red Reflex Tests	67
	Subjective Tests of Ocular Alignment	68
	Assessment of Eye Movements	71
	Ocular Rotations	71
	Convergence	71
	Fusional Vergence	72
	Forced Duction, Active Force Generation, and Saccadic Velocity	73
	The 3-Step Test	73
	Tests of Sensory Adaptation and Binocular Function	75
	The Red-Glass (Diplopia) Test	75
	Bagolini Lenses	77
	The 4Δ Base-Out Prism Test	78
	The Afterimage Test	79
	Amblyoscope Testing	79
	The Worth 4-Dot Test	80
	Stereoacuity Tests	81
	Assessment of the Field of Single Binocular Vision	81
	The Prism Adaptation Test	82
	Torticollis: Differential Diagnosis and Evaluation	82
	Ocular Torticollis	82
8	Esodeviations	85
	Epidemiology	85
	Pseudoesotropia	85
	Infantile (Congenital) Esotropia	87
	Pathogenesis	87
	Clinical Features and Evaluation	87
	Management	88
	Accommodative Esotropia	90
	Pathogenesis and Types of Accommodative Esotropia	90
	Evaluation	91
	Management	91
	Acquired Nonaccommodative Esotropia	92
	Basic Acquired Nonaccommodative Esotropia	93
	Cyclic Esotropia	93
	Sensory Esotropia	93
	Divergence Insufficiency	94
	Spasm of the Near Reflex	94
	Consecutive Esotropia	95
	Nystagmus and Esotropia	95
	Incomitant Esotropia	95
	Sixth Nerve Palsy	95
	Other Forms of Incomitant Esotropia	97

9	Exodeviations	99
	Pseudoexotropia	99
	Exophoria	99
	Intermittent Exotropia.	99
	Clinical Characteristics	99
	Evaluation	100
	Treatment	101
	Convergence Insufficiency	103
	Constant Exotropia	103
	Infantile Exotropia	103
	Sensory Exotropia	104
	Consecutive Exotropia	104
	Other Forms of Exotropia	105
	Exotropic Duane Retraction Syndrome.	105
	Neuromuscular Abnormalities	105
	Dissociated Horizontal Deviation	105
	Convergence Paralysis	105
10	Pattern Strabismus	107
	Etiology	107
	Clinical Features and Identification of Pattern Strabismus	109
	V Pattern	109
	A Pattern.	109
	Y Pattern.	109
	X Pattern.	110
	λ Pattern	110
	Management	110
	Surgical Correction of Pattern Deviations: General Principles	110
	Surgical Treatment of Specific Patterns	111
11	Vertical Deviations	115
	A Clinical Approach to Vertical Deviations.	115
	Vertical Deviations With Marked Horizontal Incomitance	116
	Overelevation and Overdepression in Adduction	116
	Superior Oblique Muscle Palsy	119
	Inferior Oblique Muscle Palsy.	124
	Skew Deviation	125
	Other Conditions With Incomitant Vertical Deviations.	125
	Vertical Deviations With Horizontal Comitance	125
	Monocular Elevation Deficiency	125
	Orbital Floor Fractures.	127
	Other Conditions With Comitant Vertical Deviations	128
	Dissociated Vertical Deviation	129
	Clinical Features	129
	Management	130
12	Special Motility Disorders	131
	Congenital Cranial Dysinnervation Disorders	131
	Duane Retraction Syndrome	131

Congenital Fibrosis of the Extraocular Muscles	134
Möbius Syndrome	135
Miscellaneous Special Forms of Strabismus	136
Brown Syndrome	136
Third Nerve Palsy	138
Fourth Nerve Palsy	140
Sixth Nerve Palsy	140
Thyroid Eye Disease	140
Chronic Progressive External Ophthalmoplegia	141
Myasthenia Gravis	142
Esotropia and Hypotropia Associated With High Myopia	143
Internuclear Ophthalmoplegia	144
Ocular Motor Apraxia	144
Superior Oblique Myokymia	145
Strabismus Associated With Other Ocular Surgery	145
13 Childhood Nystagmus	147
General Features	147
Nomenclature	147
Types of Childhood Nystagmus	148
Infantile Nystagmus Syndrome (Congenital Nystagmus)	148
Central Vestibular Instability Nystagmus (Periodic Alternating Nystagmus)	149
Fusion Maldevelopment Nystagmus Syndrome (Latent Nystagmus)	150
Acquired Nystagmus	151
Nystagmus-Like Disorders	152
Induced Convergence-Retraction (Convergence-Retraction Nystagmus)	152
Opsoclonus	153
Evaluation	153
History	153
Ocular Examination	153
Treatment	155
Prisms	155
Surgery	155
14 Surgery of the Extraocular Muscles	159
Evaluation	159
Indications for Surgery	159
Planning Considerations	160
Vision	160
General Considerations	160
Incomitance	161
Cyclovertical Strabismus	162
Prior Surgery	162
Surgical Techniques for the Extraocular Muscles and Tendons	162
Approaches to the Extraocular Muscles	162
Rectus Muscle Weakening Procedures	163
Rectus Muscle Tightening Procedures	163

Rectus Muscle Surgery for Hypotropia and Hypertropia	164
Adjustable Sutures.	165
Oblique Muscle Weakening Procedures	165
Oblique Muscle Tightening Procedures	166
Stay Sutures	167
Transposition Procedures	167
Posterior Fixation	167
Complications of Strabismus Surgery	168
Diplopia	168
Unsatisfactory Alignment	168
Iatrogenic Brown Syndrome	168
Anti-Elevation Syndrome	168
Lost and Slipped Muscles.	169
Pulled-in-Two Syndrome.	169
Perforation of the Sclera	170
Postoperative Infections	170
Pyogenic Granuloma and Foreign-Body Granuloma	170
Epithelial Cyst	170
Conjunctival Scarring	171
Adherence Syndrome	172
Delle	172
Anterior Segment Ischemia.	172
Change in Eyelid Position	173
Refractive Changes	173
Anesthesia for Extraocular Muscle Surgery.	174
Methods	174
Postoperative Nausea and Vomiting	174
Oculocardiac Reflex	174
Malignant Hyperthermia.	174
Chemodenervation Using Botulinum Toxin	175
Pharmacology and Mechanism of Action.	175
Indications, Techniques, and Results	175
Complications	176

PART II Pediatric Ophthalmology 177

15 Growth and Development of the Eye 179

Normal Growth and Development	179
Dimensions of the Eye	179
Refractive State	180
Orbit and Ocular Adnexa	181
Cornea, Iris, Pupil, and Anterior Chamber	181
Intraocular Pressure	181
Extraocular Muscles.	181
Retina	182
Visual Acuity and Stereoacuity	182
Abnormal Growth and Development	182

16	Decreased Vision in Infants and Pediatric Vision Rehabilitation	185
	Visual Development in Young Infants	185
	Classification of Visual Impairment in Infants and Children	186
	Pregeniculate Visual Impairment	186
	Cerebral Visual Impairment	186
	Delayed Visual Maturation	186
	Evaluation of the Infant With Decreased Vision	187
	Pediatric Low Vision Rehabilitation	188
17	Eyelid Disorders	191
	Congenital Eyelid Disorders	191
	Dystopia Canthorum	191
	Cryptophthalmos	191
	Ablepharon	193
	Congenital Coloboma of the Eyelid	193
	Ankyloblepharon	193
	Congenital Ectropion	194
	Congenital Entropion	194
	Epiblepharon	194
	Congenital Tarsal Kink	194
	Distichiasis	195
	Euryblepharon	195
	Epicanthus	196
	Palpebral Fissure Slants	196
	Congenital Ptosis	196
	Other Causes of Ptosis in Children	198
	Infectious and Inflammatory Eyelid Disorders	198
	Vascular Eyelid Disorders	199
	Port-Wine Stain	199
	Eyelid Hemangioma	199
	Neoplasms and Other Noninflammatory Eyelid Lesions	199
	Pilomatricoma	200
	Epithelial Lesions	200
	Eyelid Nevi	200
	Other Eyelid Conditions	201
	Trichotillomania	201
	Excessive Blinking	201
18	Orbital Disorders	203
	Abnormal Interocular Distance: Terminology and Associations	203
	Congenital and Developmental Disorders: Craniofacial Malformations	203
	Craniosynostosis	203
	Nonsynostotic Craniofacial Conditions	209
	Infectious and Inflammatory Conditions	212
	Preseptal Cellulitis	212

Orbital Cellulitis	213
Childhood Orbital Inflammation	215
Neoplasms	216
Differential Diagnosis	216
Primary Malignant Neoplasms	217
Metastatic Tumors	218
Hematopoietic, Lymphoproliferative, and Histiocytic Neoplasms	218
Benign Tumors	219
Ectopic Tissue Masses	223
Cystic Lesions	223
Teratoma.	225
Ectopic Lacrimal Gland	226
19 Lacrimal Drainage System Abnormalities	227
Congenital and Developmental Anomalies	227
Atresia of the Lacrimal Puncta or Canaliculi	227
Congenital Lacrimal Fistula	228
Dacryocystocele	228
Congenital Nasolacrimal Duct Obstruction	230
Clinical Features and Examination.	230
Nonsurgical Management	231
Surgical Management	232
20 External Diseases of the Eye	237
Infectious Conjunctivitis.	237
Ophthalmia Neonatorum	237
Bacterial Conjunctivitis in Children and Adolescents.	240
Viral Conjunctivitis in Infants and Children	241
Inflammatory Disease	244
Blepharitis	244
Ocular Allergy	246
Ligneous Conjunctivitis	249
Other Conjunctival and Subconjunctival Disorders	250
Papillomas	250
Conjunctival Epithelial Inclusion Cysts.	250
Conjunctival Nevi	250
Ocular Melanocytosis	250
Stevens-Johnson Syndrome and Toxic Epidermal Necrolysis	251
21 Disorders of the Anterior Segment	253
Abnormalities of Corneal Size or Shape	253
Megalocornea	253
Microcornea	254
Keratoglobus	254
Keratoconus	254
Abnormalities of Peripheral Corneal Transparency	255
Posterior Embryotoxon	255

Cornea Plana	255
Epibulbar Dermoid	256
Dermolipoma	256
Abnormalities of Central and Diffuse Corneal Transparency	257
Primary Causes	258
Secondary Causes	259
Treatment of Corneal Opacities	262
Congenital and Developmental Anomalies of the Globe	263
Microphthalmia, Anophthalmia, and Coloboma.	263
Nanophthalmos.	263
Congenital and Developmental Anomalies of the Iris or Pupil.	264
Abnormalities of the Iris	264
Abnormalities in the Size, Shape, or Location of the Pupil.	267
Acquired Corneal Conditions	269
Keratitis	269
Systemic Diseases Affecting the Cornea or Iris	269
Metabolic Disorders Affecting the Cornea or Iris	269
Other Systemic Diseases Affecting the Cornea or Iris	271
Tumors of the Anterior Segment	271
Cornea	271
Iris	271
Ciliary Body	273
Miscellaneous Clinical Signs	274
Pediatric Iris Heterochromia	274
Anisocoria	275

22 Pediatric Glaucomas 277

Classification.	277
Genetics.	277
Primary Childhood Glaucoma	278
Primary Congenital Glaucoma	278
Juvenile Open-Angle Glaucoma.	284
Secondary Childhood Glaucoma	284
Secondary Glaucoma Associated With an Acquired Condition	284
Glaucoma Following Cataract Surgery	285
Treatment	285
Surgical Therapy	285
Medical Therapy	288
Prognosis and Follow-Up	290

23 Childhood Cataracts and Other Pediatric Lens Disorders. 293

Pediatric Cataracts	293
General Features	293
Morphology	294
Evaluation of Pediatric Cataracts	299
Examination	300

Cataract Surgery in Pediatric Patients	301
Timing of the Procedure	301
Intraocular Lens Use in Children	301
Management of the Anterior Capsule	302
Lensectomy Without Intraocular Lens Implantation	302
Lensectomy With Intraocular Lens Implantation	302
Postoperative Care	304
Complications Following Pediatric Cataract Surgery	304
Visual Outcome After Cataract Extraction	305
Structural or Positional Lens Abnormalities	305
Congenital Aphakia	305
Spherophakia	305
Coloboma	305
Dislocated Lenses in Children	306
Isolated Ectopia Lentis	307
Ectopia Lentis et Pupillae	307
Marfan Syndrome	307
Homocystinuria	308
Weill-Marchesani Syndrome	309
Sulfite Oxidase Deficiency	310
Treatment	310

24 Uveitis in the Pediatric Age Group 311

Epidemiology	311
Classification	311
Anterior Uveitis	312
Juvenile Idiopathic Arthritis	312
Juvenile Spondyloarthropathies	315
Tubulointerstitial Nephritis and Uveitis Syndrome	316
Kawasaki Disease	316
Other Causes of Anterior Uveitis	316
Intermediate Uveitis	316
Posterior Uveitis	317
Toxoplasmosis	317
Toxocariasis	317
Other Causes of Posterior Uveitis	318
Panuveitis	318
Sarcoidosis	318
Familial Juvenile Systemic Granulomatosis	319
Vogt-Koyanagi-Harada Syndrome	319
Other Causes of Panuveitis	319
Masquerade Syndromes	319
Evaluation of Pediatric Uveitis	319
Treatment of Pediatric Uveitis	320
Management of Inflammation	320
Surgical Treatment of Complications of Uveitis	322

25	Disorders of the Retina and Vitreous	325
	Congenital and Developmental Abnormalities	325
	Persistent Fetal Vasculature	325
	Retinopathy of Prematurity	325
	Hereditary Retinal Disease	335
	Hereditary Macular Dystrophies	339
	Hereditary Vitreoretinopathies	342
	Infectious Diseases	348
	Herpes Simplex Virus and Cytomegalovirus	348
	Human Immunodeficiency Virus	348
	Tumors	349
	Choroidal and Retinal Pigment Epithelial Lesions	349
	Retinoblastoma	351
	Acquired Disorders	358
	Coats Disease	358
26	Optic Disc Abnormalities	361
	Developmental Anomalies	361
	Optic Nerve Hypoplasia	361
	Morning Glory Disc Anomaly	362
	Optic Nerve Coloboma	364
	Optic Nerve Pit	364
	Myelinated Retinal Nerve Fiber Layer	365
	Tilted Disc	365
	Bergmeister Papilla	366
	Megalopapilla	366
	Peripapillary Staphyloma	366
	Optic Nerve Aplasia	366
	Melanocytoma of the Optic Disc	367
	Optic Atrophy	367
	Dominant Optic Atrophy, Kjer Type	367
	Recessive Optic Atrophy	368
	Leber Hereditary Optic Neuropathy	368
	Optic Neuritis	369
	Papilledema	370
	Idiopathic Intracranial Hypertension	370
	Pseudopapilledema	372
	Drusen	373
27	Ocular Trauma in Childhood	375
	Special Considerations in the Management of Pediatric	
	Ocular Trauma	375
	Accidental Trauma	375
	Corneal Abrasion	376
	Thermal Injury	376
	Chemical Injury	376
	Corneal Foreign Body	376

Penetrating or Perforating Injury	376
Blunt Injury	378
Orbital Fractures	379
Traumatic Optic Neuropathy	381
Nonaccidental Trauma	381
Abusive Head Trauma	381
Ocular Injury Secondary to Nonaccidental Trauma	384

28 Ocular Manifestations of Systemic Disease 385

Diseases due to Chromosomal Abnormalities.	385
Inborn Errors of Metabolism	385
Familial Oculorenal Syndromes	391
Lowe Syndrome	391
Alport Syndrome	391
Ciliopathies	391
Neuro-Oculocutaneous Syndromes	392
Neurofibromatosis Type 1	392
Neurofibromatosis Type 2	397
Tuberous Sclerosis.	397
Von Hippel–Lindau Disease	399
Sturge-Weber Syndrome	401
Ataxia-Telangiectasia	403
Incontinentia Pigmenti	404
Wyburn-Mason Syndrome	405
Klippel-Trénaunay Syndrome	406
Albinism	406
Diagnosis	406
Treatment	408
Diabetes Mellitus	408
Intrauterine or Perinatal Infection.	409
Toxoplasmosis	409
Rubella	410
Cytomegalovirus	411
Herpes Simplex Virus	412
Syphilis	412
Lymphocytic Choriomeningitis	413
Zika Virus	413
Malignant Disease	413
Leukemia	413
Neuroblastoma	414
Basic Texts.	417
Related Academy Materials	419
Requesting Continuing Medical Education Credit.	421
Study Questions	423
Answer Sheet for Section 6 Study Questions	431
Answers	433
Index	439