

Contents

Chapter 1: Introduction to Diagnostic Imaging Techniques in Ophthalmology	1
<i>Samuel Boyd, MD</i>	
Optical Coherence Tomography	1
Optical Properties of Tissue	1
Interpretation of OCT Images	1
Corneal Topography	2
Optical Properties of the Cornea	2
Interpretation of Topographic Maps	3
Surface Curvature Measurements in Topography	4
<i>Curvature/Power Map</i>	4
<i>Elevation Map</i>	4
<i>Relative vs. Absolute Scales</i>	4
Wavefront Technology and Customized Ablations	5
Ultrasound in Ophthalmology	6
The Role of the Fluorescein Angiogram	7
Fluorescein Angiography and Filter Basics	7
Interpretation of Fluorescein Angiography	8
Electroretinogram and Electrooculogram	9
Visual Evoked Potentials	10
Confocal Microscopy	11
Chapter 2: Corneal Topography	13
<i>Amar Agarwal, M.S.; F.R.C.S.; F.R.C.Ophth.; Athiya Agarwal, M.D.; F.R.S.H. ; D.O.; Sunita Agarwal, M.S.; F.S.V.H. ; D.O.</i>	
Curvature of the Cornea	13
Keratometry	13
Keratotomy	14
Computerized Videokeratography	14
ORBSCAN	14
Paraxial Optics	15
Raytrace or Geometric Optics	15
Elevation	15
To Summarize	15
ORBSCAN I and II	15
Specular vs Back-Scattered Reflection	16
Imaging in the ORBSCAN	16
Map Colours Conventions	16
Analysis of the Normal Eye by the ORBSCAN Map	17
Analysis of Several Condition by the Orbscan Map	17
Primary Posterior Corneal Elevation	17
Iatrogenic Keratectasia	19
Presbyopic LASIK	20
ZYOPTIX Laser	21
Cataract Surgery	21
Microphakonit (Cataract Surgery through a 0.7 mm tip)	21
Chapter 3: Wavefront and Aberrometry Analysis	23
<i>Rafael I. Barraquer, MD, PhD.; Andrés Picó, OD, MD</i>	
The Ray Aberrations	23
<i>Monochromatic Aberrations</i>	24
<i>Chromatic Aberrations</i>	25
Wavefronts and Wavefront Aberrations	26

The Zernike Expansion	27
The Aberrations in the Normal Eye	29
Wavefront Measuring and Aberrometry	29
Historical Background	29
Outgoing Reflection Aberrometry (Hartmann-Shack)	30
Retinal Imaging Aberrometry (Tscherning)	32
Sequential Retinal Ray Tracing Aberrometry (iTrace)	33
Ingoing Wavefront Adjustable Refractometry (Spatially Resolved Refractometer)	34
Double Pass Aberrometry (Dynamic Skiascopy)	35
Advantages and Limitations of the Different Aberrometry Systems	36
Wavefront Analysis, Optical Quality, and Visual Performance	37
Quality Measures in the Spatial Domain (PSF, LSF, Strehl ratio)	37
Quality Measures in the Contrast Domain (MTF, PTF, OTF)	38
Wavefront Mapping Options	39
The Root Mean Square (RMS) Error and Related Metrics	40
 Chapter 4: In-vivo Micromorphology of the Ocular Coats –	
Confocal Microscopy Principles and Clinical Applications	47
Prof. Dr. med. R. F. Guthoff, MD.; Joachim Stave, MD.	
Principle of In-vivo Confocal Microscopy Based on the	
Laser-Scanning Technique	47
Slit-Scanning Techniques	48
Fundamentals of Image Formation in In-Vivo Confocal Microscopy	50
General Anatomical Considerations	51
In-vivo Confocal Laser-Scanning Microscopy	52
Confocal Laser-Scanning Imaging of Normal Structures	53
Epithelial Layer	54
Langerhans' Cells	54
Corneal Nerves	55
Bowman's Membrane	56
Stroma	56
Descemet's Membrane	57
Endothelial Cells	57
Limbal Region	57
Clinical Findings	59
Dry Eye	59
Meesmann's Dystrophy	59
Epithelium in Contact Lens Wearers	60
Epidemic Keratoconjunctivitis	62
Acanthamoeba Keratitis	63
Corneal Ulcer	63
Slit-Lamp Photograph	64
Confocal Microscopy	64
Refractive Corneal Surgery	64
Future Developments	65
 Chapter 5: The Role of Computerized Optic Nerve Campimetry	
in the Early Diagnosis of Glaucoma	71
Jerome C. Ramos-Esteban, MD	
The Reticulogeniculate Pathways	72
A. Koniocellular (K) Pathway	72
B. Magnocellular (M) Pathway	72
C. Parvocellular (P) Pathway	72
Testing the Reticulogeniculate Pathways	72
A. Short-wavelength Automated Perimetry (SWAP)	72
1. Technical Characteristics	73
2. Testing Considerations	73

Diagnostic and Imaging Techniques in Ophthalmology

3. Clinical Correlations	74
B. Frequency-Doubling Perimetry (FDP)	74
1. Technical Characteristics	74
2. Testing Considerations	74
3. Clinical Correlations	74
C. High Band-Pass Resolution Perimetry	74
1. Technical Characteristics	74
2. Testing Considerations	74
3. Clinical Applications	75
Chapter 6: Optical Coherence Tomography (OCT) and Retinal Tomography in Glaucoma	77
<i>Tarkan Mumcuoglu, MD.; Gadi Wollstein, MD.; Joel S. Schuman, MD.</i>	
Optical Coherence Tomography (OCT)	77
What is OCT?	77
Importance of Nerve Fiber Layer	78
Interpretation of OCT	78
Retinal Tomography	82
Interpretation of HRT	83
Chapter 7: Fluorescein and Indocyanine Green Retinal Angiography	87
<i>J. Fernando Arevalo, MD FACS.; Dario Fuenmayor-Rivera, MD.; Juan G. Sanchez, MD.; Reinaldo A. Garcia, MD.; Lihteh Wu, MD.</i>	
Fluorescein Angiography	87
Properties of Fluorescein Dye	87
Adverse Reactions to Fluorescein Dye	88
Normal Fluorescein Angiogram	88
Abnormal Fluorescein Angiographic Patterns	89
Indocyanine Green Angiography	90
Properties of Indocyanine Green	91
Adverse Reactions to Indocyanine Green	91
Normal Indocyanine Green Angiogram	92
Interpretation of Fluorescein and Indocyanine Green Angiography of Selected Pathological Retinal Conditions	92
Retinal Angiomatous Proliferation	95
Intraocular Tumors	96
Chorioretinal Inflammatory Syndromes	98
Chapter 8: Ultrasonography within the Framework of Ophthalmologic Differential Diagnosis	101
<i>Prof. Dr. med. R. F. Guthoff, MD.; Dr. rer. nat. Oliver Stachs, PhD</i>	
Ophthalmic Ultrasonography - Past, Present and Future	101
Examination Techniques	103
Recommendations for a Rational Sequence of Examinations	103
<i>The Examination Procedure</i>	103
<i>Principles of Obtaining the Optimal Ultrasonogram</i>	104
<i>Spontaneous Motions as a Diagnostic Sign</i>	104
<i>The "Critical Moment" Decides</i>	104
<i>The Three-Dimensional Image</i>	105
The Integration of B-Mode Doppler Instruments (Duplex Scanner)	107
Ultrasound Biomicroscopy	108
3D Ultrasound Biomicroscopy	109
Practical Approaches based on Ultrasonography	110
The Red Eye	110
Blurred Disk Margins – Elevation of the Optic Nerve head	112
Choroidal Folds	115
Leukokoria	116

Vitreous Hemorrhage	118
Examination before a Vitrectomy	119
Exophthalmus	121
Deficits in Ocular Motility	123
<i>Myogenic Deficits of Ocular Motility</i>	123
Anterior Segment Space Occupying Lesions	125
Chamber Angle Abnormalities of Questionable Origin	126
Accommodative Artificial Intraocular Lenses – Contributions of Ultrasonography	127
<i>Stretching Device</i>	128
Chapter 9: Imaging of the Eye with Very High Frequency Ultrasound	133
<i>D. Jackson Coleman, MD, FACS., Ronald H. Silverman, PhD, Harriet O. Lloyd, M.S., Mark J. Rondeau</i>	
Principles and Physics	133
Clinical Evaluation	134
Cornea	135
Iris	136
Glaucoma	137
Ciliary Body	139
Hypotony	139
Trauma	140
Intraocular Lens Sizing	141
Advances in Ophthalmic Ultrasound Imaging	141
Chapter 10: Optical Coherence Tomography (OCT) for Exploring the Anterior Segment of the Eye	145
<i>G. Baikoff, MD.</i>	
The Anterior Chamber OCT ("Visante™" Developed by Carl Zeiss Meditec)	146
Applications for Exploring the Anterior Segment with the OCT	146
<i>a. Static Measurement of the Anterior Segment</i>	146
<i>b. Dynamic Evaluation of the Anterior Segment</i>	147
<i>c. Evaluation of the Crystalline Lens with the AC OCT</i>	147
<i>d. Pseudophakic Artificial Crystalline Lens</i>	148
<i>e. Phakic Implants</i>	148
<i>f. The Cornea</i>	148
<i>g. Glaucoma</i>	150
Conclusions and the Future of Anterior Segment OCT Exploration	150
Chapter 11: Optical Coherence Tomography	153
<i>Soosan Jacob, MS, DNB, FRCS, MNAMS.; Sunita Agarwal, MS, DO.; Aathiya Agarwal, MD, DO., Amar Agarwal, MS, FRCS, FRCOphth</i>	
Principle of OCT	153
Color Coding in OCT	154
Interpretation of OCT of the Normal Retina	154
Interpretation of OCT of the Optic Nerve Head (ONH)	155
Scanning Protocols	155
Circumpapillary OCT Scans	155
Radial Scans Through the Optic Nerve Head	155
Macular Raster Scans	155
Macular Radial Scans	155
Quantitative Analysis Algorithms	156
Retinal Thickness Measurement	156
Nerve Fibre Layer Thickness Measurement and Analysis	156
Optic Nerve Head Analysis	156
Retinal Topography	156
OCT in Different Situations	156

Diagnostic and Imaging Techniques in Ophthalmology

Chapter 12: Visual Evoked Potential: Clinical Applications

165

Linda Semela, MD., Thomas R. Hedges MD.

Conventional Visual Evoked Potential	165
Method	165
Ophthalmic Applications of Conventional VEP Recording	166
<i>Retinal Disease Versus Optic Nerve Disease</i>	166
Optic Neuritis	166
Ischemic Optic Neuropathy	166
Compressive Optic Neuropathy	166
Retrochiasmal Lesions (Hemifield VEP Testing)	167
Albinism	167
VEP in Children	167
Nonorganic Visual Field Loss	168
Multifocal Visual Evoked Potential (mfVEP)	168
Method	168
Ophthalmic Applications of mfVEP Recording	169
Retinopathy	169
Glaucoma	170
Ischemic Optic Neuropathy	170
Optic Neuritis	170
Compressive Optic Neuropathy	171
Pituitary Adenoma	172
Retrochiasmal Lesions	172

Chapter 13: Electroretinogram and Electro-oculogram

175

Brighu N. Swamy, MBBS (Hons) M Med (Clin Epi); Suresh K. Pandey, MD

Electrophysiology in Ocular Diseases	175
Electrophysiology of the Retina	175
Electroretinogram	176
Clinical uses of ERG	177
<i>Congenital Nystagmus</i>	178
<i>Rod/Cone Dystrophies</i>	178
<i>Distinguishing Progressive from Non-progressive Retinal Degenerations</i>	178
<i>RP Screening</i>	178
<i>ERG in CSNB</i>	178
<i>Oguchi's Disease</i>	178
<i>Bull's Eye Maculopathy</i>	178
<i>Vascular and Inflammatory Retinopathy</i>	178
<i>Toxicity</i>	178
Focal ERG	178
Multifocal ERG	178
Pattern Electroretinogram	179
Early Receptor Potential	179
Oscillatory Potentials	179
ERG and Visual Adaptation	179
ERG and Spectral Sensitivities	179
Electro-Oculogram	180
ERG Usually Abnormal in Conditions in which EOG is also Abnormal with 4 Exceptions	180
Other uses of EOG	180
Visual Processing Pathways	180