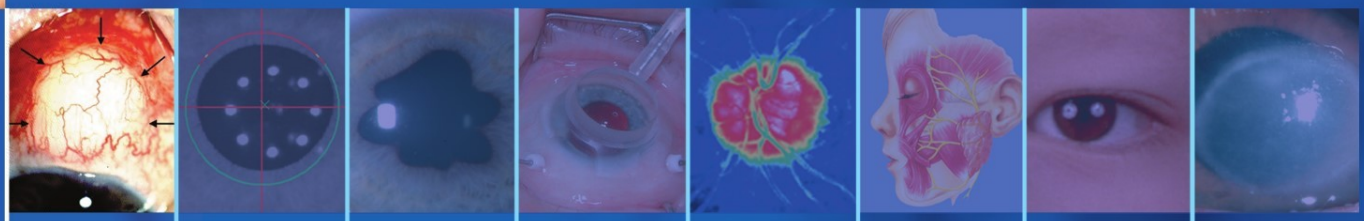
ESSENTIALS IN OPHTHALMOLOGY

G. K. KRIEGLSTEIN · R. N. WEINREB

Series Editors



Glaucoma | Cataract and Refractive Surgery | Uveitis and Immunological Disorders | Vitreo-retinal Surgery | Medical Retina | Oculoplastics and Orbit | Pediatric Ophthalmology, Neuro-ophthalmology, Genetics | Cornea and External Eye Disease

Glaucoma

PROGRESS III

Edited by

F. GREHN

R. STAMPER

Springer

Essentials in Ophthalmology

Glaucoma

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Cornea and External Eye Disease

Vitreo-retinal Surgery

Editors Franz Grehn
Robert Stamper

Glaucoma

With 67 Figures, Mostly in Colour
and 8 Tables

Springer

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Foreword

The Essentials in Ophthalmology series represents an unique updating publication on the progress in all subspecialties of ophthalmology.

In a quarterly rhythm, eight issues are published covering clinically relevant achievements in the whole field of ophthalmology. This timely transfer of advancements for the best possible care of our eye patients has proven to be effective. The initial working hypothesis of providing new knowledge immediately following publication in the peer-reviewed journal and not waiting for the textbook appears to be highly workable.

We are now entering the third cycle of the Essentials in Ophthalmology series, having been encouraged by readership acceptance of the first two series, each of eight volumes. This is a success that was made possible predominantly by the numerous opinion-leading authors and the outstanding section editors, as well as with the constructive support of the publisher. There are many good reasons to continue and still improve the dissemination of this didactic and clinically relevant information.

G.K. Krieglstein
R.N. Weinreb
Series Editors
September 2008

Preface

This third volume in the series, *Essentials of Ophthalmology,* just like the first, seeks to bring the ophthalmic practitioner up to date in the important new advances or changes in glaucoma diagnosis or management that have occurred over the last ten years. The last decade has seen significant changes in our understanding of the pathophysiology of some glaucomas, in our diagnostic approaches and in our management of them. Toward the goal of providing the most up-to-date information in a readable fashion, we have asked some of the world's experts to discuss areas to which they have contributed in a way that will be useful for the practicing doctor. For example, one of the pioneers in the imaging of live ganglion cells is Dr. Francesca Cordeiro. Her studies could lead to a potentially significant breakthrough as, in the future, clinicians may be able to determine the health and number of ganglion cells in the retina as both a diagnostic and monitoring test. As the prevalence of glaucoma increases in our aging population, epidemiology has become more important as a methodology to identify risk factors; Drs. Giangiacomo and Coleman discuss what we have recently learned that is relevant to our clinical understanding of glaucoma. Drs. Doshi, Weinreb and colleagues describe the diurnal fluctuation of intraocular pressure, how those fluctuations impact on glaucoma, the relationship of postural change to that fluctuation, and what it means for managing glaucoma. Detecting progression of glaucoma can be tricky. Imaging techniques may be helpful. Strouthidis and Garway-Heath tell us how. Our concepts of and terminology for angle-closure glaucoma have undergone major changes over the last few years. Sharma, Low and Foster describe these changes and introduce the new—now internationally agreed upon—terminology. The association of uveitis and glaucoma has been known and has frustrated those caring for patients with these two concurrent conditions for many years; Drs. Nagpal and Acharya discuss the interrelationship between uveitis and glaucoma, what the doctor should look for, and how to manage these difficult patients. New approaches to glaucoma surgery have been described recently. Drs. Mendrinos and Shaarawy describe the techniques and results of nonpenetrating glaucoma surgery. Drs. Tam and Ahmed describe and discuss several new approaches to glaucoma surgery using special shunts that have appeared in the past few years. As electronic medical record systems gain popularity around the world, Drs. Schargus and Grehn describe the European Glaucoma Society's electronic glaucoma record and their agreement on what is important to include in such a system. We hope that all the topics and authors that we have selected are helpful in improving the understanding of the many faces of glaucoma and, ultimately, will contribute to reduced visual loss and better care for our patients.

Franz Grehn
Robert L. Stamper

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Chapter 1

Imaging Individual Ganglion Cells in the Human Retina

1

Nicholas E.H. Nick Wood, Li Guo, M. Francesca Cordeiro

Core Messages

- Retinal ganglion cells (RGCs) are the key cells implicated in glaucoma, and their assessment could lead to effective treatment and monitoring regimens
- Scanning laser polarimety (SLP) gives a good measure of RNFL thickness and RGC axonal loss but cannot provide focussed information about RGCs
- High-resolution reflectance imaging uses high-quality CCDs(charge-coupled device), which can use much more information from simple funduscopic observa-tions but again provide little information on RGCs
- Optical coherence tomography (OCT) is a rapidly developing technology which is now enabling retinal cellular, functional and 3D imaging, but its role in RGC imaging is still uncertain
- Most promising technologies use the established confocal scanning laser ophthalmoscope (cSLO) combined with other methodologies to improve RGC visualization
- Imaging in experimental research has permitted the direct assessment and successful evaluation of RGCs in disease models
- Some safe techniques developed in animal models are beginning to make the crossover into clinical glaucoma detection
- Ideally, methodologies enabling the visualization of healthy and "sick" RGCs would provide a comprehensive assessment of glaucomatous changes and disease states

1.1 Introduction

Glaucoma is a leading cause of blindness worldwide [1] and it is expected that the number of people with the disease will rise dramatically by 2020 [2]. Diagnosis is traditionally from changes in the optic nerve head (ONH) and visual field loss, but these can only detect the disease after significant (25–40%) loss of retinal ganglion cells (RGCs), the key cell implicated in this process [3, 4].

The inner retinal layers, being optical media that are therefore transparent to visible-frequency light, are inherently low contrast. This presents a significant challenge for traditional imaging such as fundus imaging. Modern technologies now use many different properties of light to differentiate between the retinal structures and these technologies are enabling us to observe fine detail, such as the photoreceptor layers, in vivo [5]. Combined with other techniques, they allow the examination of individual RGCs [3, 5–7]. In vivo imaging also enables longitudinal studies [3, 5], which brings great possibilities for elucidating disease pathways and developing new treatments [8, 9].

Recent advances have allowed unprecedented access to the retinal layers, creating the possibility of potentially visualizing ganglion cells in order to provide a new and early clinical parameter for glaucomatous injury. This chapter aims to cover the current research achievements in RGC imaging and the promising directions they are taking visual science.

1.2 Description of the Imaging Techniques

- *Scanning laser polarimetry (SLP)*: A confocal imaging system with a polarimeter to measure the birefringence caused by the retinal nerve fibre layer (RNFL)
- *High-resolution reflectance imaging*: Based around a fundus camera with a high-quality CCD camera, this system can take a sequence of rapid images which can measure wavelength-dependent reflectance changes with very high temporal resolution
- *Optical coherence tomography (OCT)*: A low-coherence interferometry-based imaging system where changes in reflectivity are measured in a volume of the retina with very high axial resolution