Manual for
Eye Examination
and Diagnosis

Seventh Edition
Cornea  
Clear, front part of the eye

Iris  
Colored diaphragm that regulates amount of light entering

Aqueous  
Clear fluid in front part of the eye

Ciliary body  
Produces aqueous and focuses lens

Lens  
Clear, refracting media that focuses light

Vitreous  
Clear jelly filling the back of the eye

Sclera  
Rigid, white outer shell of the eye

Conjunctiva  
Mucous membrane covering sclera and inner lids

Retina  
Inner lining of the eye containing light-sensitive rods and cones

Macula  
Avascular area of the retina responsible for the most acute vision

Fovea  
A pit in the center of the macula corresponding to central fixation of vision

Choroid  
Vascular layer between retina and sclera

Optic nerve  
Transmits visual stimuli from retina to brain

Zonule  
Fibers suspending lens from ciliary body
Manual for
Eye Examination
and Diagnosis

Mark W. Leitman, MD
St. Peter's University Hospital
New Brunswick, NJ 08901

SEVENTH EDITION
Dedicated to Andrea Kase

It is impossible to perform a good eye exam without a good support team. Andrea has enthusiastically led our team for 26 years as office manager, ophthalmic technician, and typist of all correspondence, including the last five editions of this book. By encouraging me to bring my collection of rocks and other objects from nature into the waiting room, she helped create a museum that my patients look forward to seeing and contributing to.
Contents

In sequence of eye examination

Preface viii

Medical History 1
Medical illnesses 3
Medications 4
Family history of eye disease 5

Measurement of Vision and Refraction 6
Visual acuity 6
Optics 7
Refraction 9
Contact lenses 12
Refractive surgery 19

Neuro-ophthalmology 23
Eye movements 23
Strabismus 25
The pupil 35
Visual field testing 39
Nystagmus 43
Circulatory disturbances affecting vision 45

External Structures 49
Lymph nodes 49
Lacrimal system 49
Lids 54
Lashes 58

The Orbit 59
Exophthalmos 61
Enophthalmos 62

Slit Lamp Examination and Glaucoma 63
Cornea 63
Conjunctiva 68
Sclera 73
Glaucoma 74
Uvea 84
Vitreous 92
Cataracts 94

The Retina 100
Retinal anatomy 100
Fundus examination 102
Fluorescein angiography 103
Papilledema (choked disk) 104
White retinal lesions 106
Diseases of retinal vessels 106
Diabetic retinopathy 113
Macular degeneration 115
Common retinal diseases 117

Index 123
The first edition of this book was started when I was a medical student 35 years ago during the allotted two-week rotation in the eye clinic. At that time, all introductory books were 500 pages or more and could not be read quickly enough to understand what was going on. With this in mind, each word of this manual was carefully chosen so as to allow the beginning eye care professional to understand the refraction and hundreds of the most commonly encountered eye diseases from the onset. They are discussed with respect to anatomy, instrumentation, differential diagnosis, and treatment in the order in which they would be uncovered during the eye exam.

It is meant to be read in its entirety in a few hours and, hopefully, impart to you a strong foundation on which to grow and enjoy this beautiful and ever-changing speciality. The popularity of previous editions has resulted in translations into Spanish, Japanese, Indonesian, Italian, Russian, Greek, and an Indian reprint.

My special appreciation goes to Johnson & Johnson’s eye care division, which provided a generous grant to distribute the previous edition to 40,000 students; and to Pfizer Pharmaceuticals, which contributed illustrations compliments of www.xalatan.com (Figs 96, 158, 164, 217, 226, 231, 236, 240, 242).

MARK W. LEITMAN
Medical history

The history includes the patient’s chief complaints, medical illnesses, current medications, allergies to medications, and family history of eye disease.

<table>
<thead>
<tr>
<th>Common chief complaints</th>
<th>Causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Persistent loss of vision</td>
<td>1 Focusing problems are the most common complaints. Everyone eventually needs glasses to attain perfect vision, and fitting lenses occupies half the eye care professional’s day.</td>
</tr>
<tr>
<td></td>
<td>2 Cataracts are cloudy lenses that occur in everyone in later life. Unoperated cataracts are the leading cause of blindness worldwide. In the USA, over 2.8 million cataract extractions are performed each year.</td>
</tr>
<tr>
<td></td>
<td>3 Diabetes affects 14 million Americans, increasing from 0.3% at age 20 to 10% of the population after age 70. Diabetic retinopathy is the leading cause of blindness in the USA in those under 65 years of age.</td>
</tr>
<tr>
<td></td>
<td>4 Macular degeneration causes loss of central vision and is the leading cause of blindness over age 65. Signs are present in 25% of people over age 75.</td>
</tr>
<tr>
<td></td>
<td>5 Glaucoma is a disease of the optic nerve that is worsened by elevated eye pressure. It usually occurs after age 35 and affects 2 million Americans, with black persons affected five times as often as white persons. Peripheral vision is lost first, with no symptoms until it is far advanced. Progression to blindness is uncommon if discovered early. This is why there are so many state-sponsored eye-pressure screenings.</td>
</tr>
<tr>
<td>Transient loss of vision lasting less than ½ hour, with or without flashing lights</td>
<td>In younger patients, think of migrainous spasm of cerebral arteries. With aging, consider emboli from arteriosclerotic plaques.</td>
</tr>
<tr>
<td>Floaters</td>
<td>Almost everyone will at some time see shifting spots due to suspended particles in the normally clear vitreous. They are usually physiologic, but may result from hemorrhage, retinal detachments, or other serious conditions.</td>
</tr>
</tbody>
</table>

Continued on p. 2
<table>
<thead>
<tr>
<th>Common chief complaints</th>
<th>Causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flashes of light</td>
<td>Sparks may be due to traction of the vitreous on the retina and are sometimes associated with the onset of a retinal hole or detachment. Insults to the visual center in the occipital cortex are usually ischemic and cause more organized jagged lines of light.</td>
</tr>
<tr>
<td>Night blindness (nyctalopia)</td>
<td>Nystagmus usually indicates a need for spectacle change, but also commonly occurs with aging and cataracts. Rarer causes include retinitis pigmentosa and vitamin A deficiency.</td>
</tr>
<tr>
<td>Double vision (diplopia)</td>
<td>Strabismus, which affects 4% of the population, is the condition where the eyes are not looking in the same direction. The binocular diplopia disappears when one eye is covered. In straight-eyed persons, diplopia is caused by hysteria or a beam-splitting opacity in one eye which does not disappear by covering the other eye.</td>
</tr>
<tr>
<td>Light sensitivity (photophobia)</td>
<td>Usually a normal condition treated with tinted lenses, but could result from inflammation of the eye or brain; internal reflection of light in lightly pigmented or albinotic eyes; or dispersion of light by mucus, lens or corneal opacities, or retinal degeneration.</td>
</tr>
<tr>
<td>Itching</td>
<td>Most often due to allergy or dry eye.</td>
</tr>
<tr>
<td>Headache</td>
<td>Headache patients present daily to rule out eye causes and to seek direction.</td>
</tr>
<tr>
<td></td>
<td>1. Headache due to blurred vision or eye-muscle imbalance worsens with use of eyes.</td>
</tr>
<tr>
<td></td>
<td>2. Tension causes 80–90% of headaches. It worsens with anxiety and is often associated with temple and neck pain.</td>
</tr>
<tr>
<td></td>
<td>3. Migraine occurs in 10% of the population. There is a severe recurrent, pounding headache often accompanied by nausea, blurred vision, and flashing zigzag lights. It is relieved by rest.</td>
</tr>
<tr>
<td></td>
<td>4. Sinusitis causes a dull ache about the eyes and occasional tenderness over the sinus. There may be an associated nasal stuffiness and a history of allergy relieved with decongestants.</td>
</tr>
<tr>
<td></td>
<td>5. Menstrual headaches are cyclical.</td>
</tr>
<tr>
<td></td>
<td>6. Giant-cell arteritis occurs in elderly persons and may cause headache, loss of vision, pain on chewing, temporal scalp tenderness, arthritis, loss of weight, and weakness. An erythrocyte sedimentation rate over 40 and a positive temporal artery biopsy confirms the diagnosis. Prompt high-dose systemic steroid therapy should be started since blindness or death can occur.</td>
</tr>
<tr>
<td></td>
<td>7. Sharp ocular pains lasting for seconds are often referred from nerve irritations in the neck, nasal mucosa, or intracranial dura, which like the eye are also innervated by the trigeminal nerve.</td>
</tr>
<tr>
<td></td>
<td>8. Headaches that awaken the patient and are prolonged or associated with focal neurologic symptoms should be referred for neurologic study.</td>
</tr>
<tr>
<td>Visual hallucinations</td>
<td>Occurs in dementia, psychosis, brain disease, and from medications.</td>
</tr>
</tbody>
</table>
Medical illnesses

Record all systemic diseases. Diabetes and thyroid disease are two of the most common. Both may be first discovered in an eye examination.

Diabetes mellitus

1 Diabetes may be first diagnosed when there are large changes in spectacle correction due to the effect of blood sugar changes on the lens of the eye.
2 Diabetes is one of the common causes of III, IV, and VI cranial nerve paralysis. It is due to closure of small vessels. The resulting diplopia may be the first symptom of diabetes.
3 Cataracts and glaucoma are more common in diabetics.
4 Retinopathy is the most serious complication. If discovered early, laser treatment may reduce visual complications by 50%. Therefore all diabetics should be examined yearly.

Autoimmune (Graves’) thyroid disease

This is a condition in which an orbitopathy may be present with hyper- but also hypo- or euthyroid disease.
1 It is the most common cause of bulging eyes, referred to as exophthalmos or proptosis, and is due to white-cell and mucopolysaccharide infiltration of the orbit. A small white area of sclera appearing between the lid and upper cornea is diagnostic of thyroid disease 90% of the time (Fig. 1). This exposed sclera may be a result of exophthalmos or thyroid lid retraction due to an overactive Müller’s muscle that elevates the lid. Severe orbitopathy may be treated with steroids, radiation, or surgical decompression of the orbit.

Fig. 1 Thyroid exophthalmos with exposed sclera at superior limbus.
2 Infiltration of eye muscles may cause diplopia and is confirmed by a computed tomography (CT) scan (Fig. 2).
3 Exophthalmos may cause excessive exposure of the eye in the day and an inability to close the lids at night (lagophthalmos), resulting in damage to the cornea.
4 Optic nerve compression could cause permanent loss of vision.

**Medications**

Record patient medications. Below are listed commonly prescribed drugs causing ocular side effects.

Plaquenil, used for autoimmune diseases and malaria, causes “bull’s-eye” maculopathy (Fig. 3).

Ethambutol, used for tuberculosis, causes optic neuritis.

Phenothiazine tranquilizers (Fig. 4), niacin, a lipid-lowering agent, and tamoxifen, used for breast cancer, could damage the macula.

Corticosteroids cause cataracts and glaucoma and increase the incidence of herpes keratitis.

Pilocarpine, used to treat glaucoma, can cause cataracts (Fig. 5).
Xalatan, Lumigan, and Travatan are the most commonly prescribed glaucoma medications. All three may darken the iris and periorbital skin (eyelids) with lengthening and darkening of the eye-lashes (Fig. 6).

Amiodarone (Cordarone, Pacerone) one of the most potent antiarrhythmic drugs and Sildenafil (Viagra), Tadalafil (Cialis) and Vardenafil (Levitra) used to treat erectile dysfunction have all been suspected of causing nonarteritic anterior ischemic optic neuropathy.

Allergies to medications

Inquire about drug allergies before eye drops are placed or medications prescribed. Neomycin, a popular antibiotic in eye drops, may cause conjunctivitis and reddened skin (Fig. 7).

Family history of eye disease

Cataracts, refractive errors, retinal degeneration, and strabismus—to name a few—may all be inherited. In glaucoma, which normally affects 1% of the population, family members have a 10% chance of acquiring the disease. Eighty percent of people with migraine have a relative with the disease.

A special question should be directed to the smoking of cigarettes since it doubles the rate of cataracts and macular degeneration. It also worsens all the visual problems related to hypertension, diabetes, and Graves’ disease.
Measurement of vision and refraction

Visual acuity

The patients read the Snellen chart (Fig. 8) from 20 ft with the left eye occluded first. Take the vision in each eye without and then with spectacles.

Vision is expressed in a fraction-like form. The top number is the distance at which the patient reads the chart; the bottom number is the distance at which someone with normal vision reads the same line of the chart. Whenever acuity is less than 20/20, determine the cause for the decreased vision. The most common cause is a refractive error, i.e., the need for lens correction.

If visual acuity is less than 20/20, the patient may be examined with a pinhole. Improvement of vision while looking through a pinhole indicates that spectacles will improve vision. Use an illiterate “E” chart with a young child or an illiterate adult.

Ask the patient which way the [image of an E] is pointed. Near vision is checked with a reading card held about 14 inches away. If a refraction for new spectacles is necessary, perform it prior to other tests that may disturb the eye.

Examples of visual acuity

<table>
<thead>
<tr>
<th>Measurement in feet (meters in parentheses)</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>20/20 (6/6)</td>
<td>Normal. At 20 ft, patient reads a line that a normal eye sees at 20 ft</td>
</tr>
<tr>
<td>20/30–2 (6/9–2)</td>
<td>Missed two letters of 20/30 line</td>
</tr>
<tr>
<td>20/50 (6/15)</td>
<td>Vision required in at least one eye for driver’s license in most states</td>
</tr>
</tbody>
</table>

Fig. 8 Snellen chart.