

SEEING FOR A LIFETIME

Slide Module and Lecture Guide

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IMPORTANT!**PLEASE READ CAREFULLY**

The slides and lecture guide for this presentation were developed by the Professional Affairs Division of VISTAKON®, Division of Johnson & Johnson Vision Care, Inc.

This presentation is intended for delivery to community groups and other lay audiences. It is designed to broaden the public's understanding of basic ocular anatomy and physiology, refractive errors, vision correction options, ocular diseases, the eye care professions and what to expect from a routine eye examination.

We encourage speakers to develop their own personalized version of the presentation. The version presented here is undoubtedly too long and detailed for most situations. Please feel free to exclude any of the slides provided or include additional slides of your own choosing. The lecture guide is just that, a guide. We do not envision it being read to an audience or rendered verbatim from memory. It is meant to serve as a source of information appropriate for delivery to the general public. If you think any portion of it is inappropriate or incorrect, please let us know.

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Introduction

[SLIDE 1]

Good morning/afternoon/evening. My name is [NAME] and I am here to speak to you about "Seeing For A Lifetime". It is about your eyes and the precious gift they provide, your ability to see. The eyes are the body's primary sense organs. More than hearing, smell, taste and touch combined, it is sight that is most responsible for how you perceive the world around you. Certainly, we can all agree that the ability to see is a priceless gift, without which, normal everyday living, as we know it, would be a great deal more difficult.

Our Goal Today

[SLIDE 2]

Our goal today is to help you become more familiar with your eyes. The information presented will help you better understand how you and your family can achieve and maintain the best possible vision and ocular health. We will cover some common visual disorders, called refractive errors, including how they affect vision and how they can be corrected. You will learn about several important eye diseases, and in some cases, steps you can take to assure early detection. You will also learn what to expect from a routine eye examination. Before proceeding, however, let's briefly review some of the important structures of the eye and how they function.

The Eye Doctor

[SLIDE 3]

Where does one go for an eye examination? To an eye doctor, right? Of course, but did you know that in the U.S., there are three different professions whose members are called eye doctors? They include optometrists, who are also called optometric physicians in some states, and two groups of ophthalmologists, either medical or osteopathic physicians, who specialize in the eye. All three professionals, when properly licensed by the state in which they practice, are legally entitled to examine the eyes of patients who seek their services. Many surveys have shown that the public is very confused about who these eye professionals are and what they do.

Optometrists

[SLIDE 4]

Optometrists make up the largest group of eye doctors. You will see the initials "O.D." after their names, which means they have earned a doctor of optometry degree from an accredited college or university. Similar to education for dentists, doctors of optometry complete a four-year professional program following their undergraduate education.

According to the American Optometric Association: "Optometrists are independent, primary care providers who examine, diagnose, treat and manage diseases and disorders of the visual system, the eye and associated structures as well as diagnose related systemic conditions."

Ophthalmologists

[SLIDE 5]

Ophthalmologists have the initials "M.D." or "D.O." after their names, which means they have earned either a doctor of medicine degree or a doctor of osteopathy degree from an accredited college or university. Both complete a residency in ophthalmology after finishing medical or osteopathic medical school.

According to the American Academy of Ophthalmology: "An ophthalmologist is a medical doctor who specializes in eye and vision care. Eye M.D.s are specially trained to provide the full spectrum of eye care, from prescribing glasses and contact lenses to complex and delicate eye surgery. Eye M.D.s are also involved in scientific research into the causes and cures for eye diseases and vision problems."

So, is everyone now clear about who eye doctors are and what they do?

The Routine Eye Examination

[SLIDE 6]

If nothing else, we want you to leave today with some idea of what to expect from a routine eye examination. First, you should be aware that clinical techniques, testing procedures and instrumentation can vary a great deal from doctor to doctor, yet be entirely appropriate and consistent with the highest standards of practice. In fact, it would be unusual to find any two practitioners who conduct an eye examination in exactly the same manner. However, it would be reasonable to expect them to arrive at a similar diagnosis and recommend similar treatment options.

Please keep in mind that the information presented pertains only to so-called **routine eye examinations**. These are regularly scheduled evaluations of visual performance and eye health, including any problems being experienced of a non-emergency nature. Examples of a non-emergency problem might be that over time, you notice that your vision is not as sharp as it used to be or you have begun having mild headaches while reading. In such cases, you should call your eye doctor's office, mention the problem and schedule an appointment for a routine eye examination. These days, your next regularly scheduled eye examination may have been already pre-appointed at your last examination. If so, someone on your doctor's office staff will typically send you a card or give you a call in advance to remind you of the appointment. Obviously, these examinations are not the same as might occur if you suddenly began experiencing sharp pain in one of your eyes, or if a piece of steel just flew into your eye while you were working in your garage. Such ocular emergencies warrant special and immediate procedures to address the problem at hand and would likely bear little resemblance to the so-called routine eye examination.

A routine eye examination can be broken down into four major segments: (1) **evaluation**, (2) **assessment**, (3) **education** and (4) **treatment**.

The Case History

[SLIDE 7]

The routine eye examination typically begins with the patient **case history**, a very important procedure designed to gather information that the doctor needs to make informed decisions about the patient's present and future eye care. This starts by determining the patient's chief complaint. Determining the cause and disposition of the **chief complaint** will be the doctor's highest priority and often dictates the direction of the examination.

Here are some examples of information you might expect to be collected during the case history. If you currently wear spectacles or contact lenses, your doctor will want to know when they were first prescribed, how long you have been wearing your current prescription, and what problems, if any, you have been experiencing. You will be asked about any medications you are taking, both over-the-counter and prescription. This is important because some commonly used medications, even when taken for reasons totally unrelated to the eyes, can cause ocular side effects. For instance, certain systemic medications can reduce tear production causing dryness problems that can adversely affect contact lens wear. Your doctor will also want to know if any surgery has been done on your eyes, including refractive surgery, and will want to know if certain diseases run in your family. Some diseases - glaucoma, for example - are known to be hereditary. If a disease like glaucoma happens to run in your family, it does not mean that you will necessarily develop it yourself. It does mean that you and your children carry a higher risk, so it is important for your doctor to be aware of this so an early detection strategy can be adopted.

[SLIDE 8]

Another important part of the case history relates to the role vision plays in a patient's daily life. Everyone is different, so everyone has different visual needs. Are you involved in sports? Do you read for hours every day? What occupational vision needs do you have? Do you use a visual display terminal at work for long periods? Do you have hobbies that place special demands on your vision?

Lifestyle is an important factor in determining visual requirements. Perhaps a presbyopic patient wants to be able to read a menu without spectacles while having dinner in a dimly lit restaurant. Perhaps a teenager is self-conscious about wearing thick spectacles and wants to try contact lenses. Once again, everyone's visual needs are different. The eye doctor is trained to understand those needs and to recommend satisfactory alternatives that address the patient's lifestyle visual needs.

[SLIDE 9]

Some doctors take the entire case history themselves. Not long ago, this was more common and considered desirable because it facilitates doctor-patient bonding. However, in this age of managed care, most doctors find they can no longer afford the time and now delegate as much of the case history as possible. In many practices, case history information is now collected in stages. When you arrive for your appointment, or often by mail before your appointment, you will very likely be asked to complete a patient history form. If you are a new patient, you will be asked to provide specific details about your medical history, ocular history, past vision corrections, occupational visual requirements and lifestyle needs. If you are already an established patient, you may only be asked for any changes or additions since the last examination and to describe any problems that may be occurring.

The next stage of your case history might be with a technician who reviews the information on your history form with you and asks follow-up questions as needed. Regardless of how the case history is collected or by whom, you can be sure that at some point, the doctor will review and discuss your case history with you. This is generally a good time to ask the doctor questions or express any concerns you have related to your vision and eye health, even if only for your own peace-of-mind. If you are interested in contact lenses or refractive surgery, but no one has mentioned these options to you, this is also a good time to ask your doctor about them. Patients often assume they are not good candidates for contact lenses or refractive surgery if their doctor does not mention these. This can be a bad assumption, however, because many doctors wait for patients to express interest in contact lenses or surgery before considering whether or not they might be a viable option.

What the doctor learns from the case history often influences how the eye examination proceeds. Knowledge of what problems the patient is experiencing, especially if it is of recent onset, will certainly affect the emphasis the doctor places on certain portions of the examination. Also, knowledge learned from the case history might prompt the doctor to conduct special tests, pertaining to the patient's unique occupational or lifestyle visual requirements that might not otherwise be performed.

Vision Testing

[SLIDE 10]

A major portion of the routine eye examination is devoted to conducting clinical tests and making observations to evaluate the current state of the patient's vision and eye health. Again, like the case history, there was a time when the doctor always did all the testing. For a practice to operate with maximum efficiency, doctors are finding that their time with patients must be limited to those tests and procedures that only they have the expertise and skills to perform. Many doctors now delegate to others as much of the routine eye examination as possible without sacrificing the quality of patient care. Doctors who understand this have made the necessary investment in automated instruments and staff training that allows them to provide quality care with maximum efficiency.

With the limited time available, you will be introduced to some of the tests and procedures you are likely to experience during a routine eye examination. These are but a few of the possible tests and procedures that you may actually encounter during your own eye examination depending on the circumstances. In some practices, the doctor will conduct all the testing. In other practices, trained technicians under the doctor's authority and scrutiny will conduct some testing. Please remember, it's always the doctor who interprets the results and makes the important decisions.

When you enter the examination room, you will probably be directed to sit down in a big chair like the one in this slide. This chair, which resembles a barber's chair, is known as an **ophthalmic chair**, and it can be adjusted to accommodate people of varying sizes.

Vision Measurement

[SLIDE 11]

If you have ever had an eye examination, you probably remember that the first thing you are asked to do is read the smallest letters you can on an eye chart at the far end of the room. This is usually done with your current vision correction. If you wear spectacles or contact lenses, you would read the chart with your current prescription in place. Sometimes if you wear spectacles or contact lenses and always, if you don't, the doctor will want to measure your unaided vision. If you are wearing spectacles, it is obviously a simple matter to just take them off and read the chart. If you are wearing contact lenses, however, the measurement will probably be postponed until later, after other tests requiring the contact lenses to be worn have been completed.

Visual Acuity

[SLIDE 12]

Visual acuity is a measure of vision. It is determined by the size of the smallest letters that can be read on the chart. It has little meaning unless accompanied by information about testing conditions and other details about how the measurement was made. For instance, if it was written in a patient's record that visual acuity was 20/20, we wouldn't know if it was for the right eye, left eye or both eyes together. Neither would we know if it was for distance or near vision. It could be unaided visual acuity or the visual acuity with the patient's current correction or it could be what's known as the **best-corrected visual acuity**. Best-corrected visual acuity is the maximum visual acuity the eye can achieve when using the optimal correction. It is an important measure of vision because it defines a patient's visual capability, the point beyond which a change in correction produces no improvement in vision. Best-corrected visual acuity could be the same as unaided visual acuity if the patient is emmetropic, that is, has no refractive error at all. It could also be the same as the current correction visual acuity if the patient's current spectacles or contact lenses cannot be improved.

Distance Vision

[SLIDE 13]

Reading letters on a chart in this manner is a simple test of distance vision. It is done for each eye alone and for both eyes together. Sometimes the chart hangs on the wall and sometimes it is projected onto a screen on the wall. The standard distance for measuring distance vision is 20 feet, which means 20 feet from the patient's eyes. This requires an examination room length of more like 25 feet. Few practices can afford the space needed for such large examination rooms. Often, the chart will be hung or projected on the back wall of the room and the patient observes the chart through a mirror positioned on the front wall. This doubles the test distance allowing rooms to be built at half the required size. The most common type of chart used is called a **Snellen chart**, named after the doctor who invented it.

Distance Visual Acuity Examples

[SLIDE 14]

Let's look at a couple of distance visual acuity examples. First, direct your attention to the top half of the slide. If your visual acuity is 20/15, a standard person with 20/20 visual acuity would have to be 15 feet from the chart to see as well as you do at 20 feet. In this case, your vision is better than someone with 20/20 vision. What if you have 20/40 visual acuity? In this case, depicted at the bottom of the slide, a person with 20/20 visual acuity would see as well at 40 feet as you do at 20 feet.

If your visual acuity is 20/200 or worse, and it is the best vision you can attain even with the best correction your doctor can prescribe, then a standard person with 20/20 visual acuity would be able to see at 200 feet what you see at 20 feet. In the U.S., if both eyes are 20/200 or worse with best-correction, you are considered "legally blind" and the Internal Revenue Service will allow you to claim a double exemption on your federal income tax return.

What is 20/20?

[SLIDE 15]

You probably equate the term "**20/20**" with good vision, right? But, do you know what it means? It's the result of a test of visual acuity. The first number is the standard test distance, 20 feet or 6 meters outside the U.S. The second number is the farthest distance that an eye with 20/20 vision can be from the chart and still see as well as the eye being tested at 20 feet. A person with 20/20 visual acuity is able to identify letters of a certain size or larger at 20 feet.

20/20 is also the generally accepted standard for normal best vision of healthy eyes. Actually, 20/20 is a somewhat arbitrary standard for normal vision. While most people have 20/20 best-corrected visual acuity, some have even better than 20/20 and some cannot achieve 20/20 with the best possible correction. These people all fall within the normal limits of human vision in the absence of evidence to the contrary. An eye doctor would probably not be concerned if your best-corrected visual acuity is less than 20/20 unless it had been recorded as 20/20 or better at a previous visit.

Near Visual Acuity

[SLIDE 16]

After measuring your distance visual acuity, your doctor may want to measure your near visual acuity. Near visual acuity is usually quite similar to best-corrected distance acuity, at least until you are at or nearing the age of presbyopia. In addition to monitoring presbyopia, near visual acuity is useful in the testing of the ability of the two eyes to work together as a team and as a baseline to which future near visual acuity measurements may be compared for early detection of disease. Sometimes, the astigmatism of an eye will be different at near than at distance, enough so to affect best-corrected near visual acuity.

Near visual acuity is tested by having the patient hold a small chart at his/her normal reading distance, which is about 16 inches or 40 centimeters for most people, and read the smallest letters possible. Various near charts may be used, including a miniature version of the Snellen chart and charts with various print types encountered in the real world, such as the print from a newspaper, a telephone directory, etc. Near visual acuity is usually expressed in the 20/20 format, which is a simple conversion, for easier comparison of distance and near vision.

Common Refractive Errors

[SLIDE 17]

There are four major types of refractive error: (1) **myopia**, also known as **nearsightedness**; (2) **hyperopia**, also known as **farsightedness**; (3) **astigmatism**; and (4) **presbyopia**. The first three affect distance vision, although hyperopia, if small enough, may not affect distance vision until middle age. Most eyes that need correction of distance vision are either myopic or hyperopic. A sizable portion of both groups also has astigmatism. However, only a small percentage of eyes have astigmatism only.

Presbyopia is different from the others in that it is a near vision phenomenon caused by the loss of the focusing ability of the crystalline lens that occurs with aging. Presbyopia usually occurs at about the age of 40, but the age of onset can be earlier or later depending on the type of refractive error and other individual factors. One thing is sure, however, presbyopia eventually affects everyone, whether they have a distance refractive error or not.

Before discussing the four types of refractive error in greater detail, let's first consider the eye that has no distance refractive error. We have a name for this, too: **emmetropia**.

"The Eye is Like a Camera" Analogy

[SLIDE 18]

Think of the eye as a simple camera. In normal vision, light reflects off an object in the outside world and enters the eye through the cornea, which acts like the front, or objective, lens of a camera. An inverted image of the object is focused on the retina, which is like the film of the camera. The amount of light that reaches the retina is controlled by the iris, which varies the size of the pupil. For those of you who know photography, the pupil of the eye serves the same purpose as the "f" stop of a camera.

The Eye Is More Like An Auto-focus Camera

[SLIDE 19]

The eye is actually more complex than a simple camera. It's more like an auto-focus camera. As you may know, when you photograph objects at different distances from a camera, you have to change the power of the lens system to focus the image on the film. This is done either manually or with an auto-focus mechanism that quickly focuses the image automatically. There is a structure located just behind the iris and pupil, called the **crystalline lens** that performs a similar function for the eye.

Myopia (Nearsightedness)

[SLIDE 20]

If the optical system of the eye is too powerful for its size, the image of a distant object will focus in front of the retina. As a result, the image will be out-of-focus at the retina, making the object appear blurry. This condition is called **myopia**. Myopia is known more commonly as nearsightedness because without correction, people with myopia typically have clear near vision. About 30% of the vision correction population is myopic. To correct myopia, you could shrink the eyeball, but you might find that a bit radical. A better approach would be to reduce the power of the eye. This can be accomplished by placing a minus lens in front of the eye. Since minus lenses diverge light, they reduce the plus power of the eye enough to move the focused image back to the retina. The minus power is usually provided by spectacles or contact lenses. Another option is refractive surgery, which involves using lasers or other techniques to reduce the power of the cornea.

Hyperopia (Farsightedness)

[SLIDE 21]

For many people with a refractive error, the eye's optical system is not powerful enough for its size. Therefore, the image of a distant object is focused behind the retina and the condition is called **hyperopia**. Hyperopia is commonly known as farsightedness because without correction, people with hyperopia often have clear distance vision, although that depends on the person's age and the degree of hyperopia. The same is true for near vision. To correct hyperopia, the power of the eye must be increased. If a correction is needed, hyperopia can be corrected by placing a plus lens in front of the eye.

What is meant by "If a correction is needed"? Unlike the myopic eye, the hyperopic eye can, to a certain extent, compensate for its distance refractive error by utilizing the focusing capability of the crystalline lens to increase the power of the eye. Therefore, if a hyperope is young enough and the degree of hyperopia is not too great, the crystalline lens automatically increases in power enough to focus the image of the distant object on the retina. Of course, as already mentioned, accommodation, the ability of the crystalline lens to increase its power to focus near objects, gradually declines with age. Eventually, hyperopes are no longer able to correct their refractive error by increasing the power of the crystalline lens. When this occurs, first with near vision and then for distance vision, the additional plus power needed can be provided by plus lenses provided in spectacles or contact lenses.

You should also be aware that when uncorrected hyperopes utilize their focusing mechanism in this manner for distance vision, the amount of focusing required for their near vision will be increased by that amount as well. This is usually not a problem for young hyperopes, who have plenty of focusing ability in reserve, as long as the degree of hyperopia is not too great. However, for the not-so-young hyperope and the hyperope with a large refractive error, the muscles involved in the focusing mechanism can become strained, resulting in near vision symptoms such as eye fatigue, intermittently blurred vision and/or headaches. These problems are easily eliminated simply by partially or fully correcting the hyperopia with spectacles or contact lenses.

Refractive surgery techniques for correcting hyperopia have been developed, but are still in the testing stages.

Astigmatism

[SLIDE 22]

The next type of refractive error is **astigmatism**. Approximately two-thirds of the vision correction population has some degree of astigmatism. According to surveys that have been conducted, most of you probably recognize the word "astigmatism", but have no idea what it means. This is not surprising, because astigmatism is a complex disorder and difficult to explain. In astigmatism, the curvature of the corneal surface varies, causing entering light to bend unevenly. This results in distorted vision. Let's consider an example.

Presbyopia

[SLIDE 23]

The final type of refractive error we want to cover is **presbyopia**. The word presbyopia is from the Greek meaning "old vision". As we have already discussed, the crystalline lens of the eye, as part of the normal aging process, gradually loses its ability to focus images of near objects on the retina. As this process progresses, the closest distance a near object can be from the eye and still be focused clearly moves farther and farther away from the eye. Eventually, at about the age of 40, this progression reaches the stage called presbyopia, where you can no longer see clearly at your normal reading distance.

You may be thinking, "What's so old about being 40? That probably depends on whether you are closer to age 20 or age 60, but, don't forget, in the days of ancient Greece, the human life span was much shorter, so to be 40 years old then was to be a senior citizen. When the presbyopia phenomenon is first noticed, most of us go into denial and are content with holding books, newspapers, etc. farther and farther away from our eyes. Finally, when the arms are not long enough to see clearly, we realize it's time to do something about this.

Prescriptions for Refractive Error

[SLIDE 24]

This is a good time to explain the numbers that you see in an eyeglass prescription. The basics of a prescription are what is called the **lens formula**. A lens formula consists of three main numbers referred to as the sphere, cylinder, and axis.

The sphere power's sign (plus or minus) indicates if this is a correction for myopia (negative power) or for hyperopia (positive power). The cylinder number indicates the amount of astigmatism. The axis indicates the way that the astigmatism correction must be oriented in order to correct the vision for this eye. In some instances there is no astigmatism, and the lens formula may have only a sphere entry.

Emmetropes Need Eye Exams, Too

[SLIDE 25]

It should be pointed out that just because you happen to be an emmetrope does not mean you can forget about regular eye examinations. Why is that? There are good reasons for periodic eye examinations. First, the fact that you are emmetropic today does not guarantee that you will not develop a refractive error later. More importantly, just because you are emmetropic does not mean that you are exempt from diseases and other disorders of the eye that can occur regardless of whether or not you have a refractive error. You should also be aware that certain systemic diseases can be detected during a routine eye examination. Without routine periodic eye examinations, such eye and systemic diseases might go undetected for years. By then, a disease could be in a more advanced stage making it more difficult, if not impossible, to treat.

Blood Pressure

[SLIDE 26]

Blood Pressure is often measured at an eye examination. There are several good reasons for this. One, it is known that poorly controlled high blood pressure can have serious effects on the eye. Another reason is that there are many patients who see an eye doctor but rarely see their regular doctor. As high blood pressure is such a serious, but treatable disease, many eye doctors are happy to screen their patients as a part of the assessment of eye health.

Color Vision Testing

[SLIDE 27]

Baseline **color vision testing** is often done at an initial visit. You probably know color vision defects can be inherited. About 8% of males and 1% of females are born with a color vision defect. Such color defects are usually referred to as **color blindness**, but it's not as if the person sees the world like a black and white movie. The problem they have is that some colors are confused. A non-inherited color defect can be an early sign of some diseases. It is important to do baseline color tests to identify inherited color defects so they may be distinguished in the future from color defects of recent onset. Color vision defects may also have an occupational or educational impact and thus it is important the individual be aware if they have this.

Visual Fields Testing

[SLIDE 28]

Peripheral blind spots can be detected by what's known as a **visual fields test** that is performed separately for each eye. A small object or light is presented at various locations in space and the patient responds anytime the object appears or disappears.

Biomicroscopy

[SLIDE 29]

Modern technology has provided the eye doctor with some excellent instruments for examining the structures of the eyes with high magnification and high illumination. A **biomicroscope** is an instrument used to examine the front structures of the eye, including the eyelids and lashes, the sclera and conjunctiva, the iris and pupil, the crystalline lens and, of course, the very important cornea. Like the name implies, the biomicroscope is a microscope used for non-invasive viewing of living tissues. It offers a variety of magnification levels with three-dimensional viewing. It has a very sophisticated and versatile light source that allows the doctor to examine the various structures under a variety of lighting conditions.

We spoke earlier about the role of the front and back cell layers in preventing too much water from entering the cornea. The doctor can inspect both layers with the biomicroscope.

Eye Disease

[SLIDE 30]

The conjunctiva is rich with tiny blood vessels, which are mostly invisible when the conjunctiva is "quiet". When unwanted foreign substances, such as dust, smog, toxic chemicals and certain types of bacteria and viruses, enter the eye, the conjunctiva becomes irritated. Such irritations can progress to what is known as an inflammation of the conjunctiva, or **conjunctivitis**. This sets into motion a cascade of defensive measures by the immune system.

The blood vessels of the conjunctiva become enlarged to increase the flow of blood to the invaded area. When this occurs, the blood vessels are no longer invisible. They give the white areas on the front of the eye a reddish appearance. The redness can progress to spectacular levels and is generally referred to as a **red eye** for obvious reasons.

You may be familiar with the term pink eye. **Pink eye** is the name given to a form of highly contagious conjunctivitis caused by certain viruses. While its effects are usually mild to humans, it can be lethal to cattle, and has been known to wipe out an entire herd in a short period of time. It usually affects school children, and once introduced to a classroom by one child, it rapidly spreads until most, if not all, of the children in the class contract the condition.

Severe "Red Eye"

[SLIDE 31]

A red eye may or may not be serious, but should never be ignored. If you notice that one or both of your eyes suddenly look red, and you know it is not due to allergies or the "morning after" effects of an evening of over-indulgence, you should contact your eye doctor, even if you are experiencing little or no pain.

In general, the more serious the threat to the eye, the redder the eye looks. An eye that has developed an infection will have a grossly inflamed red appearance. Also, you should never use eye drops that reduce the redness until you know that the cause of the red eye is not a threat to the eye. Such eye drops constrict the blood vessels of the conjunctiva, thus reducing blood flow. In some conditions, this can retard the healing process and seriously threaten the health of the eye.

Cataract

[SLIDE 32]

A **cataract** is the clouding of the crystalline lens of the eye. Such clouding generally progresses over time with increasingly blurred and distorted vision and eventual blindness, but it does not cause pain. Various factors are associated with cataract formation, including the taking of certain medications, heredity, trauma to the eye, smoking and other diseases. Some types of cataract develop rapidly and some very slowly. The most common type of cataract is the gradual loss of transparency of the crystalline lens associated with the aging process. If a person lives long enough, it is highly likely that he or she will eventually develop cataracts. Another common type of cataract is associated with the absorption of radiation by the crystalline lens, including ultra-violet radiation from excessive exposure to the sun. This underscores the importance of wearing ultra-violet blocking eyewear when working or playing outdoors, particularly during the summer, during the midday hours, at high altitudes or in tropical locations.

Cataracts are relatively easy to observe with a biomicroscope. They are often associated with changes in refractive error over time. Once discovered, the eye doctor will follow the cataract's progression and change the patient's spectacles or contact lenses as needed.

Glaucoma

[SLIDE 33]

The eye doctor can measure intra-ocular pressure with an instrument called a **tonometer**. A visual fields analyzer can detect blind spots in peripheral vision. The doctor will carefully examine the appearance of the optic nerve, as this is another valuable clue in detecting glaucoma. Once diagnosed, efforts are made to manage the disease by prescribing drugs that lower the pressure either by increasing the flow of aqueous humor leaving the eye or by reducing the production of aqueous humor.

When the pupil of the eye is enlarged, the iris will bunch up at its base and may slow the exit of aqueous humor from the eye. In some eyes the elevated pressure in the eye pushes the iris slightly forward. This can be a problem for glaucoma patients with narrower than normal angles of the iris. On rare occasions, this can result in a blockage that severely limits the flow of aqueous humor from the eye, causing the pressure to quickly increase to a dangerous level. This condition, known as a **closed angle glaucoma attack**, usually occurs at night when the pupils are wide open. It generally occurs in one eye only and causes the patient excruciating pain. This is a true medical emergency. Intra-ocular pressure at this level can result in irretrievable loss of vision in a matter of only a few hours. The patient must be taken to a hospital for immediate treatment.

Ophthalmoscopy

[SLIDE 34]

Your doctor will also want to examine the structures inside your eyes. Here again, technology has been a good provider with instruments that view the inside of the eye with high magnification and high illumination. Such an instrument is known as an **ophthalmoscope**. It permits the doctor to look through the pupil into the inside cavity of the eye. To ensure the best view possible, eye drops are usually instilled to dilate or enlarge the pupils. Obviously, you can see more through a large window than you can through a small one. If you have had your eyes dilated, you already know it's not very pleasant having all that extra light entering your eyes, especially when you go outside. If you have sunglasses, it's a good idea to bring them with you to a routine eye examination. If you do not have sunglasses or forget them, you will be given a pair of throw-aways that you can wear until the eye drops wear off. Balanced against the greater thoroughness of the examination with dilated pupils, surely you would agree that the brief period of light sensitivity is really a small price to pay for peace-of-mind about the health of your eyes.

There are several types of ophthalmoscopes. The one most preferred today by eye doctors is the **binocular indirect ophthalmoscope**. There are two types. One is an odd-looking contraption that the doctor wears on his or her head. It will remind you of the headgear worn by coal miners. It has an intense beam of light that is aimed where the doctor is viewing the eye through binoculars that are suspended down from the headgear. The other type, shown here, is mounted to a frame and worn like a pair of spectacles. Both types enable the doctor to move about the eye by simply moving his or her head. The doctor also holds a large lens just in front of the eye producing a highly magnified view of the eye. This technique gives the doctor an outstanding, three-dimensional view of the fundus. The retina is carefully inspected for abnormalities with particular attention paid to the macula area and the optic disk.

[SLIDE 35]

Here is an example of the doctor's view inside the eye.

Fundus Photography

[SLIDE 36]

Another great baseline tool is **fundus photography**. This specialized camera is used to record the appearance of the back of the eye.

Diabetic Retinopathy

[SLIDE 37]

It was mentioned earlier that the eye can be affected by certain systemic diseases, **diabetes** being a notable example. As you probably know, in diabetes, the body is unable to properly regulate the consumption of sugar. As a result, if not treated aggressively, the sugar content of the blood elevates. This can seriously affect the eyes and lead to blindness. Throughout the retina of the eye are tiny blood vessels responsible for providing the light receptors - the rods and cones - with nutrients. Excessive sugar in the blood affects the walls of these blood vessels causing them to leak, especially in the macula where swelling, called **macular edema**, can occur. As the macula swells, the eye's most critical central vision is affected because images no longer focus on the macula. Also, high blood sugar sometimes stimulates the growth of new blood vessels in the area. The leaking of blood vessels and the growth of new blood vessels is known as **diabetic retinopathy** and it presents a serious threat to the diabetic patient's eyesight.

The key to managing diabetes is early detection so placing the patient on a program that restricts the diet, encourages exercise and discourages alcohol consumption and smoking can minimize its effects. Since early diabetes progresses without symptoms for a long time, it is not unusual for the disease to be discovered during a routine eye examination. Even before seriously affecting vision, the eye doctor can detect diabetes-related changes to the retina when examining the fundus with an ophthalmoscope. Again, early detection is crucial. Once vision has been lost due to leaked blood and new vessel growth in front of the retina, it is generally irreversible. However, the effects of diabetes on vision can be significantly slowed by laser surgery.

Hypertensive Retinopathy

[SLIDE 38]

Another systemic disease that affects the eyes is **hypertension** or **high blood pressure**. The eye doctor will always carefully examine the retinal blood vessels of the eyes. Hypertension causes certain telltale changes to the blood vessels, such as how they cross over each other. Sometimes hypertension is first detected during an eye examination. Unfortunately, if such changes are observed, they indicate that the patient's blood pressure has been elevated for a considerable period of time. Since eye doctors are often the only primary care practitioners seen regularly by young adults, it is not unusual these days for eye doctors to monitor their patients' blood pressure.

Keratometry

[SLIDE 39]

Another preliminary test generally performed is **keratometry**. A keratometer is an instrument that measures the curvature of the central front surface of the cornea and thus provides important information about astigmatism of the eye. The measurements are known as "K-readings", and they can be a key element in contact lens fitting. Most doctors record baseline K-readings for comparison with future readings. Why? One reason is that changes in K-readings can be an early sign of corneal disease. A good example is keratoconus, a relatively common degenerative disease of the cornea.

Videokeratography

[SLIDE 40]

Over the past few years, many practitioners have abandoned the keratometer in favor of a high-tech automated device known as a **videokeratographer**.

[SLIDE 41]

This instrument's computer generates a topographical map of most of the surface of the cornea. Such maps are now used to detect and monitor disease, fit certain types of complex contact lenses and to monitor corneal surgery outcomes.

The Refraction

[SLIDE 42]

Earlier, you were introduced to the four major types of refractive error: myopia, hyperopia, astigmatism and presbyopia. In a routine eye examination, the doctor determines a patient's refractive error by conducting a series of tests, which together are referred to as the refraction. A refraction can be conducted objectively or subjectively. The objective refraction is conducted without input from the patient by using an instrument known as a **retinoscope**. This type of refraction is very useful to determine the refractive errors of the very young or very old who may not be able to give reliable responses. The subjective refraction is conducted with input from the patient about the quality of vision with various test lenses.

A refraction is usually done with an instrument known as a **refractor** or **phoropter**, which is mounted on an adjustable arm attached to the instrument stand located next to the ophthalmic chair. The refractor looks like a big mask. It is positioned in front of the patient's face and has two holes, through which the patient looks at the eye chart. Inside the refractor are duplicate sets of small lenses of differing powers mounted on round discs. One set is for the right eye and one is for the left. By rotating the discs, the doctor can present any desired lens or combination of lenses in front of either eye alone or both eyes at the same time.

[SLIDE 43]

The results of a refraction are expressed as a formula for each eye. The formula specifies the information required to produce a spectacle lens that will correct the refractive error of each eye. We call this the **spectacle prescription**. If the patient requires correction of both eyes, the prescription will have two such formulas. The prescriptions of a patient's right and left eyes are generally different, although most of the time, quite similar.

The spectacle prescription specifies either the minus power needed to correct a myopic patient's refractive error or the plus power needed to correct a hyperopic patient. It also includes information needed to correct the patient's astigmatism, if present. If the patient is presbyopic, the prescription also specifies the near ADD power needed to correct the patient's near vision.

What about contact lens prescriptions? While the spectacle prescription is an important part of a contact lens prescription, more information is required for a complete contact lens prescription. Because contact lenses are worn on the front surface of the eye, they have additional design requirements that relate to comfort and eye health. Those design requirements are determined by a procedure known as the **contact lens fitting**, which we will cover later.

Results Of The Routine Eye Exam

[SLIDE 44]

The assessment segment of the routine eye examination actually occurs throughout the evaluation segment as the doctor integrates clinical observations and test results to ultimately decide if the patient's vision and eye health are within normal limits. If not, the doctor must determine a **diagnosis** or explanation of the nature of any abnormal findings. There can be a single diagnosis to explain the findings or multiple diagnoses if more than one abnormality is detected. The diagnosis should always explain any symptoms a patient may have been experiencing. For instance, if symptoms of blurred distance vision are reported, a diagnosis of a small increase in myopia might be reached, as long as this was consistent with the results of the refraction testing and no myopia-causing health problems were uncovered. On the other hand, even in the absence of any symptoms reported, the findings of an examination can lead to the diagnosis of a serious disease, like glaucoma. This is why it is so important for patients to receive routine eye examinations periodically.

Once a diagnosis is reached and understood by the patient, the doctor will discuss how the problem should be treated, if treatment is indicated. In some cases the condition may only warrant continued observation over time to see if it gets worse. Sometimes, as with certain degenerative diseases of the eye, no treatment is possible.

The prescribing of a treatment obviously depends on the condition being treated. For instance, the diagnosis of certain eye diseases may require pharmaceutical intervention or even surgery. Conditions such as eye fatigue or intermittent blurry vision may simply require eye exercises, much like physical therapy, or near reading spectacles. Lifestyle visual demands, such as sports, might be met by prescribing contact lenses.

Sometimes a number of treatment options are available. For instance, a diagnosis of myopia would generally be treated by prescribing a refractive correction, which could be provided by spectacles, contact lenses or even refractive surgery. Some doctors prefer to lay out such options and expect the patient to make a choice. Patients often want the doctor to make a recommendation. If you want your doctor's recommendation, don't be afraid to ask.

During the time we have left, let's briefly review several important eye diseases and finally conclude with a short discussion of treatment options for the correction of refractive errors.

Contact Lenses

[SLIDE 45]

About 13% of the U.S. population wears **contact lenses**. Contact lenses are small plastic lenses about half an inch in diameter. They are placed on the front surface of one or both eyes. There are two major classes of contact lenses: **soft contact lenses**, worn by approximately 87% of all contact lens wearers, and **rigid gas permeable** or **RGP contact lenses**, worn by the remaining 13%.

Soft Contact Lenses

[SLIDE 46]

Soft contact lenses are also known as **hydrophilic** - meaning "water loving" - because they are made from a family of plastics called **hydrogels**. Hydrogels usually contain from 35% to 75% water. As a result, soft contact lenses are wet and pliable, and therefore, more comfortable. They also transmit atmospheric oxygen to the cornea, the amount depending on the amount of water in the hydrogel material and the thickness of the contact lens. The higher the water content, the more oxygen transmitted. The thinner the lens, the more oxygen transmitted.

Disposable/Frequent Replacement Contact Lenses

[SLIDE 47]

In 1995, the first **daily disposable contact lenses** were introduced in the U.S. These lenses have the advantages of disposable and frequent replacement lenses without the disadvantages. No cleaning and disinfecting is required, and they are daily wear contact lenses, which is associated with fewer adverse responses than extended wear contact lenses. Wearing daily disposable contact lenses is the safest way to wear contact lenses developed to date.

Disposable and frequent replacement contact lenses are now available for almost anyone interested in wearing them. They correct most types of refractive errors, including astigmatism and most recently, presbyopia. Tinted contact lenses are available for easier handling, to enhance the color of the iris or to change the color of the iris. UV-blocking contact lenses are also available and help protect against harmful UV transmission into the eye but are not substitutes for UV-protective eye wear. UV-blocking contact lenses should be worn with UV protective eyewear as directed by your Eye Care Professional. Let your Eye Care Professional know if you would like to try contact lenses. Most Eye Care Professionals offer a free trial pair of contact lenses to interested patients. You should be aware, however, that such offers cover the free contact lenses only. Your Eye Care Professional may charge a fee for his or her professional services for the evaluation.

Color Contact Lenses

[SLIDE 48]

Although contact lenses are first and foremost a means of providing vision correction, many consumers enjoy the ability to change the appearance of eye color through the use of **tinted contact lenses**. Such lenses can enhance or change eye color, and may even be worn by individuals who do not need vision correction. It is important to remember that, even if lenses are worn only for cosmetic reasons, they are still a medical device that needs to be professionally prescribed and monitored, and are not without risk.

One particular concern with tinted lenses is a trend among young patients to share lenses. Such activity has a high risk of spreading eye infections and should never be done.

Vision Correction - Spectacles

[SLIDE 49]

You have already learned that spectacles are the most common form of vision correction. All forms of vision correction have advantages and disadvantages and spectacles are no different. The primary advantages of spectacles are that they provide outstanding vision and they very effectively correct all four of the major refractive errors. Disadvantages include fogging, vision affected by precipitation, limitation of the field of view and discomfort to the nose or ears when not adjusted properly. Many people simply dislike the cosmetic effects of wearing spectacles.

Spectacle lenses can be provided in minus powers for the correction of myopia and in plus powers for hyperopia. As stated earlier, the power of a lens is the degree to which it bends light. The higher the power, the greater the light bending capability of the lens.

Spectacle lenses called cylinders can also correct astigmatism. Since most eyes with astigmatism also have either myopia or hyperopia, cylinder lenses may be combined with minus or plus lenses to correct the patient's entire refractive error.

Spectacles for the Presbyope

[SLIDE 50]

Sooner or later, all people need vision correction, if only for presbyopia when they reach their early 40s. Presbyopes need additional plus power to see well at near. Various options are available for the correction of presbyopia, but you should understand that none is perfect. They all require some degree of compromise.

In the case of emmetropes, who do not need correction for distance vision, a pair of near reading spectacles can be prescribed. Here, the compromise is that the reading spectacles must be removed to see well at distance. For those who find this inconvenient, one alternative is a type of spectacles called **half-eyes**, which as the name suggests, are about half the vertical size as regular spectacles. They contain the near ADD power and the patient is able to peer over the half-eyes for distance vision.

For presbyopes who need a refractive correction for distance vision as well as near, several options are available. For instance, two pairs of spectacles could be prescribed - one for distance and one for near. This carries the inconvenience of constantly having to change from one pair to the other, not to mention the frequent misplacing or losing of the pair not being worn. Another option, invented by Ben Franklin, is the **bifocal** spectacle lens that incorporates both the distance and near corrections in the same lens. Most bifocals position the distance portion such that the patient sights through when looking straight ahead. The near portion is positioned below in the bottom area of the lens. By looking down, the patient can use the near portion to read or perform other near tasks.

For presbyopes who need clear vision at some intermediate distance between near and far for occupational requirements or hobbies, **trifocal** spectacles may be prescribed. Trifocals are like bifocals except they have a third zone added for the intermediate vision requirement.

Many presbyopes dislike wearing bifocal spectacles because the line between the distance and near portions of the lenses stands out, thus, revealing that they are now over 40 years old. For such persons, spectacle lenses called **progressive addition** lenses have been developed. These lenses correct distance vision just like regular spectacles, but unlike bifocal spectacles, the transition between the distance and near portions is invisible. This is accomplished by a special optical design in which plus power is increased as the patient moves his or her eyes down for near vision. This also provides correction of vision at intermediate distances between near and far. Some patients find it difficult, and some even impossible, to adapt to progressive addition lenses. Others find the size of the near portion of such lenses to be too restrictive. But, if a patient doesn't mind spectacles, but hates the idea of wearing bifocals, this is an excellent compromise.

Refractive Surgery

[SLIDE 51]

The newest form of visual correction is **refractive surgery**. To date, the portion of the vision correction population opting for surgical correction is very small. However, there are a variety of procedures now available and interest has been growing since laser refractive surgery, shown here, was approved by the U.S. Food and Drug Administration in 1995.

Final Comments

[SLIDE 52]

We have covered lots of information in this presentation. No one could expect you to retain it all. However, if you leave feeling that you have a little better understanding of your eyes, it will be worth the effort and someday might help you save your vision or the vision of a loved one.

Our goal was to give you some basic background about the structures of your eyes, and how they function. More importantly, we hope to have given you some idea of the importance of regular periodic eye care, including what you might expect from a routine eye examination.

Always remember that your Eye Care Professional wants what's best for you and your eyes. You should always feel comfortable expressing to him or her any questions or concerns about your eyes. After all, there really is no more precious possession a person can have than good vision and healthy eyes.

Thank you very much for your kind attention!

I would be happy to answer any questions you may have.

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