NATIONAL CENTER FOR CASE STUDY TEACHING IN SCIENCE

Why Is My Vision Blurry? Age-Related Eye Changes

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Part I – Refraction Problems*

Mrs. Horton had experienced vision problems for most of her life, but at age 78, she faced the possibility of giving up driving because she was having difficulty reading street signs. Her optometrist had done her best to correct Mrs. Horton's life-long hyperopia (hypermetropia) and astigmatisms but felt that a referral to an ophthalmologist was in order.

Questions

1. Using the figure, label the structures along the path of light as it passes from the cornea to the receptors in the eye.

   A. _____

   B. _____

   C. _____

   D. _____

   E. _____

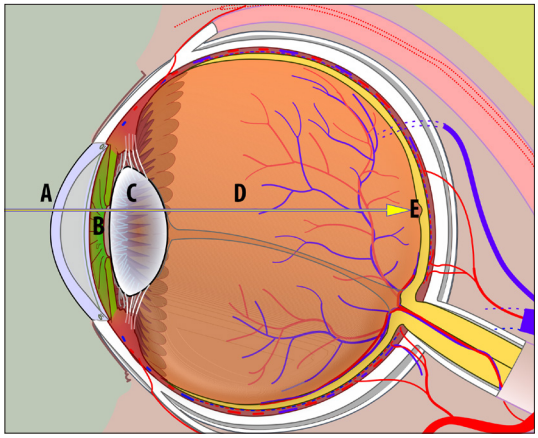

Figure 1. Diagram of human eye by Jmarcn, CC BY-SA 3.0, <https://commons.wikimedia.org/wiki/File:Diagram_of_human_eye_without_labels.svg>.

2. Define refraction. Which structures in the eye refract light?

3. Explain hyperopia (hypermetropia).

4. How does this differ from myopia?

5. Since Mrs. Horton is hyperopic, what shape of corrective lenses would she require? Why?

6. Explain astigmatism.

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* The story in this case study is true in all significant respects; only the names have been changed for reasons of privacy.

Part II – Accessory Structures of the Eye

Mrs. Horton went to see the ophthalmologist, the medical practitioner specializing in diagnosing and treating eye conditions. During the initial assessment, it was discovered that Mrs. Horton exhibited chronic eye dryness and inflamed eyelids (blepharitis). Both are related to aging. He explained to Mrs. Horton that there are two glands that play a role in keeping the surface of the eye moist: lacrimal glands and tarsal (meibomian) glands. Following a comprehensive eye exam, the ophthalmologist ruled out a common age-related lacrimal gland dysfunction called Sjogren's syndrome. It is due to an autoimmune attack on the glandular cells of both the eyes and mouth resulting in decreased secretions of tears and saliva. Instead, the ophthalmologist determined that Mrs. Horton's tarsal glands were the cause of her dry eye and blepharitis.

Questions

1. Two categories of glands produce secretions that drain into the eye. Distinguish between the tarsal glands and lacrimal glands based on product formed, location and function.

2. The ophthalmologist suggested a number of ways Mrs. Horton could increase tarsal gland secretions and reduce the inflammation, both pharmacological and non-pharmacological. Use the internet to find treatments options for tarsal or meibomian gland dysfunction.

Part III – Glaucoma

The ophthalmologist prescribed corticosteroid eye drops for Mrs. Horton to reduce inflammation and recommended off-the-shelf eye drops to reduce dryness. He also prescribed oral antibiotics to treat the bacterial infection along the rims of her eyelids causing the blepharitis. Although dry eyes could be the cause of her blurred vision, the ophthalmologist decided to investigate further and scheduled a follow-up appointment. During this next appointment, the ophthalmic technician applied anesthetic drops to Mrs. Horton's eyes to numb her corneas. The technician then used a tonometer to gently blow a puff of air on her corneas to determine the intraocular pressure in each eye. Mrs. Horton's values exceeded the normal range of 12–22 mm Hg.

Questions

1. Explain glaucoma.

2. What are the signs and symptoms of glaucoma as it progresses?

3. What are some recommended treatments for glaucoma?

Part IV – Cataracts

Mrs. Horton was shocked to discover she had another eye condition. She wondered if her glaucoma would require surgery. Instead, the ophthalmologist prescribed a third type of eye drop, this time to treat her glaucoma. It would reduce the intraocular pressure in her eye by decreasing the production of aqueous humor. Mrs. Horton sat across from her doctor wondering how she would manage to remember to administer all of these different drops at the required times each day when he informed her of an additional issue with her eyes. She had cataracts.

Questions

1. What is a cataract?

2. What are the causes of cataracts?

3. What would be a recommended treatment for cataracts?

4. What are the risks of this treatment?

Part V – Shingles

Normally cataract surgery is a relatively risk-free operation. The ophthalmologist informed Mrs. Horton that she would need to get the chronic blepharitis and glaucoma under control before she could safely have the surgery. She left the doctor's office disappointed and still struggling to see clearly, especially at night. Over the next few years, she ventured out in her vehicle less and less. While on vacation, she suddenly became aware of a strange nerve pain developing on the left side of her head, which radiated into her left eye. Upon arrival home, she went to her family doctor suspecting she had shingles (which she had had before). She was right; it was shingles and it was extremely painful, especially in her eye. The risk of developing shingles increases with age. She was prescribed acyclovir to stop the progression, but unfortunately it was ineffective as it had not been administered in time. Shingles (herpes zoster) is caused by the reemergence of a dormant virus (herpes varicella/zoster), which originally causes chicken pox. It can evade the immune system by hiding out in the dorsal root ganglion of a single spinal root or in the cranial nuclei of the trigeminal nerve (cranial nerve V). When the virus is re-activated, it travels down sensory axons to a specific dermatome where it erupts from dendrites causing painful blisters.

Questions

1. What part of Mrs. Horton's eye was affected by shingles causing her excruciating pain and further loss of vision?

2. Explain the roles of the four cranial nerves that innervate the eye and its accessory structures.

3. Besides antiviral administration early in the onset of shingles, are there any other treatments for this condition? What about prevention?

Part VI – Cataract Surgery

After managing the symptoms of her various eye conditions, Mrs. Horton eventually underwent cataract surgery in which her lens was replaced with an intraocular, artificial lens. The ophthalmologist, worried about a possible surgical infection due to her chronic blepharitis, operated first on her non-dominant, left eye. This was the eye scarred by the shingles flare-up in its cornea. Post-surgery, Mrs. Horton reported that although she could see very clearly through the areas of the cornea that were not scarred, the vision overall in this left eye was patchy. Lack of infection and excellent healing paved the way for cataract replacement in her good, dominant, right eye. Finally, with artificial lenses in both eyes, her distance vision was restored. However, as expected, she still required reading glasses, but for a different reason than prior to the surgery; her optometrist informed her that her new lenses could not accommodate for close objects.

Questions

1. Define accommodation (in relation to vision).

2. Which structures are involved in accommodation for near vision and distant vision?

3. Why did Mrs. Horton lose visual accommodation both before and after cataract surgery?

Part VII – Final Outcome and Overview

As Mrs. Horton was leaving her optometrist appointment, the doctor pointed out that although she was unlucky to have so many vision problems, they were able to restore much of her vision and more importantly, she had avoided two of the most common ones associated with the elderly. Due to her healthy lifestyle and good genetics, Mrs. Horton did not have age-related macular degeneration or diabetic retinopathy.

Although it had been a four-year ordeal, Mrs. Horton left the doctor's office with confidence knowing that she could now easily read street signs with her dominant right eye. Now she could drive home without getting lost, leaving her lots of time to organize her many oral medications, apply hot compresses to her eyes to stimulate tarsal gland secretions, wash eyes with gentle cleanser, and administer the various eye drops before it was time for bed!

Homework Activity

For each of the common age-related eye problems below, give a description of the visual impairment (e.g., loss of central vision, inability to focus up close), structures involved, treatment, and prognosis.

	Visual Impairment	*Structures Involved*	*Treatment*	*Prognosis*
Presbyopia				
Cataracts				
Glaucoma				
Diabetic Retinopathy				
Age-Related Macular Degeneration (ARMD)				