Pearls of Clinical Optometry

A Complete Guide to Optometric Practice

2023

Swami Vivekananda University
Kolkata, India

2023

Pearls of Clinical Optometry

A COMPLETE GUIDE TO OPTOMETRIC PRACTICE

ISBN 978-93-6076-131-8
Cover image: Canva.com
Cover design by Dipanwita Ghosh

Preface

In the preface of this optometry book, I aim to provide readers with context, insights, and a roadmap for navigating the content within these pages. As a practicing optometrist with a passion for advancing clinical knowledge, my goal is to offer a comprehensive resource that caters to both students entering the field and seasoned professionals seeking updated insights.

Introduction to Optometry. We begin by exploring the foundational principles of optometry, delving into the intricate balance of vision science, ocular anatomy, and clinical applications. This book is designed to serve as a guide through the multifaceted aspects of the optometric profession.

Evolution of Optometric Practices: Optometry is a dynamic field, witnessing constant advancements in technology and clinical methodologies. Throughout the book, I highlight these evolving practices, ensuring readers are equipped with the latest information to provide optimal patient care.

Comprehensive Coverage: From basic vision assessment to specialized topics like contact lens fitting, binocular vision, and ocular diseases, each chapter is crafted to provide a well-rounded understanding. Real-world case studies and practical insights are interwoven to bridge the gap between theory and application.

Target Audience: This book is tailored for optometry students, residents, and practicing professionals seeking a resource that seamlessly integrates theoretical knowledge with clinical expertise. Whether you are beginning your optometric journey or looking to enhance your skills, you'll find valuable insights within these pages.

Acknowledgements

I extend my heartfelt appreciation to colleagues, mentors, and institutions that have contributed to my growth in the field. Their support has enriched the content of this book, and I am grateful for their shared dedication to advancing optometry. I would like to express our sincere gratitude to all the clinical optometrists whose dedication and expertise continue to advance the field of eye care. Their commitment to improving patient vision and overall eye health is invaluable. We acknowledge the vital role they play in diagnosing, managing, and treating a wide range of ocular conditions. Special thanks to Mr. Saurabh Adhikari, Chief Operating Officer Swami Vivekananda University, Barrackpore, West Bengal, whose insightful feedback and support have been instrumental in the completion of this work. Additionally, we appreciate the contributions of the Swami Vivekananda University for providing the necessary resources and support for this study. We also extend our thanks to the patients who participated in our research, without whom this work would not have been possible. Their willingness to contribute to the advancement of optometric knowledge is deeply appreciated. I invite you to embark on this journey through the fascinating world of optometry, exploring its intricacies, challenges, and the rewarding experiences that come with providing exceptional eye care. Lastly, we recognize the collaborative efforts of the interdisciplinary teams, including ophthalmologists, researchers, and healthcare professionals, who work alongside optometrists to ensure comprehensive eye care and the advancement of clinical practices in optometry.

Dipanwita Ghosh

Department of Optometry

December, 2023

Content

Physiology of Vision

Dr. Prabirendra NS,

D.O.S (PG), DCLP

Assistant Professor

Department of Optometry

Swami Vivekananda University

Physiology of Vision

Maintenance of Clear Ocular Media.

Phototransduction refers to the process by which light is converted into electrical signals in the retina of the eye.

- The physiological mechanisms behind the generation and constitution of tears.
- Visual signal processing and transmission.
- The physiological properties of the cornea.

Visual perception is the cognitive process by which the brain comprehends and gives meaning to visual stimuli that are received via the eyes(1)

- The physiological mechanisms of the crystalline lens.
- The study of the movement of the eyes and the coordination of vision from both eyes (2).
- The text discusses the physiological aspects of aqueous humour and the mechanisms involved in regulating intraocular pressure.
- Oculomotion analysis
- The study of the physical properties and functions of vitreous humour.
- The study of the biological processes involved in seeing a single image with both eyes

Introduction:

Vision is an intricate process involving the coordinated functioning of two eyes and their central coordination. Ocular physiology refers to the biological processes that are essential for the proper functioning of the eyes (3). The items are:

Ensuring the clarity of the eye's optical components.

Ensuring the correct pressure inside the eye is maintained.

- The process of creating an image
- The study of how vision works in the body
- The study of how the eyes move and how they work together to provide depth perception
- The study of how the pupil functions

The most significant biological effect of light is the physiological process that occurs when it reaches the retina. This process is crucial since it is responsible for the entire process of vision. There are three essential components for vision: light to stimulate the nerve endings (rods and cones in the retina) of the visual system, a visual mechanism to convert this light energy into nervous energy (Phototransduction) and transmit it to the brain, which coordinates the received impulses and triggers appropriate responses, and finally, a consciousness or mind to interpret the visual pattern and control the responses(2).

During the visual act, these different components occur in a continuous manner and interact with one other.

• The physical mechanism involves the formation of the retinal picture.

• Physiological process refers to the passage of retinal impulse to the brain in order to create visual sensation.

• Psychological process refers to the phenomenon that happens when visual sense is coordinated with conscious awareness, resulting in perception in the mind, and the synthesis of sensations becomes flawless (4).

Preservation of transparent eye structures

Clear refractive medium of the eye is essential for proper visual function. The primary determinant of the transparency of ocular media is their lack of blood vessels. The sequential arrangement of refractive media in the eye, from front to back, is as follows (5):

- The word "tear film" denotes the thin coating of tears that envelops the eye's surface.
- The cornea is the clear anterior portion of the eye that protects the iris, pupil, and anterior chamber.
- The aqueous humour is a fluid found in the eye.
- The vitreous humour is a gel-like substance found in the eye.

Crystalline lens

Lacrimal glands, situated in the upper outer corner of the eye, generate tears. They serve several physiological functions, including lubricating the eye, protecting it from foreign particles, and maintaining the health of the ocular surface.
The tear film is essential for preserving transparency. Regarding the cornea. The answer varies based on the tear's quality and amount. The refractive index is 1.375.

The study of the functions and processes of the cornea.

The cornea is the primary surface of the eye responsible for refraction, with a refractive power ranging from +42D to +43D. Physiological factors pertaining to the cornea encompass(6):

• **Clarity**

The study of the nourishment and chemical processes involved in the cornea.

The ability of the cornea to allow substances to pass through it.

The refractive index is 1.376.

The physiology of the crystalline lens

The crystalline lens is a transparent ocular structure that plays a crucial part in the process of visual focusing, with a refractive power of +19 diopters (with the ability to be adjusted within the range of +4 to +6 diopters). The physiological aspects encompass:

Transparency refers to the quality or state of being transparent, which means being clear, open, and easily understood (7).

• Cellular metabolism

• The refractive index of the anterior part of the accommodation is 1.387, whereas the refractive index of the equator is 1.375.

Accommodation refers to the eye's capacity to enhance its ability to concentrate on nearby objects. This is achieved by the contraction of the ciliary muscle, which causes the crystalline lens to adopt a more rounded shape, essentially increasing its refractive power. Accommodation is a factor in depth perception, as the brain relies on the level of focused effort to determine the distance to an item. During the process of accommodation, the eyes undergo convergence, causing them to shift inward, and the pupil constricts, resulting in a smaller size. This sequence of occurrences is occasionally referred to as the accommodating reflex, despite not being a genuine reaction(4 ,8).

The study of the physiological mechanisms of the aqueous humour and the regulation of intraocular pressure.

The aqueous humour is a transparent liquid that fills the anterior chamber of the eye with a volume of around 0.25 ml, and the posterior chamber with a volume of about 0.06 ml. The aqueous humour is crucial for regulating intraocular pressure by transporting substances and eliminating waste products from the cornea and crystalline lens (9).

The refractive index is 1.336.

Study of the properties and functions of the vitreous humour

The vitreous humour is a clear gel mostly consisting of water (about 99%), collagen, and hyaluronic acid. It is situated in the back part of the eye. It aids in preserving the spherical form of the eyeball. During motions, the vitreous adheres to the retina, causing motion in the gel. This motion, in turn, creates tensions inside the vitreous and on the retina.

Study of the biological processes involved in vision

The physiology of vision is an intricate process that remains incompletely comprehended. The primary determinants in this process are:

The process of vision initiation, known as phototransduction, is carried out by the photoreceptor cells, namely the rods and cones.

The processing and transmission of visual impulses is a function performed by the image processing cells of the retina and visual pathway.

Visual perception is a cognitive process that relies on the functioning of the brain, namely the visual cortex and its associated parts.

Phototransduction refers to the process by which light is converted into electrical signals in the retina of the eye.

Phototransduction is the conversion of light into electrical impulses in the retina. Visual perception occurs through the activation of photoreceptor cells, specifically rods and cones, which generate nerve impulses that are sent to the brain. This intricate biochemical process involves the absorption of photons by visual pigments, changes in membrane potential, and the transmission of information across the visual pathway(10).

THE PHOTOCHEMICAL CHANGES ENCOMPASS:

Photons with wavelengths ranging from 400 to 780 nm enter the eye and interact with the pigment molecules in retinal cells, leading to different structural changes in these cells. These photochemical reactions transpire when the wavelength of light is transformed into its chemical energy equivalent. These modified molecules are accountable for the subsequent intracellular cascade sequence, ultimately leading to a series of electrical impulses transmitted to the brain. The brain will receive and interpret information based on the frequency and pattern of these impulses(8, 10).

The photochemical changes encompass:

- Rhodopsin bleaching is the gradual reduction in the effectiveness of the visual pigment rhodopsin. Rhodopsin is found in the retinal rods and is accountable for scotopic vision, which is the ability to perceive in low light conditions. Rhodopsin consists of an achromatic protein called Opsin, which is associated with a carotenoid called Retinine (also known as Vitamin A aldehyde or 11-cis-retinal). The incoming light induces the transformation of the 11-cis-retinal component of rhodopsin into all-trans-retinal through a sequence of stages. The all-trans-retinal that is generated is rapidly dissociated from opsin. Photodecomposition is the term used to describe the process of separating compounds using light. Similarly, the fading of rhodopsin caused by light is commonly referred to as bleaching
- Rhodopsin assimilates light energy, resulting in the division of opsin and all-trans-retinal. Subsequently, the all-trans-retinal undergoes retinal isomerization to be transformed back

into 11-cis-retinal. Ultimately, the 11-cis-retinal is amalgamated with opsin in order to restore rhodopsin.

Rhodopsin →light energy →All trans-retinal →(opsin separated) → 11-cis-retinal → (Retinal isomarse) → and opsin added → Rhodopsin

Regeneration of rhodopsin:

Rhodopsin regeneration entails the conversion of the dormant Metarhodopsin II back into its active state, rhodopsin. The process is referred to as rhodopsin regeneration or visual pigment renewal. Maintaining light sensitivity in the retina, particularly in low light conditions, is crucial. The regeneration of rhodopsin is accomplished by a sequence of metabolic events that involve the conversion of retinal (a derivative of Vitamin A) back into its active forms, namely 11-cis-retinal. Enzymes and other biological components in the retinal cells aid in facilitating this process. Rhodopsin regeneration is essential for the eyes to adjust to varying light circumstances and is a critical component of the visual cycle, maintaining the uninterrupted operation of the visual system (7, 8).

Rhodopsin undergoes a sequence of changes when it is exposed to light. The sequence of transformations is as follows: bathorhodopsin is initially formed, which then converts into lumirhodopsin, and then into metarhodopsin I and metarhodopsin II. This process results in the production of all-trans retinal, which is then transformed into all-trans retinol (vitamin A) by the reduction of NADH to NAD. Subsequently, the all-trans retinol undergoes isomerization to become 11-cis-retinol, which is further transformed into 11-cis-retinal by oxidising NADH to NAD. Ultimately, the 11-cis-retinal and opsin merge to restore rhodopsin (7).

Rhodopsin→Light → Bathorhodopsin → Lumirhodopsin → Metarhodopsin I→ Metarhodopsin II → all trans retinal → (NADH to NAD)→ All trans- retinol(vit A) → isomarse-→ 11-cis-retinol→NAD to NADH-→ 11-cis- retinal →Opsin add-→ Rhodopsin.

Electrical changes:

Upon exposure to light, rhodopsin becomes activated and triggers a complex cascade of metabolic events, culminating in the generation of receptor potential in the photoreceptors. This process involves the conversion of light energy into electrical energy or nerve impulses, which are then communicated to the brain via the visual pathway (9).

Visual impulse processing and transmission:

The visual system undergoes a complex sequence of stages to analyse and transmit visual impulses. The concise summary:

• Photoreception in the Retina

Signal transduction in photoreceptor cells initiates a series of interconnected actions.

• Signal propagation to bipolar cells

The bipolar cells transfer signals to the ganglion cells.

The formation of the optic nerve occurs when the axons of ganglion cells come together to create the optic nerve.

The optic chiasma is a structure in the brain where the optic nerves partially cross over.

• The optic tract transmits visual information to the lateral geniculate nucleus (LGN) located in the thalamus.

The visual cortex receives visual signals from the thalamus and is located in the occipital lobe. The visual cortex is accountable for the subsequent processing and interpretation of visual inputs.

• Higher Visual Processing: Visual information undergoes processing in several higher visual regions beyond the primary visual cortex, enabling the perception, recognition, and interpretation of complex visual situations. The visual pathway is now understood to consist of two distinct pathways: the magnocellular route, comprised of big cells, and the parvocellular pathway, comprised of tiny cells. These can be likened to two lanes of a road. The M route and P pathway are engaged in the simultaneous processing of the picture, namely in the examination of distinct characteristics of the image (8 ,9).

Difference in sensitivity of M and P cells to stimulus features:

Colour contrast. **M cell. -** No. **P cell. -** Yes

Luminance contrast. **M cell. -** Higher. **P cell. -** Lower

Spatial frequency **M cell -** Lower **P cell -** Higher

Temporal frequency **M cell -** Higher **P cell -** Lower.

VISUAL PERCEPTION

Visual perception refers to the cognitive process by which the brain comprehends and gives meaning to visual stimuli that are received via the eyes. The process encompasses many phases of processing that convert unprocessed visual data into meaningful perception. The organisation of the receptive fields in the retina and brain is utilised to encode information pertaining to a visual picture. The fundamental components of visual perception encompass the ability to see light, discern forms, perceive contrasts, and distinguish colours (10).

Photoperception - It is the cognitive recognition of light.

• Light minimum - The lowest level of brightness needed to elicit a perception of light. The measurement should be taken when the eye has undergone dark adaptation for a minimum of 20 - 30 minutes.

The human eye has the ability to function correctly in a broad range of lighting conditions throughout the day due to a complicated process known as visual adaptation (10).

The process of visual adaptation primarily involves:

Dark adaptation refers to the process of adjusting to low levels of light. Dark adaptation is the eye's capacity to adjust to lower levels of light, allowing it to transition from brilliant sunshine to a poorly lit space. This process takes time and involves the increased sensitivity of rods, which are more sensitive than cones. The illness of RDS, such as Retinitis Pigmentosa and Vitamin A insufficiency, leads to a delay in the process of dark adaption (11).

• Light Adaptation refers to the process of acclimating to intense lighting conditions. When an individual transitions abruptly from a dimly lit environment to a brightly illuminated one, their retina adjusts to the heightened light intensity, causing an increase in the visual threshold. This rapid adjustment process is referred to as light adaptation, which typically takes around 5 minutes to complete. Light adaptation essentially supersedes the previous state of dark adaptation.

The Form sense

Sense refers to the capacity to distinguish the form or structure of items. The cones play a significant role, and the sensation of shape is most vivid near the fovea, where they are densely packed and highly distinct. The perception of form is not just dependent on retinal function, but also involves significant physiological processes(10).

Element of visual sharpness

Visual acuity refers to the clinical measurement of the ability to distinguish between two spatially distant targets, which is mostly dependent on the function of the fovea.

• Minimum visibility refers to the capacity to discern the presence or absence of an item.

Resolution pertains to the capacity to differentiate between two objects situated at distinct places. The histological diameter of a cone in the foveal region measures 0.004 mm. Therefore, this signifies the most concise distance between two cones. In order to produce an image that is at least 0.004 mm in size, the object must generate a visual angle of 1 minute at the nodal point of the eye, which is referred to as the Minimum Angle of Resolution (MAR)(5) .

Clinical tests for visual acuity assess the eye's capacity to see shape or read.

Recognition refers to a cognitive task that involves identifying or acknowledging something.

Furthermore, considering spatial resolution. In order to achieve recognition, the individual must possess both familiarity with the set of test figures used and the ability to successfully answer them. The identification of faces is the most prevalent example of the recognition phenomenon.

Perception of Disparity

The concept of Contrast pertains to the visual system's capacity to discern disparities in. Differences in brightness, colour, or texture can be observed between neighbouring or separate visual items. Crucial elements of the sensation of contrast encompass (12):

• Luminance Contrast refers to the disparities in brightness or intensity between neighbouring regions.

• Colour Contrast - Variances in hues among objects or areas contribute to the sense of colour.

• Texture Contrast-Variance refers to variations in texture, such as disparities in patterns or surface roughness.

• Spatial Contrast - Describes variations in spatial frequencies that impact the ability to see intricate details or patterns.

Temporal Contrast refers to variations in visual stimuli across time, including alterations in brightness or motion.

Contrast sensitivity refers to the capacity to perceive differences in contrast levels.

Various variables including as ageing, refractive errors, glaucoma, diabetes, optic nerve illness, and lenticular alterations might impact contrast sensitivity.

Colour Perception

Colour sense, or colour perception, is the capacity of the human visual system to interpret and differentiate between different wavelengths of light, leading to the experience of diverse hues. Colour vision is primarily dependent on the cones, making it more pronounced during photopic vision (daylight vision). In poor lighting conditions (scotopic vision), all colours appear as shades of grey. This phenomenon is known as the Purkinje shift. The salient aspects of colour perception encompass(11):

The colour vision mechanism refers to the physiological process by which humans see and distinguish different hues. The process is primarily facilitated by three types of cones in the eye that are responsive to distinct wavelengths of light: short (blue), medium (green), and long (red).

• Colour blending - The brain perceives colours by combining impulses from three types of cones.

The user's text is a bullet point.

The colour spectrum encompasses the range of visible light, extending from the shorter-wavelength violet to the longer-wavelength red.

• Primary Colours - In the RGB (Red, Green, and Blue) colour paradigm, are considered the fundamental colours.

The Opponent Process Theory explains colour perception by proposing that brain processes in the visual system operate in opposition to one other, namely in the case of red vs green and blue versus yellow.

• Color Constancy - The capacity to see the unchanging colour of an item regardless of variations in lighting circumstances.

• Cultural and Individual Variation- The perception of colour can differ among individuals as a result of variables such as genetics and age.

• Color Vision Deficiency - Certain individuals experience defects in one or more types of cones, resulting in colour blindness. The predominant forms of colour blindness are red-green and blue-yellow colour vision deficiencies (11).

The study of the movement of the eyes and the coordination of vision from both eyes.

Ocular motility physiology encompasses the synchronised actions of the muscles responsible for precise visual tracking and alignment. The concise summary:

The motions of each eye are controlled by six extraocular muscles.

• Cranial Nerves - The regulation of ocular movement is governed by three cranial nerves: the oculomotor nerve (CN III), trochlear nerve (CN IV), and abducens nerve (CN VI).

The extraocular muscles function in pairs with opposing activities to generate eye movement.

Eye movements can be conjugated, meaning that both eyes move simultaneously in the same direction. This allows for synchronised visual tracking.

• Vergence Movements: These movements refer to the inward movement of the eyes (convergence) or the outward movement of the eyes (divergence) in order to preserve binocular single vision.

• Saccades refer to rapid and voluntary eye movements that transfer the focus from one location to another.

Smooth Pursuit refers to the deliberate and uninterrupted eye movements that enable the tracking of a moving object. Operated by Pursuit System.

The optokinetic reflex is a visual response that combines both pursuit and saccadic eye movements in order to track a moving object. Aids in maintaining visual stability throughout prolonged movement.

The Vestibulo-ocular Reflex (VOR) is a mechanism that synchronises eye movements with head movements in order to provide steady vision when the head is in motion. Requires input from the Vestibular System.

Regulating ocular motility is crucial for ensuring clear and steady vision during a range of tasks, such as reading and tracking moving objects. The incorporation of visual, vestibular, and proprioceptive stimuli guarantees the precision and effectiveness of ocular motions.

Stereoscopic Vision

Binocular vision is the capacity to utilise both eyes at the same time in order to experience a singular, three-dimensional representation of one's environment. Important components of binocular vision encompass (13):

Stereopsis refers to the visual sense of depth and the capacity to accurately assess the distance of objects.

Binocular disparity refers to the little variation in the pictures of an item that are perceived by each eye on the retina.

Convergence refers to the inward movement of both eyes in order to focus on a close object.

Binocular summation is the process by which visual perception is improved, particularly in low-light situations, by the integration of information from both eyes.

Binocular rivalry is a phenomenon that happens when conflicting pictures are presented to each eye, resulting in a perceived shift between the two images.

Visual Field Overlap refers to the ability to see a wide range of objects and events, including those in the periphery, which is superior than the limited field of view provided by monocular vision.

The brain creates a "cyclopean eye" by merging information from both eyes to generate a cohesive visual perception(13).

The benefits of binocular vision include enhanced depth perception, precise distance estimate, improved visual acuity, and increased contrast sensitivity.

Binocular vision normally emerges throughout infancy when the visual system matures and the brain learns to combine information from both eyes. Binocular vision is essential for performing a wide range of daily activities accurately and effectively.

Reference

1. Bowmaker, J. K. (1998). Evolution of colour vision in vertebrates. Eye, 12(3), 541-547.

2. Krag, S., & Andreassen, T. T. (2003). Mechanical properties of the human lens capsule. Progress in Retinal and Eye Research, 22(6), 749-767.

3. Lichtinger, A., & Rootman, D. S. (2012). Intraocular lenses for presbyopia correction: past, present, and future. Current opinion in ophthalmology, 23(1), 40-46.

4. Buisseret, P. (1995). Influence of extraocular muscle proprioception on vision. Physiological reviews, 75(2), 323-338.

5. Bloomfield, S. A., & Völgyi, B. (2009). The diverse functional roles and regulation of neuronal gap junctions in the retina. Nature Reviews Neuroscience, 10(7), 495-506.

6. Do, M. T. H., & Yau, K. W. (2010). Intrinsically photosensitive retinal ganglion cells. Physiological reviews.

7. Imamoto, Y., & Shichida, Y. (2014). Cone visual pigments. Biochimica et Biophysica Acta (BBA)-Bioenergetics, 1837(5), 664-673..

8. Zhou, X. E., Melcher, K., & Xu, H. E. (2012). Structure and activation of rhodopsin. Acta Pharmacologica Sinica, 33(3), 291-299.

9. Senin, I. I., Koch, K. W., Akhtar, M., & Philippov, P. P. (2002). Ca2+-dependent control of rhodopsin phosphorylation: recoverin and rhodopsin kinase. Photoreceptors and Calcium, 69-99.

10. Saito, H. A. (1983). Morphology of physiologically identified X-, Y-, and W-type

retinal ganglion cells of the cat. Journal of Comparative Neurology, 221(3), 279-288.

11. Solomon, S. G., & Lennie, P. (2007). The machinery of colour vision. Nature Reviews Neuroscience, 8(4), 276-286.

12. Yau, K. W., & Hardie, R. C. (2009). Phototransduction motifs and variations. Cell, 139(2), 246-264.

13. Harris, K. D., & Mrsic-Flogel, T. D. (2013). Cortical connectivity and sensory coding. Nature, 503(7474), 51-58.

Visual Acuity & Clinical Refraction

Arup Saha,

D.Pharm, B.Optom, M.Optom

Assistant Professor

Department of Optometry

Swami Vivekananda University

Visual Acuity & Clinical Refraction

2.1 Introduction

In the field of optometry "Refraction" is described as a clinical procedure to asses refractive condition of a patient eye to rule out refractive errors also termed as ametropia to provide appropriate refractive correction and power prescription. Now a day's refractive error is quite common and from the research study we can find a huge percentage peoples significantly pediatric group of patients suffering from refractive errors. To prevent avoidable blindness from a country it is mandatory to provide appropriate correction among maximum population.

In this chapter we will discuss in detail about ocular health examination including vision assessment, Subjective & objective type of refraction, different types of charts used in refraction process, basic skill to retinoscopy performing to estimate about the errors, trial& error process to find patient individual refractive power acceptance, power refinement processes, binocular balancing and making power prescription with its components and proper format. All of these are the vital points of clinical refraction procedure to find the best correction and enhancing vision quality. In this discussion we have tried to discover on clinical significance, necessary equipment's, test procedures, cautions, proper patient management and refractive errors correction.

2.2 Significance

Clinically assessment of refractive errors and finding its proper corrections termed as clinical refraction. It is a technical way to measure the eye health about its refractive status. Cornea and lens are called as major refractive surface as it is responsible for light refraction to project it properly on the visual sensitive retina to form the image and responsible for visualization. Sometimes pathological, mechanical or developmental facts can affect its quality to support the refraction process by affecting its anatomical health like transparency, curvature, refractive index etc. Aim to clinical refraction is to rule out the errors and finding its best correction to improve the vision quality.

Visual acuity can be described as the acuteness `of vision that is the ability of an individual patient how better quality it can be visualized/A is a compulsory assessment and step of clinical refraction conducted to see the refractive ability in distance and near both monocular and binocular mode. Different types of charts are available like Snellen's chart, log MAR Charts, tumbling E charts, LEA symbol charts etc. normally used in clinical refraction. Following the quality of visual acuity objective and subjective refraction conducted to do measurement, correction, refinement and prescription for managing refractive errors. Trial box, trial lenses including spherical and cylindrical lenses, Maddox rod, set of prisms, pinhole, Red & Green filters, stenopic slit etc. are the regular instruments for refraction processes. Beside this W4dot test, Duo Chrome test, JCC etc. are also important for binocular balancing and corrective power refinement. Here all clinical steps, indications, necessary instruments, factors interfering, evaluation, interpretation, estimation methodology will be focused.

2.3 Visual Acuity

Visual acuity can be described as the sharpness of vision that means the ability of an individual patient to see the clear image at the distance both distance and near. As per measurement with Snellen visual acuity chart it can be determined as 20/200 0r 6/60 that is a ratio regarding the letter optotypes in the chart and measurement distance at 20 feet or 6 meters at distance. Near vision distance normally taken as 33cm to perform daily reading activities.20/200 means the assessment of visual acuity targeting particular optotypes with a specific letter size that can be visible by an emmetropic patient from 200 meters away but these are visible to that particular subject patient from 20 meters only. About the components of vision, it can be described as minimum visible, resolution, recognition and minimum discrimination. Minimum angle of resolution (MAR) is an important part of visualization when light rays from the target objects are able to form at least 1 minute of arc visual angle at the nodal point of eye responsible to make visual differences between two spatially separated target points. As per diagnostics procedures to measure visual acuity following equipment's are needed.

- ➔ Snellen /log MAR visual acuity chart as distance and near target.
- ➔ Occluder to block one eye for monocular vision assessment.
- ➔ Pinhole to observe central vision quality.
- ➔ Torchlight to asses light perception and projection.
- ➔ Appropriate medical records to note the acuity result.

In case of visual acuity check up by wearing previous power glass can be termed as aided vision and without wearing any corrective glasses can be termed as unaided vision. If patient already have power prescription, then Optometrist practitioner normally preferred to take aided visual acuity to continue patient previous visit follow up.

2.3.1 Clinical procedure to measure visual acuity:

- ➔ To asses visual acuity at first need to verify about light source of vision chart, room illumination, patients' ability to seat properly and the distance measurement. In case of symbol identification need to provide proper direction to the patient so that they can help to provide positive response according to their visual ability.
- ➔ In case of outdoor camp vision screening, vision chart should keep in a proper illuminated place.
- ➔ For the 6-meter Snellen chart patient need to sit properly at 6 meters away from the chart and in some time for the low space mirror is used to manage as it can double the visual distance.
- ➔ If patient already have the power correction, then we need to asses vision wearing power correction to follow up previous diagnosis termed as aided vision.
- ➔ For the monocular vision test we need to occlude another eye with the help of blocker. Patient have to read or identify the largest to maximum smallest pattern according to the patient capability .Patient is directed to read from the left of a particular line to the right. In case of illiterate patient asked about pattern or direction of letter. Tumbling E chart is used mostly.
- ➔ Patient is asked about to read the smallest line and letters as per capability. Each line from the Snellen vision chart has particular value expressed as a fraction like 6/12 or 6/9.Here the upper number is the distance between the patient and chart (6 meter).Lower number also means the distance about the

measurement of that particular optotypes so that normal or emmetropic is able to read the same size optotypes from that mentioned distance in meter. So, if patient is able to read 6/9 without correction with the help of right eye, then it can be said that Unaided vision of OD =6/9.6/9 means that particular line or optotypes size can be seen by a normal emmetropic patient from 9 meters but that particular patient can see or identify that from the 6 meters.

➔ Pinhole is used check the central vision by blocking the peripheral light rays and aberrations. So, if patient have the visual acuity OD=6/12 and improved with pinhole to the smallest line can be recorded as with ph vision 6/6.

➔ If patient is able to read 6/18 with unaided vision and 3 letters from the next line that it can be write as 6/18+3 and if it is improved with pinhole vision to 6/6 then it is determined that refractive error can be correct up to 6/6.

➔ If patient unable to see the top most largest letter then needs to reduce 1 meter the distance between chart and patient eye until it become visible. It can be recorded as 3/60 as the distance between chart and patient eye reduced from 6 meters to 3 meters to make it visible. But if patient failed again to identify the largest letter from 1 meter, then need to ask about the hand movement and finger counting.

➔ If patient is able to count fingers from 1 meter, then it can be recorded as CF at 1 meter but if failed the need to closer again to check hand movement. If patient give positive response, then it is recorded as Hand movement close to the face.

➔ When patient failed to identify hand movement then next step is to check the light perception. If patient is able to identify light perception and projection then it is recorded as PLPR+.

➔ If patient unable to response about light perception, then recorded as NPL that means no light perception.

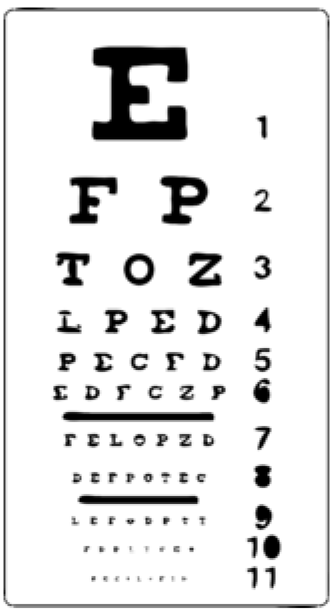
➔ Need to repeat total procedure for another eye.

➔ Report can be summarized as
OD=6/12 unaided with pinhole 6/6
OS=6/18 unaided with pinhole 6/6

2.4 Different types of vision chart use in refraction

Vision charts normally use to provide target optotypes to the patients as part of vision assessment. Patients are directed to read or identify the patterns staring from the largest size to the smallest according to patient capability. Snellen chart is mostly used clinical purpose. Beside this Tumbling E chart is also available as illiterate chart. Each optotypes are constructed in such a way that it can form 5 minutes of arc visual angle. As example 6/9 optotypes are constructed in such a way that it can form visual angle of 5 minutes of arc from 9 meter at the nodal point of an emmetropic eye. Log MAR chart mostly used in glaucoma and diabetic cases to observe mild visual improvement as because more perfection of V/A assessment.

1) Snellen Chart



Snellen's visual acuity chart was invented by Herman Snellen during 1862 to check visual acuity. It contains optotypes 5x5 unit grades that is able to form 5 minutes of arc visual angle for a particular distance. That distance considered as 6 meters or 20 feet between the chart and patient eye. The chart consists of 11 lines of block letters denote visual acuity as a fraction 6/60,6/36,6/24,6/18,6/12,6/9,6/6,6/5. If patient is able to see the letter mentioned as 6/24 that means that particular letter can form visual angle 5 minutes of arc in an emmetropic eye if placed at 24 meters away from the eye but visible by that particular patient when kept at 6 meters', D, E, F, L, N, O, P, T, and Z are the letters that specially designed to construct the chart. By occluding one eye patient is directed to read the letters from top and largest to the smallest line as per patient possibility to recognize.

2) Log MAR Chart

Log MAR chart invented and developed by Jan E Lovie Kitchin and Lan Baily that's why it also called as Baily Lovie chart. Optotype principles and construction are same but about to visual acuity measurement it is more specific. It has equal progression and each of letters can give specific acuity measurement. Chart contains 14 lines and each line each of line made up of 5 letters with standard spacing. Logarithm of MAR (minimum angle of resolution) help to determine the score of visual acuity assessment according to log MAR chart. If Snellen score is 20/20 then MAR can be calculated as 20/20=1.So log MAR of 1 score 0 that can form 1 min of arc visual angle.

3) Landolt C

Landolt C chart established and developed by Edmund Landolt. Chart consists of broken ring which are the target optotypes. Similar as Snellen chart letter size gradually become smaller from top to downwards. Ring optotypes has small gap or broken part so patient is directed to find that broken part. This broken part or small gap can be located at upper or lower position and also can be at right or left. Similar as the Snellen chart ring optotype also constructed as 5x5 grid unit so it can form 5 minutes of arc visual angle when minimum 1 min of arc visual angle is needed to make difference between two spatially separated points. Patient sit 6 meters away from the chart so that visual acuity can be recorded as 6/9 ,6/6.

4) Tumbling E

Tumbling E chart is also similar as Landolt C chart but difference is that here only English letter E is used without other letters. Similar as Snellen chart it is also constructed as 5x5 unit grid and able to form 5 minutes of arc visual angle from a particular distance. Patient id directed to identify the direction of E open side. It is designed as all direction like up, down, right and left. If patient able to identify the smallest line E letter direction denoted as 6/6 that means it can form 5 minutes of arc visual angle from the 6 meters distance.

5) **Lea test chart**

Lea test chart developed and designed based on symbol optotypes so that paediatric patient not able to read properly can identify the patterns. Lea symbol chart also developed to assess colour vision, contrast sensitivity etc. Normally patterns used to construct the chart like circle, pentagon, square etc. All that patterns quite different from each other and patient directed to identify the patterns with different size.

2.5 Subjective & Objective refraction

Total refraction procedure can be classified into subjective and objective part. Subjective means active participation of patient with response when patient response plays a significant role to find the correction. On the other hand, during objective refraction basically depends on calculation interpretation and evaluation with the help of equipment's and machine-like auto-refractometer, retinoscopy etc. Objective refraction is the initial part of refractive error assessment. Static Retinoscopy, Dynamic retinoscopy, autorefractometry etc. are the significant point under objective part.

Subjective refraction depends on patients' response and it is part of refractive error examination with help of trial lenses, trial frame, vision chart, pinhole, Maddox rod, stenopic slit, astigmatic fan and block, Jackson cross cylinder, fogging technique etc. After clearing objective part, we can find estimation about the refractive errors. Then according to the result, we perform monocular subjective corrective correction to find best acceptance using spherical and cylinder lenses. Trial and error method used to find the best sphere and cylinder power correction according to the patient's refractive demand. Duo chrome test is helpful to find over or under correction and JCC, astigmatic fan & block, stenopic slit etc. used find cylinder power with proper axis alignment. After completing subjective correction all procedure both at distance and near, it is needed to perform binocular balancing also with help of Duchrome test with fogging, prism dissociation etc.

2.6 Cycloplegic refraction

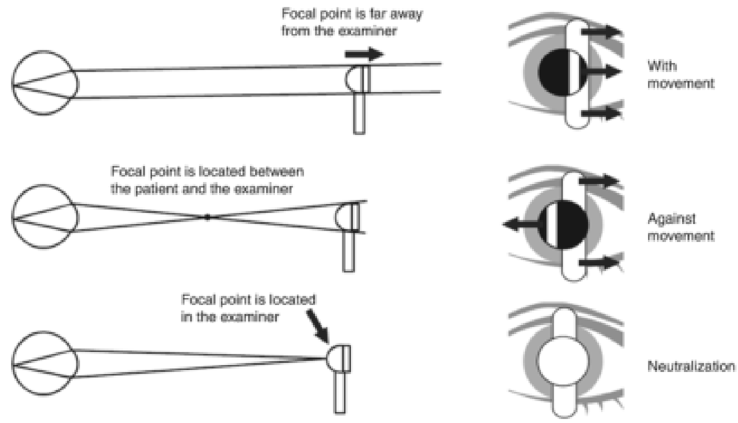
Cycloplegic refraction normally performed to rule out the latent problems like latent hypermetropia, accommodation excess, etc. In case of pediatric patient or school going patient accommodation is highly active. Excessive near work is also responsible for accommodative problems. Mydriatic drugs are used to relax the circular muscle so that it will not affect normal refraction. Cycloplegic drugs like cyclopentolate can create temporary paralysis used to relax high accommodation. Due to high accommodative power artificially, myopia may occur but it can be unmasked if accommodation relaxed. But in case of Cycloplegic refraction it will take times to create effect. So, refraction done before drug application and also need to repeat that again when drug application become effective. So, the interval between refraction without drug effect and after dug instillation depends on the drug. Within 30 minutes Cyclopentolate can create total accommodative relaxation and after 3 hours approximately effect will be lower but dilated pupil may take 24 hours to become normal. Atropine may take minimum 3-4 days to become normal but in case of adverse effect or complication it must be stopped immediately.

2.7 Retinoscopy

Retinoscopy is a significant part of objective refraction to find out estimation about the refractive errors. As per procedure it can be divided into static and dynamic. In case of static refraction accommodation will be at rest because patient s directed to focus at a distant point or target. For a normal patient far point is located at infinity but in case of refractive errors like myopia it become finite. So, by neutralization of the papillary reflex observed by retinoscope we can detect estimate error values.

If accommodation become functioning instead of relaxing as target is located nearby to the eyes, then it is termed as dynamic retinoscopy.

Principles:



Retinoscopy is the objective way of refraction to estimate the refractive errors. Retinoscopy works on Illumination stage, projection stage and reflex stage. Based on illumination technique it can be divided as self-illuminated streak retinoscope and plane mirror or Priestley smith (both concave and plane effect) retinoscope. In case of plane mirror retinoscope additional light source is needed to reflected by the mirror and projected into patient's eye retina. When the light rays reflected off from the retina it is observed by the observer through the peep hole to evaluate the nature of retinal reflex. That retinal reflex observed by the practitioner, its nature (with motion or against motion) depends on the refractive status of the patient's eye. Retinal reflex occurring when light rays projected into patients' eye and illuminated retinal area then the light rays reflected off from the retina specifically from that illuminated area focus on the observer eye to view the image of that illuminated area that depends on patients' refractive status.

In case of static retinoscopy far point located at the infinity but when it located between patients' eye and infinity point, patient become myopic and if the far point located behind the infinity, patient become hypermetropic.

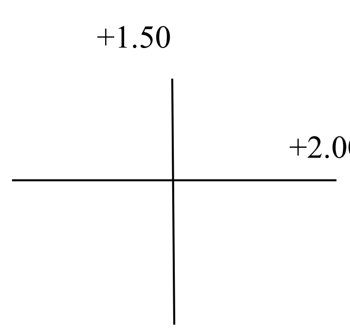
According to the retinoscopy observation when patient focusing at distance target point and accommodation is at rest, if far point is located behind the retinoscope may cause with reflex. When far point is located between the patient's eye and retinoscope may cause against reflex. If far point located at the retinoscope plane then neutral effect may occur.

2.7.1 Static retinoscopy technique

- ➔ If patient has previous medical data, then need to find the previous glass prescription and aided visual acuity. But if patient bearing no previous medical data, then need to start from unaided visual acuity and recording medical history.
- ➔ At the staring of retinoscopy patient is recommended to seat properly so that patient eye level and observers eye level can be adjusted with same height.
- ➔ Retinoscopy performed under dim light room illumination because dim illumination help observer to find the bright reflex.
- ➔ Patient is directed to focus at the distance target point (like large optotype) to make the accommodation at relax.
- ➔ During retinoscopy performing, observation point of retinoscope should be aligned with the patient's visual axis.
- ➔ Light source from the streak retinoscope projected into patients' eye to find the red reflex.
- ➔ Need to observe to movement of red reflex associated with the streak movement. If the reflex movement observed similar direction with the steak termed as with motion. If streak reflex motion observed as the opposite direction to the streak can be termed as against motion. When there will be total illuminated pupillary reflex without motion can be termed as neutralization point.
- ➔ Observer normally performs retinoscopy from 1 hand distance that is 66 cm termed as working distance. That will be compensated later during calculation of refractive power.
- ➔ Based on streak reflex nature, with movement can be neutralized with plus lens and against movement will be neutralized with the minus lens.
- ➔ Neutralization stage depends on the nature of streak reflex (intensity, width and speed of motion).

When the refraction steps will become closer to the neutralization, the reflex will be wider, brighter and faster.

- ➔ In case of cross retinoscopy both principle meridians need to be checked properly to find the neutralization value. As example if horizontal light reflex finds the power meridian 90 degree and vertical light reflex find the power meridian 180 degree. Suppose horizontal reflex find neutralization at +2.00 and vertical reflex find data as +1.50.It can be written as



- ➔ Astigmatism means the different refractive powers existed in different meridians. In such cases at first need to neutralize the most prominent with motion steak reflex and the Cylinder axis will be 90 degrees away from the previously neutralized well defined streak reflex meridian. In case of finding correct axis reflex will be found as narrow and brighter.
- ➔ After getting the both meridian neutralized powers need to compensate the working distance. For the 1 hand distance 66cm need to deduct power amount calculation like that inverse of 100/66 meter (working distance should be in meter). That is 1.51D.
- ➔ So, after the hand distance calculation it can be estimated as
- ➔

+/- plano (vertical axis) (meridian a)

+0.50 (horizontal axis) (meridian b)

So as per finding if we consider plano (meridian a) for the spherical power then the cylinder power calculation will be (meridian b – meridian a).so here calculated value is +0.50D and axis is 180 degree.

We can write estimate power value as +/_Plano/ +0.50 x 180 degree.

- ➔ In case of presbyopia correction additional power given over the distance power according to patient age, acceptance and reading or working distance.

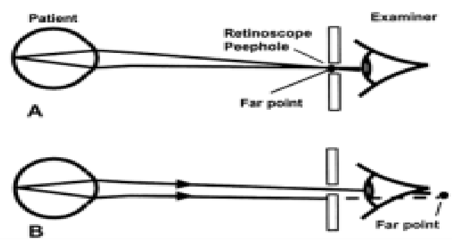
2.7.2 Dynamic retinoscopy:

Unlike static retinoscopy, accommodation is active because patient is directed to focus t nearby object located at the same line with the peephole. Dynamic retinoscopy recommended for the patient suffering from accommodative excess, ill sustain, spasm or insufficiency cases. This is the objective way to check the accommodative functions. During dynamic retinoscopy patient is directed or encouraged to utilize accommodative ability.

Procedure:

- ➔ To perform dynamic retinoscopy, need to sit patient properly same as static technique as eye level of patient and observer should be same.
- ➔ Dim light illumination preferred to perform retinoscopy because light reflex can be observed properly.
- ➔ Patient is directed to see the near object to stimulate the accommodation. Dim light allowed seeing the near object properly.
- ➔ Based on retinoscopy technique it can be classified as Mahendra, MEM, NOTT, BELL retinoscopy etc.
- ➔ During near retinoscopy distance correction should be given to make the far point at infinity.
- ➔ At the beginning patient is directed to see the distance and that time pupillary reflex need to be observed though retinoscopy. In case of normal patient with movement can be seen.
- ➔ Retinoscopy should perform from the reading distance. Near target should be located at the same line with the peephole.

- Then gradually patient will focus from distant point to the near object that stimulates accommodation.
- Due to changing focus from distance to near it will create accommodative demand so in case of normal eye slightly against movement we can see. Then we can note that as accommodation can act rapidly with complete and steady.



- In case of dull glow, greater against movement may occur due to excess action and greater with motion can be a sign of sluggish action or lag of accommodation.

Reference:

1. 2020-2021. BCSC Basic and Clinical science Course. American Academy of Ophthalmology. https://www.aao.org/education/bcscsnippetdetail.aspx?id=2db1ca5e-45e0-45e8-9991-8955754ffd8c

2. Themes,U. (2020,November 28).Clinical Refraction.Ento Key. https://entokey.com/clinical-refraction-/

3. Kaur K, Gurnani B. (Updated 2023,June11).Statpearls.Treasure Island, Subjective refraction techniques. http://www.ncbi.nlm.nih.gov/books/NBK580482/

4. Marsden, J. (2014). How to measure distance visual acuity. PubMed Central (PMC). https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4069781/

5. Disha_Eye_Hospital. (2018, March 14). 17Interesting Facts on Eye Chart -Disha Eye care.Disha Eye Care. https://www.google.com/amp/s/www.dishaeye.org/blog/17-interesting-facts-eye-chart/

6. Isdin Oke (2023, July 10). Retinoscopy-Eye Wiki https://eyewiki.org/Retinoscopy#:~:text=Retinoscopy%20is%20an%20exam%20technique,light%20in%20a%20patient's%20pupil.Retinoscopy

7. Mark E Wilkinson, (ODJanuary 2016) Plus Cylinder Subjective Refraction Techniques for Technicians| General Refraction Techniques page 1-7https://webeye.ophth.uiowa.edu/eyeforum/video/Refraction/pdfs/Std-subj-Refract-Plus-Cyl-Tech-s.pdf

8. Duochrome test-Eye wiki (n.d) https://eyewiki.org/Duochrome_Test

9. Eyemantra. (2023, January 23).Eyeglass prescription|OD&OS| RX Information. EyeMantra. https;//eyemantra.in/eyeglasses/eyeglasses-prescription/

Introduction to Refraction
&
Ophthalmic Dispensing

Arup Saha,

D.Pharm, B.Optom, M.Optom

Assistant Professor

Department of Optometry

Swami Vivekananda University

Introduction to Refraction

&

Ophthalmic Dispensing

3.1 Introduction

Clinically assessment of refractive errors and finding its proper corrections termed as clinical refraction.It is a technical way to measure the eye health about its refractive status.Cornea and lens are called as major refractive surface as it is responsible for light refraction to project it properly on the visualsensitive retina to form the image and responsible for visualization. Sometimespathological, mechanical or developmental facts can affect its quality to support the refraction process by affecting its anatomical health like transparency, curvature, refractive index etc.Aim to clinical refraction is to rule out the errors and finding its best correction to improve the vision quality.

Visual acuity can be described as the acuteness `of vision that is the ability of an individual patient how better quality it can be visualized/A is a compulsory assessment and step of clinical refraction conducted to see the refractive ability in distance and near both monocular and binocular mode.Different types of charts are available like Snellen'schart,log MARCharts, tumbling E charts,LEA symbol charts etc. normally used in clinical refraction. Following the quality of visual acuity objective and subjective refraction conducted to do measurement,correction, refinement and prescription for managing refractive errors. Trial box,trial lenses including spherical and cylindrical lenses,Maddox rod,setof prisms,pinhole,Red & Green filters,stenopic slit etc. are the regular instruments for refraction processes.Beside this W4dot test,DuoChrome test,JCC etc. are also important for binocular balancing and corrective power refinement. Here all clinical steps,indications, necessary instruments,factors interfering,evaluation, interpretation,estimation methodology will be focused.

3.2 Subjective & Objective refraction

Total refraction procedure can be classified into subjective and objective part. Subjective means active participation of patient with response when patient response plays a significant role to find the correction. On the other hand, during objective refraction basically depends on calculation interpretation and evaluation with the help of equipment's and machine-like auto-refractometer, retinoscopy etc. Objective refraction is the initial part of refractive error assessment. Static Retinoscopy, Dynamic retinoscopy, autorefractometry etc. are the significant point under objective part.

Subjective refraction depends on patients' response and it is part of refractive error examination with help of trial lenses, trial frame, vision chart, pinhole, Maddox rod, stenopic slit, astigmatic fan and block, Jackson cross cylinder, fogging technique etc. After clearing objective part, we can find estimation about the refractive errors. Then according to the result, we perform monocular subjective corrective correction to find best acceptance using spherical and cylinder lenses. Trial and error method used to find the best sphere and cylinder power correction according to the patient's refractive demand. Duo chrome test is helpful to find over or under correction and JCC, astigmatic fan & block, stenopic slit etc. used find cylinder power with proper axis alignment. After completing subjective correction all procedure both at distance and near, it is needed to perform binocular balancing also with help of Duchrome test with fogging, prism dissociation etc.

3.3 Retinoscopy

Retinoscopy is the objective way of refraction to estimate the refractive errors. Retinoscopy works on Illumination stage, projection stage and reflex stage. Based on illumination technique it can be divided as self-illuminated streak retinoscope and plane mirror or Priestley smith (both concave and plane effect) retinoscope. In case of plane mirror retinoscope additional light source is needed to reflect by the mirror and projected into patient's eye retina. When the light rays reflected off from the retina it is observed by the observer through the peep hole to evaluate the nature of retinal reflex. That retinal reflex observed by the practitioner, its nature (with motion or against motion) depends on the refractive status of the patient's eye. Retinal reflex occurring when light rays projected into patients' eye and illuminated retinal area then the light rays reflected off from the retina specifically from that illuminated area focus on the observer eye to view the image of that illuminated area that depends on patients' refractive status.

In case of static retinoscopy far point located at the infinity but when it located between patients' eye and infinity point, patient become myopic and if the far point located behind the infinity, patient become hypermetropic.

According to the retinoscopy observation when patient focusing at distance target point and accommodation is at rest, if far point is located behind the retinoscope may cause with reflex. When far point is located between the patient's eye and retinoscope may cause against reflex. If far point located at the retinoscope plane then neutral effect may occur.

3.3.1 Dynamic retinoscopy:

Unlike static retinoscopy, accommodation is active because patient is directed to focus t nearby object located at the same line with the peephole. Dynamic retinoscopy recommended for the patient suffering from accommodative excess, ill sustain, spasm or insufficiency cases. This is the objective way to check the accommodative functions. During dynamic retinoscopy patient is directed or encouraged to utilize accommodative ability.

Procedure:

- ➔ To perform dynamic retinoscopy, need to sit patient properly same as static technique as eye level of patient and observer should be same.
- ➔ Dim light illumination preferred to perform retinoscopy because light reflex can be observed properly.
- ➔ Patient is directed to see the near object to stimulate the accommodation. Dim light allowed to see the near object properly.
- ➔ Based on retinoscopy technique it can be classified as Mahendra, MEM, NOTT, BELL retinoscopy etc.
- ➔ During near retinoscopy distance correction should be given to make the far point at infinity.
- ➔ At the beginning patient is directed to see the distance and that time pupillary reflex need to be observed though retinoscopy. In case of normalpatient with movement can be seen.

- ➔ Retinoscopy should perform from the reading distance. Near target should be located at the same line with the peephole.
- ➔ Then gradually patient will focus from distant point to the near object that stimulate accommodation.
- ➔ Due to changing focus from distance to near it will create accommodative demand so in case of normal eye slightly against movement we can see. Then we can note that as accommodation can act rapidly with complete and steady.
- ➔ In case of dull glow, greater against movement may occur due to excess action and greater with motion can be a sign of sluggish action or lag of accommodation.

3.4 Clinical procedures (Subjective refraction)

During subjective refraction patients' response is very significant as it helps to find the patient acceptance so that practitioner can provide the best correction.

As per methodology

- Visual acuity needs to record under monocular condition both for distance &nearby. Aided if patient bearing power spectacle or medical record and unaided for the new patient not carrying medical reports and previous follow up data.
- Need to perform objective method to find the estimation of refractive errors.
- Trial and error method monocular condition to find the acceptance.
- Power refinement and cross checking to confirm about the refractive power. Spherical power refinement then cylinder power with axis and power meridian verification with JCC, stenopic slit, Astigmatic fan and block chart etc.
- Binocular balancing to enhance quality of single vision. Astigmatism mayoccur when curvature irregularity found.
- After distance correction, near add power isprovided according to patient's age, visual status and reading or near work distance.
- Pupillary distance measurement (IPD) to align the eye properly without aberration.
- Beside this optical center marking, segment height, segment top, segment drop, distance reference point etc. are also necessary for proper spectacle alignment.
- Prescription formatting and advice.

3.4.1 Discussion (Subjective Refraction)

Next to the medical history recording,Visual acuity measurement and objective correction estimation need to start the subjective correction to find the best acceptance of power monocularly.

- ➔ Trial frame provided to patient and need to ensure about that patient is comfortable with that to see without any obstruction.
- ➔ With help of blocker need to block the other eye.
- ➔ According to the objective value found earlier need to start correction with sphere lenses. In case of old follow up then power glass prescription also will be helpful.
- ➔ Correction should be initiated with weakest concave lens to correct myopia or convex lens maximum

value for the hypermetropia correction.

- ➔ During lens trial, loose lenses from the trial box used to set into trial frame and need to ask patient about the improvement of vision.
- ➔ After providing the sphere correction nearby to the final correction we can trial +0.25,-0.25,+0.75,-0.75,+0.50,-050 lenses over that.So that patient may give response to the correction.
- ➔ After getting the best sphere if still recognition problem reported about the smallest lines, then cylinder power needs to trial.
- ➔ Patient is asked that cylinder power vision improving or not. If improving with the cylinder lens then we can align the axis according to the objective correction. But if rejected then there is no cylinder power. Need to verify with the pin hole. With pin hole vision if improved visual acuity then need to verify with loose trial lenses again until best correction. Same procedure repeated to another eye by occluding the recent corrected eye.
- ➔ After distance correction provided to both eye then occlusion eliminated to see that binocularly patient is comfortable or not to see the normal vision. We can check the powers by Fogging, Duo-Chrome etc. to verify about the over correction o under correction. JCC can be performed to check the cylinder power both power meridian and axis meridian. Binocular balancing method helps to align the corrective powers binocularly so that patient will have best vision correction.

- ➔ Next to the distance correction for the presbyopia correction near add power provide according to age binocularly from a particular reading or near work distance and need to check that patient can read or identify the smallest print to have normal near vision.

3.5 Power verification:

3.5.1 Fogging technique:

- ➔ Fogging performed to relax the accommodative reflex so that accurate power can be finalized.
- ➔ During the beginning of the procedure need to provide pus lens over the correction according to the NRA value (Negative relative accommodation). In case of sphero-cylinder correction we can provide spherical equivalent power and over that we can do the fogging procedure.
- ➔ After fogging up to 6/24 line we need to reduce fogging. To reduce fogging, we need to place next lower plus lens over the main convex lens that used to Fogg previously then we can remove that previous one.In such a way we can gradually decrease fogging amount to enhance vision clarity.
- ➔ While finding the best acceptance maximum plus lens is preferred. So, if the subjective correction value is +1.00 and during fogging reducing it is reported that clear vision observed at +1.25 then +1.25 is the final power.In same way if the correction is -1.25 and during fogging it is found that patient feeling comfortable while using +0.50 over the previous correction -1.25.So,the final power is -0.75 because maximus plus acceptance preferred when minimum minus is acceptable.

3.5.2 Duo Chrome test:

- Duo means two and Chrome means color.So, during the Duo Chrome test two colored optotype target chart provided to find the acceptance between two colors.
- During the test green and red these two colors preferred.Normally green colorhas the tendency to focus 0.24D in front of the retina and red color has the greater wavelength sofocus 0.20D beyond the retina.
- So, incase of myopic patient have the tendency to see red colour better because of focusing in front of retina soit can project red colour to the fovea (visual sensitive part of retina). On the other hand, hyperopic eye can see the green color better because due to focusing beyond the retina it can drag the green colors upon fovea.
- The aim of the test to make the balance between the powers sothat patient will report both the colors are equally same or equally clear.
- In case of green color is better as reported by patient then we have to add +0.25 and need to ask that both colors are becoming equal clear or not. Similarly,if patient reported red color has better clarity, then we need to provide -0.25 over the eye until patient will report both colored optotype are equally clear.

3.5.3 Pin hole:

- Sometimes pin-hole plays greater role in sphere power refinement.Pin hole has the central aperture and all the peripheral areas are blocked so, that it can reduce the aberrations occurring from the peripheral rays blocking to enhance the central vision.
- If pin hole is provided over the correction and if patient can see the previously unreadable smaller line that means more correction needed to achieve the best refractive power.

3.6 Cylinder power refinement:

- As part of cylinder power refinement both the power meridian and the axis meridian recheck is mandatory.
- Appropriate cylinder lens correction is needed to provide the sharper image quality.Here we will discuss briefly about JCC and astigmatic fan & block technique.

3.6.1 JCC:

- Jackson Cross Cylinder consists of two types of cylinder lens which are equal strength but opposite power.
- Main principle of JCC technique is collapsing Strums Conoid.
- Commonly +/-0.25D and +/-0.50D is used.
- (Axis verification) To find the axis alignment need to adjust the JCC handle with the axis meridian of correcting cylinder lens and it is performed under monocular condition.
- Next to alignment observer do the flipping of JCC and patient is asked that which position is clear. If patient report the vision improvement while flipping then need to rotate the cylinder lens axis towards the red marks for 10 degrees.
- Now again need to align the JCC handle with the new axis and need to verify that patient can see clear in any position or both position is blur. If patient reports clear image while flipping when red mark of JCC is locating opposite position during the previous lens alignment. So, it is

reversal point and again need to rotate lens towards red line for 5 degrees. This procedure continued until patient reports both flipping and placing position of JCC is appearing blur.

- (Power verification) Need to align JCC axis with the cylinder lens axis. Then need to ask patient that is the vision becoming clear while flipping. Due to flipping, + axis and then – axis both will align with the cylinder correction lens axis so power will be decrease or increase by 0.25D(because +/-0.25 JCC lens is using here).If patient reports clear vision while aligned with minus lens then cylinder power will be increased by 0.25.
- Need to continue that until patient reports blur during both flipping sides.

3.6.2 Astigmatic fan & block:

Astigmatic fan used to find the cylinder power refinement axis and power. Test is performed monocularly.

- Chart consists of radiating lines like sun shine. Patient need to seat properly and power correction provided.
- Fogging procedure performed to relax accommodation so the axis ca be verified easily.
- Due to fogging both principle meridian will become myopic but one particular meridian will be closer to the retina. So, it is reported by patient as a clear line.
- If patient reports that all the lines are equally clear then there is no astigmatism.
- If patient reports clearer single line, then need to find the direction. Patient is asked to think the fan chart as clock dial. So that patient can make reply the direction as 1 o clock or 3 o clock in such types of direction.
- If patient denote the fine line as 2 o clock, then it is 130 degrees.
- Need to apply cylinder power axis perpendicular to the 130 degree that is 40 degrees and this will be continued until patient reports all meridian equally clearer.
- If overcorrection applied then only opposite axis may be clearer compare o others. In such cases need to decrease the power to make all meridian clearer.

3.7 Binocular Balancing:

Binocular balancing performed at the last phase of entire refraction procedure. It helps to maintain balance between two eyes about accommodative effects and equalization of vision.

Here we will discuss shortly about alternate occlusion technique, Prism dissociation test, prism dissociation with duo chrome balance test as part of binocular balancing.

3.7.1 Alternate occlusion technique:

- Test initiated by blocking one eye and correction provided to both eyes.
- Rapidly need to alternate the occlusion with a half of second interval so that it will prevent stimulating accommodative actions.
- Fogging applied by +1.00 to both yes so, V/A will become blurred up to 6/12
- Patient is asked during alternate occlusion about which eye can see clearer.
- If patient reports that right eye feels clearer, need to increase fogging value of right eye by adding +0.25 D until

patient reports that both eyes become fogged equally.

- ➔ After that need to reduce the fogging y +0.25 until best vision quality achieved.
- ➔ As per patient response if right eye accepted +0.25 extra fogging to maintain balance between two eyes and the previous acceptance power is -1.75D then finally after balancing it will be -1.50D and other eye will have power same as previous acceptance because during balancing no extra power required there.

3.7.2 Prism dissociation test:

- ➔ During prism dissociation test 3D prism needed to perform the test and fogging also need to be applied.
- ➔ Fogging technique applied over the correction so that V/A will be reduced to 6/12.
- ➔ Both eyes need to occluded with the blocker. Then 3 Prism Diopter applied over right eye as base up and same applied over another eye as base down.
- ➔ Then occlusion is removed from to eyes and asked to see the target about 6/12 or best vision as per quality. Patient directed to report that both eyes are equal blurring or not. If not blurring equally then +0.25 will be applied over the better eye having comparatively clear vision to make equal blurring between two eyes.
- ➔ If patient replied about equal blurring, then gradually fogging and Prism will be removed.
- ➔ If patients left eye needed +.25D extra to maintain balance the vision and if the previous corrective subjective power is -.00/1.00x180 degree then the final power will be -1.75/-1.00 x 180 degree.

3.7.3 Prism dissociation with Duo chrome:

- ➔ To perform the test 3Prism diopter prism, loose convex lenses, Duo chrome test chart trial frame all are needed.
- ➔ Test is conducted in dim light illumination so that patient can see the target optotype letters clearly.
- ➔ Similarly, as Prism dissociation test need to provide base up prism to the right eye and base down prism to the left eye.
- ➔ After that patient is directed to look at the duo chrome test chart and simultaneously +0.25 lenses provided to both eye until patient report both the colour Red & Green can be seen equally clear.
- ➔ Now patient is directed to see the lower image at the right eye and gradually fogging lens power reduced until patient report the both colours on duo chrome test chart is equally clear.
- ➔ Then patient is directed to see the higher image at the left eye and same process applied to reduce fogging until black letters on both red & green colour background can be reported equally clear.
- ➔ Next to this step, prisms are removed from both eyes and again fogged with +1.00 lens then gradually reduced 0.25 steps until achieving best maximum plus acceptance and having best visual acuity.

3.8 Components of power prescription:

After achieving best power correction by subjective and objective method, sphere & cylindrical refinement, completing binocular balancing steps, distance &

near vision to confirm the final acceptance, it is needed to prescribe the power components properly.

- Power prescription consists of sphere power, cylinder power and axis. Spherical power means the specific spectacle lens power that located at all the meridians. On the other hand, cylinder power is located in a particular axis termed as power meridian and perpendicular to the power meridian is termed as axis meridian that is mentioned in the prescription. Normally cylinder power is used to correct the astigmatism means the irregular refractive surface curvature. Spherical power is used to correct the refractive errors like myopia, hypermetropia, and presbyopia types of refractive errors.
- **Example:**

  OD: +1.25/-0.50 x 180 6/6.Near add: +1.25 Ds N6.

  In this prescription format we can find +1.25 Ds power as a spherical power.

  -0.50D cylinder power and the axis meridian are written as 180 degrees when the power meridian is at 90 degree.

  To correct the presbyopia near addition power provided +1.25 Ds to correct near refractive error due to physiological loss of accommodation.

  So, the Near power will be

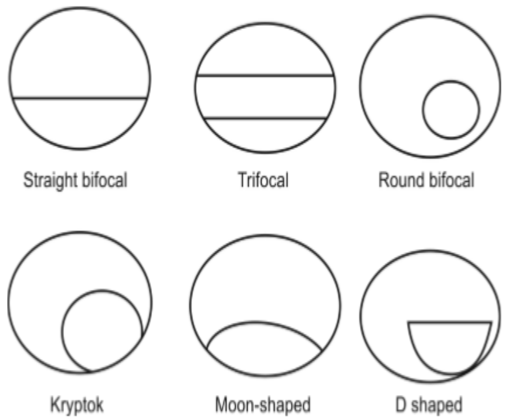
  +2.50/-0.50 x 150 (N6). Near power – Distance power = near addition power.

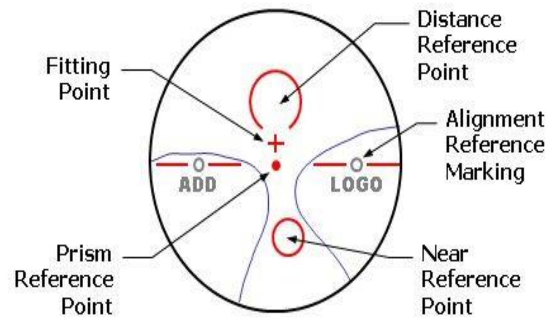
3.9 Pupillary Distance (PD):

- Optical Centre of lens need to be coincided with the Pupillary Centre of that eye to minimize the aberration.It is measured by PD ruler or Pupilometer.
- PD means the Pupillary distance can be measured by straight line distance from the nasal bridge to the pupillary center points on each eye.It is also termed as monocular PD.
- Distance between the pupillary centers between two eye termed as IPD that is inter pupillary distance measured as mm.Normal IPD range 60-65mm.

3.10 Spectacle lens types:

- Spectacle lens is provided to correct refractive errors to achieve best vision by fitting into ophthalmic frame that is suitable to patients face.
- Based on the vision zone spectacle lens can be divided into single vision, bi focal, tri focal, multifocal and progressive lenses.
- Normally pediatric patient specially school going age,young adults, adult age below 40 years old prefer that single vision lenses.It is also cheaper compare to other types.
- Single focusing lens has only one vision Zone so that patient can focus at distance, intermediate and near simultaneously.
- **Bifocal** lens consists of two vision zone specialized to treat presbyopia and distance correction both at a time.
- Upper vision zone designed for distance vision and lower part is specialized for the near power. During study o near work eye deviated nasally slightly due to accommodative convergence with down gaze.
- As per design of Near vision zone design corridor it can be classified as straight bifocal, round bifocal, Kryptok bifocal, Moon shaped bifocal, D bifocal etc.





Major Reference Points of a Progressive Lens

- In such type of lenses 3 types of vision zone designed. Upper most area specialized for distance vision, lower most part is specialized for lower vision. Middle zone is specialized for intermediate vision zone. It reduced the image jumping tendency and enhanced the vision quality.

- Multifocal lenses designed as multifocal vision zone is able to see the target object form variable distance. Progressive lens is the updated modified version of multifocal design. About the progressive lens there is no vision zone marking so that cosmetic appearance is good but both side have the aberration zone. Patient has to look through the vision corridor located between the aberration. Based on vision corridor design it is also further classified into hard design and soft design. It is popular for the computer users because at a time patient is able to see computer monitor, keyboard, mouse located at variable distance.

3.11 Tinted lens:

- **Tinted lens used to reduce glare problem, enhance focus depth, reduce fatigue ,photophobia block UV rays and protect our eyes. In some cases also enhance clarity of vision during dim light helpful for night driving.**
- **Grey tints** ->(used as anti fatigue,reduce glare)

  Yellow tints ->(Used in low light condition and increase visibility)

  Green tints ->(minimize light sensitivity and reduce eye stress)

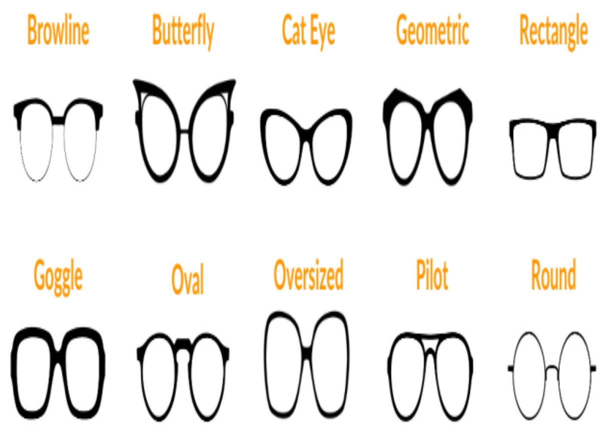
  Brown tints ->(Enhance sharpness and depth of vision during day time, restrict harmful light rays and reduce stress)

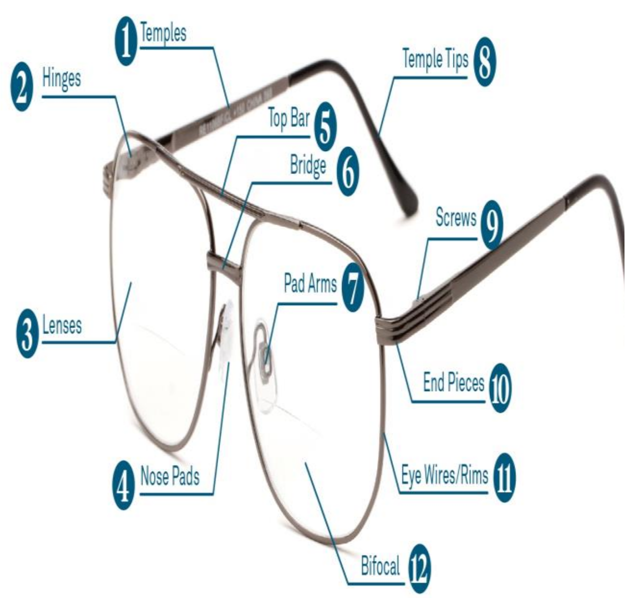
Blue tints->(cosmetic purpose use,improve colour depth, enhance perception**)**

3.12 Polarized sunglass:

Polarization makes a huge difference when it comes to sunglasses. When sunlight or light coming from any external source comes down and hits an object specially an object with a flat horizontal surface such as the road, car windshield, lake water surfaces then reflect off from it doesn't scatter in all direction but it going to bounce off in a flat horizontal way then we can call it as polarized light. Polarized filter selectively neutralizes horizontal lights and eliminate it so that we need not to see the whole reflection from that type of surfaces. For this reason, it can enhance focus depth, decrease eye stress and irritation, enhance clarity and very useful for the light sensitive patients reducing glare problem.

3.13 Spectacle frame parts & types:

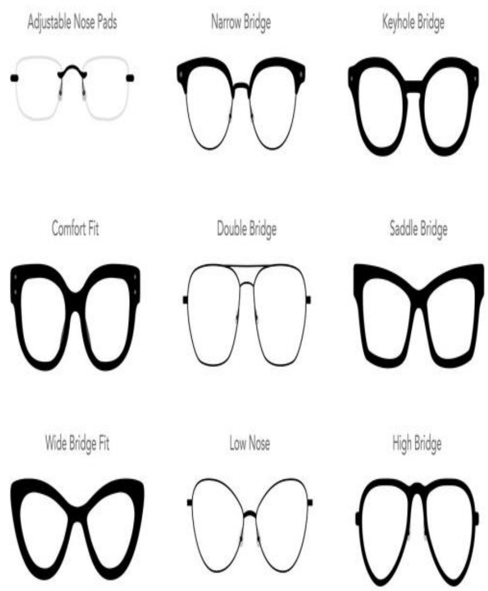




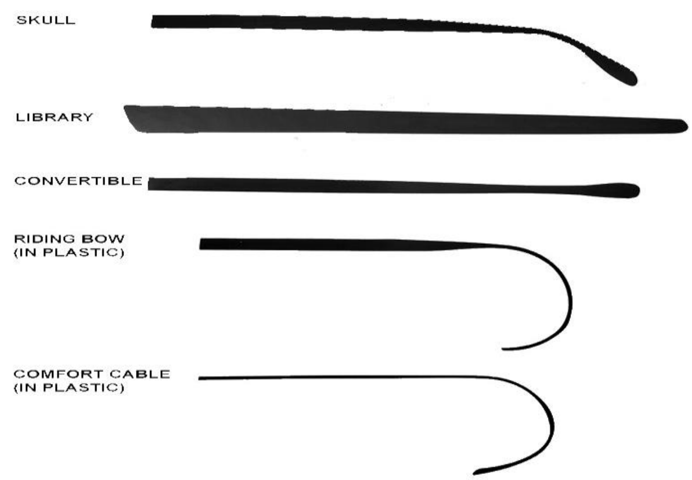
➔ Based on rim design and structure we can divide spectacle frame structure as
  Full rim
  Semi rimless or half frame
  Rimless.

➔ Frame materials
  Acetate,
  Plastic

Metal
Titanium e



➔ Based on **nose bridge style** it can be classified as
Narrow bridge
Comfort fit
Wide bridge fit
High bridge
Low nose
Saddle



Based on temple design it can be classified as

-> Skull

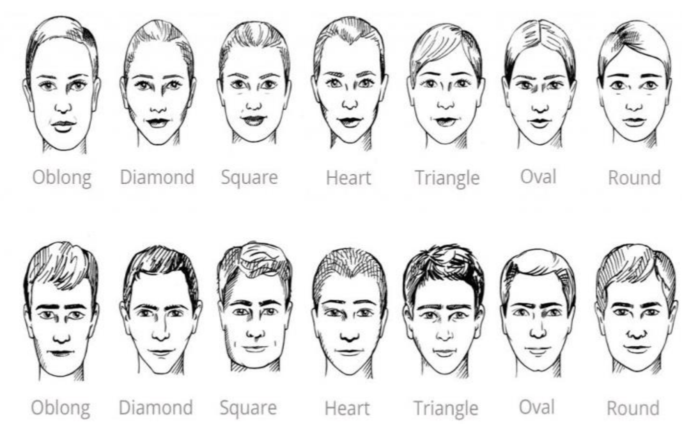
-> Library

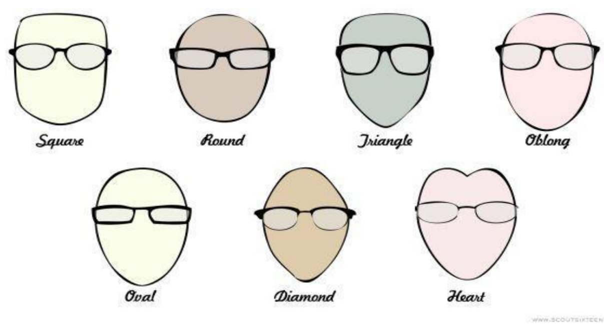
-> Convertible

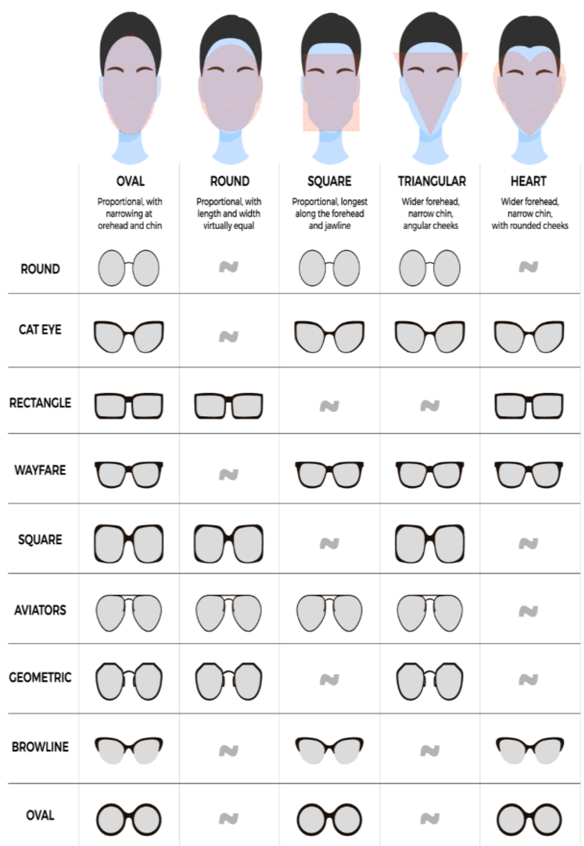
-> Riding Bow

-> Comfort cable

3.14 Different types of faces and frame fitting







3.15 Spectacle care advice to patient:

Spectacle care and maintenance is needful for proper use of that.

->Patient is advised to keep the spectacle frame always inside the box after its use

-> If possible, need to wash the lenses at least once a day.

->Microfiber is the best option to clean the lens.

-> Use of any other rough cloths like tower, shirt, saree can be harmful for the lens as nit may cause for unexpected scratches and also affect the coatings.

-> Need to avoid unnecessary touch to the lens.

-> Need to keep spectacle before sleeping.

-> Need to avoid very warm places to keep the spectacle.

-> For the older patient better use of a eye glass string.

-> Need to avoid ammonia-based household cleaner.

->Always need to wear spectacle holding both temples.

Reference:

1) American Association for pediatric Ophthalmology and strabismus. August 1,2023. Retinoscopy. https://aapos.org/glossary/retinoscopy

2) 2020-2021. BCSC Basic and Clinical science Course. American Academy of Ophthalmology. https://www.aao.org/education/bcscsnippetdetail.aspx?id=2db1ca5e-45e0-45e8-9991-8955754ffd8c

3) Hollis J, Allen PM, Heywood J. Learning retinoscopy: A journey through problem space. Ophthalmic and Physiological Optics 2022: 940-947

4) Kaur K, Gurnani B. (Updated 2023, June11). Statpearls.Treasure Island, Subjective refraction techniques. http://www.ncbi.nlm.nih.gov/books/NBK580482/

5) Isdin Oke (2023, July 10). Retinoscopy-Eye Wiki https://eyewiki.org/Retinoscopy#:~:text=Retinoscopy%20is%20an%20exam%20technique,light%20in%20a%20patient's%20pupil.Retinoscopy

6) Elliott DB. Clinical procedures in primary eye care E-Book. Elsevier Health Sciences;2020.

7) Corboy JM. The Retinoscopy Book: an introductory manual for eye care professionals. Slack incorporated;2003

8) Themes,U. (2020,November 28).Clinical Refraction.Ento Key. https://entokey.com/clinical-refraction-/

9) Disha Eye Hospital (2018, March14).17 interesting Facts on Eye Chart-Disha Eye Care.

https://www.google.com/amp/s/www.dishaeye.org/blog/17-interesting-facts-eye-chart/

10) Retinoscopy-Eye Wiki (2023, July 10) https://eyewiki.org/Retinoscopy#:~:text=Retinoscopy%20is%20an%20exam%20technique,light%20in%20a%20patient's%20pupil.Retinoscopy

11) Mark E Wilkinson, (ODJanuary 2016) Plus Cylinder Subjective Refraction Techniques for Technicians| General Refraction Techniques page 1-7https://webeye.ophth.uiowa.edu/eyeforum/video/Refraction/pdfs/Std-subj-Refract-Plus-Cyl-Tech-s.pdf

12) Varghese, A. (2021, September7). Tinted lens guide-Spectacular by lenskart. https://spectacular-blog.lenskart.com/

13)Idnay S. (2023, March 21). What are the different types of eyeglass frames. Marvel Optics. https://marveloptics.com/blog/eye-health/what-are-the-different-types-of-eyeglass-frames/

14) Yashasvi. (2023, June 1) Different types of face shapes and its significance. Styles at Life. https://stylesatlife.com/articles/types-of-face-shapes-how-to-determine-it/

15) Spectacles and how to choose them: an elementary monograph-Digital collections-National Library of medicine. (n.d.)http://esource.nlm.nih.gov/68050750R

Low Vision and Visual Aids

Dr. Prabirendra NS,
D.O.S (PG), DCLP
Assistant Professor
Department of Optometry
Swami Vivekananda University

Low Vision and Visual Aids

INTRODUCTION

Low vision refers to a condition when an individual has inadequate vision that hampers their ability to accomplish everyday tasks, even when using the most effective corrective glasses, contact lenses, or undergoing medical interventions such as surgery. Possible causes of vision loss include:

• Reduced visual clarity.

• Impairment of the visual field

• Reduced ability to distinguish between different levels of contrast

• Deprivation of ability to perceive colour

Low vision, as defined by the World Health Organisation (WHO), refers to individuals who have visual impairments that persist even after receiving treatment such as surgery or refractive correction. These individuals have a visual acuity of less than 6/18 to light perception (PL) or a visual field of less than 10° from the point of fixation (i.e., 20° across). However, they are still able to use their vision, or have the potential to use it, for planning and/or executing tasks.

EFFECT OF LOW VISION ON VISUAL PERCEPTION

• Central vision loss refers to the impaired capacity to view objects or people's faces directly in the line of sight. This can occur due to conditions such as macular degeneration, albinism, stargardt disease, toxoplasmosis, histoplasmosis, and others.

• Peripheral vision loss - Individuals with peripheral vision loss have challenges in navigating independently, which vary depending on the extent of their visual loss. The initial stage difficulty is very insignificant, but in the advanced stage (known as tunnel vision), individuals may be unable to see steps. This condition can be attributed to several factors such as Retinitis pigmentosa, Hemianopia, Glaucoma, and Juvenile diabetes.

• Generalized Visual Impairment - Generalised visual impairment refers to a condition where an individual has a decrease in the capacity to see clear and crisp details, often caused by changes in the refractive media of the eyes. Experience symptoms such as complete loss of vision, diplopia, impaired nocturnal vision, reduced contrast sensitivity, and difficulties with glare caused by congenital injury, age-related cataracts, corneal opacity, myopia, and amblyopia, among other conditions.

Night Blindness, also known as nyctalopia, is a condition characterised by the inability to see in low light conditions such as at night, in moonlight, or in dimly lit areas. This condition can be caused by several factors including Retinitis pigmentosa, diabetes, retinopathy, and glaucoma.

Patients with conditions such as retinitis pigmentosa or cataracts experience reduced brightness difference and impaired contrast sensitivity, leading to difficulties with light and glare.

PRIMARY FACTOR CONTRIBUTING TO VISUAL IMPAIRMENT

Macular Degeneration, Glaucoma, Diabetic Retinopathy, Retinitis Pigmentosa, Cataract, and other retinal dystrophies are the primary factors leading to impaired vision in western nations. These ocular conditions impact visual perception in various manners. The severity of each condition is correlated with the degree of impairment in visual acuity, visual field, and contrast sensitivity, and this will differ among individuals.

Age-related macular degeneration

Macular Degeneration (MD) is the primary cause of blindness in Australia. The condition leads to gradual deterioration of the macula, the core region of the retina, which ultimately leads to loss of central vision. Age-related Macular Degeneration (AMD) is the most prevalent type of Macular Degeneration. Macular degeneration (MD) impacts around 14% of Australians aged 50 and beyond, and its prevalence rises with advancing age. Macular degeneration (MD) may be classified into two types: Dry MD and Wet MD. Dry MD, which is the predominant form of the illness, leads to a progressive decline in central vision. Moist

Macular degeneration is marked by an abrupt decline in visual acuity and is caused by the proliferation of anomalous blood vessels inside the retina.

Glaucoma

Glaucoma refers to a collection of ocular conditions characterised by gradual deterioration of the optic nerve located in the posterior of the eye. The injury typically arises from an obstruction in the flow of aqueous fluid in the eye or its drainage, resulting in elevated intraocular pressure. Alternatively, it may arise from inadequate blood circulation to the nerve fibres, a deficiency in the optic nerve's strength, or a deterioration in the overall health of the nerve fibres. Glaucoma progressively impairs an individual's eyesight, first with the peripheral vision. Individuals may possess glaucoma without any awareness of its presence, as the predominant kind of glaucoma typically lacks discomfort or first indicators. Timely diagnosis is crucial as any loss of vision is permanent.

Diabetic retinopathy

Diabetic retinopathy, a disorder characterised by alterations in the minuscule blood vessels that provide nourishment to the retina, is the primary cause of visual impairment in individuals with diabetes. During the initial phases of diabetic retinopathy, there is a weakening of small blood vessels, causing them to leak fluid or small quantities of blood. This leakage leads to distortion of the retina. During the later stage, the blood arteries in the retina become obstructed or entirely closed, leading to the death of specific parts of the retina.

Cataracts

A cataract is the condition in which the normally clear lens of the eye becomes cloudy. As a cataract develops, the lens becomes cloudy, similar to frosted glass, which results in the inappropriate focusing of light onto the retina, leading to a blurry image. Cataract removal can be accomplished by cataract surgery, which depends on the advice of an ophthalmologist and the individual's unique requirements.

Retinitis Pigmentosa

Retinitis pigmentosa is a hereditary disease that leads to the gradual deterioration of the retina. Typically, it is characterised by first symptoms of nyctalopia, often known as night blindness, which is subsequently accompanied by a progressive decline in peripheral vision. It has the capacity to finally lead to total blindness. Retinitis pigmentosa is a kind of retinal degeneration that is the leading cause of blindness among young persons in Australia. Among individuals in their twenties and thirties, this condition is the second most prevalent cause of blindness, surpassed only by diabetes. The majority of cases of retinitis pigmentosa are hereditary. However, in some instances, a genetic mutation may occur, leading to the manifestation of the disease even without any hereditary predisposition.

Achromatopsia

Absence of colour perception in its entirety. Abnormal cone shape. Visual acuity reduced to 6/36. Colour blindness. Nystagmus is a possibility. Severe sensitivity to light. The impact on visual field and near eyesight is minimal.

Albinism

Hypopigmentation refers to the whole or partial absence of pigments in the eye, skin, or hair, which is characterised by a light-colored iris and eyebrow. Retinal abnormality, undeveloped macula, and improper eye-brain connection. Visual acuity has decreased to a range of 6/36 to 6/18. Visual acuity at close range is hardly impacted. Experiencing severe sensitivity to light. Nystagmus is a condition characterised by involuntary eye movements. Visual acuity will be poor in those with high refractive errors and significant astigmatism.

Aniridia

Iridal hypoplasia refers to the incomplete development of the iris, resulting in partial or near-total absence of the iris. This is a congenital anomaly that often affects both eyes. The overall look resembles that of an exceptionally huge pupil. Severe sensitivity to light. Reduced visual clarity. Nystagmus is a condition characterised by involuntary and repetitive eye movements. Tunnel vision, characterised by the narrowing of the visual field, may be observed.

OPTICS OF LOW VISION

The underlying concept of all low vision optical devices is to magnify the size or proportion of visual things. The magnification of most modern aids is calculated using the formula $M = D/4$, where M indicates magnification and D represents dioptric power. This estimate relies on the presumption that the patient's unaided eye has the ability to adjust its focus sufficiently to keep the object at a distance of 25 cm. Furthermore, it assumes that while using magnification, the reading material is placed accurately at the primary focal plane of the lens. However, in actuality, none of these assumptions are valid in practical scenarios. Hence, the degree of magnification may be modified by changing the distance between the object and the lens. This category consists of spectacles and portable magnification equipment.

The formula may be represented as $M = D + A/2.5$, where A is the amplitude of accommodation. The formula for magnification, M, is given by $M = D + A - h AD/2.5$, where D is the distance between the eye and the lens.

Where h is the distance of the eye lens, measured in metres.

This indicates that:

• To enhance magnification, it is advisable to position the eye in close proximity to the lens, hence minimising h.

• The reading material should be positioned as near to the patient's eye as possible.

according to the limitations of his lodging.

• When the optical lens distance is predetermined, the object is positioned at a defined distance. The highest magnification occurs when the eye is positioned as close as possible to the lens. This is utilised in stand magnifiers. Therefore, it is accurate to indicate the magnifying power of the gadget in Diopters rather than using the X notation. Due to variations in manufacturer calculations, the X notation may not align precisely. Nevertheless, this statement remains mostly accurate for all practical intents and calculations.

To get the "Dioptric Power" of the lens, just multiply the magnification by a factor of 4. To determine the distance in inches from the eye, divide the Dioptric power by 40. As an illustration, a lens with a magnification factor of 4X corresponds to a power of 16 Diopters. When divided by 40, we have a working distance of 2.5 inches. A lens with a magnification of 5X is equivalent to 20 Diopters and has a reading distance of 2 inches.

Factors to Consider Regarding Magnification in Devices for Individuals with Low Vision

Low vision devices utilise one or a combination of the following four types of magnifications:

1. Proportional magnitude

2. Proximity

3. Angular is a framework for building web applications.

4. Pertaining to the interaction of electricity and light.

Proportional Magnitude

Magnification refers to the process of increasing the size of an item without the use of an optical system. It involves making the thing larger to match the visual acuity levels of the patient, such as using a large print textbook.

Relative distance magnification refers to the amplification of the apparent distance between two objects.

Magnification is accomplished by bringing the item closer to the observer, causing a bigger picture to be formed on the retina. The degree of magnification is inversely related to the distance difference from the initial position. Optical systems, such as conventional magnifiers, are typically used to create this effect.

Angular magnification refers to the ratio of the apparent size of an object as seen via an optical instrument, such as a microscope or telescope, to its actual size.

Magnification refers to the perceived change in size of an item when viewed via a device, relative to its actual size when viewed without the instrument. This form of magnification is typically achieved using telescopic devices (Fig. 3.3).

Electro-optical magnification refers to the process of increasing the size or scale of an image using electronic and optical technologies.

This is accomplished via the use of electronic devices that either magnify items directly by scanning or generate them using computers. There are four methods for achieving the appearance of bigger objects.

1. Approach the object: Bringing the object closer by a factor of 2 will result in a 2X increase in size. When an object is positioned near the eye, it necessitates a significant amount of accommodation. While children are capable of accomplishing this, adults find it more challenging. Children can enlarge text and small objects by holding them in close proximity to their eyes, thereby eliminating the need for magnifiers to view nearby objects in some cases.

2. Increase the size of the item

3. Utilise an optical instrument

4. Utilisation of electronic and projection methods to increase the size of an image.

Increased magnification results in (Fig. 3.4):

1. Reduced in size

2. Reduced proximity between objects

3. Requires additional lighting

4. Increased challenge in utilisation

5. Decreased focal plane.

• Higher magnification results in a reduced field of view. Although a 6X magnifying offers more magnification compared to a 3X magnifier, it also has several disadvantages. The magnifier lens undergoes a reduction in size, resulting in a decrease in both the working distance and depth of focus. Similarly, a telescope with a magnification of 3X has a field of view measuring 12.5 degrees, but a telescope with a magnification of 4X narrows the field of vision to around 10 degrees. Consequently, the selection of the device is contingent upon these considerations, rather than only on the desired outcome.

ADD PREDICTION

There are two methods for determining the Dioptric add for individuals with impaired vision:

1. The inverse of Snellen's visual acuity may be determined by calculating the reciprocal of the Snellen fraction. For example, if a patient has a visual acuity of 2M print, the Snellen equivalent is 6/30 or 20/100. The inverse of the fraction 20/100 is 100/20, which is equivalent to 5 Diopters. Reciprocals may be calculated for any examination using either metric or Snellen's notation.

2. The inverse of the distance: For instance, while testing near acuity at a distance of 40 cm, if a 1M print is viewable at 2M, the patient would need to hold it at a distance of 20 cm. This is because the retinal size of the picture is magnified. The needed addition is calculated by dividing 100 by 20 (the distance), resulting in 5 Diopters. Furthermore, if the visual acuity was 4 metres at a distance of 40 centimetres in order to read 1 metre. The patient is now required to bring the object within a distance of 10 centimetres in order to read it. The needed sum is obtained by dividing 100 by 10, resulting in 10 Diopters. The projected number of Diopters of spectacle glasses needed by an individual with reduced visual acuity to read a specific print size is calculated based on their corrected visual acuity. In order to estimate the addition, it is necessary to first know the corrected visual acuity and the desired print size. The magnification power may be determined by calculating the Logarithm of the Minimum Angle of Resolution (Log MAR) visual acuity. Assume that the highest level of visual acuity after correction is 6/60 or 0.10. The desired level of visual acuity is 6/12, which is equivalent to 0.The needed magnification is equal to the denominator of the required vision, which is calculated as 60/12 or 0.10/0.5, resulting in a magnification of 5X. Therefore, it is recommended to attempt the use of 5X magnifiers for this patient.

EVALUATION OF VISUAL IMPAIRMENT

In order to assist individuals with limited vision, it is imperative to conduct a comprehensive evaluation of their visual capabilities.

The evaluation of a patient with low vision aims to determine the extent of their available vision and how they utilise it in their daily activities. A comprehensive understanding of their visual abilities and needs enables professionals to provide appropriate recommendations and make informed decisions regarding the prescription of optical and non-optical aids.

ASSESSING THE POTENTIAL BENEFICIARIES

During the assessment, the low vision specialist should collect a thorough medical history and inquire about the individual's functioning challenges. Furthermore, it is crucial to examine any physical constraints that can impede the use of particular equipment. Afterwards, a sequence of examinations should be conducted to evaluate the patient's visual capabilities, which encompass visual acuity, visual fields (both central and peripheral), contrast sensitivity, and colour vision. The data acquired from these tests will yield useful insights into the potential benefits of gadgets and, if applicable, the specific sorts of technology that should be recommended. The examination for individuals with low vision is carried out in a collaborative manner by an ophthalmologist and an optometrist. Each specialist concentrates on comprehending the patient's specific visual impairments and evaluating their visual needs.

Evaluation of Requirements for Patient with Visual Impairment

Low vision patients may not be able to perform all tasks as a typical person would. However, by identifying the appropriate mix of visual and non-visual equipment, it is possible to improve their quality of life and provide them with a certain level of independence.

The predominant requirements of these patients include:

• Engaging in the act of reading or writing

• Financial management for housekeeping

• Authentication

• Visual impairments or difficulties in viewing television

• Recreational pursuits

• Variations in luminosity

• Travelling throughout the night

• Perceiving the distance or depth of objects

• Absence of glare

• Identifying and distinguishing between different faces and items

• Navigating through unexpected territories and environments.

The wishes of poor vision patients may generally be effectively addressed. However, these wants may or may not be explicitly expressed by certain patients, thus it is necessary to ask a series of questions in order to comprehend their demands.

Requirements and anticipated outcomes for long-range visual acuity

A low vision assessment, often the initial stage in vision rehabilitation, aims to precisely evaluate the functionality of one's eyesight in real-life situations and daily activities. Visual acuity extends beyond the ability to read an eye chart and include the capacity to perceive people, street signs, television screens, blackboards in school, and other visual cues that assist individuals in navigating their daily lives. Distance vision is a fundamental requirement and a common expectation for all patients. It is necessary to comprehend one's potential daily tasks and how remote equipment should be recommended in order to be employed. Visual acuity criteria for close-up vision The patient will need to be queried with targeted inquiries on their vision. The objective is to ascertain individuals' ability to manage tasks that are in close proximity (8,9). In order to evaluate this, it will be necessary to ask certain questions. These factors will also vary based on the patient's level of literacy. It is crucial to assess his reading skills before commencing the study of history. Frequently, the patients recommended for low vision prescription are individuals who are unable to read or write and have no interest in doing so. Their requirements differ significantly from those of the literate individuals. Additional variables that might influence this decision include the rate at which one reads, the level of exhaustion (fatigue) experienced from reading, the accessibility of eyeglasses and assistive devices for individuals with impaired vision, as well as the availability of printed or Braille materials. Distance visual acuity should not be employed as the only criterion for determining the optimal reading equipment. The near vision exam requires only a brief period of focused attention. Certain jobs may need prolonged focus on items in close proximity. Tiredness and exhaustion can have an impact on eyesight.

Dyslexia

Reading is highly coveted by both students and working individuals. Many of them rely on others or family members to read books to them. The majority of the elderly population in rural areas of our country have either not had access to education or have limited reading skills. Conversely, many literate elderly individuals struggle with reading as their main challenge. It is common to find age-related macular degeneration (ARMD) in this age group, which leads to a state of being "disilliterate." These individuals have a strong desire to spend their time reading and improving their reading skills, and this is achievable for many through the use of optical aids or speech output devices.

Disability in Writing

The majority of individuals are able to maintain their writing skills, but they are unable to read their own handwritten documents, resulting in a loss of motivation to write. Patients, particularly students, may indicate that they can write, but their speed may be slow or they may struggle to write in straight lines. Some individuals may also report experiencing fatigue due to leaning too closely while writing.

Everyday Tasks

To optimise the utilisation of low vision equipment, it is advisable to inquire about the individual's routine activities. Here are many illustrative instances:

Activities of daily living encompass personal care, such as reading mail, writing checks, telling time, recognising money, making meals, and identifying and measuring drugs.

Journeying

Recognising addresses and street signs, securely navigating street crossings, and utilising public transit.

Recreation

The activities include reading books, watching TV, playing cards, solving crossword puzzles, crocheting, and utilising a computer.

Lighting Requirements

To determine appropriate recommendations for illumination, it is necessary to inquire patients about their individual requirements.

Do you experience visual challenges in various lighting environments?

Lighting encompasses both natural and artificial sources of illumination. The quantity and orientation of light play a crucial role in optimising visual performance. While individual lighting preferences may vary, generally speaking, enough lighting is most beneficial. Some individuals may choose incandescent bulbs, while others may prefer fluorescent tube lighting.

Does the individual perform more effectively in well-lit conditions than in areas with reduced sunlight?

Does the presence of light from a door or window enhance a person's productivity indoors?

Is there any disparity in the manner in which an individual can navigate in darkness as opposed to in illuminated conditions?

Issues with excessive brightness and reflection

Does the individual experience sensitivity to glare, whether it be in outdoor or indoor settings? Do they have challenges in visual perception in varying lighting conditions? Do they exhibit improved vision on sunny or overcast days? Does the person attempt to shield their eyes from the sun using a hat, hand, or by turning away?

Highlight the differences

How does he articulate his visual impairment in perceiving contrast (6,7), such as differentiating a light grey clothing against a white bedspread, drinking milk from a white cup, or reading print that is not sufficiently black, as seen in bank pass books?

DEFECT IN THE FIELD

Does he experience any areas of visual blurring or distortion? If yes, where are these areas located? Does his vision improve when he looks slightly away from the object? Can he perceive items on both sides? These inquiries can help assess the presence of any visual field abnormalities.

Locomotion and Direction

Do you travel without assistance? Do you encounter any difficulties when moving independently indoors or outdoors? The purpose is to assess your visual ability to navigate and avoid collisions. Please provide information about your mobility status both indoors and outdoors. Additionally, please describe how well you can perceive objects when looking directly at them, to the side, above, and below. Are you limited to a small area or can you freely move throughout the entire village or town?

Colour

Accurate utilisation and comprehension of colour is crucial in certain circumstances. The selection and coordination of colours hold significance in many household activities.

Work-related requirements

The use of vision for specific purposes is essential in performing daily tasks at the workplace. Allocating sufficient time to each patient and inquiring about their individual needs is crucial. The more time spent on evaluating their requirements and comprehending their issues in low vision work, the higher the likelihood of achieving success. Dealing with the remaining tasks will then become much easier.

ASSESSMENT AND EVALUATION OF AIDS FOR THOSE WITH LOW VISION:

Document in the Sequential Sequence

1. Collecting personal information will involve obtaining details such as the individual's name, age, residence, family members, family income, current occupation, and current academic achievements.

2. Details on the ocular illness, including its aetiology, age of onset, and familial background.

3. The complaints include issues with distant vision, close vision impairments, specific lighting requirements, problems with glare, and difficulties with movement. These are all part of the functional vision checklist.

4. Assessing visual acuity using Snellen's, Log MAR charts, or any other designated chart for near visual acuity.

5. Prior refractive error or prescription strength of glasses.

6. Evaluate the refraction and acceptance of the binocular vision and compare it with the performance of the prior glasses.

7. Indicate the functioning eye.

8. Assessment of contrast sensitivity.

9. Utilisation of Goldman or Amsler charts for visual field assessment.

10. Has any prior assessment been conducted about low vision devices? If so, please provide details on the tests conducted, the outcomes, the specific low vision device that was recommended, and an analysis of the reasons behind the device's success or failure in the past.

11. Visual acuity in the presence of glare.

12. Commence the experimentation with optical instruments. Document the enhancements seen for both close-range and long-range applications, and provide comments about their success or failure.

13. Provide recommendations for non-optical assistance based on individual requirements.

14. Concluding prescription.

15. Determine if the vision has been achieved. If not, recommend rehabilitation assistance.

16. Subsequent appointment. Continuously monitor and record his additional requirements, as well as his levels of contentment and discontentment.

Categories of visual aids for those with low vision

• Optical devices designed to assist those with visual impairments

• Non-optical aids (devices)

Optical aids, such as a magnifier, can be used to enhance visual clarity.

Magnifiers are specifically designed to assist individuals with low vision in performing tasks up close while wearing their current reading glasses. They have been utilised as a means of enhancing vision for many years. The fundamental principle behind the use of magnifiers is to enlarge the image, covering a larger portion of the retina. This increased coverage allows the brain to interpret the image more easily compared to an unenlarged image. For some patients, a magnifier may be the primary solution to address all of their reported difficulties. Alternatively, it can serve as an excellent secondary aid. For instance, a patient may use a spectacle microscope for reading but rely on a handheld magnifier for checking prices while shopping.

FUNDAMENTAL PRINCIPLES OF A MAGNIFIER

1. As the power of the lens increases, the diameter decreases.

2. The lens must be positioned closer to the paper as its strength increases.

3. As the magnification increases, the seen area decreases.

A stronger lens limits the transmission of light, necessitating a greater amount of light.

5. The orientation of a magnifier can have a significant impact.

6. The proximity of the eye to the magnifier directly correlates with the breadth of the field of view.

High-powered lenses exhibit significant distortion.

Classification of magnifiers

There are several categories of magnifiers, including hand-held, stand, lighted, and pocket magnifiers. Within each category, these magnifiers can have a magnification power ranging from 2× to 10×. Lower powered magnifiers are bigger in size, while more powered ones have narrower lenses.

PORTABLE MAGNIFYING GLASS

Hand-held magnifiers are the most commonly used visual aids. To view an object, it should be held at the focal distance of the magnifying lens. For instance, if a 5x magnification lens with a power of +20.00 D is used, the object should be held at a distance of 5 centimetres (100/20 centimetres = 5 centimetres) from the magnifier. At this distance, the light rays exit the magnifier with zero vergence. This means that the magnifier can be held at any distance from the eye without affecting the le

Characteristics

1. Hand-held magnifiers are more suited for brief tasks, but for extended periods of reading, the patient may struggle to maintain the proper focal length.

2. The need to enlarge the field of view while using a magnifier closer to the eye renders them monocular, unless a very big lens is used.

Handheld magnifiers come in several forms and sizes, which vary based on their power and intended use.

Magnifying glass on a stand

The stand magnifier is a popular choice among patients due to its user-friendly nature. It automatically positions the magnifier at the correct distance from the reading material. The stand magnifier can come with or without illumination, and it can also be focusable or non-focusable. A non-focusable stand magnifier consists of a convex lens mounted rigidly, which is intentionally placed closer to the page than its focal distance. This reduces peripheral aberrations. As a result, the rays that come out of the stand magnifier are no longer parallel but divergent. This requires some effort to adjust the focus or the use of a moderate reading addition to bring the image into focus.

This virtual picture is designed to be observed from a typical distance with an addition of +2.50 D. However, in reality, patients typically prefer a higher addition in order to bring the image closer and expand their field of view.

The benefits of a fixed focus stand magnifier are as follows:

1. Consistent emphasis achieved by inflexible lens attachment.

2. Reading distance is within the standard range.

3. Beneficial for particular, temporary, and unique jobs that need attention to detail.

4. Beneficial for youngsters.

5. Can be utilised with a conventional reading supplement.

The drawbacks of a fixed focus stand magnifier are as follows:

1. Limited visual field.

2. The posture might be uncomfortable and fatiguing.

3. The occurrence of aberrations is reduced when the image is seen at an angle.

Focusable units are effective in correcting minor refractive faults and serve as a viable option for patients who are unable to comfortably utilise powerful glasses or hand magnifiers due to the need for a certain reading distance. The focusable unit allows the eye to be positioned in close proximity to the lens.

The benefits of the focusable stand magnifier include:

• Accommodation is not necessary and is beneficial for patients who have declined magnifiers or glasses due to challenges in maintaining focus distance.

The drawback of the focusable stand magnifier is its limited field of view.

Magnifying glass for bars

A bar magnifier is a cylindrical reading tool that rests horizontally on a page. It stretches the letters without causing them to separate, resulting in magnification only in the vertical direction. Individuals with a limited central field of vision who require minimal magnification can benefit from this optical characteristic. Bar magnifiers are typically only offered in low magnification options.

Magnifier of the Fresnel type

A Fresnel lens magnifier is a thin plastic lens used as a handheld magnifier for people with subnormal vision. The lens surface is created with a series of rings or zones that are pressed into the material. This manufacturing method allows for the production of spherical, elliptical, and parabolic surfaces in various sizes at a low cost. The resolution and magnification power, which can reach up to 10 times for ophthalmic purposes, are determined by the number of rings per inch. The main advanta

Optical instruments used for observing distant objects by collecting and magnifying light.

Telescopes enhance the resolution of faraway objects by enlarging the image through angular magnification. A basic telescope consists of two optical components: the objective lens and the eyepiece. In telescopes that provide angular magnification, the objective lens has a positive power and is positioned towards the object being observed, such as in Galilean and Keplerian or prismatic telescopes used for individuals with impaired vision.

A Galilean telescope consists of a convex objective lens and a concave ocular lens. When these lenses are separated by the difference in their focal lengths, they create a real and upright image. The concave ocular lens always has a higher power. The rays leaving the system are parallel when the secondary focal point of the objective lens aligns with the primary focal point of the ocular lens. Galilean telescopes used for low vision can be either focusable or non-focusable.

A Keplerian telescope employs convex lenses for both the objective lens and ocular lens. The inverted image is corrected by an internal prism system. Keplerian telescopes generally offer superior image quality and brightness throughout the field of view compared to Galilean telescopes. Keplerian telescopes typically have a larger field of view and are available in higher magnifications than the Galilean design.

Optical device used for magnifying distant objects, typically used by those with visual impairments.

A bioptic telescope may be recommended for individuals who require a telescope for regular use but have a mobile lifestyle. This type of telescope utilises standard plastic ophthalmic lenses within a frame, with a small aperture drilled into the upper section of each lens. A miniature telescope is then mounted within each aperture. The conventional lens is used for general viewing purposes, while the bioptic telescope is employed for observing distant objects with greater detail. To utilise the bioptic telescopes, the individual lowers their head and raises their eye to peer through the telescope portion. When the telescope is not needed, the individual raises their head and resumes viewing through the conventional lenses.

Telescope with a wide field of view

The full field telescopes provide complete coverage of the lens within the frame. While they offer a wider field of view compared to bioptic telescopes, they are exclusively used for visual tasks that can be performed while standing or sitting. Walking with this type of lens is challenging and should only be attempted under the guidance of a knowledgeable low vision instructor.

Telemicroscopes

Telescopes are specifically built to see items that are far away. They are not suitable for viewing objects that are close by since they do not have the ability to adjust focus. However, certain telescopes are equipped with an ocular lens that can be adjusted outward, which creates a magnifying effect and allows for focusing on nearby objects.

A telemicroscope is essentially a telescope that has a reading cap integrated into its front, specifically the objective lens. The working distance of the telemicroscope is determined by the power of the reading cap. To ensure that no converging rays enter the telescope, the material must be positioned at the focal point of the reading cap. The magnification of the telemicroscope varies depending on the strength of the reading cap. For instance, using a 4.00 D cap, the magnification of the telemicroscope is equal to the power of the telescope. A reading cap stronger than +4.00 D will increase the magnification, while a reading cap weaker than +4.00 D will decrease the magnification. The magnification can be calculated using the following formula—

The power of a telemicroscope is equal to the product of the power of the telescope and the diopter of the cap divided by four.

Telemicroscopic lenses offer a larger working distance compared to microscopic lenses, but they do so at the expense of a reduced field of view.

Optical instruments used for magnifying small objects and structures are called microscopes.

A low vision microscope is essentially a convex lens that is installed on spectacles. It operates based on the idea of magnifying objects by adjusting their relative distance. When choosing a microscopic lens, there are many fundamental alternatives to consider—

Microscopes with a wide field of view

Full field microscopes are installed in traditional frames at a standard vertex distance. They can be constructed using various lens designs such as spherical lenses, aspheric lenses, and doublets.

Microscopes with half-eye design

Half eye microscopes consist of convex lenses that are mounted in a half eye frame and worn at a normal to slightly longer vertex distance. The main benefit of using a half eye microscope is the ability to view distant objects without obstruction. Traditional half eye microscopes are made up of convex spherical lenses with a prism base designed for binocular vision. Each lens typically includes prism that is equal to the power of the microscope plus diopter.

For instance, a half eye with a power of +8.00 D would possess a base-in prism of 8.00 D in front of each eye.

Bifocal microscopes

Bifocal microscopes are installed within standard frames at a typical distance from the eye's vertex. The height of the segment is determined by the individual's requirements and the strength of the bifocal lens. The microscope lens enables the user to have both hands available and is particularly advantageous for extended periods of reading. Additionally, it offers the widest field of view. However, it does reduce the distance at which one can work.

SURVEILLANCE SYSTEM USING CLOSED-CIRCUIT TELEVISION (CCTV)

Closed circuit television (CCTV) is an electronic magnification system used by visually impaired individuals to read. It utilises the principle of projection magnification to allow low vision patients to visually examine printed or handwritten material, as well as various objects, through a magnified image projected onto a monitor screen.

The conventional Closed-Circuit Television (CCTV) system comprises three primary elements: a camera, a monitor, and a mobile reading platform. The camera is focused on an object, and its image is displayed on a television monitor. The monitor functions as the screen where the magnified print image is projected. The movable platform is positioned on a flat surface, such as a table or desk, and the reading material is placed on it. The platform is specifically designed to be positioned beneath the camera.

The CCTV system allows the patient to choose between ordinary polarity, which is black lettering on a white backdrop, or reverse polarity, which is white letters on a black background, for reading. Furthermore, many black and white CCTV systems offer a "photo mode" in addition to the polarity shift.

When chosen, the camera returns to the default contrast and brightness settings, which are optimal for viewing photographs.

The CCTV systems offer a range of magnification levels, from 4 x to 65 ×, with minor changes in the screen size system. The benefits of CCTV systems include

1. Controls for adjusting brightness and contrast are provided.

2. Photographs may be readily observed.

3. Binocularity remains achievable even while using higher levels of magnification.

Nevertheless, there are also drawbacks linked with the use of CCTV—

1. The physical dimensions may impede the ability to carry and move it around easily.

2. Adequate training and dedicated practise are necessary to attain proficiency as a user.

3. Insufficient accessibility to maintenance services for components.

4. The initial expense is exorbitant.

Devices that do not rely on optics or light-based technology.

Non-optical devices are crucial in enhancing the effectiveness of optical low vision devices. In cases where optical devices have limitations, non-optical devices can assist in their usage. Non-optical devices are also frequently used independently. The following non-optical aids are commonly utilized—

Large print

Large print involves the use of relative size magnification, where making an object larger makes it easier to see. The amount of magnification depends on comparing the new larger object to the standard size object. The advantages of using large print include its easy acceptance by individuals with low vision. Large print is sometimes used in combination with low power optical devices to achieve the appropriate level of magnification. However, a major drawback of large print is its limited magnification capabilities. Large print books typically do not exceed 18 points, providing only a 1.8 × magnification. As a result, only a small portion of the low vision population can rely solely on large print.

Lighting

Proper lighting is crucial for patients with low vision. The intensity of light should be adjusted on the printed material and should not shine directly into the eyes. Illumination refers to the light that hits the material being viewed and reflects directly into the eye. This light enhances contrast by increasing the difference between the light coming from the object being viewed and the background light level. Glare, on the other hand, is unhelpful light that comes from indirect sources and enters the outer edges of the eye, thereby increasing the background light and reducing contrast. Since glare reduces contrast and causes fatigue and strain, it is important to consider using illumination control devices with all optical aid systems. A gooseneck lamp or a flexible arm lamp can be extremely beneficial. However, not all patients require a high level of light. Therefore, the low vision specialist must determine the most comfortable level of light for each patient.

SPECIAL TYPE AIDS

INK PEN WITH A BLACK FELT TIP

Using a black felt tip pen instead of a blue ballpoint pen helps increase contrast, which is important for reading printed information. Additionally, the felt tip pen allows for greater writing, creating a magnified picture.

Typoscopes

A typoscope is a device made of black cardboard that has a narrow opening. It effectively obscures all text except for the line being read through the opening. By framing a single line of text with black, it enhances the visibility and sharpness of the line, hence enhancing the contrast.

BOOKSTAND

A reading stand serves the purpose of providing a convenient position for holding reading material, allowing the patient to maintain a close working distance without exerting strain on the neck and back muscles or fatiguing the arms. Some individuals may choose to incorporate an adjustable lamp into the reading stand to assist with reading, particularly during prolonged periods. Additionally, reading stands can be utilised to decrease the distance between the individual and the reading material, thereby enhancing the magnification effect.

HEADGEAR OPTIONS: VISORS AND CAPS

Visors and hats can serve as a means of shielding oneself from the sun's rays.

Conversational Goods

Devices such as talking books, talking watches, talking calculators, and talking telephones are commonly available with speech output. Many of these voice-output products also feature a large display that includes magnification and voice output. This combination creates a highly practical product.

Haptic goods

The sense of touch serves as the second most significant sensory input when the visual sensory input is impaired. Braille is the predominant means of providing this tactile input.

Tool for easily guiding a thread through the eye of a needle.

A needle threader is a non-optical tool designed specifically for the job of threading a needle.

NOTEX

Notex can be designed to help identifying the different notes.

Nocturnal visual assistance device

A Nightscope or torch can be used to provide extra lighting during nighttime movement.

A pinhole spectacle is a type of eyewear that uses a series of small holes to improve vision.

Pinhole spectacles, whether single or multiple, can be beneficial for individuals with lens opacities, pronounced vitreous opacities, and corneal scars. Unlike traditional glasses, pinhole spectacles are made from an opaque material such as metal or plastic. The user looks through one of the small holes in the material, which has the effect of narrowing the bundle of diverging rays from each point on the object being viewed. This helps to eliminate peripheral beams, glare, and any refractive errors in the lens or cornea. The size of the aperture should be determined through a trial and error method. When using reduced apertures, it is important to compensate for the loss of illumination. Additionally, it should be noted that increased illumination leads to greater pupil contraction.

Optical lenses have the ability to absorb light.

Low vision encompasses more than just poor visual acuity. It also involves dealing with issues such as glare and contrast enhancement, which pose unique challenges for clinicians working with individuals with low vision. To address these challenges, low vision absorptive lenses should possess the ability to absorb ultraviolet light. Certain absorptive lenses, which function as filters, can alter the perception of brightness or darkness in a scene, block out specific colours, or enhance contrast without affecting the overall colour spectrum.

Coloured lenses have the most significant impact on colours that are opposite to them. For instance, a red lens allows red light to pass through but blocks or absorbs blue and green light. When a low vision patient uses a red filter, it eliminates blues and greens. A green lens blocks red or orange light, while a yellow filter blocks blue light. Using an orange or yellow filter on a cloudy day can create the illusion of sunshine. Neutral density lenses decrease the amount of light that reaches the eye without changing its colour. These lenses are beneficial for patients who experience photophobia or have a sensitivity to light.

Patients experiencing discomfort from red-deficient fluorescent light may find relief by using yellow, orange, or red filters. In general, these filters enhance contrast, which is particularly beneficial for patients with mobility issues in low-contrast environments.

Absorptive lenses offer several advantages for individuals with low vision, including the elimination of discomfort glare, reduction of veiling glare, improved ability to adapt to changes in lighting conditions, and enhanced contrast and/or visual acuity. These lenses are available in both glasses and plastic materials, offering a range of options for low vision patients.

1. Noir Filter: Noir Medical Technologies produces a wide range of plastic filters with different levels of light transmission in both goggles and frames. The Noir UV shield styles provide various levels of light transmission while completely blocking UV rays, while the Noir filter styles not only block UV rays completely but also significantly reduce infrared rays.

2. Corning Photochromatic Filters (CPFm) have been developed with the aim of creating a filter that can safeguard the eyes from increasing retinal degenerations.

3. The Younger Protective Lens Series has created filter lenses that safeguard the eyes by blocking out UV and short-wavelength blue light.

Polarisation refers to the process of dividing or causing a division between two opposing groups or individuals, often resulting in a clear distinction or separation between them.</text

The addition of a filter to the lens can enhance glare reduction by introducing polarisation. Polarisation effectively diminishes glare caused by reflected surfaces. Various lens designs are available that include polarised filters, including as single vision, bifocal, trifocal, and progressive lenses, which are offered in both glass and plastic materials.

Reflective coating

Applying a mirror coating to a lens diminishes the amount of light that passes through and functions as a filter. The mirror coating can be either complete or partial.

Coating designed to reduce reflection

An antireflection coating is used to minimise lens reflection. It can be applied as a single layer or multiple layers. In the case of prescriptions for low vision patients, lenses with extreme curvatures or doublet lens designs are often needed. However, these lenses tend to produce reflections that negatively impact visual performance. Antireflection coating is effective in reducing these reflections.

PSYCHOLOGICAL INDICATORS OF COLOUR PREFERENCE

Dr. Sumitra DOS holds a Bachelor of Optometry (B Optom), a Diploma in Medical Billing and Coding (DMBS), and a Doctor of Medicine in Biology (MD BIO).

The choice and preference of a particular tint may reflect the mood, behaviour, nature, personality and also the attitude of a person towards the perception of life. Different people like different tints. Certain tints are preferred more on particular occasion than others. At times its influence may also be seen on the tint selection for visual purposes irrespective of their effects and benefits. The choice between three primary colors-blue, yellow and red may reflect different nature and mood of a person. A person who lacks self confidence, concentration, courage, energy and also has poor memory with absent mindedness may be found to prefer blue tint. Usually these kinds of people change their mood frequently and are restless. Lack of practical application is mostly seen among them. In contrast people who prefer yellow tint are suspicious about everything. They are found to be seen suffering from inferiority complex, zealous and always indulged in finding faults in others. They lack love and affection and may be selfish, mischievous and cunning. Red tinted liking people may be seen as stubborn with fixed ideas. Desire to be alone and, escaped may be the traits of their nature. They keep their difficulties and anxieties within them and sulk over them. Love, affection and mercy towards others are usually not seen among them.

UTILISING CONTACT LENSES FOR ASSISTANCE WITH LOW VISION

The utilisation of contact lenses for low vision patients has significant applications for individuals of all ages. When properly utilised, this specialised technique can provide clear benefits compared to other methods of correcting low visual acuity, often yielding more effective results. Both corneal and haptic contact lenses are used in the practise of improving subnormal vision.

Highly myopic individuals can benefit from using contact lenses.

Patients with progressive or pathological myopia can achieve favourable clinical outcomes by using contact lenses. Spectacle lenses may not offer satisfactory visual quality due to aberrations, distortions, image size issues, or other optical phenomena. Hence, contact lenses should be taken into consideration.

Albinism and Contact Lenses

Albino patients often experience glare and sensitivity to light. They commonly exhibit a specific type of eye movement, known as pendular nystagmoid movements, when trying to use their maculas. This movement can negatively impact their vision. To alleviate the sensitivity to light, contact lenses can be tinted or designed with an opaque outer edge. This can also help slow down the nystagmoid movement and potentially improve visual acuity.

Aniridia contact lenses

Patients with aniridia can benefit from specialised prosthetic lenses that help alleviate the issue of photosensitivity.

Keratoconus Contact Lenses

Keratoconus is a condition where the cornea, the transparent outer layer of the eye, becomes thin and distorted, resulting in a protrusion or bulging. It typically affects both eyes, with one eye showing more progression than the other. The irregular shape of the cornea makes it difficult to improve vision using glasses. However, using contact lenses can provide immediate benefits as they serve as a substitute for the cornea and help to refract light properly.

Colour vision deficiency contact lenses

At times, a contact lens can be utilised to improve colour perception. Individuals experiencing challenges with distinguishing red and green may be prescribed a specialised lens known as the X-Chrome lens.

X-Chrome is a crimson contact lens that is often worn on the non-dominant eye, but there are exceptions. Its main purpose is to induce retinal rivalry, a phenomenon that allows the brain to see and differentiate between different hues.

Utilising contact lenses as a telescopic system.

A Galilean telescopic system can be constructed using a contact lens. In this system, a high-powered concave contact lens serves as the eyepiece or ocular lens, while a lower-powered convex spectacle lens is worn over it as the objective lens. The total magnification of the system can be calculated by comparing the dioptric power of the contact lens to that of the spectacle lens.

ADVANCEMENT IN THE FIELD OF AIDS RESEARCH AND TREATMENT

Field-expansion assistive devices provide a range of choices for those with limited visual fields. There are three alternatives for individuals seeking to compensate for a wider region of missing field:

1. Optimise the picture compression to maximise the utilisation of the available viewing space.

2. Offer prisms that transfer pictures from the blind region to the visible area.

3. Utilise a mirror to project an image from an area that is not within one's line of sight. A reverse telescope has been employed to expand the effective visual range for patients experiencing loss of peripheral vision. In this technique, the person gazes through the objective lens of the telescope instead of the ocular lens. By reversing the telescope, the user is able to observe an entire scene because the image is not enlarged, but rather reduced in size. However, in order to derive benefits

Fresnel prism lenses are flexible plastic lenses that can be temporarily attached to regular spectacle lenses. They are commonly used as trial lenses for testing spherical power, bifocal segments, or prisms. One of their main applications is in the treatment of field loss. Fresnel prisms can cover the entire lens or only extend into the area of field loss. When the individual looks through the prism area, they will see a lower contrast image from the missing field. Due to the decrease in visual

Monocular hemianopic mirrors are employed to redirect an image from a blind area into the visible field of view.

Computer-assisted devices

In the past patients with severe visual impairment were severely restricted in what they could read and write. They needed to wait for a scheduled radio broadcast or the arrival of an audiotape or brailled materials. The introduction of hi-tech aids like Closed Circuit Television and advances in optical systems have enabled the patients with residual vision to access normal print, but with higher magnification, some patients experience difficulty searching, scanning and writing with these devices. The development of computer assistive devices have the potential to remove many of these restrictions. With specialized assistive equipments, some patients with low vision can use the home computer to convert digitized text into a format that compensates for any degree of visual impairment, enlarging text on a screen or converting it tospeech. With the computers, the patient can locate specific information using search or find functions and type his message and correspondence. Once the information is found, the patient can read by listening them. Financial and banking transactions can be conducted with computers. Newspaper and magazines are available on the World Wide Web or on commercial on-line information services. Thus the personal computers have become an important assistive devices that allows for accessing and processing information, and therefore, a world of limited vision may no longer be a restrictive environment. For a low vision patients four basic types of adaptation may enable them to use a computer as low vision device:

1. Low vision aids that rely on hardware components

2. Low vision aids that rely on software

3. System for vocalisation or recognition of speech

4. System for displaying Braille

Ocutech Vision Enhancing Systems

OCUTECH is a company that specialises in the development and production of advanced visual aids.

Ocutech, Inc., founded in 1984, is a prominent worldwide pioneer in creating sophisticated bioptic telescopes for people with vision impairments. The firm has obtained significant financial backing, surpassing $1.5 million, from the National Eye Institute (NIH) and the Ontario Ministry of Health in Canada. The Ocutech bioptic systems have undergone rigorous research and thorough independent clinical studies, where they have been chosen above alternative solutions at a ratio of 3 to 1. Ocutech VES®-Bioptic telescopes are relied upon by a large number of visually impaired persons across the world.

The initial iteration of the Ocutech bioptic telescope, known as the VES®, was created by Russ Pekar, Ph.D., the visually challenged president of Ocutech. Dr. Pekar has firsthand knowledge of the demands and difficulties experienced by those with visual impairments. He is dedicated to developing low vision devices that are efficient, user-friendly, aesthetically pleasing, and pleasant to use. In 1996, Ocutech gained global recognition for developing the pioneering VESAutoFocus (VES®-AF), the sole autofocusing bioptic telescope in existence. The VES®-AF development project spanned a duration of more than 6 years and incurred a total expenditure of almost $1 million in order to achieve its completion. Currently, the VES-AF is worn by several individuals worldwide, allowing them to get the most realistic magnified vision attainable using a low vision device. The VES-AF provided newfound independence to those who previously experienced little success with bioptic telescopes. Numerous individuals have expressed that it had a transformative impact on their lives. Ocutech was awarded the Winston Gordon Award by the Canadian

National Institute for the Blind in 1999 for its creative development of the VES-AF.Ocutech is dedicated to meeting the requirements of those with vision impairments and provides extensive warranties for its products. Ocutech Low Vision Aids may be obtained from specialised doctors and clinics that focus on low vision treatment worldwide. Your queries are warmly welcomed.

Note: All Ocutech products have received CE approval. The VES®-AF Bioptic Telescope System (4x) is a self-focusing bioptic telescope that has won awards. It is the only one of its kind in the world. The VES®-AF offers the most natural magnified vision possible, as the image becomes clear immediately wherever you look, just like natural vision. It eliminates the inconvenience of having to focus and the fatigue of having to hold still to keep the image in focus. The VES®-AF consists of a 4x Keplerian telescope connected to a safe computerised infrared autofocusing system. This system measures the distance of focus more than 30 times per second, ensuring a clear image immediately, even at a distance as close as 12 inches. This clear vision allows visually impaired individuals to work more efficiently and in a more relaxed and comfortable position. The VES-AF operates all day long with a rechargeable battery pack.

The VES®-AF offers the broadest visual range among 4 power bioptics and has a weight equivalent to conventional manual-focus expanded field devices from other manufacturers. The development of VES®-AF was supported by the National Eye Institute and its effectiveness has been demonstrated in clinical trials funded by the NIH.

Characteristics

• Optimal, enhanced visual perception

• A consistently sharp image at a minimum distance of 12 inches

• This 4 × bioptic telescope has the largest field-of-view currently available.

• Lightweight (weighs only 2.3 ounces)

• Simple to showcase, suitable for use, and distribute

The focusing eyepiece can effectively correct refractive errors ranging from +12 to -12.

• Eyepiece and filter adjustments are offered

• Equally simple to order, just like any traditional bioptic telescope system

Ocutech's innovative bridge mounting mechanism allows for customizable adjustment of the eyepieces.

The OCUTECH VES® II is available with three magnification options: 3X, 4X, and 6X.

The Ocutech VES-II, the original Ocutech system, is the preferred choice of patients in NEI funded research, with a ratio of 3 to 1.

The Ocutech Vision Enhancing System® (VES®-II) is an improved version of Ocutech's original bioptic telescope system. It was developed and tested with funding from the National Eye Institute. The VES®-II addresses the main issues of conventional bioptic telescope systems(1,2), such as limited field of view, unattractive appearance, heavy weight, and lack of control over positioning. These issues have hindered their acceptance by patients and caused difficulties for prescribers. The VES®-II bioptics p

The OCUTECH VES®-MINI is a visual enhancement system with a magnification power of 3X and a field of view of 15 degrees.

Introducing the most compact, lightweight, and broadest field bioptic telescope to date!The Ocutech VES®- Mini is a compact and advanced bioptic telescope system that provides a 3x enhanced field of view using Keplerian optics. The device offers a unique mix of a remarkably broad 15-degree field-of-view inside a small and space-efficient physical structure. The VES®—Mini has the same dimensions as tiny focusing Galilean telescopes and is only half the size of typical extended field telescopes offered by rivals. The Mini's optics offer precise internal focusing capabilities for correcting refractive flaws ranging from +12 to -12, as well as for near seeing at a minimum distance of 7 inches. The user-friendly diagnostic kit simplifies the process of showcasing and recommending this top-notch telescope system, while minimising the time, effort, and any risks involved. The VES®-Mini may be prescribed and ordered like any other traditional bioptic telescope system. It is available for both monocular and binocular use, and can be used for both distance and close applications. The device may be purchased either with Ocutech's stylish ophthalmic frames as a whole package or it can be put into frames given by the prescriber.

Characteristics

• This bioptic telescope is unique because it offers both a large field of vision and a small size in a single device.

• Optics are specifically engineered to reduce interference from the telescope structure and maximise the useable area of the carrier lens.

• Adjustable focus range from infinity to a minimum distance of 7 inches

• Automatically adjusts for refractive error adjustments ranging from +12 to -12.

• Eyepiece, reading cap, and filter adjustments are provided.

• Can be easily mounted in various stylish frames

• Demonstrating, fitting, and ordering are effortless.

• Prescribe for single-eye, both-eye, and both near and far vision needs

• Equally effortless to distribute, just like any typical bioptic telescope system

• Suitable for all bioptic applications.

TRAINING IN ORIENTATION AND MOBILITY

Orientation refers to the understanding of one's position in space, whereas mobility refers to the capacity to move about the environment in a safe, efficient, and autonomous manner. All low vision patients may not need orientation and mobility training, but those who are unable to move about with ease and independently may be gradually exposed to the situations like traveling in residential, school or business areas and using public transportation. Successful mobility depends on the effective use of visual informations rather than visual acuity. The other variable which affect mobility training are peripheral field defects, light levels and contrast sensitivity. Some patients can be made self-sufficient with the use of low vision travel devices (3,4). For others whose problems are not completely solved with these devices, the referral for an orientation and mobility evaluation is indicated. The mobility instructor performs a functional vision assessment to evaluate mobility potential and plan a training programme emphasing effective use of vision and other services. Recommended travel aids are incorporated into the programme.

Assessment of functional orientation and mobility

Prior to commencing a training programme, it is imperative to conduct a comprehensive assessment of the visually impaired patients' low vision. This assessment should take into account the patient's case history and functional evaluation for orientation and mobility. It is essential to conduct this evaluation both during the day and at night. If the patient requires evaluation in different environments such as residential areas, college campuses, businesses, indoors, outdoors, or other specific surroundings, multiple sessions may be scheduled to prevent excessive fatigue. Various behaviours are observed in all settings and under different lighting conditions.

1. Object recognition and avoidance distances: The patient's ability to identify and subsequently avoid objects is assessed based on their size, colour, texture, and distance. It is noted whether the patient can identify both stationary and moving objects. Additionally, the assessment includes determining whether the patient relies on tactile or auditory cues before utilising their vision.

2. Movement assessment: The system detects the direction and distance of vehicles, people, and other objects. 3. Scanning behaviour: The system also observes if the patient tends to focus more on one side than the other.

4. Gaze: The patient's direction of focus, whether it is straight at the item, to the side, or slightly up or down. Also, if fixating on an object triggers nystagmus or not.

5. Orientation Landmarks: What hints and landmarks does the patient rely on for orientation? If visual landmarks are employed, do they share common qualities such as size, colour, and relative location?

6. hue perception: Does the patient exhibit a preference for a specific hue over others? How does the lighting conditions impact their capacity to perceive and utilise colours?

Assistive devices and methods for movement

While there exists a wide range of mobility aids, specifically five categories of visual aids are employed for the purpose of enhancing mobility -

1. Traditional eyeglasses or contact lenses.

2. Glare and light regulating devices such as absorptive lenses.

3. Optical devices such as handheld monocular telescopes and head-mounted bioptic telescopes that provide magnification assistance.

4. Compressing devices.

5. Prisms and mirrors are utilised to shift the position of an image. Certain individuals with impaired vision may require nonvisual techniques to enhance their vision in unfavourable circumstances, such as during the night, in unfamiliar areas, or in bad weather. There are six categories of nonvisual aids that can be employed either independently or in conjunction with visual aids—

1. Sighted guide refers to the act of holding onto the arm of a person who can see.

2. Extended cane or assistive cane.

3. Utilise a defensive arm manoeuvre to prevent physical contact or harm to the upper and lower regions of the body.

4. Trailing refers to the act of moving along a wall with the rear of the hand.

5. Canine guide.

6. Electronic devices.

Reference

1. Sivakumar, P., Vedachalam, R., Kannusamy, V., Odayappan, A., Venkatesh, R., Dhoble, P., ... & Narayana, S. (2020). Barriers in utilisation of low vision assistive products. Eye, 34(2), 344-351.

2. Agarwal, R., & Tripathi, A. (2021). Current modalities for low vision rehabilitation. Cureus, 13(7).

3. Demmin, D. L., & Silverstein, S. M. (2020). Visual impairment and mental health: unmet needs and treatment options. Clinical Ophthalmology, 4229-4251.

4. Honavar, S. G. (2019). The burden of uncorrected refractive error. Indian Journal of Ophthalmology, 67(5), 577-578.

5. Javadi, M. A., & Zarei-Ghanavati, S. (2008). Cataracts in diabetic patients: a review article. Journal of ophthalmic & vision research, 3(1), 52.

6. Vashist, P., Senjam, S. S., Gupta, V., Gupta, N., & Kumar, A. (2017). Definition of blindness under National Programme for Control of Blindness: Do we need to revise it?. Indian journal of ophthalmology, 65(2), 92-96.

7. Ganesh, S. C., Narendran, K., Nirmal, J., Valaguru, V., Shanmugam, S., Patel, N., ... & Ehrlich, J. R. (2018). The key informant strategy to determine the prevalence and causes of functional low vision among children in South India. Ophthalmic epidemiology, 25(5-6), 358-364..

8. Minto, H., & Butt, I. A. (2004). Low vision devices and training. Community eye health, 17(49), 6.

9. Ager, L. (1998). Optical services for visually impaired children. Community Eye Health, 11(27), 38.

10. Jackson, M. L., Schoessow, K. A., Selivanova, A., & Wallis, J. (2017). Adding access to a video magnifier to standard vision rehabilitation: initial results on reading performance and well-being from a prospective, randomized study. Digital Journal of Ophthalmology: DJO, 23(1), 1.

11. Sapkota, K., & Kim, D. H. (2017). Causes of low vision and major low-vision devices prescribed in the low-vision clinic of Nepal Eye Hospital, Nepal. Animal cells and Systems, 21(3), 147-151.

12. Deemer, A. D., Bradley, C. K., Ross, N. C., Natale, D. M., Itthipanichpong, R., Werblin, F. S., & Massof, R. W. (2018). Low vision enhancement with head-mounted video display systems: are we there yet?. Optometry and Vision Science, 95(9), 694-703..

13. Lee, S. M., & Cho, J. C. (2007). Low vision devices for children. Community Eye Health, 20(62), 28.

14. Şahlı, E., & İdil, A. (2019). A common approach to low vision: examination and rehabilitation of the patient with low vision. Turkish journal of ophthalmology, 49(2), 89.

15. Hayhoe, M., Gillam, B., Chajka, K., & Vecellio, E. (2009). The role of binocular vision in walking. Visual neuroscience, 26(1), 73-80.

16. Neve, J. J. (1989). Reading with hand-held magnifiers. Journal of medical engineering & technology, 13(1-2), 68-75.

17. Spitzberg, L. A., & Goodrich, G. L. (1994). New ergonomic stand magnifiers. In Low Vision (pp. 159-162). IOS Press.

18. Rohrschneider, K., Bayer, Y., & Brill, B. (2018). Closed-circuit television systems: Current importance and tips on adaptation and prescription. Der Ophthalmologe, 115, 548-552.

19Bendall, M. L., De Mulder, M., Iñiguez, L. P., Lecanda-Sánchez, A., Pérez-Losada, M., Ostrowski, M. A., ... & Nixon, D. F. (2019). Telescope: Characterization of the retrotranscriptome by accurate estimation of transposable element expression. PLoS computational biology, 15(9), e1006453.

20. Katz, M., Citek, K., & Price, I. (1987). Optical properties of low vision telescopes. Journal of the American Optometric Association, 58(4), 320-331.

21. Gilbert, C., & Van Dijk, K. (2012). When someone has low vision. Community Eye Health, 25(77), 4.

Paediatric Eye and Binocular Vision Examination

Dipanwita Ghosh,

PhD Scholar, M.Optom, B.Optom, C.C.E.H

Assistant Professor & Head

Department of Optometry

Swami Vivekananda University

Paediatric Eye and Binocular Vision Examination

5.1 GENERAL INTRODUCTION

Optometrists as a primary health care and comprehensive eye care practitioner are clinically trained to provide effective eye and vision care to children in India. Primary health care practitioners are the first level of contact with patient who provides all basic necessary health care and create the bridge to enter the specialty care of those conditions needs referral.[1] Through eye care patient enters the health care system because our eye and visual system are directly connecting with systemic health conditions. Every individual need eye care at a certain point of time in life.

According to the last report in 2020, 35 million people are visually impaired and 0.24 million children are blind in India and the leading causes are cataract and refractive error. [2,3] Unfortunately lack of knowledge and awareness among parents leading to late detection of vision disorders. Optometrists as a primary eye care practitioner need to do vision screening of every single children in the community until receives professional eye examination. (Table 1)

This chapter of Pearls of Clinical Optometry describes the protocol of proper eye health and visual examination procedure for infants and children for timely detection, diagnosis and treatment to promote normal visual development. The aim of this chapter is to evaluate the clinical methods of pediatric visual system assessment.

This clinical practice guideline provide a outline for pediatric eye health examination which also includes proper recommendation, timely detection and diagnosis with necessary referral for treatment. The goal is to develop proper protocol and timetable to examine eye health and visual system of pediatric patient, to reduce the complications of visual system by early detection, treatment, and prevention. Also to increase awareness among parents, patients other health care providers about the importance of regular eye check up.

Comprehensive Eye Examination			Vision Screening				
	AOA[1]	AAO[2]	Modified Clinical Technique[3]	School Nurses[4]	AAP[5]	PBA[6]	Head Start[7]
Patient history							
Chief complaint	X	X					
Visual and ocular history	X	X		Observation		Observation	
General health history	X	X					
Family medical history	X	X					
Developmental history	X	X					
Visual acuity measurement	X	X	X	X	X	X	X
Measurement of refractive error Retinoscopy	X	X	X	Plus lens test			
Cover test	X	X	X	X	X	Optional	X
Near point of convergence	X						
Stereopsis	X			X	X	Optional	
Positive and negative fusional vergences	X						
Versions	X	X		Tracking			

Table 1: Comparison of components of vision screening and regular visual examination of pediatric age group [4]

5.2 Pediatric eye and vision examination:

The pediatric population signifies a wide range of age from birth till 18 years. Although this age group varies in their capabilities significantly. Thus the pediatric age group has been subdivided into 3 subcategories as follows:

- Infant & toddler (Birth to 2 years 11 months)
- Preschool children (3-5 years 11month)
- School aged children (6- 18 years)

Clinically it has been found that the most of visual milestones developed by the age of 6month to 6 years, thus it’s called the critical period of visual development.(Table 2) Thus the first eye examination should be done at a age of 6 month. About the age of 3 years a child develops a good receptive and cognitive abilities and also express in language. By the age of 6 years a child developed all the visual abilities like a adult thus any tests can be done. While selecting testing procedure for children it is very important to rely on chronological age of the child and their specific capabilities. The goal of pediatric eye examination includes:

- Examination of the function of visual system
- Examination of ocular health and systemic health conditions
- Diagnosis and management plan
- Create awareness and educate patient and parents for preventive measures

Early detection and treatment of various ocular conditions is very necessary to avoid the potential causes of permanent visual impairment. Although screening of the pediatric population specially infant and toddlers are very challenging, thus can lead to misdiagnosis or underdetection of various ocular conditions like amblyopia, anisometropia, refractive error, strabismus etc.

VISUAL DEVELOPMENT INVENTORY	Newborn	1 Month	2 Months	4 Months	6 Months	9 Months	12 Months	18 Months	24 Months	3 Years
OCULOMOTOR										
Fixation	To face									→
Saccades										
H	⊕							→	One shift to target	
V	⊖	⊖	⊕					→		
Pursuits	⊖	⊖	Emerging	⊕						→
Visually directed reaching	⊖	⊖	⊖	?	⊕					→
Face regard	⊕									→
OKN: T-N and N-T	Asymmetric	Asymmetric	Asymmetric	Asymmetric	Symmetric					→
response	⊕									→
ACUITY Preferential Looking OU	20/400 to 20/1200	20/300 to 20/1200	20/150 to 20/600	→	20/50 to 20/200		→	20/40 to 20/100	20/30 to 20/80	20/20
Visual Evoked Response VEP OU	20/100	20/200	20/80		20/40					
BINOCULARITY										
Alignment		⊕					→	Adultlike levels of Angle Lambda		→
Near point of convergence	Up to 10 in			→	To nose					→
Fixation of moving target	⊖	⊖		Response ⊕						→
10 Δ response	⊖	⊖			70% of time					→
Stereopsis	None			Emerging	Well developed					
ACCOMMODATION										
Accuracy	Accurate for 30 cm (12 in)			Well developed	Accurate for 75 to 150 cm					→
Lag				+0.75						→
PUPIL RESPONSES	⊕Sluggish	Well developed								→
Color Vision	Notices color Can't distinguish R, G, or Y		Distinguishes R-G not Y-G	Recognizes similar hues within color group						Normal
Blink response to visual threat			⊕							→
Contrast sensitivity function			Adult-like low frequency attenuation							Adult-like btwn 3-5 yr

Key: ⊕ Emerging; ⊖ Not existing; → Continues; R = Red; G = Green; Y = Yellow

(Courtesy of Dr. Janice Scharre, Illinois College of Optometry, Chicago.)

Table 2: Visual Development Inventory

5.3 Examination sequence:

Examination of pediatric patients may include the following procedures:

5.3.5 Case History

A comprehensive history taking staring from demographic details of the patient may include the following questionnaire:

- Firstly ask the parents if they have noticed any visual problems that's define as chief complain
- Visual and ocular history
- Family history
- Birth history
- Developmental history
- Medication history
- Allergy history

- **Family History –**
  Following questions can be asked:
  - History of jaundice or phototherapy
- **Developmental history**
  - Birth weight
  - Any history of multiple ear infections or other illnesses?
  - Any delayed development?
  - Vaccination status
  - Any history of allergy from any drug?
  - History of any head or eye injury?
  - Is there any hereditary health /eye problem exists among the family of both parents?
- **Birth history during Pregnancy –**
  - Mother age at the time of birth
  - Any use of medication during pregnancy?
  - Any exposure to radiation during pregnancy?
  - Any history of infection during pregnancy?
  - Any history of smoking, alcohol or drug consumption during pregnancy?
- **Birth history during Delivery**
  - Term of pregnancy
  - History of lack of oxygen at the time of birth or any history of oxygenation?
  - Type of delivery includes forcep delivery, C section
  - Duration of the labor
  - APGAR score
- **Visual Problems**
  - Does the child rubs her eyes?
  - Any history of eye turning noticed?
  - If yes then at what time of day? Which eye deviates most frequently?
    - Direction of deviation?

Many cases squinting is the common presenting complaint. However rule out true squint from a pseudo deviation is a critical thing in infants because of there epicanthal fold or tele canthus. Most of the infants achieved proper alignment between two eyes within 6 months of age.

i. Visual Acuity

Pediatric visual acuity measurement is crucial for assessing the vision of infants, toddlers, and young children. Unlike adults, who can usually communicate about their vision, children may not be able to express vision problems verbally. Therefore, various techniques are employed to measure visual acuity in this population. It is difficult to get a precise visual acuity in infants. As the regular subjective visual acuity testing charts can not be used infants thus some special tests are done to make assumption of visual acuity.

In infant and toddler the test procedure includes:

- Fixation preference test

- Forced choice preferential looking test with Teller acuity card
- Catford Vision Drum Test
- Optokinetic Nystagmus (OKN) drum test
- Bock candy bead test

Fixation preference test is done with a vertical 10D base up or base down prism which causes vertical separation of image. The child being sited on mothers lap the examiner looks at the fixation preference of both eyes. It has found very effective in detection of 3 line difference between the two eyes in moderate amblyopia.

Forced choice preferential looking test uses the black and grey stripped 12 Teller acuity cards and presented as a game in front of a baby. The baby will be sited on mothers lap white the examiner will be standing behind the testing cards and will look at the infants fixation pattern from a small whole at the center. 1 teller card with stripes imprinted will be place on one side of the testing plate and a same luminance empty grey background. The different resolution of lines of each Teller cards correspond different acuity. The test is performed at a distance of 16 inch. If the child fixates at the tellers grating card that signifies the child can resolve the stripes. The examiner observes where the child prefers to fixate. The resolution of the card started wit hthe largest stripes and then with each completing steps increase the stripes acuity. The infants visual acuity noted from the last card responded correctly. Clinical use of forced choice preferential looking test is very successful although in case of strabismic amblyopia is can underestimate the acuity. Thus to confirm the acuity electrodiagnostic tests like VEP should be done for direct assessment.

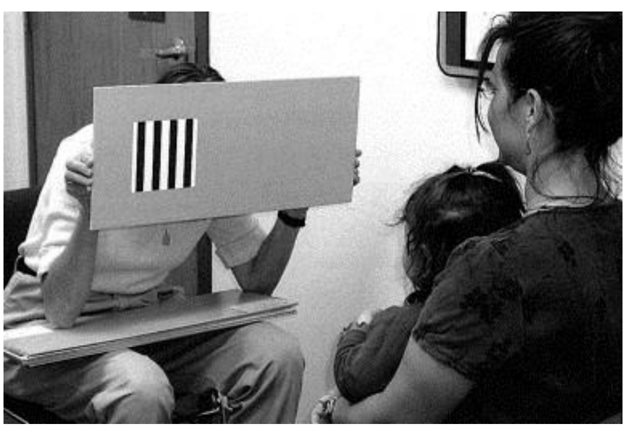


Fig 1. Teller Acuity Card Test

Goldman was the first to propose presenting oscillating stimuli in front of the patient and observe the eye movement. The optokinetic nystagmus (OKN) drum test is a diagnostic tool used to evaluate the visual system's response to moving stimuli, particularly in assessing the integrity of the ocular motor system and visual pathways. The OKN drum consists of a drum-shaped device with vertical stripes or patterns on its surface. The drum can rotate horizontally around the subject's line of sight. The patient sits or stands facing the drum at a comfortable distance. They may wear an eye patch over one eye to allow for monocular testing if necessary. Examiner rotates the drum, causing the stripes or patterns to move horizontally across the patient's visual field. The speed of rotation can be adjusted depending on the patient's age, condition, and the specific purpose of the test. The examiner observes the patient's eye movements, specifically looking for the presence of optokinetic nystagmus. Nystagmus is a rhythmic, involuntary movement of the eyes, and optokinetic nystagmus is triggered by the movement of visual stimuli across the retina. Optokinetic nystagmus typically consists of slow eye movements in the direction of the moving stimuli (smooth pursuit) followed by quick, corrective movements in the opposite direction (saccades). The presence, symmetry, and quality of optokinetic nystagmus can provide valuable information about the integrity of the patient's visual system. The visual angle is calculated from the size of the stripe from the specific distance. Then it's converted into Snellen acuity.

Fig 2. OKN Drum test

Bock Candy bead test is done in children below 1 years of age. Different size colorful candy bead are placed on examiner's hand. If the child grab the bead and eat it signifies the child resolve the acuity of the size of the candy as small as 1mm. Although many researches have shown that this test only equivalent about 20/200 Snellen's acuity. The test should be done monocularly.

In case of any abnormality detected in examination of toddlers or infant electrodiagnostic tests or Teller acuity card test should be done to get precise measurement of visual acuity.

Assessment of Visual Acuity in preschool children includes:

- Lea Symbol chart
- Broken Wheel test
- HOTV test
- Landolt C test
- Tumbling E test
- Allen picture card test
- Lighthouse flashcard test
- Sjogren Hand test

A child of 3 years age developed almost all the visual abilities and also psychological and behavioral development. Thus subjective tests can be done but some special modifications that involve minimum verbal interactions and allows simple tasks like matching or pointing objects.

The Lea Symbols Chart Test is particularly useful for testing young children or individuals who may have difficulty with letter recognition, as it relies on simple geometric shapes instead. Additionally, it helps minimize the potential for memorization compared to letter-based charts, ensuring more accurate results, especially during repeated testing. It consists of 4 shapes (apple, house, square and circle). The child has to point out the similar object from a testing distance of 3meter. The chart consists of LOGMAR acuity and also provide Snellen acuity for each line. Similarly HOTV test consists of only 4 optotypes which is easier to recognized by a preschool child. In studies it has been found that Lea symbol chart is having high testability than HOTV test in 3 years old child. [4]

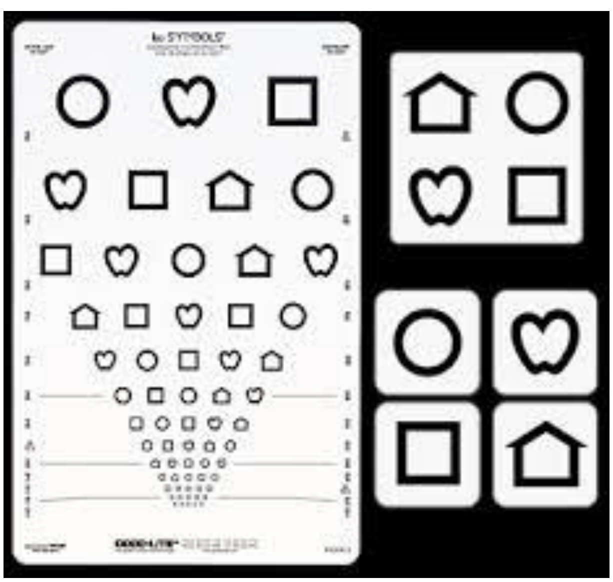


Fig 3. Lea Symbol chart

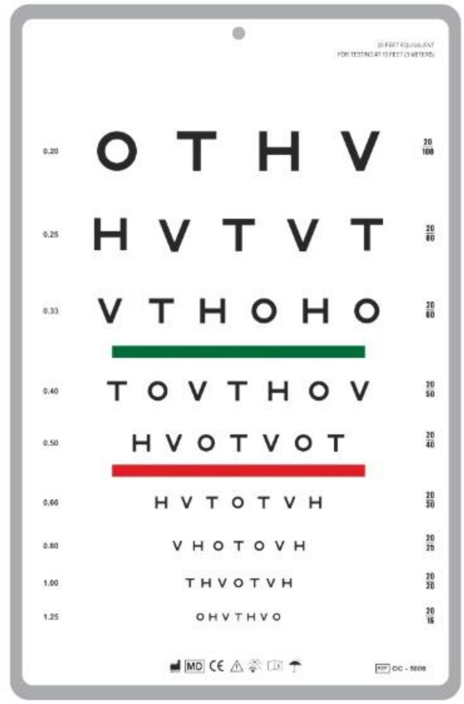


Fig 4. HOTV test chart

Broken wheel test also very interesting test to perform in child 3-5 years of age. This test card consists of 7 pairs of 5×7 inch cards that is shown from a distance of 6meter. The optotype ranges in a size from 20/100 to 20/20. If the child shows the broken wheels card correctly four pictures of a row then smaller size cards are then shown.

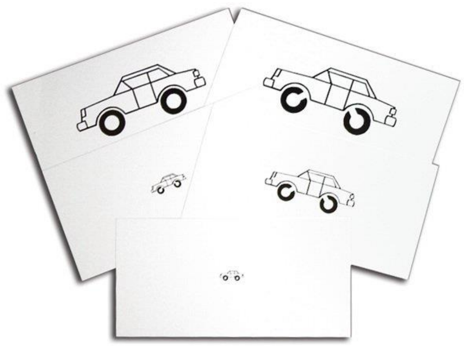


Fig 5. Broken wheel test

Landolt C test, tumbling E test and Sjogren Hand test are direction identification tests . The child has to identify the direction of the open side of the figures i.e left, right, up, down. The test should be done both monocularly and binocularly. The acuity represented in Snellen acuity.

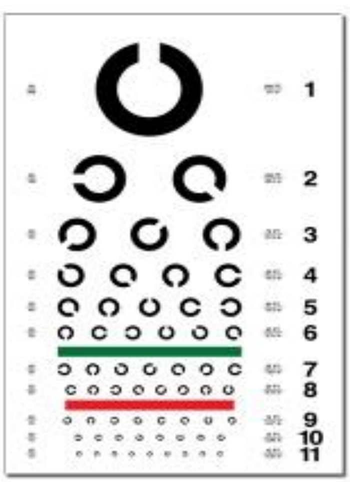


Fig 6. Landolt C Test

Though this test required accurate understanding of spatial orientation. It has been found that tumbling E test is found to be more accurate to understand the optotypes.

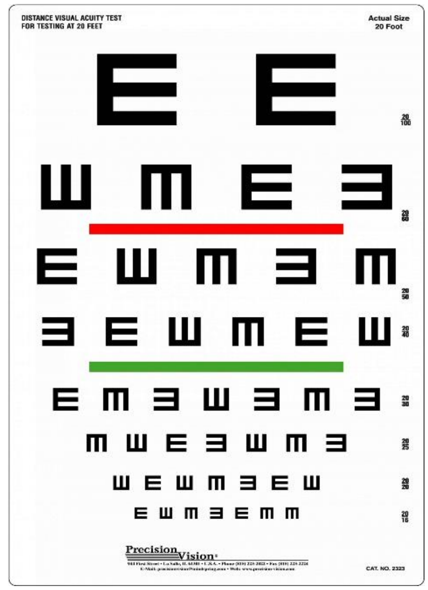


Fig 7. Tumbling E Test

Test like Allen picture card consists of 7 test plates of familiar shapes or objects. The test card designed for a standard distance of 30feet and can be converted into Snellen acuity easily. The child asked to point out the similar object from sample card or respond verbally.

Fig 8. Allen picture card test

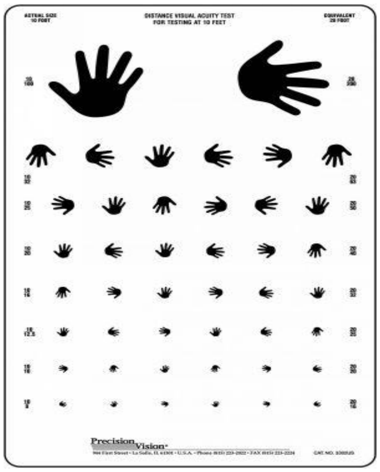


Fig 9. Sjogren Hand Test

Visual acuity of school aged children may be assessed with Snellen chart.

5.3.6 Refraction

The procedure of refraction in child is very different from adult. The procedure depends on the age of the child. The prescription mostly completely based on objective retinoscopy. After birth all the child with good health are usually found hypermetropic. Some less amount if astigmatism found to be present in children below one year but reduces with age. In preschooler age it is possible to take subjective visual acuity measurement but subjective refraction again remains challenging thus glass prescription rely on objective refraction. After 5 years of age it is possible to take visual acuity measurement and also follow subjective refraction like adults.

Measurement of refractive error in infant and toddlers involve only

- Cycloplegic retinoscopy
- Near retinoscopy

In preschoolers static retinoscopy and cycloplegic retinoscopy may be performed.

In school going child we can perform static retinoscopy, cycloplegic retinoscopy and subjective refraction.

Cycloplegic Retinoscopy

It is very important to choose the cycloplegic agent carefully based on the iris pigmentation, patient with Down syndrome, trisomy of chromosome 13/18, cerebral palsy children with Down syndrome, cerebral palsy, trisomy 13 and 18 and any CNS disorder. It can cause hypersensitivity reactions even in low weight child. Cyclopentolate hydrochloride 0.5% (below 1 year) , 1% (above 1 year) is a choice of drug. It is used twice in 5min interval and retinoscopy is performed 20-30 mins after last drop. A mixture of 0.5% cyclopentolate, 2.5% phenylephrine and 0.5% tropicamide can produce both cycloplegic and mydriatic effect. In studies it has been found that tropicamide 1% is a useful alternative of cyclopentolate in nonstrabismic infants.[5]

Near retinoscopy is an alternative technique in infants may be done in patients with hypersensitivity to cycloplegic drugs. Though it has been not found as reliable comparative to cycloplegic refraction. [6-8]

In Child below 1 year of age 2D of hypermetropia has been found , also it has been seen 2D of astigmatism in patients till 3 years of age.[9] Although this amount mostly reduces with age by 2.5 years to 5 years of age.[10-11] Thus it is advised to monitor this low amount of refractive error in children before prescribing. (Table 3)

Condition	Diopters beyond which glasses should be considered		
	Age 0-1 years	Age 1-2 years	Age 2-3 years
Isometropia			
Myopia	≥ - 4.00	≥ - 4.00	≥ - 3.00
Hyperopia (no eso)	≥ + 6.00	≥ + 5.00	≥ + 4.50
Hyperopia (eso)	≥ + 2.00	≥ + 2.00	≥ + 1.50
Astigmatism	≥ 3.00	≥ 2.50	≥ 2.00
Anisometropia			
Myopia	≥ - 2.50	≥ - 2.50	≥ - 2.00
Hyperopia	≥ + 2.50	≥ + 2.00	≥ + 1.50
Astigmatism	≥ 2.50	≥ 2.00	≥ 2.00

Table 3: Guidelines for refractive correction in infants and toddlers

For older children usually traditional procedures are followed that include cycloplegic refraction and subjective refraction . Retinoscopy may be performed with loose lens rock so that the examiner can observe the proper fixation of the child at distance.

Keratometry

Keratometry may be performed to evaluate the corneal astigmatism. Corneal reflection of the rings are observed to determine the corneal astigmatism. Intact circular ring indicate spherical cornea and distorted ring indicate toric cornea. For children hand held keratoscope is useful and acurate to detect astigmatism or any irregularities in the cornea.

Retinoscopy

Retinoscopy is a vital tool to assess refractive state in child. It is necessary to perform retinoscopy rapidly in infants and toddlers rapidly due to limited attention. To perform retinoscopy in infant may be necessary to attract attention at far distance by the parents with colorful toys or object. Retinoscopy can be easily performed on preschooler and older children as they easily fixate on then distance target. It is better to ask the child to read the target letters loudly to ensure the proper fixation while doing retinoscopy in child. The distance target should placed at 6meter.

Monocular Estimate Method (MEM)

The MEM retinoscopy is performed to evaluate the accommodative status of the eye. The test is performed at a near working distance of the child. The goal is to check whether the accommodative response is equal to the accommodative stimulus or not. The MEM card consists of letters , symbols or picture printed on the side that can be attached at the retinoscopy head with a center hole to observe the reflex of the patient's pupil. The child should wear their spectacle and asked to read the target letters loudly. The examiner should place the retinoscopy plane at slightly downgaze. The test should be performed very quickly. If with motion seen then plus lens used to neutralize indicates lag of accommodation. If against motion observed then it should be neutralized with minus lens indicates lead of accommodation. The lens should be placed quickly and estimation is done so to avoid alteration of accommodation system. Normal lag of accommodation is between +0.50D to +0.75D.

5.3.7 Binocular Vision & Ocular motility Assessment

Evaluation of binocular vision, accommodation system and ocular motility includes the following tests:

- Cover test
- Ocular motility test
- Near point of convergence
- Amplitude of accommodation
- Monocular estimated method
- Stereopsis
- Version and vergence
- Accommodative convergence versus accommodation ratio (AC/A ratio)
- Negative relative accommodation

➢ Positive relative accommodation

In infant and toddlers corneal reflex tests like Bruckner test, Krimsky test are the choice of evaluation of ocular deviation. Extraocular motility may be performed using interesting targets or pen light in all cardinal positions of gaze.

In preschool aged child also, the same tests may be performed to assess the binocular status. Cover test mat be performed at primary gaze. While measurement of NPC recording of both break point and recovery point is also necessary. Fusional vergence can be assessed objectively using prism bar step vergence test. Stereopsis can also be assessed with normal commercially available tests. Extraocular motility should be performed to check all the 6 cardinal direction of gaze.

In school aged child it has been found that the most prevalent ocular condition are accommodative and anomalies of binocular vision. [12] This conditions effects their school performance and the child experience symptoms like headache, eye strain, blurred vision, diplopia, skipped lines which decrease the comprehensive reading attention in child. [13,14-20] Evaluation of accommodation and vergence system also include fusional vergence amplitude, facility. Qualitative testing of eye movements like saccades, pursuits and fixation pattern should be assessed.

5.3.8 Ocular Health Assessment

Ocular health assessment in children include:

- Evaluation of anterior segment and ocular adnexa
- Intra ocular pressure measurement
- Evaluation of posterior segment
- Pupillary response
- Visual field screening

Color vision testing generally done with pseudoisochromatic test plates having high testability in preschool aged and in older child.

Intraocular pressure generally measures with help of Perkins hand held tonometer and tonopen. Another easier method is Keeler air puff tonometer. Tonopen gives a precise data in older child. To perform the test in infant may be done in sleeping condition also. If unable to perform the IOP with these method then conventional digital IOP measurement is also acceptable in infants.

Examination of the pupil size and observation of the reflex both direct and consensual in children is also necessary. In neonates pupils are small and equally round.

Evaluation of visual field may be done using confrontation test in pre school age children. Pediatric visual field testing devices may be used for school aged children and HVF also in older children.

Direct ophthalmoscopy is an objective method to evaluate the posterior segment of the eye in children. To perform the test in infant, mother may hold the baby horizontally in her arms or may be placed the baby on her shoulder. It is advised to avoid touching the face of the baby and the attention of the baby should be keep at different distance all over the room with help of assistant. Set the ophthalmoscope at zero power with white filter. The red reflex of both eyes should be compare. Then move towards the baby in slightly 15 degrees and shine the light through the pupil. It is necessary to note down that the reflex is clear and red.

5.4 Conclusion

After completion of the assessment Optometrist should analyze the report to diagnose and plan the management. In necessary cases proper referral to Ophthalmologist, pediatrician and other primary care practitioner are indicated.

References:

1. Behera, B. K., Prasad, R., & Shyambhavee (2022). Primary health-care goal and principles. *Healthcare Strategies and Planning for Social Inclusion and Development*, 221–239.
2. Mannava, Sunny; Borah, Rishi Raj1; Shamanna, B R. Current estimates of the economic burden of blindness and visual impairment in India: A cost of illness study. Indian Journal of Ophthalmology 70(6):p 2141-2145, June 2022.
3. Vashist, P., Senjam, S. S., Gupta, V., Gupta, N., Shamanna, B. R., Wadhwani, M., Shukla, P., Manna, S., Yadav, S., & Bharadwaj, A. (2022). Blindness and visual impairment and their causes in India: Results of a nationally representative survey. *PloS one*, *17*(7), e0271736.
4. Hered R, Murphy S, Clancy M. Comparison of the HOTV and Lea Symbols charts for preschool vision screening. J Pediatr Ophthalmol Strabismus 1997; 34:24-8.
5. Twelker JD, Mutti DO. Retinoscopy in infants using a near noncycloplegic technique, cycloplegia with tropicamide 1%, and cycloplegia with cyclopentolate 1%. Optom Vis Sci 2001; 78(4):215-22.
6. Saunders KJ, Westhall CA. Comparison between near retinoscopy and cycloplegic retinoscopy in the refraction of infants and children. Optom Vis Sci 1992; 69:615-22.
7. Borghi RA, Rouse MW. Comparison of refraction obtained by "near retinoscopy" and retinoscopy under cycloplegia. Am J Optom Physiol Opt 1985; 62:169-72.
8. Wesson MD, Mann KR, Bray NW. A comparison of cycloplegic refraction to near retinoscopy technique for refractive error determination. J Am Optom Assoc 1990; 61:680-4.
9. Banks M. Infant refraction and accommodation. Int Ophthalmol Clin 1980; 20(1):205-32.
10. Gwiazda J, Mohindra I, Brill S, Held R. Infant astigmatism and meridional amblyopia. Vision Res 1985; 25:1269-76.
11. Mohindra I, Held R, Gwiazda J, Brill S. Astigmatism in infants. Science 1978; 202:329-30.
12. Scheiman M, Gallaway M, Coulter R, et al. Prevalence of vision and ocular disease conditions in a clinical pediatric population. J Am Optom Assoc 1996; 67:193-202.
13. Scheiman M, Rouse MW. Optometric management of learning related vision disorders. St. Louis, MO: CV Mosby, 1994:321- 2.
14. Duke-Elder S. System of ophthalmology, vol V. Ophthalmic optics and refraction. St. Louis, MO: CV Mosby, 1970:451- 86.
15. Daum KM. Accommodative dysfunction. Doc Ophthalmol 1983; 55:177-98.
16. Hennessey D, Iosue R, Rouse MW. Relation of symptoms to accommodative infacility of school aged children. Am J Optom Physiol Opt 1984; 61:177-83.
17. Haddad HM, Isaacs NS, Onghena K, Mazor A. The use of orthoptics in dyslexia. J Learn Disabil 1984; 17:142-4.
18. Sheedy JE, Saladin JJ. Association of symptoms with measures of

oculomotor deficiencies. Am J Optom Physiol Opt 1987; 55:670-6.
19. Ludlam WM, Ludlam DE. Effects of prism-induced accommodative convergence stress on reading comprehension. J Am Optom Assoc 1988; 59:440-5.
20. Garzia RP, Nicholson SB, Gaines CS, et al. Effects of nearpoint visual stress on psycholinguistic processing in reading. J Am Optom Assoc 1989; 60:38-44.

Enhancing Performance Through Sports Vision Training

Dipanwita Ghosh,

PhD Scholar, M.Optom, B.Optom, C.C.E.H

Assistant Professor & Head

Department of Optometry

Swami Vivekananda University

Enhancing Performance Through Sports Vision Training

6.1 Introduction

Sports vision encompasses the visual skills necessary for optimal performance in athletic activities. From tracking a fast-moving ball to judging distances accurately, athletes rely heavily on their visual system to succeed in their respective sports. We will discuss about the significance of sports vision training in enhancing athletic performance, the key visual skills involved, and the methodologies used to develop and improve these skills. Athletes rely heavily on their visual abilities to excel in their respective sports. From tracking fast-moving objects to making split-second decisions, the visual demands placed on athletes are diverse and rigorous. This chapter delves into the specific visual requirements of athletes across various sports and the implications for training and performance enhancement.

6.2 Understanding Sports Vision

Vision is not solely about seeing clearly; it involves a complex interplay of various visual skills. In sports, these skills include eye-hand coordination, dynamic visual acuity, peripheral vision, depth perception and visual reaction time. Each of these skills plays a crucial role in different sports, from baseball and basketball to soccer and tennis.

6.2.1 Dynamic Visual Acuity

Dynamic visual acuity refers to the ability to see objects clearly while they are in motion. In sports like baseball or cricket, where the ball travels at high speeds, athletes with superior dynamic visual acuity can track the ball more effectively, giving them an advantage in timing their actions. Athletes must maintain clear vision even when objects are in motion. This skill is crucial in sports such as baseball, tennis, and soccer, where athletes need to track fast-moving balls accurately.

Measuring dynamic visual acuity (DVA) involves assessing an individual's ability to see objects clearly while they are in motion. Several methods can be used to quantify DVA, each with its own advantages and limitations. Here are some common approaches:

1. Computerized Tests

Computerized tests present moving stimuli on a screen, and participants are required to identify characteristics of these stimuli, such as letters, shapes, or symbols. The stimuli may move horizontally, vertically, or in other directions at varying speeds. The participant's responses are recorded, and their accuracy or reaction time is measured. Examples of computerized DVA tests include:

Tachistoscope Tests: Present stimuli for brief durations, requiring participants to identify them accurately despite their rapid movement.

Flicker Tests: Display rapidly alternating images to assess participants' ability to perceive moving objects accurately.

2. Vision Tracking Systems

Vision tracking systems utilize specialized equipment to track participants' eye movements as they attempt to follow moving objects. By analyzing eye movement patterns and gaze fixation points, these systems can provide insights into an individual's dynamic visual tracking abilities.

3. Clinical Assessments

In a clinical setting, optometrists or ophthalmologists may perform DVA assessments using standardized visual acuity charts or equipment. These assessments typically involve presenting moving targets or optotypes at specific distances and speeds, with the participant indicating their ability to discern the details of the stimuli.

4. Sports-Specific Tests

Some sports-specific assessments incorporate dynamic visual tasks relevant to particular athletic activities. For example, in baseball or cricket, athletes may be tested on their ability to track a moving ball accurately using specialized equipment or simulated game scenarios.

6.2.2 Depth Perception

Depth perception allows athletes to accurately judge distances between objects in their environment. Accurate depth perception is essential for judging distances and spatial relationships between objects. In sports such as golf or archery, precise depth perception is essential for accurately aiming at targets situated at varying distances.

Measuring stereopsis and depth perception involves assessing an individual's ability to perceive depth and spatial relationships accurately. These visual skills are essential for various activities, including sports, navigation, and tasks requiring hand-eye coordination. Here are several common methods used to quantify stereopsis and depth perception:

1. Stereopsis Tests

Random Dot Stereograms:

Participants view images containing randomly distributed dots, with some dots forming a pattern that creates a sense of depth perception when viewed with both eyes. The Stereo Fly Test and the Randot Stereotest are examples of random dot stereograms used for assessing stereopsis.

Titmus Fly Test:

This test uses polarized glasses and a book of stereoscopic images to assess stereopsis. Participants identify specific figures or patterns that appear three-dimensional when viewed with both eyes.

2. Depth Perception Tests

Frisby Stereotest:

Participants identify the orientation or position of three-dimensional shapes presented at varying depths. The Frisby Stereotest assesses both stereopsis and depth perception by requiring participants to manipulate shapes to match a reference model.

Random-Dot Kinematograms:

These tests involve moving random dot patterns presented on a screen to create the illusion of depth. Participants may be asked to identify the direction of motion or judge the relative depth of objects within the stimuli.

3. Clinical Assessments

Randot Stereoacuity Test:

This clinical test uses polarized glasses and a series of graded circles to assess stereoacuity, which is the smallest binocular disparity (difference in retinal images between the two eyes) that can be perceived. Results are typically reported in seconds of arc.

Howard-Dolman Test:

This test measures depth perception by presenting participants with a series of three-dimensional shapes or objects at different distances. Participants identify the order of the objects based on their perceived depth.

4. Virtual Reality (VR) Simulations

VR-Based Depth Perception Tasks:

Participants interact with virtual environments containing objects at various distances. Tasks may include reaching for virtual objects, judging distances accurately, or navigating obstacles within the virtual space.

6.2.3 Peripheral Vision

Peripheral vision enables athletes to be aware of their surroundings without directly focusing on them. It is crucial in team sports like basketball or soccer, where players need to be constantly aware of the positions of teammates, opponents, and the ball, even when it is not within their central field of vision.

Measuring peripheral vision involves assessing an individual's ability to detect and recognize visual stimuli located outside the central field of view. Peripheral vision is crucial for situational awareness, navigation, and detecting objects or movements in the environment. Here are several common methods used to quantify peripheral vision:

1. Confrontation Visual Field Testing

Finger Counting:

During a confrontation visual field test, the examiner or participant raises fingers in the periphery of their visual field while the participant maintains fixation on a central target. The participant then counts the number of fingers presented in each visual quadrant.

Static Perimetry:

Static perimetry assesses the visual field's sensitivity by presenting stimuli at various locations within the peripheral visual field. Participants indicate when they detect the stimuli using a button or keypad. The results are plotted on a visual field map to assess sensitivity across different regions.

2. Kinetic Perimetry

Goldmann Perimetry:

Goldmann perimetry involves systematically moving a target, typically a colored or illuminated stimulus, from the periphery towards the central visual field. Participants indicate when they first detect the target's movement or appearance. This method assesses the visual field's extent and sensitivity to moving stimuli.

3. Automated Perimetry

Humphrey Field Analyzer (HFA):

The HFA is a computerized device that presents stimuli of varying brightness levels at different locations within the visual field. Participants respond when they detect the stimuli, and the results are analyzed to assess sensitivity across the visual field.

4. Clinical Assessments

Amsler Grid Test:

The Amsler grid consists of a grid of horizontal and vertical lines with a central fixation point. Participants view the grid with each eye separately and identify any distortions, missing areas, or other abnormalities in the grid's pattern, indicating potential peripheral vision deficits

6.2.4 Eye-Hand Coordination

Eye-hand coordination involves the synchronization of visual input with motor responses. It is fundamental in sports like tennis or table tennis, where athletes must precisely time their movements to meet a moving object with their racket or paddle.

Measuring eye-hand coordination involves assessing the ability of an individual to synchronize visual input with motor responses accurately. Several methods can be used to quantify eye-hand coordination, each focusing on different aspects of this skill. Here are some common approaches:

1. Targeted Tasks

Pegboard Test:

Participants are asked to insert pegs into corresponding holes on a pegboard as quickly and accurately as possible. This test assesses fine motor control and coordination.

Coin-Stacking Task:

Participants are tasked with stacking coins or small objects into a tower using tweezers or their fingers. This test evaluates precision, dexterity, and spatial awareness.

2. Object Manipulation Tasks

Dexterity Tests:

These tests involve manipulating objects of varying sizes, shapes, and textures using hands or handheld tools. Tasks may include assembling puzzles, threading needles, or sorting objects based on specific criteria.

Finger Dexterity Tests:

Participants perform specific finger movements or sequences, such as tapping fingers in a coordinated pattern or rapidly moving fingers between designated points. These tests assess finger agility and coordination.

3. Virtual Reality (VR) Simulations

VR-Based Coordination Games:

Participants interact with virtual environments using hand-held controllers or gestures. Tasks may include catching virtual objects, navigating obstacles, or completing hand-eye coordination challenges within the virtual space.

4. Biomechanical Analysis

Motion Capture Systems:

High-speed cameras and motion capture technology track participants' hand movements with precision. This allows for detailed analysis of movement trajectories, velocities, and coordination patterns during specific tasks.

6.2.5 Visual Reaction Time

Visual reaction time is the speed at which an athlete can respond to a visual stimulus. In sports such as boxing or basketball, quick reactions can mean the difference between success and failure. Quick reaction times are vital in sports like sprinting, basketball, and martial arts, where athletes must respond rapidly to visual stimuli to gain a competitive edge.

Measuring visual reaction time involves assessing how quickly an individual can respond to a visual stimulus. Visual reaction time is crucial in various situations, including sports, driving, and occupational tasks that require rapid responses to visual cues. Here are several common methods used to quantify visual reaction time:

1. Simple Reaction Time Tasks

Choice Reaction Time Test:

Participants are presented with multiple stimuli, each associated with a specific response. They must quickly identify the correct stimulus and execute the corresponding response. This task assesses the time taken to discriminate between stimuli and initiate a motor response.

2. Clinical Assessments

Light or Sound Trigger Tests:

Participants are instructed to press a button or perform a specific action in response to the sudden appearance of a light or sound stimulus. The time between stimulus onset and response execution is recorded using specialized equipment.

3. Computerized Tasks

Go/No-Go Tasks:

Participants are presented with a series of visual stimuli and instructed to respond (e.g., press a button) when a specific target stimulus appears (Go trials) while refraining from responding to other stimuli (No-Go trials). Reaction times are measured for correct responses to Go trials.

Computerized Reaction Time Tests:

Computerized programs present visual stimuli on a screen, and participants are instructed to respond as quickly as possible when a target stimulus appears. Reaction times are recorded automatically by the software.

4. Sports-Specific Assessments

Reactive Agility Tests:

Athletes perform agility drills or sports-specific movements in response to visual cues, such as changes in direction or the appearance of a target stimulus. Reaction times are measured based on the time taken to initiate the required movement.

6.3 Sport-Specific Visual Demands

Team Sports

In team sports such as basketball, soccer, and volleyball, athletes must quickly scan the field or court, anticipate opponents' movements, and make split-second decisions based on visual cues from teammates and opponents.

Individual Sports

In individual sports like tennis, golf, and archery, athletes rely heavily on their visual skills to aim accurately, track the trajectory of the ball or target, and adjust their movements accordingly.

Combat Sports

Combat sports such as boxing, mixed martial arts (MMA), and fencing require athletes to react swiftly to opponents' movements, anticipate strikes, and maintain focus and concentration under pressure.

6.4 Sports Vision Training Methodologies

Sports vision training aims to improve these visual skills through targeted exercises and drills. These may include:

1. Ocular Motor Exercises: Activities that enhance eye movement control, such as tracking moving objects or following patterns.

2. Visual Awareness Drills: Exercises designed to expand peripheral vision and increase awareness of the entire visual field.

3. Depth Perception Training: Techniques to improve depth perception, such as virtual reality simulations or specialized equipment that alters visual depth cues.

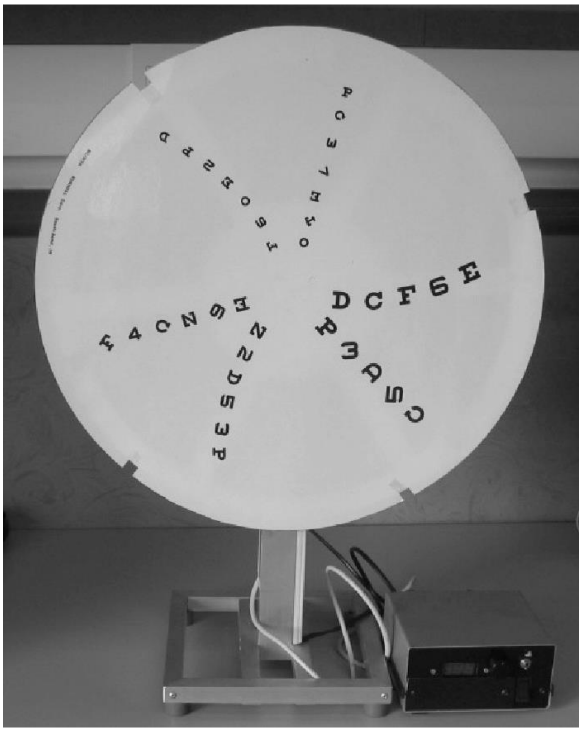


Fig 2. Bernell’s Rotator

4. Hand-Eye Coordination Drills: Practice routines that challenge athletes to synchronize visual input with motor responses, such as juggling or ball-catching exercises.

Fig 3. Marsden Ball with stick exercise

5. Reaction Time Training: Activities focused on improving the speed and accuracy of visual responses, such as reacting to visual cues with specific movements.

6. Cognitive Training

Cognitive training techniques, including visual attention and decision-making exercises, can sharpen athletes' mental processing speed and improve their ability to interpret and respond to visual information effectively.

7. Technology Integration

Incorporating advanced technologies such as virtual reality (VR) simulations, eye-tracking systems, and neurofeedback devices into training regimens can provide athletes with valuable feedback and enhance their visual performance in simulated game-like environments.

6.5 Conclusion

Sports vision training plays a vital role in enhancing athletic performance by improving the visual skills necessary for success in sports. By understanding the importance of eye-hand coordination, dynamic visual acuity, peripheral vision, depth perception and visual reaction time, athletes and coaches can implement targeted training methodologies to maximize their visual capabilities and gain a competitive edge on the field or court.

This chapter provides an overview of the importance of sports vision and strategies for training visual skills to enhance athletic performance.

References:

1. Hitzeman SA, Beckerman SA. What the literature says about sports vision. Optom Clin. 1993;3(1):145-69. PMID: 8324322.

2. Abernethy B.(1996) Training the Visual-Perceptual Skills of Athletes. Insights from the study of motor expertise. *The American Journal of Sports Medicine* 224(6), 89-92.

3. Abernethy B., Wood J.M.(2001) Do generalized visual training programs for sport really work? An experimental investigation. *Journal of Sports Sciences* 119, 203-222.

4. Abernethy B., Wood J.M., Parks S.(1999)Can the anticipatory skills of experts be learned by novices? *Research Quarterly for Exercise and Sport* 770, 313-318.

5. Adam J., Paas F., Buekers M., Wuyts I., Spijkers W., Wallmeyer P.(1999) Gender differences in choice reaction time: evidence for differential strategies. *Ergonomics* 442(2), 327-335.

6. Allen R., McGeorge P., Pearson D.G., Milne A.(2006) Multiple-target tracking: a role for working memory. *The Quarterly Journal of*

Experimental Psychology 59, 1101-1116.

7. Allen R., McGeorge P., Pearson D., Milne A.B.(2004) Attention and expertise in multiple target tracking. *Applied Cognitive Psychology* 118, 337-347.

8. Alvarez G.A., Franconeri S.L.(2007) How many objects can you track? Evidence for a resource-limited attentive tracking mechanism. *Journal of Vision* 77(13:14), 1-10.

9. Bressan E.S.(2003) Effects of visual skills training, vision coaching and sports vision dynamics on the performance of a sport skill. *African Journal of Physical, Health Education, Recreation and Dance* 99(1), 20-31.
10. Bressan E.S.(2003) Effects of visual skills training, vision coaching and sports vision dynamics on the performance of a sport skill. *African Journal of Physical, Health Education, Recreation and Dance* 99(1), 20-31.
11. Maman P., Sandeep K.B., Jaspal S.S.(2011) Role of sports vision and eye hand coordination training in performance of table tennis players. *Brazilian Journal of Biomotricity* 55(2), 106-1.

INTRODUCTION TO CONTACTOLOGY

Dr. Manas Chakraborty,

D.H.M.S , D.O.S, D.C.L.P, B.OPTOM, M.OPTOM

Assistant Professor

Department of Optometry

Swami Vivekananda University

Introduction to Contactology

7.1 Introduction

Contact lenses are thin, curved surface placed directly over the surface of the eye to correct vision and are used for cosmetic & therapeutic purposes. Contact lens made up of flexible plastic material that allows oxygen to pass through to the eye. The function of contact lenses depends on wettability, water content, oxygen permeability, oxygen transmissibility, light transmissibility, refractive index, and resistance to temperature, dimensions and flexible stability. It's a popular alternative to eye glasses as they are less noticeable and can providewider field of vision.

7.2 History of contact lens

In 16th century the renowned Italian scientist inventor & artist Leonardo Da Vinci first sketched the concept of the contact lens. The concept of sketch was how the refractive error can be corrected by looking through the bottom of a glass bowl filled with water.Thus, the concept of contact lens came up and the ideas have been modified and developed in times. Such concept happened on 1508. In 1638 French philosopher Rene Descartes also given the concept of a glass tube filled with liquid which placed directly over the cornea for the correction of refractive error. As it placed over the corneal surface, there were problems for blinking properly and that's why the concept rejected. In 1801 Thomas Young made a pair of contact lenses by using wax and it affixed water filled lenses on the eyes to neutralize the refractive errors.

In 1823 the British astronomer demonstrated the practical contact lens design and in 1887 Muller, German physicist created the first glass contact lens design. At the same time Swiss physician Adolf E Fick and Paris optician Edouard Kalt made and fitted the first glass contact lenses to correct vision problem in the year 1888. In 1939 contact lens design and material modified from glass to plastic. In 1948 such plastic contact lenses worn on to the cornea as corrective corneal lenses. Californian optician Kevin Tuohy resembled the modern gas permeable contact lenses which are the most popular contact lenses now days.

The revolution happened in the history of contact lenses when the first hydrophilic hydrogel soft contact lens material invented by Czech chemist Otto Wichterle and Drahoslav Lim in 1959 in which led to launch of the first FDA approved soft contact lensin United States in the year 1971 by Bausch & Lomb's SOFLENS brand as contact lens.

In 1887-88 the gas permeable contact lenses introduced but gradually modification made and in 1978 finally modern gas permeable contact lens established.

In 1981 extended wear soft contact lenses produced which could be worn overnight. In 1986 again modified gas permeable contact lens made of fluroperm material introduced where oxygen transmissibility is highest (RGP). In 1987 disposable soft contact lens established and the concept of planned replacement therapy introduced.

Specifically in 1996 one day disposable (daily disposable) contact lens introduced.

In 2002 another remarkable materials Silicon amalgamate with Hydrogel material (soft) formed silicon hydrogel material of soft contact lens which has great value in transmitting the oxygen near about 95% for maintaining the absolute nutrition of the cornea.

In 2010 total custom made contact lenses manufactured for the benefit of corneal health and the clarity of vision with optimum comfort.

Soft contact lens made of hydrogel and silicon hydrogel materials have been huge success and become the most popular.

7.3Classification of contact lenses

Based on purpose of use contact lens can be classified into,

a) Optical
b) Therapeutic
c) Cosmetic
d) Soft contact lens

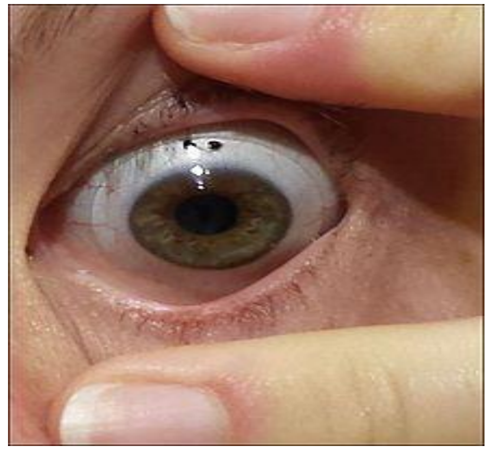
Tinted contact lens
Scleral lens fitting

7.3.1 Based on Anatomical location

->Corneal contact lens

->Scleral contact lens

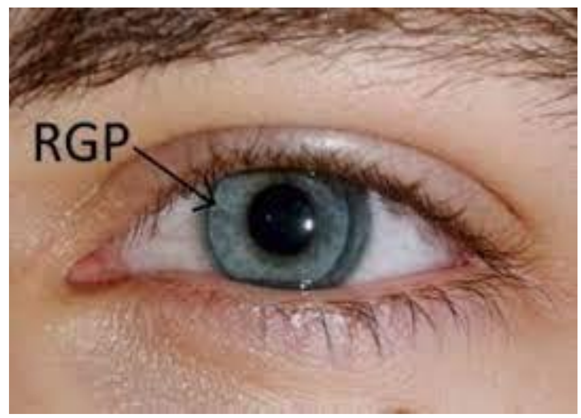
->Semi scleral contact lens



7.3.2Nature of contact lens

->Rigid non gas permeable contact lens (PMMA)

-> Rigid gas permeable contact lens (CAB)-> Soft contact lens made up of Hydrogel and



Silicon Hydrogel

-> Hydrogel having low oxygen transmissibility (less than 50%), Silicon Hydrogel have high oxygen transmissibility (near about 95%)

→ Filcon-- these are hydrophilic, non-rigid lens material.

→Focons—these are hydrophobic rigid lens materials.

7.3.3 Classification based on wearing schedule

→ Daily wear contact lenses
->Hard (non-gas permeable)

->Rigid gas permeable

-> Soft Hydrogel.

→ Extended wear contact lens

->Highwater content soft contact lens (more than 50%)

→Disposable contact lenses made of silicon hydrogel.

7.3.4Classification based on water content

→High water content lens (more than 50%)

→Low water content lens (less than 50%)

7.3.5 FDA Classification

Group 1

→ Low water content, Nonionic polymers (Tefilcon, Tetrafilcon A, Lotrafilcon, galyfilcon)

Group 2

→High water content, Nonionic polymers (Alphafilcon A, Omafilcon A, Omafilcon, Afilcon A)

Group 3

→Low water content, ionic polymers (Balafilcon A, Deltafilcon A, Bufilcon A)

Group 4

→High water content, ionic polymers (Etafilcon, Etafilcon A, Ocufilcon D)

7.3.6 Anomalies of Refraction

-> Refractive anomalies that mean errors in refraction while the light rays either focus in front or behind the sensitive retina responsible for blurry image formation also termed as Ametropia.

-> Refractive anomalies can be classified into 4 types

Myopia: When light rays are focusing in front of retina also called near sightedness. Myopia can be corrected with the help of concave spherical lenses.

Hypermetropia: When light rays are focusing behind the retina also called as far sightedness. Hypermetric conditions can be corrected with convex spherical lenses.

Astigmatism: When particular meridian of a refractive surface is responsible for excess or less amount of focus due to surface irregularity and ultimately cause to distorted blurry vision can b corrected with cylindrical lens.

Presbyopia: Physiological loss of accommodation may cause less amount of focusing capacity responsible for hypermetropic condition during near vision. The amount of refractive error based on the amount of accommodation losing connected with aging. Additional plus lens provided with the regular correction to correct such types of near refractive errors.

Symptoms of refractive errors:

->Double vision

->Hazy vision

-> Glare and halo appearance

->Strabismus conditions

->Headache

->Eye stress

->Trouble while changing focus from distance to near or intermediate vision zones.

Refractive errors can be managed by providing

->Eyeglasses

->Contact lens correction

-> Refractive Surgery

Diagnosis and management procedures can be described as medical &ocular history taking, Visual acuity testing, Refraction, finding acceptance and correction, comprehensive eye examinations.

Here we will briefly discuss about dispensing contact lenses to correct the refractive errors and its fitting procedures with assessment.

7.4Indicationand contraindication of Contact lens

5.4.1Indications

->Contact lenses are simply used in

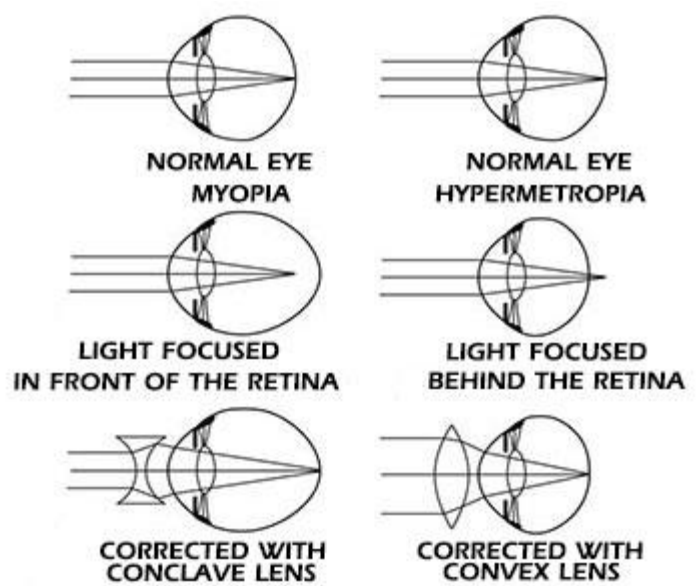
1) Optically for high refractive error correction specially Myopia, Unilateral Aphakia, Irregular Astigmatism, Anisometropia, Keratoconus.

2) In case of iris deformities such as Aniridia, Coloboma, Albinism.

3) In Glaucoma drug delivery system.

4) Operative - Pars plana vitrectomy, Photo coagulation, Goniotomy, post vitreo retinal surgery in some cases epithelial defect.

5) Diagnostics- Gonioscopy, Electro Retinography, Fundus examination in



patients with astigmatism, fundus photography.

6) Therapeutic: Corneal pathologies, Pseudo Aphakic Bullous Keratopathy, Corneal ulcer, Recurrent corneal erosion syndrome, Fillamental Keratitis, Post superficial keratectomy, Dry eyes, Post keratoplasty, Post cornel tear repair – microleak.

7) Pediatric: Amblyopia Opaque contact lens for occlusion.

8) Preventive: Trichiasis, Exposure Keratitis, Prevention of symblepharon.

9) Occupational: Sportsmen, Police, and Pilot.

10) Cosmetic: Pthysis bulbi, corneal scur

7.4.2 Contraindications

1) Absolute contraindication:

Chronic dacryocystitis, dry eyes, hordeolum Internum and externum, Uveitis, Blepharitis, conjunctivitis, Scleritis, 5^{th}& 7^{th} nerve palsy, Allergic conjunctivitis, Superficial punctate keratitis, Sub epithelial keratitis, Corneal ulcer.

2) Relative contraindication:

Pregnancy,

Giant papillary conjunctivitis, Strabismus conditions.

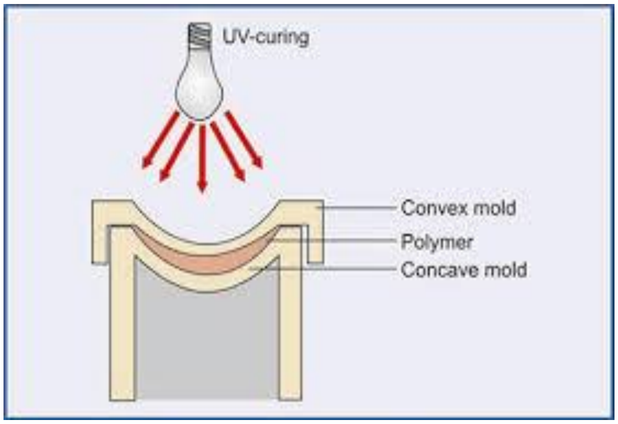
3) Corneal hypoaesthasia

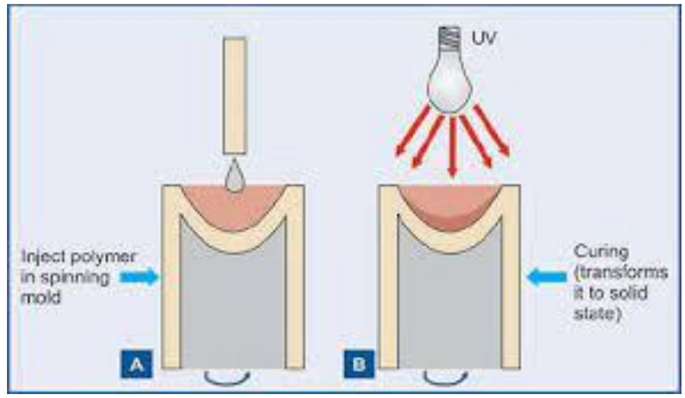
7.5.1 Manufacturing techniques for Soft Contact lens

-> Contact lens manufacturing process is a complex technique involving cutting, quality testing, sterilization and tools setting for incorporating dioptric power in it also involves in choice of materials and the production technology.

The semi molded manufacturing ->

The prime thing of semi molded manufacturing is lathe cutting. Lathe cutting is the technique where small hard disk of contact lens (blank) material on a rotating shaft which rotates at 6000 revolutions per minute and shaped with a computerized cutting tool. After making the lens it goes through different stages of shaping, polishing, hydration and then quality assurance with sterilization process. In this manufacturing process the focus is to control human factors.





The full molded manufacturing ->

The full molding process mainly uses precision molds to form contact lens at one time through a numerical control mode mainly injection molding process. Injection molding is the process of heating the soft contact material to a liquid state and then injecting it into a precise pressurized mold. After molding polishing moisturizing and quality assurance test are performed.

Cast molding:

Cast molding is the process of designing a mold, injecting liquid material into the mold then hardening it with high temperature and pressure then demolding grinding, polishing and finally hydrating it into a finished product.

Most disposable contact lenses are manufactured by this method.

Spincasting:

Liquid material of contact lens injected into the rotating mold and the centrifugal force, gravity and surface tension forming smooth film which is then hydrated into a finished product.

7.5.2 Manufacturing techniques for rigid Contact lens

The majority of rigid contact lenses are made by lathe cut technique rather than molded. The following manners to be followed;

->Contact lens blank buttons are cut from a rod of plastic that looks like a curtain rods.

->The inside curve is then cut and polished. In this stage the lens is referred to as a semi-finished blank.

->The front surface is than cut and polished.

->Intermediate and peripheral curves are applied.

-> The edge is then finished and this is now a completed RGP lens.

#Modification of finished lens

->**Diameter reduction**:

The lens is mounted concave side up on a rotating spindle and the blade of the razor or knife is rocked back and forth on the edge. The file and emery board are used mainly for small reduction of lens diameter. When the lens has been reduced the intermediate peripheral curves must be applied and blended.

->**Blending**:

Blending is done to make the junction between intermediate and peripheral zone smooth finishing. In this process the lens is held by a suction cup and rotated on the tool in the opposite direction to the tool rotation.

->**Edge shaping**

If a lens has a secondary curve but no bevel. Then it is necessary for shaping the edge of the lens. The edge will be smooth and rounded by the help of a file or razor blade. After shaping the edge, it is polished by a rag wheel, or a felt disc or a sponge.

->**Power Change**

Velveteen and drum tool are used. Velveteen is soaked with water and then pulled over the sides of a drum tool and fastened tightly with rubber bands. A depression is formed in the tool the lens is held by a brass lens holder and suction cup. To add plus power the lens is held so that the convex surface is against the velveteen and is exactly centered on the tool. To add minus power the lens is held so that the convex surface is against the velveteen at the outer edge of the tool. The lens is rotated once or twice a full 360 degree against the rotation of the tool.

->Peripheral curve

Peripheral curve can be applied by the use of a tool having a radius of curvature of 12.25, 11.5, 10.5, 9.5. Lens is carefully mounted over the lens block so that it is not act angle. It may be fixed by a double-sided tape. The block is kept perpendicular to the tool that means concave side down and Sharp pointed pencil acts as a spindle. The polishing agent (X-PAL) is applied to the surface of a radius tool and lens is held so that the concave surface rests lightly against the tool, revolving at about 1500RPM. The entire edge of the lens must touch the tool at the same time. Equal pressure should be exerted on all meridians of the lens.

-> Removing Scratches:

During the Scratch removing time care should be taken so as not to deformed the optics of the lens. In some cases, new lenses affected optically by scratches that should be removed carefully. During the scratch's removal process from the rigid lenses, the lens is fitted with a suction cup or a spindle against the velveteen covered drum when it is rotated.

X-PAL polishing agent is used to remove scratches from the inside (Base curve) of a lens. Convex shaped tool is used to remove the scratches and polish the lens with X-PAL. The best procedure to use sponge tool to remove scratches from inside of a lens.

7.6 Contact lens materials for soft and rigid contact lens

(Rigid)

→Hard (Rigid non gas permeable) contact lens made up of PMMA (Poly Methyl Methacrylate) having negligible oxygen transmissibility with less wearing time and comfortability. That is why it is becoming most unpopular.

→Rigid Gas permeable contact lenses made up of CAB (Cellulose Acetyl Butyrate),silicone (high O2 transmissibility with less wettability), Styrene(less O2 transmissibility with good wettability), Silicon Acrylate, Fluoropolymers having more oxygen transmissibility than PMMA.

→ Cellulose Acetyl Butyrate (CAB) is type of thermoplastic material and derivative of wood cellulose. It has good wettability but disadvantage is the tendency to wrap.

→Silicon Acrylate materials are the co-polymers of PMMA and silicon Vinyl monomers, such two mixed materials unitedly known as Siloxanyl Methacrylate. MMA have the standard wettability and silicon material have the quality of high oxygen transmissibility. Silicon content can be altered and manufactured with different Dk values with high oxygen permeability.

→Fluoropolymers:

RGP lenses with co-polymer of Fluorine, which have high oxygen permeability and high-quality surface properties lead to extended wear contact lenses.

(Soft)

Hydrogel lenses (Hydroxyethyl Methacrylate):

→These soft lenses are widely used, made of Hydroxyethyl Methacrylate which are resistant to any chemical or enzymatic reaction biodegradation and can bear with the chemical & thermal sterilization.

Silicon Hydrogel lenses

→These lenses have high Dk value and low water content. The silicon material satisfies the high oxygen transmission capacity so such lenses are used for prolonged wearing schedule.

High Water content lenses

→ These are more than 60% water content lenses used for increased exposure of the cornea to atmospheric gases as it has high water content characteristics so reduced lens thickness also can deliver much amount of oxygen delivery within the lenses so more oxygen reaches to cornea. This type of lens is considered to be easier to handle when inserting, removing and disinfecting.

Disadvantage of this type of lens that it can draw out tears from eye surface to maintain its moisture and responsible to drying out of eye in sometimes.

7.7 Contact lens properties

7.7.1 Refractive index

Refractive index of a contact lens material is an important physical parameter that effects the lens design as the refracting power of a lens for any given thickness and curvature is directly related to its refractive index. It is also an indirect measure of the water content of a soft contact lens, the RIs are closely corelated with the water content. Contact lenses are worn on the eyes have index of 1.42-1.52 and thickness is 0.2 mm. The equation that relates the focal length of a spherical lenses to the index of refraction of the lens and radii of curvature for the front and back surfaces is called Lens Maker's Equation.

Lens Maker's Equation:

$\mathbf{1/F = (n-n_0)(1/r_1-1/r_2)}$ where $\mathbf{n_0}$=1.00 for air.

7.7.2 Water content

Water content is an important feature of soft contact lenses.Water enriches contact lenses with oxygen so the high-water content lens becomes more oxygen permeable. This is why the patient gets more comfortable wearing and breathable cornea. According to water content the contact lenses can be divided into 3 different categories such as,

- **High water content lens.** (percentage of water content is 61%-75%). Not only wearing comfort but also easier to handle when inserting, removing and disinfecting.
- **Mid water content lens. (**41%-60% water content)

Suitable for flowing oxygen to the cornea without absorbing the water of the natural tear film. Also, comfortable to wear, inserting, removing, cleaning & disinfecting.

➔ **Low water content lens** (25%-40% water content)
Helpful for comfortable wearing and the breathable eye without drying out the cornea.

7.7.3 Oxygen permeability

It is the parameter of a contact lens that denotes the ability of lens to let oxygen reach the eye by diffusion that means how easily oxygen passes through the particular material. In soft contact lenses the oxygen permeability depends on the thickness and material of the lens especially concerning the water content because permeability depends on lens thickness. Oxygen permeability denotes by Dk where "D" denotes the Diffusion coefficient and "K" denotes Solubility co-efficient.

7.7.4 Oxygen and light Transmission

Oxygen transmissibility depends on the thickness of lens and lower thickened have the tendency to pass through oxygen quickly. It is denoted by **Dk/t** where **"t"** is the thickness of the contact lens.

Light transmission properties depend on the optical properties of the material of the contact lenses. Light converging capability, refractive index, surface smoothness, transparency, thickness, abbe value (chromatic dispersion), specific gravity, UV rays absorbing property etc. may interfere light transmission through a particular material. All these are the inherent properties of contact lenses.

7.7.5 Wettability

Wettability means how easily a liquid spread over the surface of a contact lens. Wettability can be quantified by the contact angle. Contact angle is specific angle which is formed between drop of liquid and the surface of the lens, where contact angle is low then the wettability of that surface is high.

7.8 Conclusion

The introduction to contactology provides an overview of the field that focuses on contact lenses. It highlights the study of various aspects such as design, materials, fitting, and usage of contact lenses. Contactology is an important discipline that contributes to improving vision correction options for individuals who prefer contact lenses.

References:

1) Kumar P,Mohamed A, Bhombal F, Dumpati S, Vaddavalli PK. Prosthetic replacement of the ocular surface ecosystem for corneal irregularity: Visual improvement and optical deice characteistics.Cont Lens Anterior Eye. 2019 Oct;42(5):526-532.

2) Rathi VM,Mandathara PS, Dumpati S. Contact lens in Keratoconus. Indian J Opthalmol.2013 aug;61(8):410-5

3) Lee SE, Kim SR, Park m. Oxygen permeability of soft contact lenses in different pH,Osmolarity and buffering solution.Int j Opthalmol. 2015;8(5):1037-42

4) Musgrave CSA, Fang F. Contact lens Material: A Materials Science perspective.Materials(Basel).2019 Jan14;12(2)

5) Alipour F, Khaheshi S, Soleimanzadeh M, Heidarzadeh S, Heydarzadeh S. Contact Lens-related complications: A Revew. J Opthalmic Vis Res.2017 Apr-June;12(2):193-204.

6) Gurnani, B. (2023, June 11). Contact Lenses. StatPearls - NCBI Bookshelf. https://www.ncbi.nlm.nih.gov/books/NBK580554/

7)A brief history of contact lenses. (n.d.-b). Visiondirect.co.uk. https://www.visiondirect.co.uk/blog/history-of-contacts

8) Center for Devices and Radiological Health. (2018b, January 16). Types of contact lenses. U.S. Food And Drug Administration. https://www.fda.gov/medical-devices/contact-lenses/types-contact-lenses

9) Center for Devices and Radiological Health. (2018c, January 16). Types of contact lenses. U.S. Food And Drug Administration. https://www.fda.gov/medical-devices/contact-lenses/types-contact-lenses

10) Gurnani, B. (2023, June 11). Contact lenses. StatPearls - NCBI Bookshelf. https://www.ncbi.nlm.nih.gov/books/NBK580554/

11) Lenses, F. C. (2023, August 30). Contact lens manufacturing methods. Wholesale Contact Lens From Manufacturer| Cosmetic Contact Lens Wholesaler. https://www.freshladylenses.com/contact-lens-manufacturing-methods/

12) Erickson, G. B. (2022). Prescribing for the athlete. In Elsevier eBooks (pp. 83–116). https://doi.org/10.1016/b978-0-323-75543-6.00012-7

13) Contact Lenses 101, Part 1: Contact lens materials. (n.d.). CooperVision. https://coopervision.com/practitioner/ecp-viewpoints/technicians-and-staff/contact-lenses-101-part-1-contact-lens-materials

14) Gurnani, B. (2023b, June 11). Contact lenses. StatPearls - NCBI Bookshelf. https://www.ncbi.nlm.nih.gov/books/NBK580554/

15) Musgrave, C. S. A., & Fang, F. (2019). Contact Lens Materials: A Materials Science perspective. Materials, 12(2), 261. https://doi.org/10.3390/ma12020261

16) Lentiamo.co.uk. (2021, January 17). Are contact lenses with high water content better? https://www.lentiamo.co.uk/blog/contact-lenses-high-water-content.html

17) SRO, A. (n.d.). Oxygen permeability | Alensa UK. https://www.alensa.co.uk/dictionary/oxygen-permeability.html

18) Lee, S. E., Kim, S. R., & Park, M. (2015). Oxygen permeability of soft contact lenses in different pH, osmolality and buffering solution. DOAJ (DOAJ: Directory of Open Access Journals), 8(5), 1037–1042. https://doi.org/10.3980/j.issn.2222-3959.2015.05.33

19) A review of contact angle techniques. (2017, January 31). Contact Lens Update. http://contactlensupdate.com/2017/01/31/a-review-of-contact-angle-techniques/

20) Themes, U. (2016, July 10). Basics of soft contact lens fitting. Ento Key. https://entokey.com/basics-of-soft-contact-lens-fitting/

21) Mondal, S. (2022, January 30). FITTING PROCEDURE FOR RIGID CONTACT LENS. Optography. https://optography.org/fitting-procedure-for-rigid-contact-lens/

CLINICAL GUIDE TO CONTACT LENS FITTING & CARE

Dr. Manas Chakraborty,

D.H.M.S , D.O.S, D.C.L.P, B.OPTOM, M.OPTOM

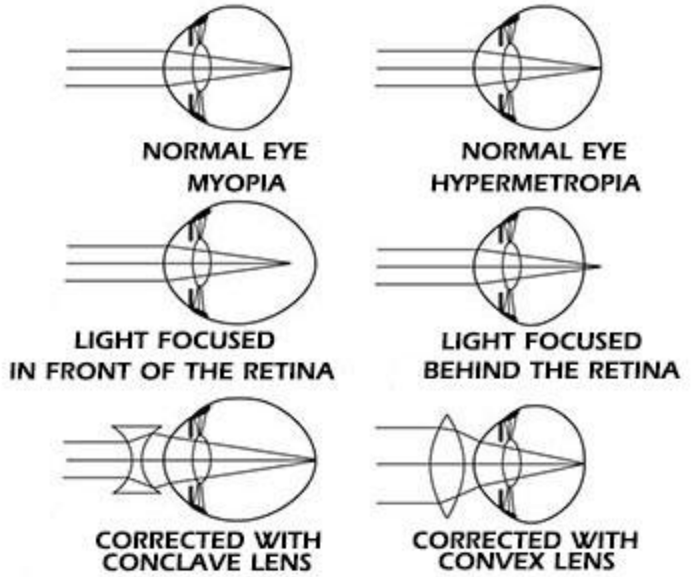
Assistant Professor

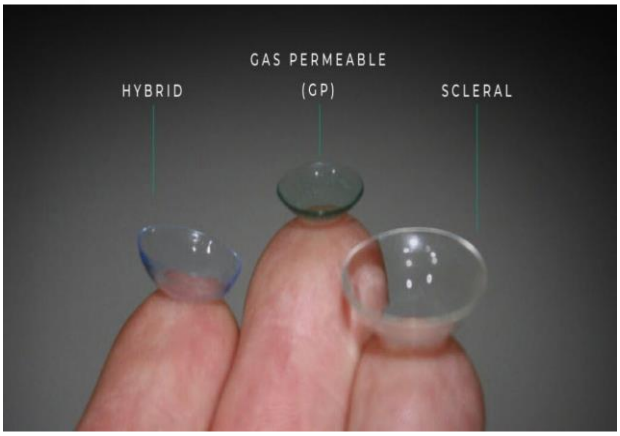
Department of Optometry

Swami Vivekananda University

8.1. Introduction

Contact lenses are thin, transparent refractive surface placed over the cornea to correct refractive errors. Normally contact lens mostly used to fix refractive anomalies but now a day's also it becoming significant in vision therapy, drug delivery, cosmetic purposes etc. In case of astigmatism **hard or semi gas permeable** contact lens provided to correct surface irregularities also with help of forming tears lenses. Beside this Ortho K or overnight contact lenses also designed to reshape corneal curvature as part of myopia control managements. For perfectly contact lens use, care and practice it is necessary to know about the steps of contact lens fitting, calculation of the different parameters of cornea & contact, trial and fitting assessments and also steps of contact lens care with multipurpose solutions. Due to improper use of contact lens may be harmful for our vision as it can induce allergic changes, infections, neovascularization, irritation to patient eye with stress, falling of visual acuity, excess dryness etc. Beside this in case of lack of awareness about contact lens use also responsible for contact lens quality loss, protein deposition, less amount of oxygen supply capacity to corneal surface, tear exchange etc. In this chapter we will discuss about contact lens fittings, clinical steps of management and evaluation, parameters and calculations, fitting assessments, complications, special and recent advancements, care and maintenance etc.





8.2.1 Refractive Errors

->Refractive anomalies that mean errors in refraction while the light rays either focus in front or behind the sensitive retina responsible for blurry image formation also termed as Ametropia.

-> Refractive anomalies can be classified into 4 types

Myopia: When light rays are focusing in front of retina also called near sightedness. Myopia can be corrected with the help of concave spherical lenses.

Hypermetropia: When light rays are focusing behind the retina also called as far sightedness. Hypermetric conditions can be corrected with convex spherical lenses.

Astigmatism: When particular meridian of a refractive surface is responsible for excess or less amount of focus due to surface irregularity and ultimately cause to distorted blurry vision can be corrected with cylindrical lens.

Presbyopia: Physiological loss of accommodation may cause less amount of focusing capacity responsible for hypermetropic condition during near vision. The amount of refractive error based on the amount of accommodation losing connected with aging. Additional plus lens provided with the regular correction to correct such types of near refractive errors.

8.2.2 Symptoms of refractive errors:

->Double vision

->Hazy vision

-> Glare and halo appearance

->Strabismus conditions

->Headache

->Eye stress

->Trouble while changing focus from distance to near or intermediate vision zones.

Refractive errors can be managed by providing

->Eyeglasses

->Contact lens correction

-> Refractive Surgery

Diagnosis and management procedures can be described as medical &ocular history taking, Visual acuity testing, Refraction, finding acceptance and correction, comprehensive eye examinations.

Here we will briefly discuss about dispensing contact lenses to correct the refractive errors and its fitting procedures with assessments.

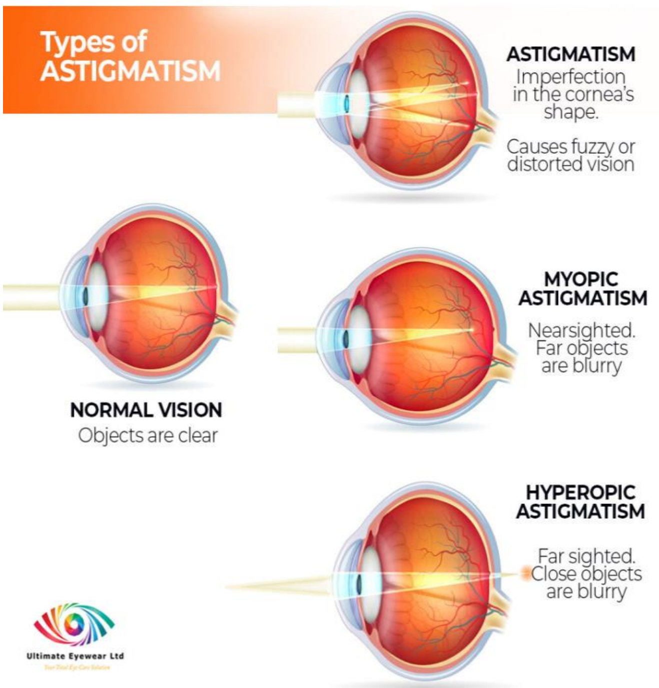
8.3.1 Soft Contact lens fitting

Patient selection is very important to fit the contact lens to the patients.

→Patient selection procedure:

a) General & Ocular history
b) Patients' motivation.
c) Actual requirement of contact lens.
d) Assessment of general hygiene of the patient.
   All these are considered for the patients and practitioner's beneficial purpose.

8.3.2 Clinical eye examination:



a) Visual Acuity test.
b) Clinical Refraction for distance & near both.

c) Corneal Topography. (Anterior Optic Zone Radius and Base Curve)
d) Palpebral Aperture Size.
e) Horizontal Visible Iris Diameter. HVID
f) Ocular Motility test.
g) Corneal Sensitivity test.
h) Tear Film Break Up time.
i) Intra Ocular Pressure checkup.
j) Fundus Examination.
k) Slit Lamp Bio Microscopy

→Lids and lid margins
→Conjunctiva (Palpebral and Bulbar)
→Tear film assessment
→Cornea
→ Pupil
→Anterior Chamber
→ Angle
→ Lens

8.3.3 Instruments used for the assessments

→Visual acuity chart (Snellen chart, Bailey Lovie LOGMAR Chart etc.)
→Retinoscope (Static & Dynamic)
→Trial lens set or Phoropter.
→Simple ruler.
→Slit Lamp Biomicroscope with filters use with fluorescein (Wratten filter no12).
→Schiotz or Goldman applanation tonometer.
→Cover-uncover test.
→Prism
→Direct or Indirect Ophthalmoscope.
→Cochet-Bonnet aesthesiometer. (Corneal sensitivity measurement)

8.3.4 Fitting procedure:

Before trial fitting of soft contact lens, a complete eye examination to

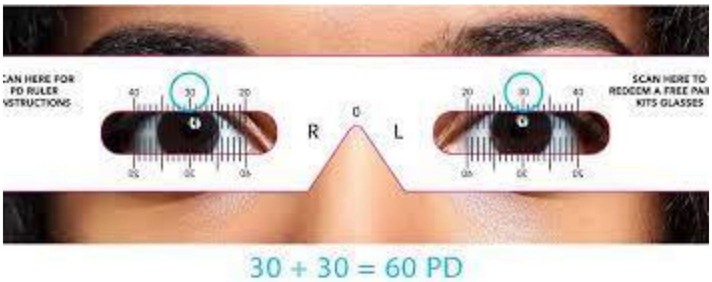
be done

Measurements:

→Refraction

→Detailed slit lamp examination

→Keratometric Reading is needed to find the radius of curvature of anterior cornea in millimeters and HVID.



→Vertex compensation should be measured if the patient's spectacle refraction more than +/- 4.0 D.

It can be measured by a conversion table or vertex distance compensation formula that is

F (spectacle sphere power)÷

1-d (vertex distance) x F (spectacle sphere power)

Vertex distance is measured by the distance from back surface of the spectacle lens to anterior surface of the eye.

After compensating the vertex distance, the new refractive power will be the power of the contact lens.

Base Curve of the optic zone of the cornea will be the base curve of the trial contact lens. Base curve is measured by vertical K1 and horizontal K2 reading in millimeter then add both and divided by 2 to find the base curve of the trial lens.

Overall diameter of cornea is measured by taking the vertical measurement (VVID) and HVID in mm. Then need to add both and then divided by 2 to find the average diameter of cornea.

For the soft contact lens trial need to select the overall diameter by adding 1.5 to 2.0 mm with the average diameter of the cornea.

Now need to select the trial Soft Contact Lens based on the above-mentioned parameters and to put the lens on the corneal surface.

Then need to observe the comfortability of the patient by wearing the SCL and visual status. Then if all these are reported ok then need to check movement of the trial contact lens over the cornea. If all the parameters of the trial contact lens found ok then the final soft contact lens will be ordered as per the parameters of trial contact lens.

8.3.5 Assessment of fit:

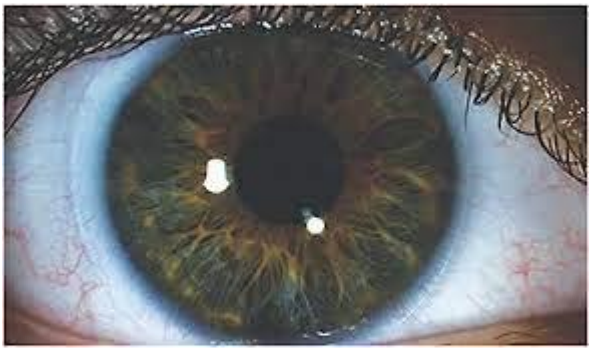
To assess the optimum fit the followings need to be checked

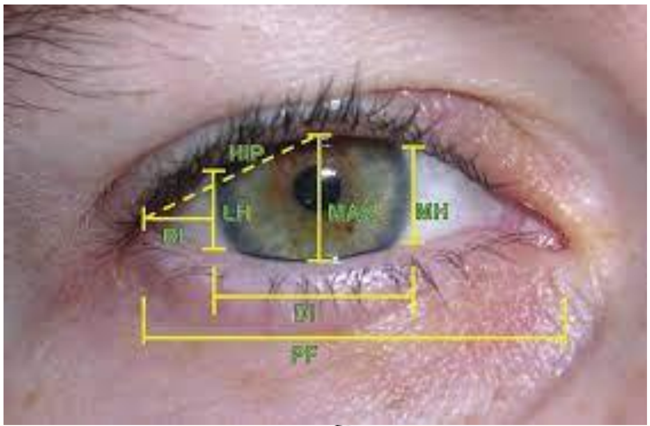
1) **Centration:** Well centered lens should provide

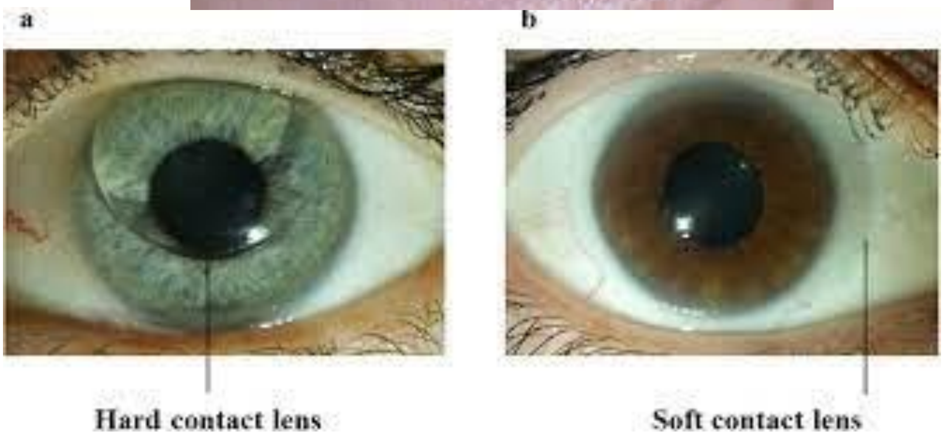
a) Good corneal coverage

b) Overlapping on limbus in all quadrants by 1 mm.

2) **Lens movement** should be observed on







Primary gaze, up gaze, lateral gaze with push up test.

3) **Surface evaluation**.

4) Vision

5) Comfort

8.4. RGP Contact lens fitting:

Three main areas should be considered:

1) Basic Parameters measurements
2) Lens fitting evaluation
3) Prescription

1) Basic Parameters measurement:

->Full eye examination (Including Slit lamp examination, routine refraction test, Visual acuity and vertex distance measurement)

->Visual field test

-> Tonometry

-> Binocular vision assessment

->Keratometry, Keratoscopy.

->Measurement of HVID

-> Vertical palpebral aperture.

-> Pupil diameter examination in various illuminated conditions

-> The position of lids

-> Tear break up time

2) Lens fitting Evaluation:

After examination of all these parameters RGP trial lens should be selected according to overall diameter, base curve and power which is closest to the optimum correction of the patient.

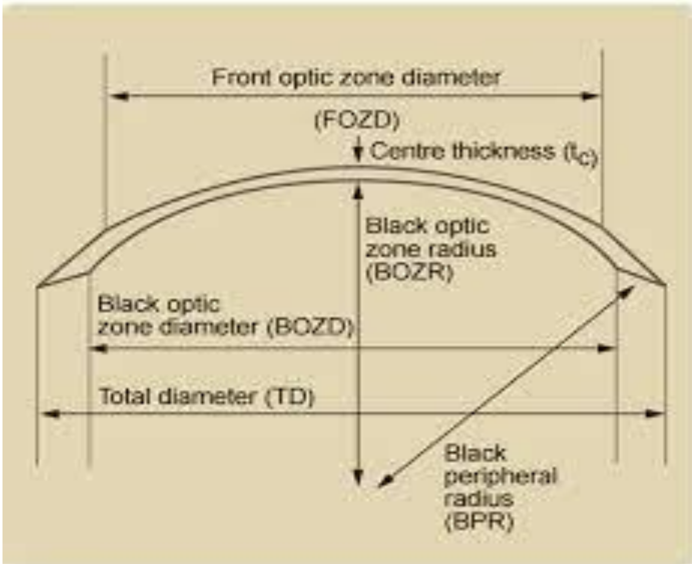
->Corneal anterior optic zone base curve should be selected and align with the posterior base curve of the RGP contact lens.

-> Overall diameter of the RGP lens will be 1.5-2 mm less than average corneal diameter (both from HVID and VVID).

->If a patient having +/- 4 Diopter refractive errors then the vertex distance compensation is not necessary but if greater than that then vertex compensation is necessary to select the trial contact lens power.

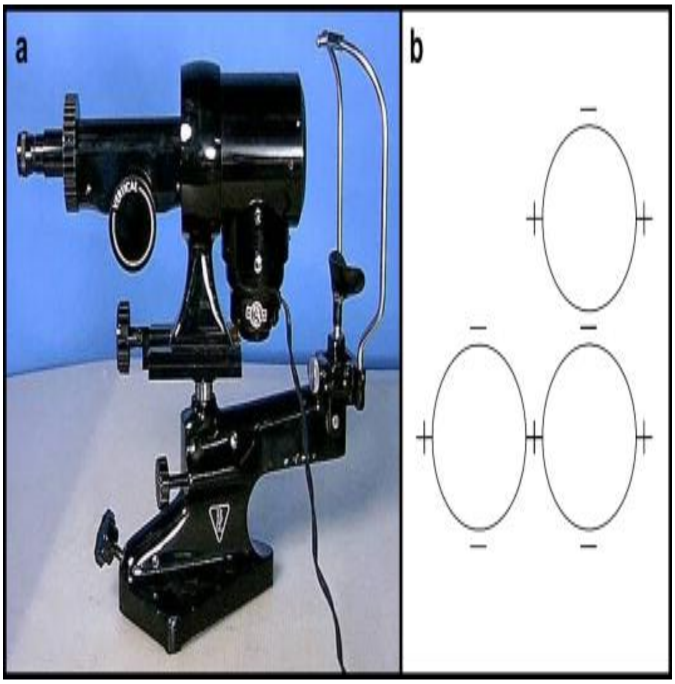
->If the diameter of the cornea becomes 11 or 11.5mm then the diameter of the Trial contact lens (TCL) will be 9-9.5mm.

->If the average Keratometric reading is 7.65mm then the base curve of trial contact lens should be selected as 7.65mm.



8.4.1 Assessment of fit:

Now after inserting the lens (TCL) on the cornea need to give approximately 10 minutes to the patient to subside the excess



tears and initial discomforts.

Then we can perform the fitting evaluation.

The lens movement should be checked. The lens should move around 1-1.5 mm with each blink and will be smooth, unobstructed and uniformed. Normal movement indicates the normal tear exchange that removes the debris under the lens and significant exchange of oxygen underneath the RGP during blink.

Centration: Well centered lens will remain over the cornea during all gaze positions otherwise the lens may be low riding or high riding.

Corneal coverage: The overall diameter of the RGP lens is always smaller than the overall diameter of cornea.

Alignment: Static and dynamic; alignment is perfectly evaluated by the fluorescein pattern called as fluorescein pattern test.

->Static:

When the lens is in stationary position the fluorescein pattern with central alignment meet peripheral minimal clearance and adequate pooling in the peripheral curves should be evaluated.

->Dynamic:

Evaluation of the movement of the lens with the blink and tear exchange under the lens along with centration and the coverage should be evaluated.

The following three areas should be observed to evaluate the ideal fit of the RGP lens over the cornea.

- ➔ Central
- ➔ Mid peripheral
- ➔ Edge width with clearance

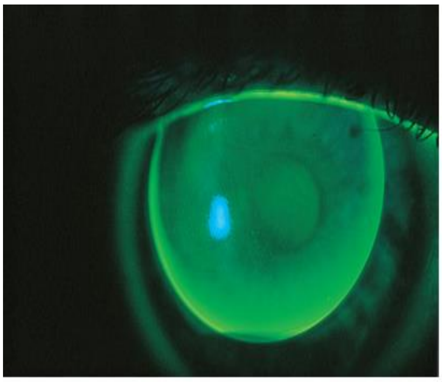
Ideal fluorescein pattern:

Centration: Central

Movement: 1-1.5 mm and smooth

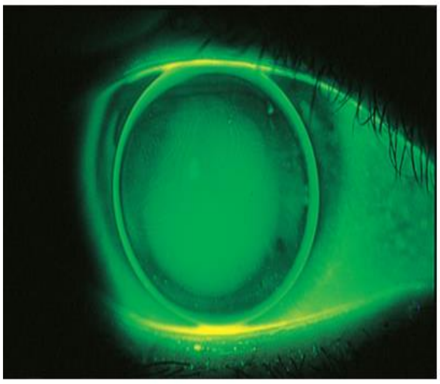
Central: Alignment

The Mid: Peripheral bearing minimal

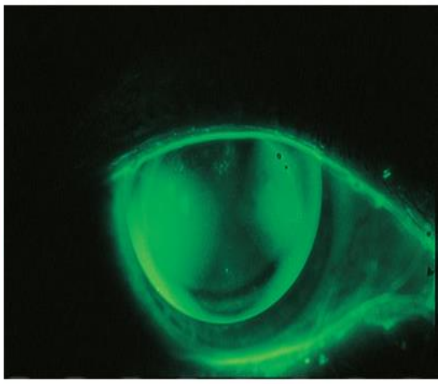


Fluorescein pattern of a good fit with minimal apical clearance.

Fluorescein pattern demonstrating a flat fit.



Fluorescein pattern showing a steep fit.



Against-the-rule astigmatic band.

Edge Band: 0.26- 0.35mm

Steep fittings:

Centration: Central

Movement: Restricted.

Central: pooling.

The Mid: Mid Peripheral bearing heavy.

Edge Band: Narrow (less than 0.25mm.)

Flat fittings:

Centration: Poor, unstable

Movement: Excessive, Rotation

Central: Touch with corneal apex.

The Mid: Mid peripheral bearing pooling.

Edge Band: Wide. (Greater than 0.4mm.)

8.5. Contact lens complications

So many complications may arise if the care, maintenance and fittings of the contact lenses not handled properly. All those complications like corneal abrasions, epithelial edema, microcysts, superficial punctate keratitis, peripheral corneal staining (3-9 o clock position), sterile corneal infiltrates, corneal neovascularization, microbial infection, infective keratitis, Warpage, endothelial changes etc. being included during the wearing of contact lenses.

Conjunctival complications included allergic conjunctivitis (mainly thiomersal containing contact lens solutions). Giant Papillary Conjunctivitis (GPC, Immunological complications in which the contact lens deposits and proteins acts as allergic stimulus). Superior Limbic Keratoconjunctivitis (Hyper sensitivity reaction to Thiomersal or Preservatives used in contact lens solution.

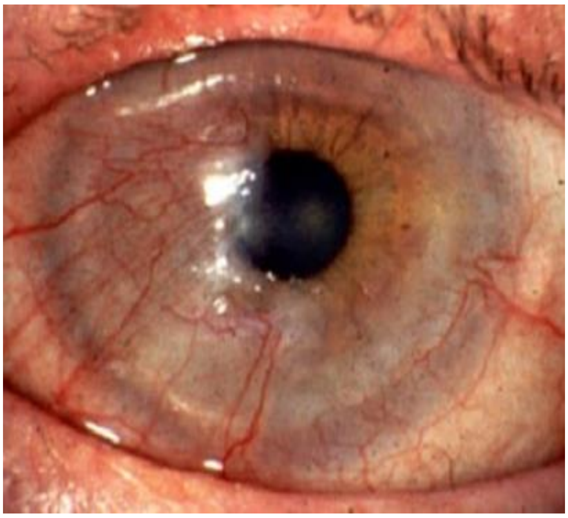
Other complications like associated with physical damage to the contact lens (lens breakage, chipping, cracking etc.)

Lens discoloration (complications for systemic use of drugs like Rifampicin, Fluorescein, Phenylephrine etc.).

Loss of lens, deposits over the lens

8.6. Contact lens care and maintenance

Proper care of different types of contact lenses is very important for successful wearing of contact lenses and also reducing the risk for adverse effects.



Some basic points regarding contact lens maintenance are as follows

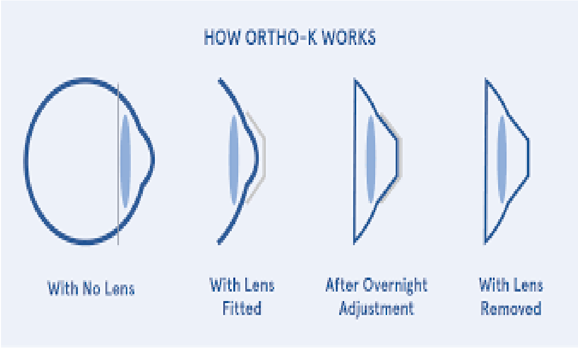
1) Before wearing (over the eyes) the lenses, patients should wash and dry hands thoroughly.
2) Contact lens should be cleaned with recommended contact lens solutions.

3) After removing (from the eyes) the contact lenses rinse the lenses thoroughly with the recommended

solutions and gently rub the lenses to clean the lenses properly and then keep the lenses in the lens box filled with solutions. During contact lens wear, remaining solution should be thrown away and air dried properly to maintain healthy lens storage.

4) After contact lens removal need to rub that properly with help of clean fingers and use of saliva or ordinary homely made saline water strongly prohibited.

5) Need to avoid activities like swimming, taking bath, using swimming pool during using contact lenses.
6) Except specialized contact lens normally recommended daily use contact lenses contraindicated for the overnight use while sleeping.
7) To maintain lens care properly correct and detailed instruction is necessarily should be provided to the patient with proper periodic follow up and application of right contact lens care solution with a correct manner.
8) Lens solution is needed to properly cleaning all protein debris and precipitations and disinfections.



Thimerosal, Chlorhexidine gluconate, Benzalkonium Chloride,

Alcohol based disinfectants (like isopropyl alcohol 20%, Ethanol 5% etc.). Sorbic acid, DYMED, Chlorine systems etc. are the newest less sensitive chemical agent used as preservatives.

9) Now days multipurpose solution introduced (like ReNu multi-purpose solution, Opti free express etc.) indicated for lens cleaning, disinfecting and protein debris cleaning so that different types of solutions for different purposes are no longer needed. Multipurpose solution composed of surfactant (ionic or non-ionic chemical agents), antimicrobial, Buffer system to maintain pH, Chelating agents, abrasive particles, osmolarity to maintain isotonicity etc.

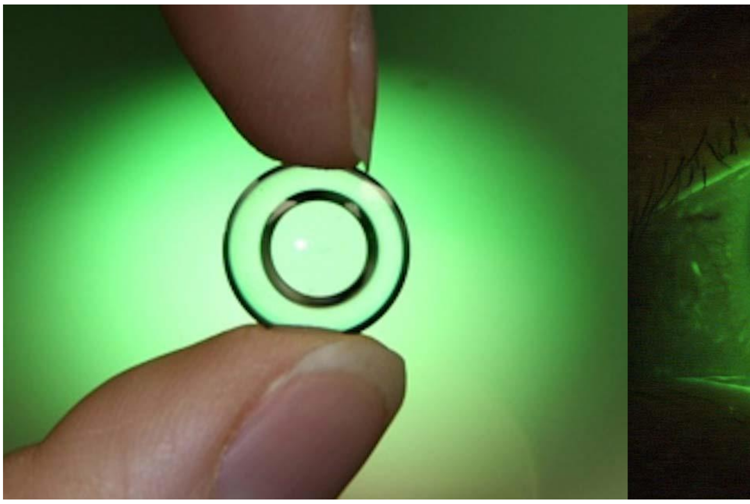
8.7. Special contact lenses

Now a day's contact lens is also using in different purposes rather than correcting refractive power by conventional lenses.

Contact lens also using in Orthokeratology, Therapeutic colored contact lenses, tinted lenses for cosmetic purpose use, prosthetic contact lenses, Occlusive contact lens u

se in vision therapy, contact lens use in drug delivery etc.

->Orthokeratology lens specially designed RGP lens that can reshape corneal curvature during overnight using while sleeping. Ortho-K lens are playing vital role in myopia control.



->In case of albinism patients (lack of pigmentation) patient suffer from the glare problem and colour contact lens widely use in the field of ophthalmic practice to minimize such type of problems.

-> Prosthetic contact lens is type of opaque or occlusive contact lens use broadly in case of ocular prosthesis practice field to cover the congenital or acquired eye deformities.

-> Contact lens also used in vision therapy to patch the right eye and make force to the affected amblyopic eye to improve fixation stimulations behavior.

8.8. Conclusion

The clinical guide for contact lens fitting and care serves as a valuable resource for eye care professionals, providing essential information and guidelines for ensuring the safe and effective use of contact lenses. By following the recommendations outlined in the guide, practitioners can optimize patient outcomes and minimize the risk of complications associated with contact lens wear. With regular updates and adherence to best practices, this guide continues to play a vital role in improving patient safety and promoting long-term ocular health in contact lens wearers.

References:

1) Gurnani, B. (2023, June 11). Contact Lenses. StatPearls - NCBI Bookshelf. https://www.ncbi.nlm.nih.gov/books/NBK580554/

2) Center for Devices and Radiological Health. (2018b, January 16). Types of contact lenses. U.S. Food And Drug Administration. https://www.fda.gov/medical-devices/contact-lenses/types-contact-lenses

3) Center for Devices and Radiological Health. (2018c, January 16). Types of contact lenses. U.S. Food And Drug Administration. https://www.fda.gov/medical-devices/contact-lenses/types-contact-lenses

4) Lenses, F. C. (2023, August 30). Contact lens manufacturing methods. Wholesale Contact Lens From Manufacturer| Cosmetic Contact Lens Wholesaler. https://www.freshladylenses.com/contact-lens-manufacturing-methods/

5) Erickson, G. B. (2022). Prescribing for the athlete. In Elsevier eBooks (pp. 83–116). https://doi.org/10.1016/b978-0-323-75543-6.00012-7

6) Contact Lenses 101, Part 1: Contact lens materials. (n.d.). CooperVision. https://coopervision.com/practitioner/ecp-viewpoints/technicians-and-staff/contact-lenses-101-part-1-contact-lens-materials

7) Musgrave, C. S. A., & Fang, F. (2019). Contact Lens Materials: A Materials Science perspective. Materials, 12(2), 261. https://doi.org/10.3390/ma12020261

8) Lee, S. E., Kim, S. R., & Park, M. (2015). Oxygen permeability of soft contact lenses in different pH, osmolality and buffering solution. DOAJ (DOAJ: Directory of Open Access Journals), 8(5), 1037–1042. https://doi.org/10.3980/j.issn.2222-3959.2015.05.33

9) A review of contact angle techniques. (2017, January 31). Contact Lens Update. http://contactlensupdate.com/2017/01/31/a-review-of-contact-angle-techniques/

10) Themes, U. (2016, July 10). Basics of soft contact lens fitting. Ento Key. https://entokey.com/basics-of-soft-contact-lens-fitting/

11) Mondal, S. (2022, January 30). FITTING PROCEDURE FOR RIGID CONTACT LENS. Optography. https://optography.org/fitting-procedure-for-rigid-contact-lens/